BYTE

THE SMALL SYSTEMS JOURNAL

JANUARY 1986 VOL. 11, NO. 1

$3.50 IN UNITED STATES
$4.25 IN CANADA / £2.10 IN U.K.
A McGRAW-HILL PUBLICATION
0360-5280

ROBOTICS

TURBO "NEW" PACK $95.00

[illegible]

- Turbo GameWorks™
- Turbo Editor Toolbox™

NEW!

TURBO HOLIDAY PACK $125.00

[illegible]

- Turbo Pascal® 3.0
- Turbo Tutor®
- Turbo DataBase Toolbox™

[illegible]

[illegible]

SAVE OVER 30% ON OUR GIFT PACKS!

Announcing Borland's New Turbo Editor Toolbox™ $69.95

IT'S ALL YOU NEED TO BUILD YOUR OWN WORD PROCESSOR FOR ONLY $69.95!

You get all the modules you need to build your own word processor.

- You get ready-to-compile source code.
- You get a full-featured word processor that looks and acts like WordStar™; we call it MicroStar™
- You get a 200-page manual that tells you how to integrate the editor procedures and functions into your programs.

You can use Turbo Editor Toolbox "as is" or modify it any way you want.

And you don't get a bill for Royalties. Because Borland doesn't believe you should pay for something more than once.

All this and more for only $69.95.

And until March 1, 1986 you can get Borland's new Turbo Editor Toolbox for even less! (Only $47.50 when you buy the special Turbo New Pack.)

YOU CAN HAVE MANY WINDOWS ON THE WORLD. The new Turbo Editor Toolbox features windowing, a technique that lets you see several documents—or several parts of the same document—at once. You know best what your needs are. Turbo Editor Toolbox lets you open the windows you want. And to make those windows part of your program.

WITH TURBO EDITOR TOOLBOX YOU CAN HAVE THE BEST OF ALL WORD PROCESSORS IN YOUR WORD PROCESSOR. You can make WordStar behave like Multi-Mate. Support windows just like Microsoft's® Word™. And do it as fast as WordPerfect does it. Incorporate your new "hybrids" into your programs to achieve incredible control and power.

Turbo Editor Toolbox. It's the kind of tool that almost everyone needs—and we're the kind of company to give it to you at a reasonable price, without any compromise on quality. (We're so sure you'll be satisfied that we offer a 60-day money-back guarantee—something no one else does.)

THE CRITICS' CHOICE

"Turbo Pascal has got to be the best value in languages on the market today—and Borland International, by delivering excellent products at reasonable costs, is leading the software industry where it has to go. Turbo Pascal is more than just a good program at a low cost. It's also a low-cost, well-conceived programming language making it possible for lots of people to produce good programs."
Jerry Pournelle, BYTE

"This compiler, produced by Borland International, is one of the best programming tools presently available for the PC."
Michael Covington, PC Tech Journal

"Language deal of the century...Turbo Pascal."
Jeff Duntemann, PC Magazine

BORLAND INTERNATIONAL

Three Special Gift Packs

60-DAY MONEY-BACK GUARANTEE

Introducing Borland's New Turbo GameWorks™ $69.95

THE GAMES YOU CAN PLAY, REPLAY, REVISE AND REWRITE BUT CANNOT RESIST. (Turbo Pascal Source Code included!)

We give you the source code, the manual, the diskettes, the 60-day guarantee and the competitive edge. Let the games begin. Chess. Bridge. Go-Moku.

State-of-the art games that let you be player, referee, and rules committee—because you have the Turbo Pascal source code. Which means that you can play a game or create a game, any time and any way you want.

Borland's new Turbo GameWorks lets you combine gamesmanship with craftsmanship. Discover the secret techniques and moves used by the Old Masters. Learn exactly how state-of-the-art computer games are made—so you can go off and make your own. Since you have the source code, you can always change the game. Or rig the game, if no one's looking.
Pure Magic. That's Turbo GameWorks. And part of the "sourcery"—Turbo GameWorks is only $69.95. When combined with our new Turbo Editor Toolbox in the Turbo *New* Pack, it's only $47.50.

SHORT CUTS, SECRETS AND STRATEGIES. The Turbo GameWorks manual takes you step-by-step through all the games. How to play them. How to modify them. How to use the power of Turbo Pascal to write new games.

You'll learn general problem analysis, how to identify all possible moves, "rule of thumb" strategies, procedures for testing strategies, and ways to rate options. You'll also be introduced to "top down" program design, the development of basic algorithms, the use of constants and data structures and ways to design short cuts with incremental updating.

On top of all that, you'll have a lot of fun (if you want to).

So go to play (and work) with Borland's new Turbo GameWorks. It's unique. It's fascinating. And it's brand-new. Be first with the latest and greatest—order your Turbo GameWorks today.

BORLAND'S TURBO GAMEWORKS AND SOME OF ITS MASTER PIECES

Chess, the ultimate strategic game. A game so old that no one knows its exact origins. Turbo GameWorks lets you play chess at six different levels from the beginner to the sophisticated user. And you have many ways of playing with your Turbo GameWorks. Let the computer solve checkmate problems. Set the time limit for each game. And there's more.

Decide whether you or the computer "goes first." Trade places with the computer at any point in the game. It's all possible with GameWorks.

Go-Moku, also known as "Five-in-Line," is a very old Japanese game played on a board of squares. The first player to get five game pieces in a row—either horizontally, vertically, or diagonally—wins the game.

It's an intriguing game. But you're not limited to playing it one way. With Turbo GameWorks, you can modify it your way.

Bridge. Play bridge with a friend or team up against the program—you decide which hands the computer plays. You can even decide to let the program cheat! The program automatically bids and plays its own hands. And, since you can tinker with the source code, you can make "your" Bridge unlike any other.

TURBO HOLIDAY JUMBO PACK $245.00

Now you get the whole Turbo Pascal family including its newest members at an incredible price.

- Turbo Pascal 3.0 combines an integrated programming environment with the fastest Pascal compiler in the galaxy.
- Turbo Tutor teaches you step-by-step how to use the Turbo Pascal development environment. With commented source code for all program examples on diskette.
- Turbo DataBase Toolbox gives you all the tools you need to sort and search your data and build powerful database applications.
- Turbo Graphix Toolbox™ gives you a complete library of Pascal procedures to build applications using high resolution graphics and graphics window management.
- NEW! Turbo GameWorks—Chess, Bridge, Go-Moku. Secrets and strategies of state-of-the-art computer games are revealed with complete source code.
- NEW! Turbo Editor Toolbox—the Pascal modules that let you build your own word processor. A full-featured WordStar-like program, MicroStar™, is included on your disk.

You're getting everything at only $40 each. And if you already own one or several members of the Turbo family, be creative—nothing can stop you from buying the Jumbo Pack, picking out the ones you already have and giving them as holiday gifts for family or friends. At these prices you can afford to give to others and to yourself!

4585 Scotts Valley Drive, Scotts Valley CA 95066
Phone (408) 438-8400 Telex 172373
Inquiry 38 for End-Users. Inquiry 39 for DEALERS ONLY.

NOT COPY-PROTECTED

Holiday Gift Packs, Turbo GameWorks™ & Turbo Editor Toolbox™

Available at better dealers nationwide. Call (800) 556-2283 for the dealer nearest you. To order by Credit Card call (800) 255-8008, CA (800) 742-1133.

The holiday packs include an upgrade coupon for both options so you get BCD and 8087 support for $39.95 (regularly $55.00).

Carefully describe your computer system!

Mine is: __ 8-bit __ 16-bit

I use: __ PC-DOS __ MS-DOS __ CP/M-80 __ CP/M-86

My computer's name and model is: ____

The disk size I use is: ☐ 3½" ☐ 5¼" ☐ 8"

Name: ____

Shipping Address: ____

City: ____

State: ____ Zip: ____

Telephone: ____

NOTE: Turbo Editor Toolbox and Turbo GameWorks are available for the IBM PC and true-compatibles using Turbo Pascal 3.0 ONLY.

*Gift Pack Offers Last Until March 31, 1986

		Quantity
*Turbo Holiday Jumbo Pack	$245.00	____
*Turbo Holiday Pack	$125.00	____
*Turbo New Pack	$95.00	____
Pascal	$69.95	____
Pascal w/8087	$109.90	____
Pascal w/BCD	$109.90	____
Pascal w/8087 and BCD	$124.95	____
Turbo DataBase	$54.95	____
Turbo Graphix	$54.95	____
Turbo Tutor	$34.95	____
Turbo Editor	$69.95	____
Turbo GameWorks	$69.95	____

These prices include shipping to all U.S. cities. All foreign orders add $10 per product ordered.

Amount: (CA add 6% tax) ____

Payment: VISA MC Check Bank Draft

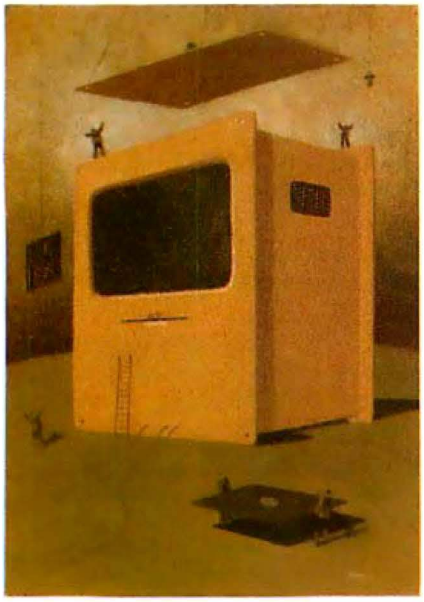
Credit Card Expiration Date: ____ / ____

Card #

COD's and Purchase Orders will not be accepted by Borland International. California residents: add 6% sales tax. Outside USA, add $10 and make payment by bank draft, payable in U.S. dollars drawn on a U.S. bank. H15

With Dazzling Discounts!

C·O·N·T·E·N·T·S



82

FEATURES

158

THEMES

REVIEWS

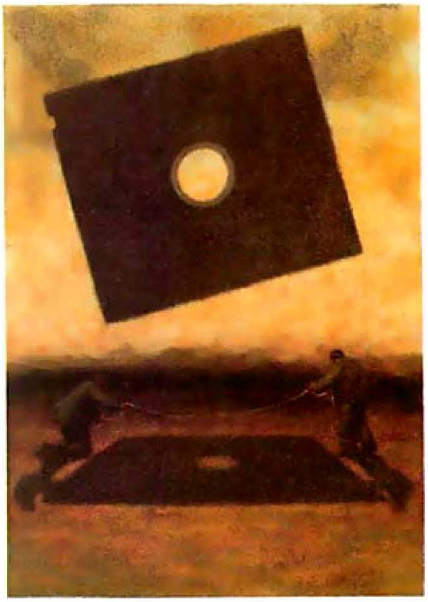
BYTE (ISSN 0360-5280) is published monthly with one extra issue per year by McGraw-Hill Inc. Founder: James H. McGraw (1860-1948). Executive, editorial, circulation, and advertising offices: 70 Main St., Peterborough, NH 03458, phone (603) 924-9281. Office hours: Mon–Thur 8:30 AM – 4:30 PM, Friday 8:30 AM – 1:00 PM, Eastern Time. Address subscriptions to BYTE Subscriptions, POB 590, Martinsville, NJ 08836. Postmaster: send address changes, USPS Form 3579, undeliverable copies, and fulfillment questions to BYTE Subscriptions, POB 596, Martinsville, NJ 08836. Second-class postage paid at Peterborough, NH 03458 and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Subscriptions are $21 for one year, $38 for two years, and $55 for three years in the USA and its possessions. In Canada and Mexico, $23 for one year, $42 for two years, $61 for three years. $69 for one year air delivery to Europe. 17,100 yen for one year surface delivery to Japan. $37 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $3.50 in the USA and its possessions, $3.95 in Canada and Mexico, $4.50 in Europe, and $5 elsewhere. Foreign subscriptions and sales should be remitted in United States funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue. Printed in the United States of America.

COVER PAINTING BY ROBERT TINNEY

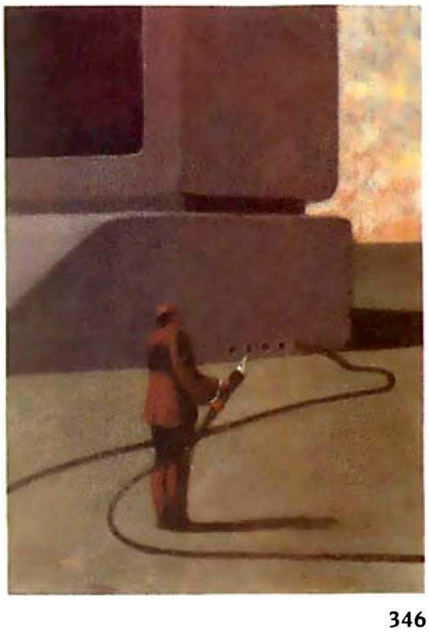
BYTE January

VOLUME 11, NUMBER 1, 1986

KERNEL



288



346

Address all editorial correspondence to the Editor, BYTE, POB 372, Hancock, NH 03449. Unacceptable manuscripts will be returned if accompanied by sufficient first-class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

Subscription questions or problems should be addressed to: BYTE Subscriber Service, POB 328, Hancock, NH 03449

SECTION ART BY ROB COLVIN

BYTE

EDITOR IN CHIEF
Philip Lemmons
MANAGING EDITOR, PRINT
Gene Smarte
MANAGING EDITOR, ELECTRONIC PUBLISHING AND COMMUNICATIONS
George Bond
CONSULTING EDITORS
Steve Ciarcia
Jerry Pournelle
Bruce Webster
SENIOR TECHNICAL EDITORS
G. Michael Vose, *Themes*
Gregg Williams
TECHNICAL EDITORS
Thomas R. Clune
Jon R. Edwards
Richard Grehan
Glenn Hartwig, *Reviews*
Ken Sheldon
Jane Morrill Tazelaar
Tom Thompson
Charles D. Weston
Eva White
Stanley Wszola
Margaret Cook Gurney, *Associate*
Donna Osgood, *Associate, San Francisco*
Alan Easton, *Drafting*
NEWS AND TECHNOLOGY
Ezra Shapiro, *Bureau Chief, San Francisco*
Rich Malloy, *Senior Technical Editor, New York*
Phillip Robinson, *Senior Technical Editor, Palo Alto*
Tony Lockwood, *Senior News Editor, Peterborough*
ASSOCIATE NEWS EDITORS
Dennis Barker, *Peterborough*
Brenda McLaughlin, *San Francisco*
Lynne M. Nadeau, *Peterborough*

CONTRIBUTING EDITORS
Jonathan Amsterdam, *programming projects*
David Betz, *programming*
Mark Haas, *at large*
Rik Jadrnicek, *CAD, graphics, spreadsheets*
Robert T. Kurosaka, *mathematical recreations*
Alastair J. W. Mayer, *software*
Alan Miller, *languages and engineering*
Dick Pountain, *U.K.*
William M. Raike, *Japan*
Perry Saidman, *computers and law*
Robert Sterne, *computers and law*

COPY EDITORS
Bud Sadler, *Chief*
Dennis Barker
Elizabeth Cooper
Anne L. Fischer
Nancy Hayes
Lynne M. Nadeau
Paula Noonan
Joan Vigneau Roy
Warren Williamson

ASSISTANTS
Peggy Dunham, *Office Manager*
Martha Hicks
Cathy Kingery
June N. Sheldon

ART
Rosslyn A. Frick, *Art Director*
Nancy Rice, *Associate Art Director*

PRODUCTION
David R. Anderson, *Production Director*
Denise Chartrand
Michael J. Lonsky
Jan Muller

SENIOR VICE PRESIDENT/PUBLISHER
Harry L. Brown
PUBLISHER'S ASSISTANT
Beverly Jackson

PERSONNEL
Cheryl Hurd, *Office Manager*
Patricia Burke, *Personnel Coordinator*

TYPOGRAPHY
Sherry McCarthy, *Chief Typographer*
Len Lorette
Donna Sweeney

ADVERTISING SALES
Dennis J. Riley, *Director of Sales and Marketing*
Sandra Foster, *Administrative Assistant*
ADVERTISING/PRODUCTION (603-924-6448)
Lisa Wozmak, *Supervisor*
Robert D. Hannings, *Senior Account Coordinator*
Marion Carlson
Karen Cilley
Lyda Clark
Michele Jackson
Denise Proctor
Wai Chiu Li, *Quality Control Manager*
Julie Nelson, *Advertising/Production Coordinator*

CIRCULATION (800-258-5485)
Gregory Spitzfaden, *Director*
Andrew Jackson, *Subscriptions Manager*
Cathy A. Rutherford, *Assistant Manager*
Laurie Seamans, *Assistant Manager*
Susan Boyd
Phil Dechert
Mary Emerson
Louise Menegus
Agnes E. Perry
Jennifer Price
James Bingham, *Single-Copy Sales Manager*
Claudette Carswell
Karen Desroches

MARKETING COMMUNICATIONS
Horace T. Howland, *Director (603-924-3424)*
Vicki Reynolds, *Marketing Production Manager*
Lisa Jo Steiner, *Marketing Assistant*
Stephanie Warnesky, *Marketing Art Director*
Sharon Price, *Assistant Art Director*
Doug Webster, *Director of Public Relations (603-924-9027)*
Wilbur S. Watson, *Operations Manager, Exhibits*

PLANNING AND DEVELOPMENT
Michele P. Verville, *Manager*
Patricia Akerley, *Research Manager*
Cynthia Damato Sands, *Reader Service Coordinator*
Faith Kluntz, *Copyrights Coordinator*

ACCOUNTING
Kenneth A. King, *Assistant Controller*
Vicki Weston, *Accounting Manager*
Linda Short, *D/P Manager*
Edson Ware, *Credit*
Marilyn Haigh
Diane Henry
Vern Rockwell
JoAnn Walter

BUILDING SERVICES/TRAFFIC
Anthony Bennett, *Building Services Manager*
Brian Higgins
Mark Monkton

RECEPTIONISTS
L. Ryan McCombs
Cheryl Castro, *Assistant*

Editorial and Business Office: 70 Main Street, Peterborough, New Hampshire 03458, (603) 924-9281
West Coast Offices: McGraw-Hill, 425 Battery St., San Francisco, CA 94111, (415) 362-4600.
McGraw-Hill, 1000 Elwell Court, Palo Alto, CA 94303, (415) 964-0624.
New York Editorial Office: 1221 Avenue of the Americas, New York, NY 10020, (212) 512-2000.

Officers of McGraw-Hill Information Systems Company: President: Richard B. Miller. Executive Vice Presidents: Frederick P. Jannott, Construction Information Group; Russell C. White, Computers and Communications Information Group; J. Thomas Ryan, Marketing and International. Senior Vice Presidents: Francis A. Shinal, Controller; Robert C. Violette, Manufacturing and Technology. Senior Vice Presidents and Publishers: Laurence Altman, Electronics Week; Harry L. Brown, BYTE and Popular Computing; David J. McGrath, Construction Publications Group Vice President: Peter B. McCuen, Communications Information. Vice President: Fred O. Jensen, Planning and Development.

Officers of McGraw-Hill, Inc.: Harold W. McGraw, Jr., Chairman; Joseph L. Dionne, President and Chief Executive Officer; Robert N. Landes, Executive Vice President and Secretary; Walter D. Serwatka, Executive Vice President, Publishing Services; Shel F. Asen, Senior Vice President, Manufacturing; Ralph R. Schulz, Senior Vice President, Editorial; George R. Elsinger, Vice President, Circulation; Ralph J. Webb, Vice President and Treasurer.

E·D·I·T·O·R·I·A·L

A Threat to Future Software

Last October Digital Research Inc. yielded to pressure from Apple and agreed to change its GEM software to decrease its resemblance to Apple Macintosh software. (GEM is an operating environment for several MS-DOS– and PC-DOS–based computers that allows a user to interact with a computer via windows and icons rather than the usual text-only commands.) Let's ignore, for the moment, the uncertain worth of a "visual copyright" (the legal term for Apple's copyrighting of the overall "look" of Macintosh software). Let's also ignore the ethics of Apple's actions. *The point to focus on, instead, is that Apple's actions are to no one's benefit*: Both the microcomputer industry and Apple itself will suffer from their effects.

Apple's actions will slow the growth of the microcomputer industry, which will hurt Apple by shrinking the potential microcomputer audience. Already, several small companies are worried that some project they're working on (and, often, they with it) will be cut down because it is "too Mac-like." In addition, the success of Apple's tactics may encourage other companies to try similar actions, thus increasing the paralysis and anxiety in the industry.

These actions will stifle the *incremental evolution* that is at the root of any significant growth in our industry. By "incremental evolution" I mean the process of gradual improvement of a product type that eventually leads to a more robust, useful product. For example, Ashton-Tate's Framework did not spring full-blown from the heads of the programming team at Forefront. It had its roots in Dan Bricklin's and Bob Franston's VisiCalc spreadsheet, Sorcim's Supercalc (which added functions and sold to a market not supported by VisiCalc), Mitch Kapor's VisiPlot (which gave the distinctive highlighted menu bar now used in so many programs), the software integration of Lotus 1-2-3, and the icons, windows, and pull-down menus of—well, you get the point. If companies are afraid to go to market with what they think are incremental—but distinct—improvements on a basic design, we will become a stagnant industry bounded by the usual and comfortable.

According to Irving Rappaport, Apple's associate general counsel, Apple's intent is to prevent other companies from creating products that are easy to use because of their similarity to the Macintosh. "If people look at it and say, 'Gee, that's like the Mac—I can operate that,' when that's the result you get, it's over the line" of infringement of Apple's copyrights. The effect of this intent is to fragment the industry in the face of what was becoming a de facto standard for human-computer interaction. This lack of standardization will cause many people to stay uninterested in computers because they will have to relearn basic skills with each brand of computer they encounter. (Imagine how many people would drive cars if car manufacturers used different controls for every function in the car.)

Apple might argue that, by claiming a larger slice of a smaller pie, it will still come out ahead. We believe that it will be hurt directly by its actions and will end up with a smaller piece of a pie that is itself smaller. Apple will, in effect, build a wall around its ghetto of Macintosh products, thus limiting its own growth and encouraging people to "live" elsewhere.

Texas Instruments' TI-99/4A provides a good example. TI announced that it intended to directly profit from *all* software written for its machine by forcing third-party software developers to publish their products through TI. When a brave few brought out 99/4 cartridges on their own, TI added a proprietary chip to their cartridges that the computer required before it would run the enclosed software. Needless to say, the few developers working on 99/4 software wisely turned to support other computers.

The same may happen to Apple. IBM already sells over half the business computers bought today, and IBM PC-compatibles account for a fairly large slice of what's left. If Apple has been slowing the erosion of its market share to IBM with the Macintosh line (and I think it has), its current moves will alienate software and hardware developers, who will begin to lavish their creativity upon the more congenial IBM PC-compatible marketplace. And where innovation goes, the market will follow.

Consider: IBM made its software and hardware architectures open. It allowed the development of innumerable hardware clones, many far more similar to IBM products than GEM is to the Macintosh desktop; consequently, the IBM PC-compatible market far outdistanced its combined competitors in less than two years. On the other hand, Apple is actively discouraging not only copying but also *borrowing* from its software design. It claims the sole right to benefit from a set of ideas that Apple itself has borrowed and improved on (the most direct borrowing was from work done at Xerox PARC). Given these two opposing directions, what do *you* think will happen?

A Call to Action

We at BYTE call on Apple to recognize the long-term implications of its actions and limit itself to prosecuting cases where the alleged theft is not of "looks" but of actual program code. Barring that, we call on Apple to license its allegedly copyrightable interface to markets that do not directly compete with its current or planned product line—if the licensing fees are reasonable, everyone will profit.

If neither of these things happen, we call on the judicial system to hand down rulings that reflect a strict interpretation of the visual copyright laws—that is, that a product is at fault only if it shows *no* distinguishing characteristics in appearance or operation from the alleged original; this would protect products that show incremental evolution. We also call on the industry to do two things. The first is to stand up to Apple and see the case decided on its legal merits. The second is to develop an alternative graphic interface and allow its wide adoption throughout the non–Apple computer community; in this way, the rest of us can get on with the business of making computers—in general—good enough that everyone will want to use them.

[*Editor's note: Apple maintains that the agreement covers "only three specific products," but one of them is* GEM *Desktop, which defines the overall* GEM *environment. Also, according to Kathleen Dixon of Apple, the agreement includes any custom work* DRI *has done, including the modified* GEM *software that* Atari *uses in its* 520ST *computer.*] ■

—*Gregg Williams, Senior Technical Editor*


Maxell Corp. of America, 60 Oxford Drive, Moonachie, NJ 07074
maxell

SmarTerm 220 software makes DEC terminals obsolete!

You don't need a DEC terminal to access DEC's new generation host software. Now you can use your IBM PC and SmarTerm 220 terminal emulation software to access All in One, A to Z, and other popular mainframe software. SmarTerm 220 gives you sophisticated, accurate DEC VT220, VT100, VT102 and VT52 emulation, and includes TTY mode to link you to popular services like The Source, CompuServe, Dow Jones, EASYLINK, and Tymnet.

As you've learned to expect from Persoft, the industry leader in software terminal emulation, SmarTerm 220 continues the tradition of offering "smart" software solutions where IBM PC hardware limitations prevent exact duplication of DEC terminal features. For example, we give you horizontal scrolling for 132-column text display, and also support popular 132-column video display boards. And we provide "convenience" features not found in other terminal emulation packages like: "Branch to DOS" hot key, automatic installation, color support, multiple setups, "smart" softkeys, remappable keyboard layouts, and online help screens detailing PC and AT keyboard mappings. Our unique support for DEC's popular EDT editor includes convenient keyboard mapping of the "GOLD" and PF function keys, as well as an EDT specific on-line help screen, and keytop chart.

International business people take note: SmarTerm 220 fully supports European versions of the DOS operating system, 8 bit mode, the VT220 multinational character sets, and the compose key.

SmarTerm 220 is a powerful communications package as well, allowing text and binary file transfer at speeds up to 19,200 baud. In addition to the popular XMODEM "error-free" protocol, we include our own PDIP protocol and supply you with free BASIC and FORTRAN programs which implement the protocol on VAX/VMS systems.

"Farm out" your obsolete DEC terminal, and join the satisfied users who "reap" the benefits of SmarTerm!

The SmarTerm family:
SmarTerm 220—DEC VT220
SmarTerm 100—DEC VT100
SmarTerm 125—DEC VT125
SmarTerm 400—Data General Dasher D400
SmarTerm 4014—Tektronix 4014
And now the new SmarTerm 240—DEC VT240

PUT YOUR DEC TERMINAL OUT TO PASTURE!

After SmarTerm, what do you do with your obsolete terminal?

IDEA CREDIT: Ann Garner Riddle of Winston-Salem, N.C.

Persoft, Inc – 2740 Ski Lane – Madison, WI 53713
(608) 273-6000 – Telex 759491

persoft

Inquiry 430 for End-Users. Inquiry 431 for DEALERS ONLY.

M·I·C·R·O·B·Y·T·E·S

Staff-written highlights of late developments in the microcomputer industry.

Epson, Toshiba Announce Color LCDs

Toshiba has developed an active-matrix, eight-color, 640- by 480-pixel, 10-inch-diagonal liquid-crystal display (LCD) that nearly matches the brightness of a standard color TV. No pricing or availability information was given.

Epson announced a backlit, high-contrast, 5.13-inch-diagonal color LCD with a resolution of 480 by 440 pixels (one-third of which are red, green, or blue). Epson says the display's contrast ratio is more than 10 times that of a standard reflective LCD and has a viewing angle greater than 60 degrees. Epson also unveiled a high-contrast, 9-inch-diagonal monochrome LCD with a resolution of 640 by 400 pixels. Samples of both displays will be available during the first half of 1986; prices should be approximately twice as much as standard reflective LCDs.

Epson also announced two 10-inch-diagonal monochrome displays using ferroelectric smectic-C crystals. The 640- by 400-pixel and 640- by 200-pixel displays are said to have high contrast ratios, low power consumption, and moderate cost; samples may be available late this year.

Optical-Disk Developments: Write-Once Drives, Partnership

Optimem, which currently makes 12-inch write-once optical-disk drives, showed a prototype multifunction 5½-inch optical-disk drive at COMDEX. The drive will work with read-only, write-once, and erasable disks produced by 3M. Optimem had not yet finalized specifications for the drive but expects to begin shipments in 1986.

Sony announced a new line of write-once optical-disk drives. The WDD-2000 uses a 20-cm (8-inch) optical disk that can store 1 gigabyte of formatted data; a single drive with a controller will have a list price of $16,000. The WDD-3000 uses a 30-cm (12-inch) optical disk to store 2.1 or 3.2 gigabytes of formatted data, depending on the disk used; a single drive with a controller will have a list price of $19,000. Sony also unveiled a jukebox-style device capable of holding 50 of the 12-inch disks.

AGA Inc., New York, NY, introduced an optical-disk system for the IBM PC based on a 12-inch write-once drive from Alcatel-Thomson Gigadisk. AGA says its Discus 1000 stores up to 3 gigabytes of text data or up to 50 gigabytes of graphics images on a 1-gigabyte disk, using a proprietary data-compression technique. The drive alone is available for $21,500; with the data-compression facility, it's $31,000.

Du Pont and N. V. Philips revealed a joint venture to produce optical disks, including 4.7-inch CD-ROM and CD audio disks, a 12-inch write-once disk, and an unspecified erasable disk. The joint venture hopes to produce 200 million disks annually by 1990, half for data storage.

New Developments in 32-bit Chips

Signetics, Sunnyvale, CA, unveiled the 68070, a microprocessor that is compatible with Motorola's 68000 but also includes on-chip memory management and direct memory access. Samples of the 68070 should be available from Signetics and parent company Philips next summer, with production quantities available in late 1986.

National Semiconductor began shipping samples of its 32332 microprocessor, which provides more on-chip functions and memory-addressing capability than the 32032. New on-chip features include dynamic bus-sizing (8-, 16-, or 32-bit data buses), burst-mode memory addressing, a barrel shifter, an expanded instruction queue, and support for external cache memories. The 32332 expands the 32032's 16-megabyte address space to 4 gigabytes by adding a full 32-bit address register. While the 32032 was available only in 6-, 8-, and 10-MHz versions, the 32332 will instead run at 10, 12, or 15 MHz. Weitek Corporation will interface its two-chip, 64-bit, floating-point math coprocessor to the 32332.

The Royal Signals and Radar Establishment, Malvern, England, is developing the Viper, a

(continued)

new 32-bit, RISC (reduced instruction set computer) microprocessor design. Because RSRE wanted a reliable chip for use in weapons and nuclear power plants, the design team used mathematical-correctness techniques that compare a formal specification of the chip with the logical implementation, which they hope will guarantee an error-free architecture and instruction set.

Also in England, a fingerprint-matching computer based on an array of 100 INMOS Transputers is being developed for the Home Office. When finished, the experimental system should run 25 times faster and cost one-fifth as much as the current system, which uses a minicomputer and vector processors.

Vitesse, GigaBit Logic Announce LSI Gallium-Arsenide ICs

Vitesse Electronics will develop gallium-arsenide (GaAs) versions of some Advanced Micro Devices 2900-series devices, which include microprocessors, controllers, and signal-processing chips. AMD currently produces the high-speed parts using silicon bipolar technology; Vitesse expects that the use of LSI GaAs could enhance performance four to six times. Samples of the first components are expected in mid-1986, with full production starting late next year.

Separately, GigaBit Logic announced GaAs multiplexer and demultiplexer (mux/demux) circuits that it says allow fiber-optic data transmission at up to 1.5 gigabits per second (gps), or three times the current limits of silicon. Eight standard 135-megabit-per-second transmissions can be combined in a single 1.1-gps signal. While the mux/demux circuits use about 200 gates per chip, both GigaBit Logic and Vitesse plan to produce GaAs chips with more than 1000 gates in the spring.

Kodak Proposes Tiny Magnetic Disk for Photographs

Eastman Kodak, Rochester, NY, has lined up more than 30 companies—including Sony, Hitachi, and Fuji—to support its 47-mm (1.85-inch) floppy disk for storage of electronic still images. The 800K-byte disk can store up to 50 images of 240-line NTSC video. Eventually, the disk is intended for use in cameras; for now, Kodak is working on a 35-mm film-to-disk transfer station for use in developing labs and a still-video player/recorder for the disks.

Nanobytes

To back up the newer 3½-inch hard disks, **Data Electronics Inc.** and **3M** agreed on a smaller tape-cartridge format that will permit tape backup systems to fit in the same space as a 3½-inch disk drive; drives using earlier ¼-inch tapes required more room. DEI and 3M agreed on two formats: a 120-inch-per-second (ips) 24-track ¼-inch tape that stores 40 megabytes and a 90-ips 12-track tape 0.15 inch wide that stores 20 megabytes. . . . **TDI Software Ltd.** has released a full Modula-2 compiler for **Atari**'s 520ST computer. In England, the compiler is priced at £195. . . . **VMark Computer**, Natick, MA, announced a database-management/application development system that can convert source programs for the Pick operating system to run under **AT&T**'s UNIX System V. . . . **Tall Tree Systems**, Palo Alto, CA, announced the Jlaserprinter, a $400 laser-printer interface for its JRAM-3 memory board for the IBM PC. The Jlaserprinter uses the JRAM-3's expanded memory to allow laser printers like **Hewlett-Packard**'s LaserJet to print high-resolution graphics quickly. . . . **Micron Technology** of Boise, ID, is offering 256K-bit error-correcting DRAM chips. Configured as 64K by 8 bits, the chips cost approximately $6 in quantities of 100. . . . **Novell Inc.**, Orem, UT, announced System Fault Tolerant NetWare software for IBM AT-based LAN file servers, providing three distinct levels of protection from hardware faults. . . . **AST** announced the Shared Resources Network, a new 5-megabit-per-second LAN, which can be made compatible with IBM's PC Network by using AST's NETBIOS software. Each $495 network adapter card comes with a removable ROM chip that allows diskless IBM PCs to be connected to the network. . . . **Integrated Device Technology**, Santa Clara, CA, announced plug-in replacements for **Advanced Micro Devices** 2900 bit-slice processor chips; the Microslice-family chips use from one-third to one-fifth of the power of the AMD chips. . . . **Cermetek Microelectronics**, Sunnyvale, CA, is offering the CH1812A, a DAA component that provides a direct interface to both leased and dial-up phone lines. The DAA conforms to both FCC and Canadian DOC rules and is priced at $18.95 in 1000-piece quantities. . . . **Motorola**'s new 68824 Token Bus Controller (TBC) chip fully implements the ISO Open Systems Interconnect data-link layer for networks; it also conforms to **General Motors** Manufacturing Automation Protocol specifications. . . . **LSI Logic**, Milpitas, CA, announced a CMOS gate array with 50,000 gates made of more than 500,000 transistors.

Go Portable...

with cordless printing and disk drive power when you travel.

Imagine a full-featured, battery-powered computer system—complete with disk drive and printer—that fits in your suitcase on trips. Now you can make your Tandy 200 or Model 100 more powerful than ever.

Don't Travel Without Your Files

The Tandy 200/Model 100 Portable Disk Drive (26-3808, $199.95) gives you fast access to 100K of data on 3½" floppy diskettes. That means you don't have to leave your important documents, reports, spreadsheets, statistics and other vital data back home.

This portable drive may be small, but it's not a toy. Menu-driven operation makes it easy to use. It features these powerful operating system functions: FORMAT, SAVE, LOAD, KILL, RENAME and BACKUP. See a list of files anytime. And you can choose battery operation, or attach an optional adapter to use AC power.

Get Automatic Hardcopy in Your Hotel Room

Like the Portable Disk Drive, the TRP 100 Thermal Ribbon Printer is made to be used anywhere—with batteries or AC power.

Sitting in your hotel room before an important meeting, you can produce a printout of a report you composed on the plane. Or, with your 200/100's direct-connect modem, you can tap into your home office's computer for the latest data to update your spreadsheet.

The TRP 100 (26-1275, $299.95) uses plain 8½" paper and a thermal ribbon for high-contrast characters. Or you can use thermal roll paper without the ribbon for direct transfer. It even produces bit-image graphics.

True Portable Power

Take off with Tandy 200/100 peripherals today. And don't forget our selection of software. Tandy is Clearly Superior!

Radio Shack®
The Technology Store™

New 1986 Computer Catalog! Send Me a Copy.

Mail To: Radio Shack, Dept. 86-A-895
300 One Tandy Center
Fort Worth, Texas 76102

Name ____________

Company ____________

____

Address ____________

City ____________

State ____________

Phone ____________

Zip ____________

Prices apply at Radio Shack Computer Centers and at participating stores and dealers. Batteries extra.

Inquiry 304

by more people can by more people.

And it's the fastest way to network those users, too. Because now, local area networking capabilities are built right in.

dBASE III PLUS can also help put developers in the fast lane. With a new Data Catalog and more than 50 new commands and functions. Plus code encryption and linking, improved debugging aids, assembly language calls and much more.

To obtain a free dBASE III PLUS demo disk, call 800-437-4329, Extension 0282,* for the authorized Ashton-Tate® dealer nearest you.**

And get your hands on dBASE III PLUS.

It's the software more people can look forward to using. Inquiry 26

*In Colorado call (303) 799-4900, Extension 0282. **Upgrades are available to all dBASE III owners. Requires IBM® PC or 100% compatible. Trademarks/owners: Ashton-Tate, dBASE III/Ashton-Tate; IBM/International Business Machines Corporation. ©1985 Ashton-Tate. All rights reserved.

The Mac and the DSI Sieve Benchmark

As I read the benchmarks in "The DSI-32 Coprocessor Board, Part 1: The Hardware" (August 1985, page 120), I noticed a missing system in the comparisons, the Apple Macintosh. Being a MacUser, I found this disappointing, so I set up and ran the benchmarks on my 512K-byte Mac. My only significant change to the benchmarks used by DSI is the use of a base (pointer) register rather than a global variable for the arrays used. This change allows use of the Mac's ROM memory manager and does not represent a radical change to the routines.

The DSI Sieve benchmark is not fully representative of a machine's Boolean and integer capabilities, calling for only three register variables and using no pointers. Applications written by advanced programmers take better advantage of these tools. Accordingly, I used three versions of Sieve, calling them Sieve (same as the DSI Sieve), RSieve (using more registers), and PSieve (using registers and pointers). The performance of these roughly represents the performance of inexperienced, intermediate, and advanced programmers' code. The Float and FLT benchmarks are transliterations of FORTRAN into C with some assumed register optimizations. See table 1.

All three forms of Sieve beat the IBM PC AT for *n* = 40,000 (and the AT could not run *n* = 80,000). This is due to the much higher costs for 32-bit integer/addressing arithmetic on the AT, needed for addressing large amounts of data and for most applications except games and graphics. Thirty-two-bit integers are standard on the Mac with the SoftWorks compiler. The single-precision Float benchmark for the AT with the 80287 floating-point coprocessor is less than five times faster than the software floating-point coprocessor of the Mac, a surprising result. The hardware advantage of the AT did show up in the FLT benchmark, however. In 64-bit floating-point, the AT's hardware was 12 times faster than the Mac's software.

A quick note on the VAX timings. The VAX C compiler that I am familiar with automatically pointerizes loops such as the Sieve benchmark. PSieve is therefore the equivalent benchmark, and the Mac's speed in this benchmark is near that of the VAX-11/750, particularly impressive since the 750 costs more than 30 times as much. I would like to see the performance of more machines using the multiple Sieve benchmarks since they test a wider spectrum of CPU architectures rather than reducing all to a common denominator.

I have one complaint about the DSI article. It seems to have been written by Definicon Systems Inc., and page 134 reads like a full-page ad for DSI. While the designers may understand the hardware better, I would like to also see an independent review of the system by BYTE.

William L. Hembree
Las Cruces, NM

Table 1: *Reader Hembree's benchmark results for the Macintosh.*

	n	Sieve	RSieve	PSieve
	8191	4.23	3.37	2.80
	20000	10.50	8.37	6.93
	30000	15.87	12.53	10.47
	40000	21.25	16.97	14.00
	80000	43.00	34.33	28.32
Float	(40000)	78.90		
FLT	(256000)	1759.85		

Definicon Systems replies:

We did not think it was fair to include the Mac in the benchmark comparisons because it did not have a hardware floating-point accelerator. Mr. Hembree's own data shows that the Mac is 100 times slower than the DSI in floating-point execution (Float and FLT benchmarks). Floating-point arithmetic is present in virtually all application software, from simple spreadsheets to complex statistical packages.

The Sieve benchmark we used was taken from BYTE. In order to evaluate Mr. Hembree's newer versions, we compiled and ran them. To our surprise, the PSieve version reported an incorrect number of primes. We traced the problem to a double increment of i *in the second* FOR *loop. Without the fix, Mr. Hembree's pointerized version ran in 1.05 seconds on the DSI-32. When the problem was corrected, it took 1.43 seconds. I have*

(continued)

Table 2: *Definicon benchmark results.*

	n	Sieve	RSieve	PSieve (corrected)	# of Primes
	8191	1.75	1.58	1.43	1899
	20000	4.45	4.23	3.51	4202
	30000	6.70	6.36	5.33	6056
	40000	8.95	8.51	7.08	7836
	80000	17.90	16.81	13.95	14,683
Float	(40000)	0.71			
FLT	(256000)	16.45			

LETTERS POLICY: *To be considered for publication, a letter must be typed double-spaced on one side of the paper and must include your name and address. Comments and ideas should be expressed as clearly and concisely as possible. Listings and tables may be printed along with a letter if they are short and legible.*

Because BYTE *receives hundreds of letters each month, not all of them can be published. Letters will not be returned to authors. Generally, it takes four months from the time* BYTE *receives a letter until it is published.*

This Little Fella Means Business.

The Mouse by Maynard Electronics makes your favorite programs faster, easier, and smarter!

Teach The Mouse To Type.

A single Mouse click will instantly produce the character, sentence, paragraph, or anything else you've selected. **Click:** you call up the CustomKey menu. **Click:** your file is saved. **Click:** a commonly used paragraph appears in place. No other mouse gives you such power and versatility.

At last, an "intelligent" mouse! Now you can add command power to your programs, when you want, the way you want — instantly! The Mouse by Maynard Electronics comes with our CustomKey™ software which lets you assign and reassign commands **while using your favorite programs — even those without mouse utilities.** Fly through programs like Symphony,* Lotus 1-2-3,* Framework,* MultiMate,* and others with undreamed of speed! And of course, it's fully compatible with all programs written for a mouse, too.

A Tale Of Three Mice . . .

Compare our Mouse with the others running around and you'll see, there's no comparison! Here are just a few features across the board:

FEATURES	Maynard Mouse	Micro-soft	Mouse Systems
# of Button Combinations	7	3	5
Button Auto Repeat	Yes	No	No
Diagnostics	Yes	No	Yes
Dynamic Scaling	Yes	No	No
Cursor Overshoot Control	Yes	No	No
Adjustable Cursor Speed/Up, Dn (while running application)	Yes	No	No
Adjustable Cursor Speed/Rt, Lft (while running application)	Yes	No	No
Buttons-Definable (while running application)	Yes	No	No
Macros-Definable (while running application)	Yes	No	No
User-Definable Alternate Cursor Movement	Yes	No	No

Free Drawing!

Purchase The Mouse now and receive the popular paint program Telepaint* at no additional cost — a $149 value!

*Symphony and Lotus 1-2-3 are trademarks of Lotus Development Corporation. Framework is a trademark of Ashton-Tate. MultiMate is a trademark of SoftWord Systems Inc. Telepaint is a trademark of LCS/Telegraphics.

Maynard Electronics

Shaping tomorrow's technology.

460 E. Semoran, Casselberry, FL 32707 • 305/331-6402

Available at the finest computer stores. Contact your local dealer or write to us today for product information.

not, as Mr. Hembree did, removed the calls to MALLOC or PRINTF from the times reported for execution.

Table 2 shows the data for the DSI-32 corresponding to Mr. Hembree's benchmarks.

I disagree strongly with the concept that any benchmark or combination of benchmarks can do anything other than show that a particular architecture is competitive with another. For instance, programmer productivity is rarely quantified. We have found, for example, that a 400-line C program takes 15 seconds to compile on the DSI-32, 5 minutes on an Atari 520ST, and 4.3 minutes on a Mac. Why shouldn't this data be relevant when considering a computer's performance? If the VAX compiler automatically pointerizes code and thus makes it run faster, is this not a valid measure of productivity enhancement? Our compiler automatically registers variables. This saves the programmer the task of keeping track of which variables are most efficiently registered. Is this not an important factor in overall productivity?

It really should not matter whether a computer uses a microprocessor from XYZ company or ABC company or whether it performs a sieve in 1.43 seconds or 1.85 seconds. What should be important is what the machine can do for you and how long it takes you to get the machine to do what you want it to.

It is a travesty of objectivity that simplistic benchmarks have become the most widely accepted method for performance evaluation.

The DSI-32 project has so far taken four worker-years to bring to fruition. If BYTE magazine had not become involved, it would be yet another closed-architecture computer accessible only to the inveterate hacker. The technology of 32-bit microcomputer design would still be locked within corporate vaults. BYTE provided a forum for Definicon to promulgate its technology while recognizing that projects such as these will only be made available to the hobbyist while adequate financial return for the development cycle can be maintained.

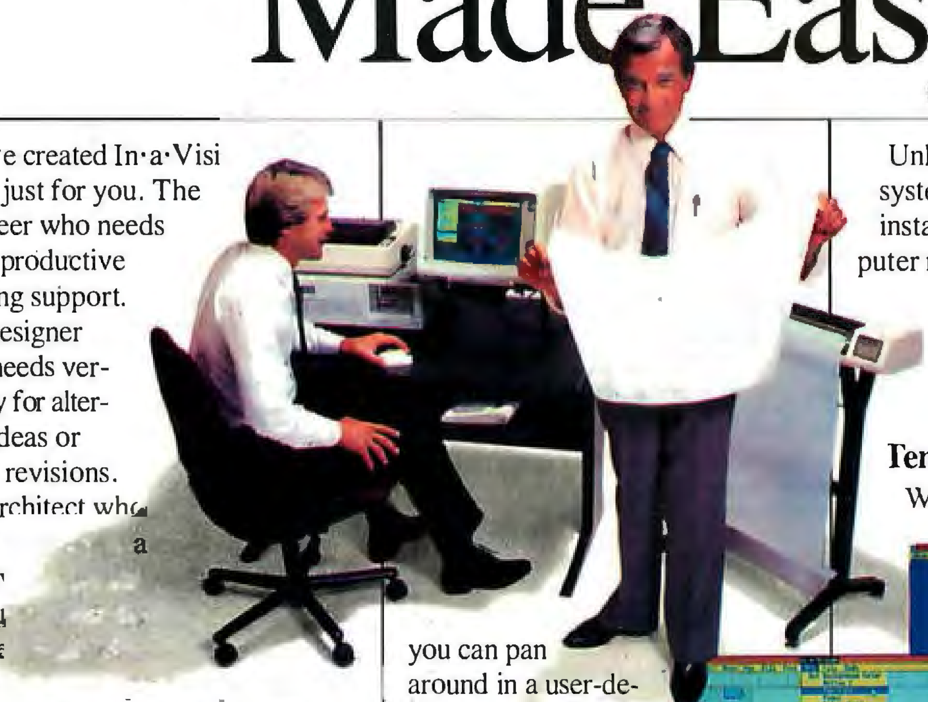
Finally, there was a misprint in the benchmark data published in the August issue. The time for a VAX-11/780 to perform an 8191 Sieve should be 1.09 seconds, not 1.90, as printed.

BYTE replies:
Publishing hardware-construction articles presents us with a dilemma. If the author

(continued)

Introducing In·a·Vision

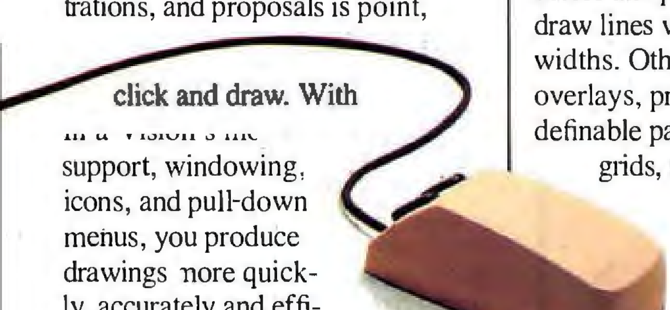
Complex Drawing Made Easy



We created In·a·Visi just for you. The engineer who needs more productive drafting support. The designer who needs versatility for alternate ideas or quick revisions. The architect who needs a variet drawi busine needs rials as well as detailed charts and organization charts.

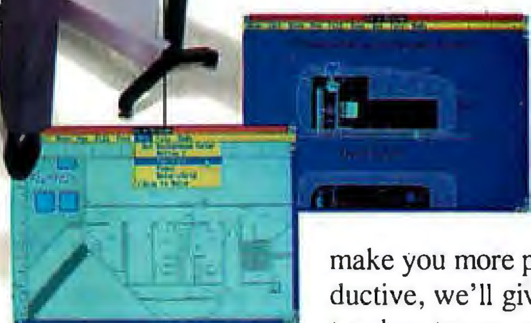
Point. Click. Draw.

Now all you do to create complex technical drawings, systems designs, blueprints, diagrams, illustrations, and proposals is point,



click and draw. With support, windowing, icons, and pull-down menus, you produce drawings more quickly, accurately and efficiently than ever before.

In·a·Vision's advanced technology includes many features not found on comparable systems costing thousands more. For example, you can pan around in a user-definable drawing space up to 68″ × 68″ and zoom in on specific areas for greater detail. Scale, rotate and dimension symbols, fill an area with your choices of predefined colors and patterns, as well as draw lines with multiple styles and widths. Other features include overlays, predefined and user-definable page sizes, rulers, grids, and symbol libraries



Multi-tasking in a PC-based CAD system.

In·a·Vision uses multi-tasking to enable you to continue drawing while printing hard copies as well as edit multiple drawings simultaneously.

Unlike more expensive CAD systems, In·a·Vision is easy to install and use. Even the computer novice can be productive in less than a day. And In·a·Vision is not copy-protected.

Ten Day Trial Period.

We're so sure In·a·Vision will make you more productive, we'll give you ten days to prove it to yourself. If In·a·Vision doesn't improve your productivity, return it within ten days for a full refund.

In·a·Vision will make your complex drawing tasks simple and make you more productive. Satisfaction guaranteed. Dial 800-272-3729 to order or for a free brochure. In Texas or for customer support, call (214) 234-1769. MICROGRAFX, Inc., 1820 North Greenville Avenue, Richardson, Texas 75081.

MICROGRAFX™
The Picture of Success.

(Most popular graphics cards, plotters and printers supported.) Microsoft Windows compatible. Call for specific operating environment requirements.

Inquiry 241

doesn't support the project by arranging for key parts to be available from one source at reasonable prices and by answering questions of all those readers who build the project, then readers become frustrated an and angry. Readers have to go through all the trouble of buying every part in quantity one and at high prices. If the assembled project doesn't work properly, readers rightly want help diagnosing the problem. Supporting 400 readers who have built a project requires time and effort on the part of the designer. Usually the demands far exceed what any individual author is willing to undertake.

On the other hand, when we make certain that a project is backed by the resources of a firm with an adequate staff and that parts and support are easily available, some readers believe that the article is intended to force them to buy a commercial product. This is not the case. Unfortunately, there is never likely to be a charitable foundation that supports hardware-construction projects with design and support engineers, a purchasing manager, clerical help, and all the other resources that go into producing a complex electronic project.

Based on years of experience, we believe that arrangements such as our continuing one with Steve Ciarcia and the DSI-32 agreement with Definicon serve our readers much better than publishing schematics and leaving the reader with no hope of support. Readers who prefer can always work from the schematics and ignore the support firm. BYTE has no financial interest in any of these projects.

Because our readers' greatest interest is in new technology, we are determined to do hardware-construction articles based on new and advanced chips. Ciarcia's project based on the 64180 and Definicon's based on the 32032 are excellent examples. They afford readers an opportunity to work with systems based on advanced chips without having to buy a large development system from a semiconductor manufacturer. We would like to do more articles based on advanced chips, but we are usually unable to convince anyone to undertake the financial risk and the burden of support. Such articles require purchasing hundreds of parts with no certainty as to how many people will build the project and buy the parts. There are sometimes supply problems with the new parts as well.

We're now trying to make arrange-

(continued)

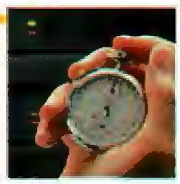
M MORE GIANT STEPS.
ER FOOTPRINTS.

SECURITY.

Free your sensitive files, such as payroll and personnel, from unauthorized scrutiny and free yourself from unnecessary anxiety. Put them on a Bernoulli Box cartridge, and put the cartridge where you *know* it will be safe.

Check out the latest Bernoulli Box family members today. More giant steps towards the complete data independence of businesses using the IBM PC, XT, AT, most compatibles, and the Macintosh.*™ Giant steps with very small footprints.

For the dealer nearest you, call 1-800-556-1234, ext. 215. In California, call 1-800-441-2345, ext. 215.



PERFORMANCE.

The amazing speed of The Bernoulli Box—with access times and transfer rates that rival and often surpass the best hard disk drives—translates into the best freedom of all: the freedom of time. And now The Bernoulli Box offers users the option of booting from The Bernoulli Box cartridge with any of the IBM PC or compatible computers.

*The Bernoulli Box for Macintosh is available in a 5-megabyte single-drive version and a 20-megabyte dual-drive version for AppleTalk.™

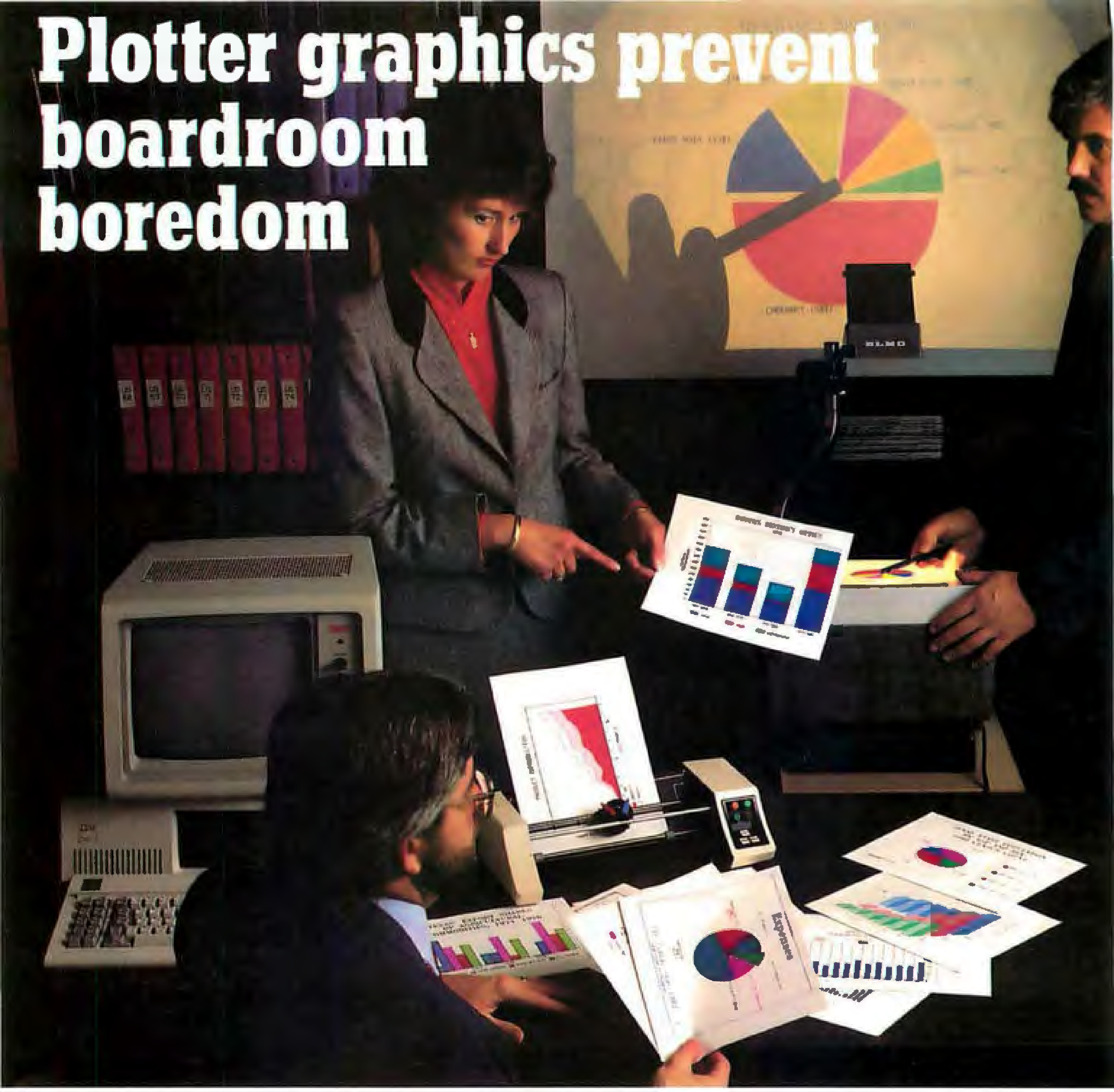
E
OULLI
X®

IOMEGA®

IOMEGA Corporation
1821 West 4000 South
Roy, Utah 84067

Inquiry 175

Plotter graphics prevent boardroom boredom



Crisp, clean, hardcopy graphics make dramatic impressions. Now, with Houston Instrument's **PC Plotter**, you have an affordable way to link the power of graphics to your personal computer. The **PC Plotter** produces quality graphics at a price you won't mind paying. It allows you to produce vibrant line, bar, and pie charts using eight different colors on either paper or overhead transparencies. And you can create either 8½" x 11" or 11" x 17" graphics.

Whether you're a computer wizard or novice, the **PC Plotter** is simple to operate and can be used with virtually any computer on the market today. Plus, your graphics software choices are unlimited. Houston Instrument products are supported by a versatile collection of more than 250 graphics software packages.

For example, just take a look at the above photo and you'll see plots created by PFS:® Graph, Lotus® 1-2-3,™ Peachtree Business Graphics System,™ Design Intelligence,™ Energraphics,™ and Smart Spreadsheet with Graphics.™

Make the most out of owning an IBM,® Apple® or other personal computer. Give it a **PC Plotter**. . . and give your presentations the visual advantage you need to win in business.

Visit your authorized Houston Instrument dealer or local computer store today and ask for a demonstration of the **PC Plotter**. For more information, call us at 800-531-5205. Texas residents may phone (512) 835-0900. Houston Instrument products are designed, marketed, and manufactured in Austin, Texas.

houston instrument

Inquiry 406 4P019

ments for hardware projects based on three different 32-bit processors: the INMOS Transputer, the Acorn RISC Machine, and the Motorola 68020. Anyone interested should contact Phil Lemmons.

We didn't publish the DSI-32 article without assuring ourselves that the board would work. Phillip Robinson of our West Coast staff saw the DSI-32 assembled and working before we published the article on it. Definicon also shipped us a DSI-32 board that functioned properly in an IBM PC here in our main office. Our technical staff edited the article.

An independent review of the DSI-32 is a good suggestion. We'd prefer to do that as a collaboration among as many DSI-32 users as possible. Those interested should contact Glenn Hartwig.

COMPRESSING DATA

On page 392 of the October 1985 BYTE (Letters), readers found an interesting "printing experiment" that surely could use more explanation. Although it's called a "high-density bar code" in its caption, the sample has little resemblance to a conventional bar code image; rather, it appears to be a direct binary high-density representation of bits framed by an error detection/correction and timing format.

A format like the sample printed has good prospects for delivery of machine-readable data. I count about 64 information bits in width (excluding error detection and framing information), with a density estimated to be 128 bits per inch. The same 128-bpi density seems to be used in the vertical direction, with a length of 7.5 inches. Multiplying the numbers, we can estimate that the test patch represented some 61,440 bits, or about 7.5K bytes. Multiply that by 10 or so columns, and we have an apparent page capacity in excess of 75K bytes. For source code of programs, you'd probably want to use a token-compression scheme. In some experiments I did in 1981 with token-compression techniques, I was able to achieve almost 3:1 compression for large Pascal source programs. Thus, as a means of representing a high-level language program with comments, your 7.5K-byte sample in October could represent the equivalent of over 20K bytes of uncompressed Pascal source text. A 20K-byte source program, while not large, is a significant chunk.

There was another fundamental problem with the bar code formats we printed a long time ago in BYTE. Those bar code formats were ugly to look at. The sample

(continued)

printed in the October 1985 BYTE has information, but at a small enough scale to look reasonably good to the human eye's wonderful power of averaging.

The use of this density represents a significant advance, probably enough to justify purchase of a specialized reader designed like no bar code reader presently on the market. I conjecture that a line-image CCD (charge-coupled device) video sensor could span the width of the image with 128 or 256 pixels relatively inexpensively. A brute-force capture device could be made to take advantage of this format provided that it addressed the problem of maintaining alignment during the scan. Rough alignment of the scan with the vertical direction of the page can be provided by the "gutter" of the magazine or a ruler. Vertical timing is obtained from the edges of the pattern as printed. Enough memory to allow processing of several conceptual horizontal lines would allow for a small amount of skew on the part of the line sensor. Averaging adjacent pixels and using a digital threshold test would allow capture of the smallest dots in the format. Vertical timing information present in the format as printed would calibrate the pattern to the actual velocity variations of the person using the device, reducing the need for sampling of the image. Scanning ought to be possible in a few seconds for each chunk of 7.5K bytes or so.

If this technology works, BYTE, its advertisers, and its readers finally have a way of printing recoverable data for source/object code of significant programs, a capacity that was not possible in our earlier experiments with bar code formats. (See my editorial in the April 1980 issue, which summarized BYTE's bar code experiments from 1976 through 1980.) Now, whoever is responsible for this experiment must still answer the entrepreneurial problems: Who will build the bar code readers, and at what cost to the end user? Which comes first, the widespread printing of information or the availability of the readers? By presenting a regular fare of significant programs in source form using this format, BYTE could spawn a whole new marketplace for machine-readable keyless data entry from print.

CARL HELMERS
Peterborough, NH

BYTE replies:
The printed software strip on page 392 of the October 1985 BYTE is called a Cauzin Softstrip. The strip was designed by Cauzin Systems Inc. of Waterbury, Connecticut, and was unveiled at COMDEX last November along with the company's $200 Cauzin Softstrip Reader. Cauzin is promoting the device, which will first be available for the Apple Macintosh and IBM Personal Computers, as a new way of reproducing and distributing programs and data. Robert L. Brass, president of the company, explained the technology behind the Softstrip to me.

The Softstrip can be printed in low-, medium-, or high-density formats. The strip that appeared in BYTE was in medium density and contained about 3000 bytes of information. The standard Softstrip is a bit longer—9.5 inches—and holds approximately 3500 bytes. (High- and low-density strips of the standard size hold 5500 and 500 bytes, respectively.)

(continued)

PERFORMANCE

THAT IS OUT OF THIS WORLD...

$389.00
MODEL 2000 20MHz DUAL TRACE

$549.00
MODEL 3500 35MHz DUAL TRACE DELAYED SWEEP

...AT A DOWN TO EARTH PRICE

At last! Truly affordable test equipment with no compromise in design, and features you would expect to find only on oscilloscopes costing hundreds of dollars more! JDR Instruments presents two, new, high-performance models backed by a two year warranty and technical support which is only a phone call away. Perfect for the technician or advanced hobbyist, both models feature Dual Trace capability and a variety of operating and triggering modes, including CH-B Subtract and X-Y operation.

MODEL 2000 has a 20 MHz bandwidth and 20 calibrated sweeps ranging from .2s to .2μs. A convenient built-in component tester provides additional diagnostic power.

INCLUDES TWO HIGH QUALITY 1x, 10x TEST PROBES

MODEL 3500 features a 35 MHz bandwidth and exceptional 1mV/DIV sensitivity. Delayed sweep and variable holdoff allow stable viewing of complex waveforms.

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

JDR INSTRUMENTS
1224 South Bascom Avenue
San Jose, California 95128 (408) 995-5430

Cauzin's use of a near-infrared sensor in its reader gives the Softstrip some interesting properties. The sensor emits a near-infrared beam of light, which heats the carbon used in black ink and photocopier toner; the receptor portion of the sensor measures the slight heat increase of a dark area. With this method of sensing, you can write with colored inks (or spill coffee, tea, or cola) on a Softstrip and not impair its ability to be read. However, writing across a Softstrip or printing it on multicolored paper is an effective way of copy-protecting it—any attempt to photocopy it will result in extra photocopy toner deposits that will render the Softstrip unreadable.

The Softstrip format was designed to be reliably readable, even in less than ideal conditions. In its medium-density mode, each line of the Softstrip (past the obvious header information at the top) represents 4 bytes (32 bits) of data. Each bit of data is encoded as what Cauzin calls a dibit*—a white square followed by a black represents a 1 bit, and the opposite represents a 0 bit. (Because of this, 4 bytes of data are represented as a line of 64 black and white squares.) Two parity bits are on either end of a line of Softstrip data. A clever scheme of using one bit for parity of the even bits and the other for parity of the odd bits—plus a checksum on each line and the method of scanning (discussed below)—gives the Softstrip Reader a 1 in 10 billion chance, according to Cauzin, of making an undetected error.*

With an effective accuracy of 0.00001 inch, the scanner scans in increments of 0.0025 inch. In a medium-resolution Softstrip, each line of data is 0.001 inch high; this means that each data line is scanned four times, each in a slightly different place. The sensor integrates the density of each half of the dibit and decides the bit's status based on the multiple versions of this information. Cauzin claims that this method is much more immune to errors than a system that would simply watch for the density transition in the middle of a dibit.

The Cauzin system does not do any data compression, but there are numerous public-domain programs that compress and restore arbitrary files. As Mr. Helmers points out, such compression could effectively double or triple the amount of data that a Softstrip could encode. It is conceivable that a single Softstrip (9.5 by 0.625 inches) holding compressed data could encode as many as five pages of high-level language source code!

Cauzin hopes that its product will become widely accepted and that Softstrips will become a common form of low-cost software storage. We are enthusiastic about the product and wish the company well. We look forward to the day when the Softstrip format is in wide enough use to merit its inclusion in BYTE listings.

INTEL'S BENCHMARKING STRATEGY

There has been a lot of discussion lately (particularly on the UNIX Usenet news network) concerning Intel's recent advertising campaign comparing the Intel 80286

(continued)

If the Hayes® Smartmodem 1200™ is smart, this one is utterly brilliant.

First came the Smartmodem 1200. Now, there's the smarter Smartmodem 2400.™ It's twice as fast. Or just as fast. Or even not as fast. Because it's smart enough to automatically adjust to 2400, 1200 or 300 bps communications. And to make sure you can communicate, it gives tests. It tests the phone line, it tests remote modems, it even tests itself. Because the Smartmodem 2400 features advanced diagnostics.

Moreover, the 2400 is a smart communicator. It communicates with mainframes and minis. Both synchronous and asynchronous transmissions are supported by the Hayes standard command set for 2400 bps. And you can transmit data to another room, or another country because the 2400 meets CCITT international standards.

So, if you want to make fast work of high-volume communications, you'd be very smart to see your authorized Hayes dealer for a look at the Smartmodem 2400 or 2400B, a plug-in board for the IBM PC and compatibles.

Say yes to the future with Hayes.

Now you can be smart, smarter and smartest all at once.

SMARTMODEM 2400

• Direct connect • Auto-answer auto-dial • Bell 103, 212A and CCITT V.22 and V.22 bis compatible • Synchronous or Asynchronous • Full or half duplex • Nonvolatile memory for communications settings • Automatic fallback to 1200 or 300 bps • Voice/data switching • Audio speaker • Advanced diagnostic tests: analog, digital and remote digital loopback • Touch tone or pulse • Automatic adaptive phone line equalization • Two-wire lease line capability • Supports single and multi-line phone systems • Call progress monitoring

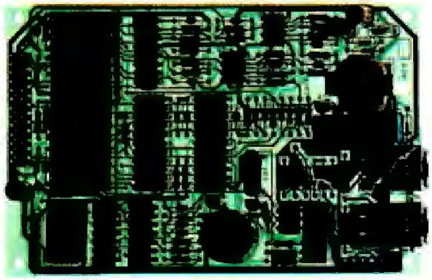
SMARTMODEM 2400B

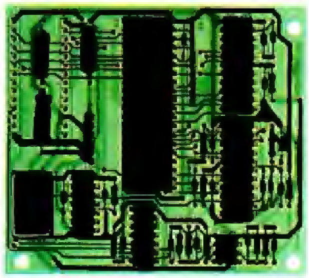
• Plug-in board for IBM PC packaged with Smartcom II Software • Above features plus synchronous/asynchronous via standard PC communications port • Rear panel communications port switch

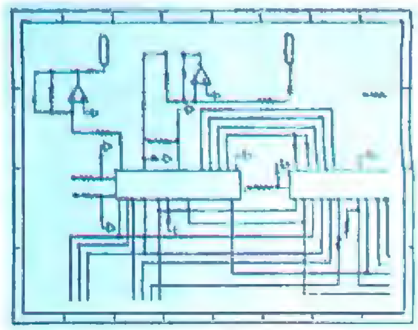
SMARTCOM II®

• Menu-driven communications software • 26 communications sets for automatic log-ons • Error-free XMODEM and Hayes Verification protocols • VT100/102 and VT52 emulation • Unattended batch operation • For most popular computers

When you positively custom







Reliability

is your obvious first requirement in this vital link between your product and the outside world. At Ven-Tel —with 12 years experience and millions of modems designed and shipped—we don't take reliability for granted...*so you can.*

Compatibility

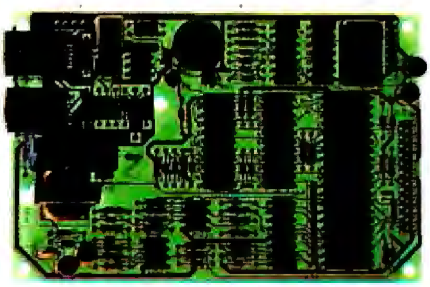
with industry standards. All Ven-Tel modems utilize the industry standard "AT" command set, guaranteeing compatibility with virtually all types of software. And every Ven-Tel custom modem is fully compatible with our complete line of standard desktop and PC internal modems. We also meet Bell 212A and CCITT V.22bis standards in speeds up to 2400 baud.

Quick Turnaround

is more than a phrase to us. We've built a reputation for meeting product deadlines among some of the nation's largest and most demanding manufacturers. From start to finish in as little as 90 days, Ven-Tel can help you get your product to market quickly. You can even begin development using our standard modules while your design is being finalized.

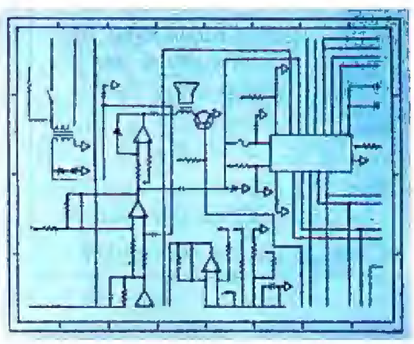
take a good

absolutely, need reliable modems...



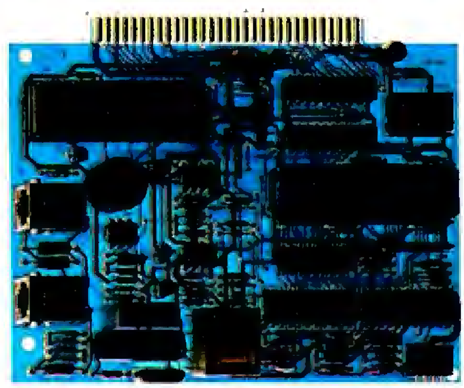
Customizing

your modem is your choice. From our standard off-the-shelf boards, to complete custom design, to licensing our proprietary CMOS chip design (for quantities in excess of 100,000 annually), we guarantee the right modem solution based on your deadline, design and volume requirements. Custom hardware configurations and firmware give you maximum freedom for integrating the modem into your overall product design.



Compact Size

is an important requirement in applications like credit check terminals, portable computers and trouble monitors. Ven-Tel modem density is state-of-the-art to provide excellent "real estate" value, with complete auto-dial/auto-answer, AT compatible, 212A modems—in as little as 12 square inches. With power requirements as low as 500mW.



Competitive Pricing

makes the Ven-Tel custom modem package one definitely worth looking into. For quotations based on your modem specs or a discussion with our experienced OEM sales engineers, call **800/538-5121 (outside California). In California, call 408/727-5721.** Or contact us for our custom modem brochure:
Ven-Tel, OEM Products Division,
2342 Walsh Avenue,
Santa Clara, CA 95051.

Inquiry 369

look at Ven-Tel

LETTERS

to the Motorola 68010 and 68020. Intel has published a document entitled "iAPX 286 High Performance Benchmark Report" (hereafter referred to as "the report") to support its claim that the 80286 offers superior performance over the Motorola 68010 and 68020 chips. Both the advertising and the report use the benchmarks that appeared in my article ("Benchmarking UNIX Systems," August 1984 BYTE, page 133) as the basis for comparing the Intel and Motorola chips.

After studying the Intel report, I believe there are several problems with Intel's approach to benchmarking that should be addressed. While the problems presented below may not prove to invalidate Intel's claim, they do raise doubts as to the objectivity and impartiality of Intel's benchmarking strategy. As author of the majority of the benchmarks Intel has used to make its claim, I feel compelled to discuss some problems with Intel's benchmarking strategy.

On July 22, 1985, I hand-delivered to the local Intel office a list of problems with its benchmarking strategy and reasons why I believe the company cannot legitimately make the conclusion it did. As of today, I have not received a satisfactory response to most of these issues, which are outlined below.

1. The listing for the pipes.c benchmark as published in Intel's report is incorrect. If this listing is identical to the source code used to evaluate the 80286-based systems mentioned in Intel's report, then the program will terminate prematurely, resulting in invalid timings. This listing is as it was presented in the August 1984 BYTE. However, an error was made on my part when I furnished the listing to BYTE, and a line was inadvertently deleted. I notified BYTE of the omission, and BYTE published a correction in the January 1985 issue (page 14). Intel should have used the corrected benchmark. Intel has responded favorably to this error and has rebenchmarked its systems. I have been told that Intel will publish a correction.

2. Intel admits that the benchmark data used for the Masscomp and Sun Microsystems machines is the data presented in the August 1984 BYTE. The BYTE article was originally slated to appear in the February 1984 issue. Due to production delays, however, it did not appear until August. Although I have no precise record, the benchmark data I gave to BYTE is probably as old as, if not older than, December 1983. This means that Intel is

(continued)

comparing benchmark results from 68010 machines over a year old to current 80286 benchmarks! Intel apparently did not make an effort to benchmark current 68010 machines other than the AT&T 7300. More recent, but still dated, benchmark data I have shows that the Sun is much faster than reported in at least two benchmarks. Intel should have noted the benchmark dates of the Sun and Masscomp machines clearly as being old and benchmarked current production machines, as it did with the Intel-based microcomputers.

3. The 80286-based microcomputers benchmarked all ran XENIX 3.0. The Motorola-based microcomputers ran different operating systems: System III, System V, and Berkeley 4.1 BSD. The BYTE UNIX benchmarks, as stated in the August 1984 article, are UNIX *operating-system* benchmarks. They are not microprocessor benchmarks and should not have been used as such. The consistently superior results obtained on the microcomputers running XENIX as compared to the microcomputers running other versions of UNIX indicate that performance differences may be due more to differences in operating-system software than to microprocessor design. For example, XENIX 3.0 uses an internal buffer size of 512 bytes; 4.2 BSD uses a 1024-byte buffer size. The pipes.c benchmark as published in BYTE does not take differing buffer sizes into account and assumes a 512-byte buffer size. Read and write operations thus appear to be less efficient on the Sun as compared to other machines. In short, by not taking system differences into account, Intel did not employ the scientific method. Thus, there are too many unknowns for a conclusion to be reached. Intel should have benchmarked a Motorola-based microcomputer running XENIX or an Intel-based microcomputer running something other than XENIX if it wanted to reach conclusions about CPU performance under similar circumstances and operating systems.

On a related issue, Intel's version of the other benchmarks used in the report are flawed, some critically. The company's C translation of the Whetstone benchmark as published has two errors:

1. It is performing one loop more than necessary in module three. This is actually a detriment to Intel's results.
2. The Whetstone uses a single dimension array of four elements. These elements are correctly referenced using the subscripts 0, 1, 2, and 3. Intel's benchmark uses the subscripts 1, 2, 3, and 4.

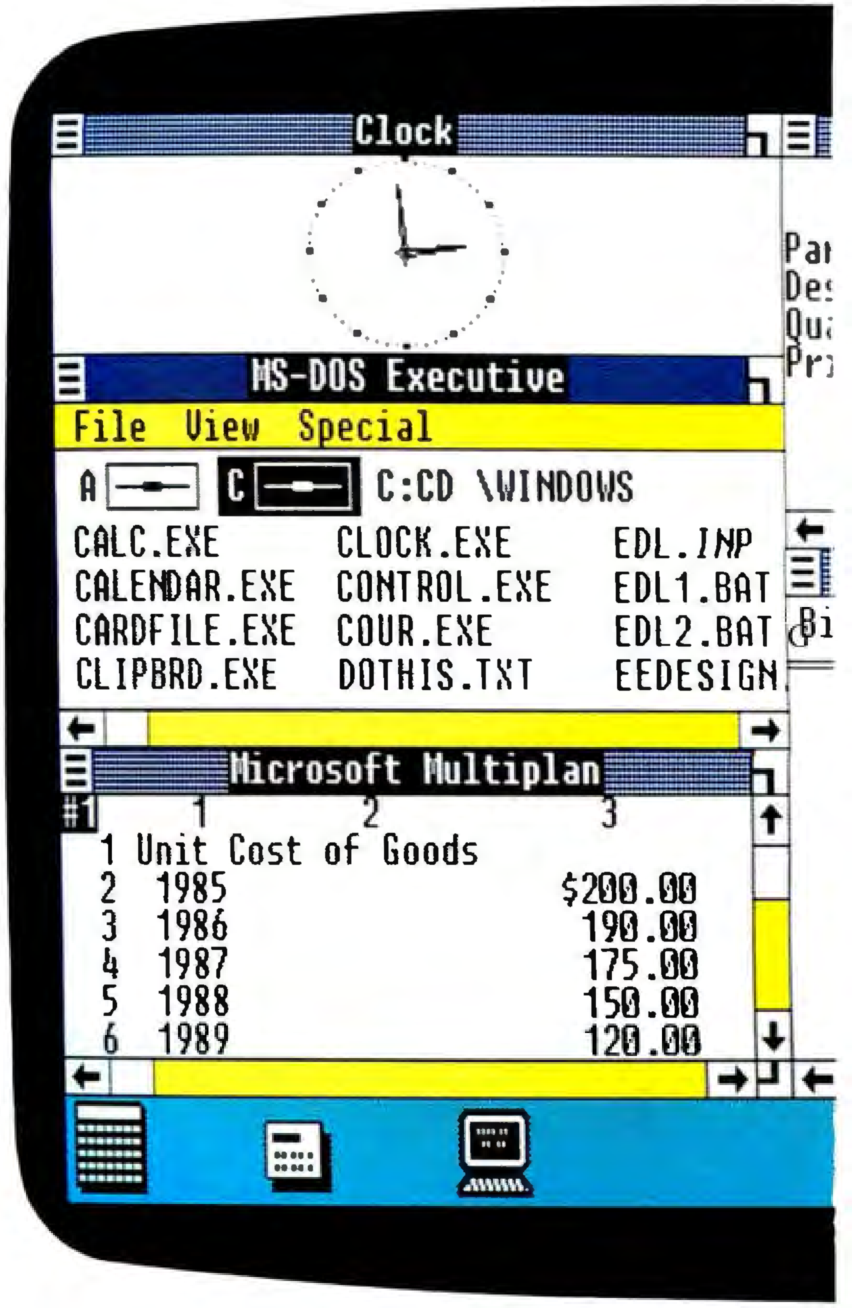
Intel's version of the Fibonacci recursion benchmark has a more substantial flaw. Because of an extra semicolon, the benchmark makes one iteration instead of the 10 iterations, as implied in the listing.

In all likelihood, the errors in the Whetstone benchmark did not significantly affect the results on the machines benchmarked in the report. However, because of these flaws the results from this industry-standard benchmark cannot be compared to data from other versions of the Whetstone.

The same may be true for the errors in the Fibonacci benchmark. Both instances raise doubts as to Intel's knowledge of the C language, which it has specifically selected for comparing microprocessors.

(continued on page 407)

Introducing Power Windows.



Microsoft® Windows has arrived.

For anyone who uses a computer in earnest, that is extremely good news.

Windows gives you a practical way to integrate programs. It radically decreases the time it takes to move from one application to another. Dramatically simplifies the means of consolidating data from many different programs.

And, as a graphical extension of the MS-DOS® operating system, it gives you a highly visual way to work and to organize your work.

In short, Windows brings efficiency to all those processes of personal computing which have till now been awkward, unwieldy, inconvenient.

The joys of job hopping.

With the advent of Windows, you can work with multiple applications. And switch from program to program with ease.

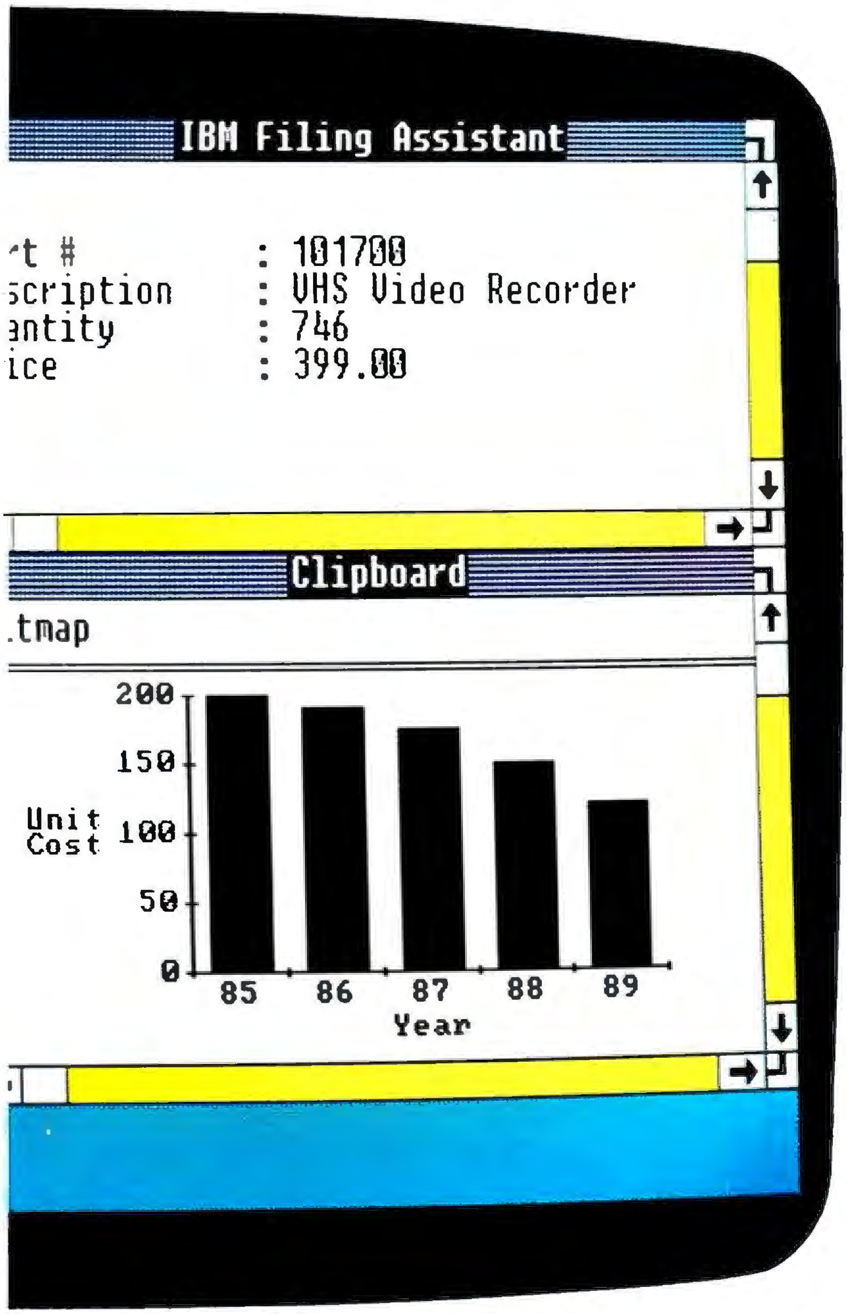
Start up with one application, then another, and another. Leap back and forth between applications as your work routine dictates. Then pick up right where you left off.

The ability of Windows to change quickly from program to program logically and naturally magnifies the utility and productivity of the personal computer. And is a recognition of the way people who exploit the power of PC s really do their jobs.

Breaking the 640K barrier.

Just like you, Microsoft Windows can handle several projects at the same time. Juggle assignments. Deal with frequent interruptions.

And Windows will ignore the 640K limit of your PC, especially if you have a hard disk, the Intel® Above Board, or expanded memory. It will execute the rather neat trick of working with more programs than memory can hold at one time.



Common ground.

Finally, Windows is not only an immensely powerful tool for today, it's also a solid base for a new generation of Windows applications.

As an introductory offer, two of these—Microsoft Windows Write and Paint—are included in the package. Along with more than a dozen other programs.

In Windows applications you have a common interface which includes drop-down menus, dialog boxes, icons. Along with a richer environment that allows you to mix pictures and text. And to summon different type faces and styles at a keystroke.

Windows is a bridge between today's applications and the graphics based software now evolving. A way to work interchangeably with today's programs. And tomorrow's.

If you're somone who uses personal computing as a natural part of your work life, who capitalizes on the productive powers of sophisticated applications, look into Windows, a new vision of what a computer can do.

Spreading knowledge.

Another great service Windows performs is accelerating the movement of information from one program to another.

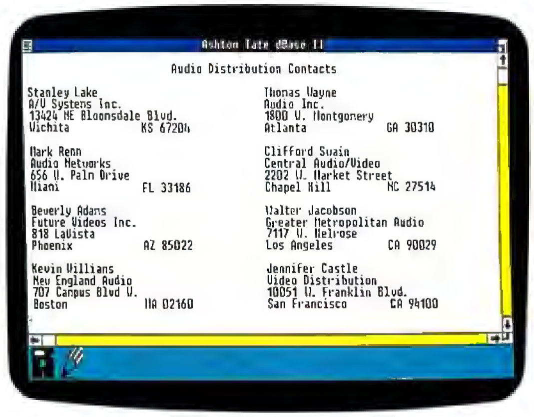
Collecting and combining that information is as simple as taking a "snapshot" of data in one program. Editing it. Then consolidating it with data from other programs.

With Windows, you can enjoy the advantages of conventional integrated programs without their compromises. Because Windows lets you put together the applications that you know, and that get a job done for you.

Choose your best word processor, spreadsheet, database—you name it. They're all there for you at a keystroke.

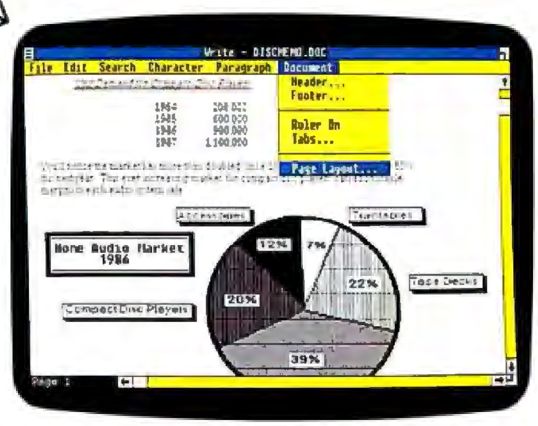
Windows breaks down walls.

Spreadsheet information from Lotus® 1-2-3® can be captured. And then transferred to Windows Write, our graphic word processing program for consolidating, editing, and formatting.

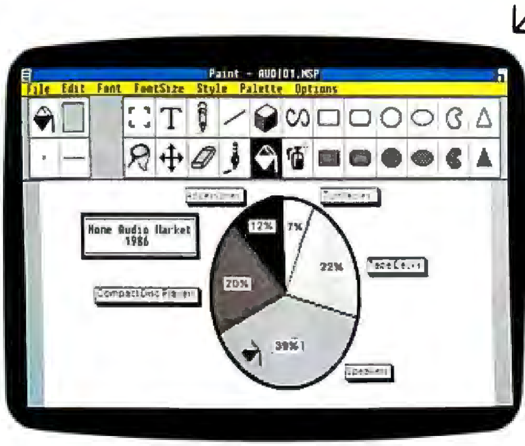


Data from dBASE II® can also be copied and transferred to Write.

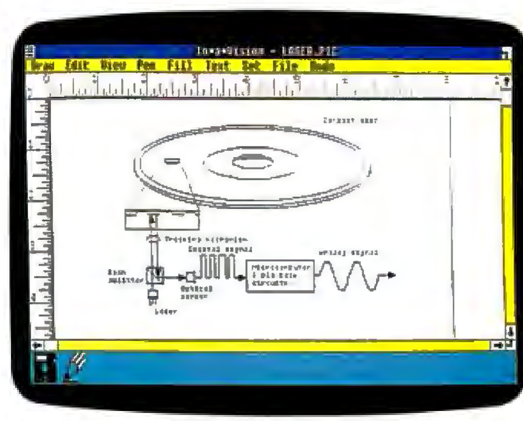
Using your spreadsheet data, build a Lotus chart. Then capture it from the screen. And paste it into Windows Paint.



Windows Write is a straightforward and able word processor. It serves as the "great integrator" in Windows. The place where text and graphics from all your other programs are organized and formatted for presentation. What you see on the screen is what you'll get on the printout.



Windows Paint is an illustrator's studio. A palette of graphic tools. Use Paint to create drawings and diagrams. Or, in this case, to enhance a 1-2-3 chart to emphasize your point.



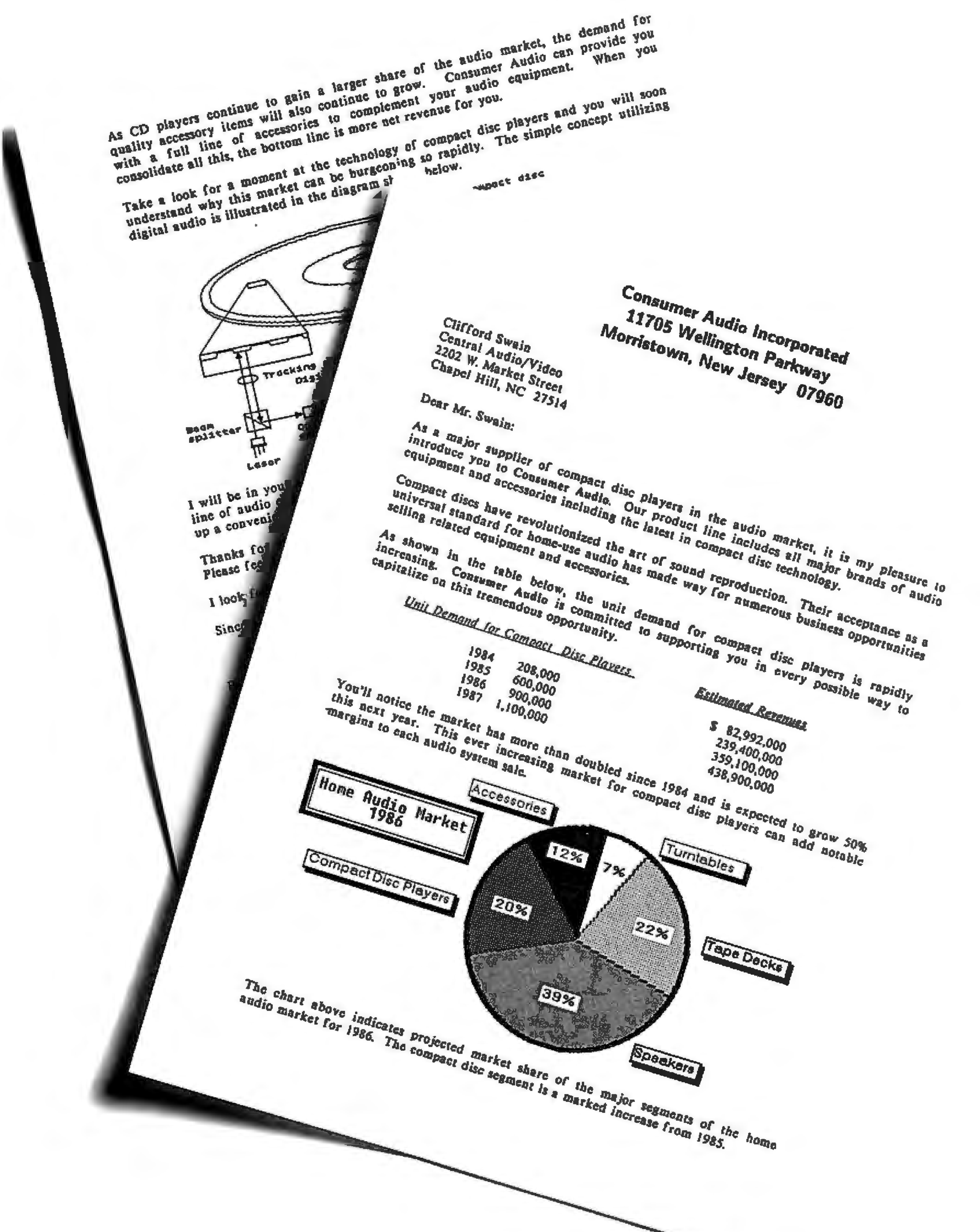
In-a-Vision, a Windows application by Micrografx, Inc., is a computer-aided design program. Its highly detailed technical illustrations are easily transferred to other Windows applications.

Windows lets you freely combine information from all your applications. And gives you the means to organize, compose, format and print it.

Because Write and Paint are graphic programs, they brilliantly exploit the capabilities of dot matrix and laser printers. When you're satisfied with what you've done in Write, print it. For a stunning presentation.

Windows provides an easy means of selecting and gathering text and graphics from your programs. And then consolidating it all—text, numbers, and images—in one application.

Windows Write and Windows Paint can serve as a staging area. There you highlight, expand,


As CD players continue to gain a larger share of the audio market, the demand for quality accessory items will also continue to grow. Consumer Audio can provide you with a full line of accessories to complement your audio equipment. When you consolidate all this, the bottom line is more net revenue for you.

Take a look for a moment at the technology of compact disc players and you will soon understand why this market can be burgeoning so rapidly. The simple concept utilizing digital audio is illustrated in the diagram sh below.

Consumer Audio Incorporated
11705 Wellington Parkway
Morristown, New Jersey 07960

Clifford Swain
Central Audio/Video
2202 W. Market Street
Chapel Hill, NC 27514

Dear Mr. Swain:

As a major supplier of compact disc players in the audio market, it is my pleasure to introduce you to Consumer Audio. Our product line includes all major brands of audio equipment and accessories including the latest in compact disc technology.

Compact discs have revolutionized the art of sound reproduction. Their acceptance as a universal standard for home-use audio has made way for numerous business opportunities selling related equipment and accessories.

As shown in the table below, the unit demand for compact disc players is rapidly increasing. Consumer Audio is committed to supporting you in every possible way to capitalize on this tremendous opportunity.

Unit Demand for Compact Disc Players		Estimated Revenues
1984	208,000	$ 82,992,000
1985	600,000	239,400,000
1986	900,000	359,100,000
1987	1,100,000	438,900,000

You'll notice the market has more than doubled since 1984 and is expected to grow 50% this next year. This ever increasing market for compact disc players can add notable margins to each audio system sale.

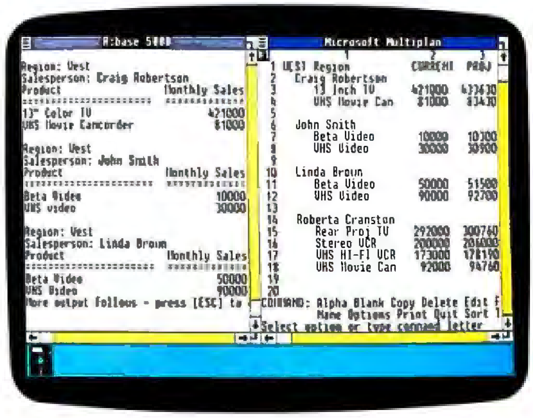
The chart above indicates projected market share of the major segments of the home audio market for 1986. The compact disc segment is a marked increase from 1985.

and compose text, charts, and illustrations drawn from a variety of programs. Then format it all for printing.

For instance, you can move data from Lotus 1-2-3 and dBASE II into the Windows Write word processor. A chart from 1-2-3 can likewise be pasted into Paint, a drawing tool. There you have the means to transform a basic chart into something that communicates exactly what you want to say. Which you then transfer to the letter being produced in Write. When you're happy with content and composition, print the page on a graphic printer just as you see it. The better your printer, the better the result.

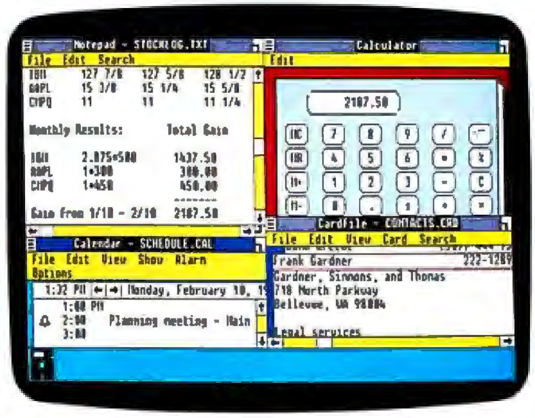
Spend a day with us. You'll

7:45 AM. Early as usual. Opening Windows lands you in the MS-DOS Executive, the Windows command center and file directory. Run the Windows Calendar program and see what's up for the day.



7:55 AM. You've got a report due by the end of the day. A comprehensive sales analysis. Bring up Multiplan® and R:BASE 5000® Copy regional sales data from R:BASE into Multiplan.

1:30 PM. Market's closed. How'd you do? Open Terminal to dial Dow Jones News/Retrieval® and check the final quotes. Copy and paste them into Notepad.



1:45 PM. You did pretty well today. So use the Windows Calculator to figure your gains. Which you duly note in Notepad. Your good luck, however, requires a call to your tax attorney. A quick click brings up his listing in Windows Cardfile. Another click dials him automatically on your modem.

One of the great beauties of Windows is that in the here and now you enjoy the benefits of computing's future path—graphically oriented software. Without giving up any of the applications you're happy with today.

Windows integrates the DOS programs you're already using with a wide array of Windows applications.

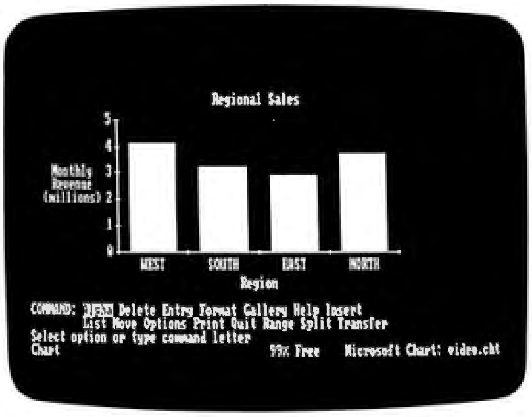
In addition to Windows Write and Paint, the package includes a collection of Windows desktop applications which you can use to manage your day-to-day activities. A calendar, cardfile, notepad, calculator, and telecommunications program, just to name a few. Used together with your standard applications, they can handle an impressive list of office routines.

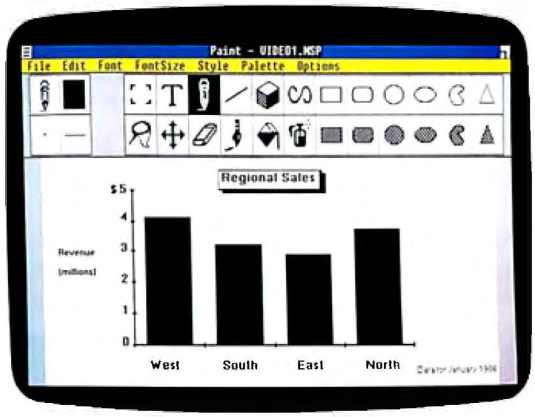
Spend a day with Windows and the future of business computing falls into place.

Windows isn't merely an operating environment. It's an extremely useful collection of applications.

And because Windows runs most existing

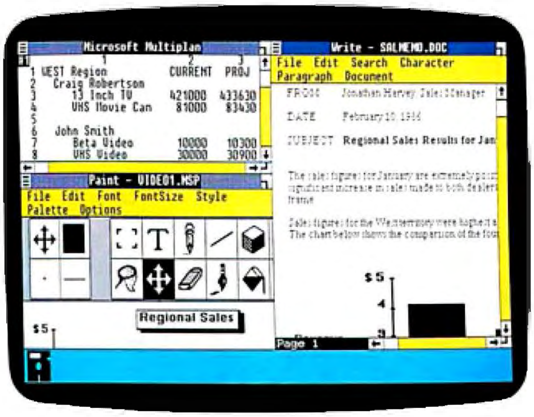
never give up a Windows office.

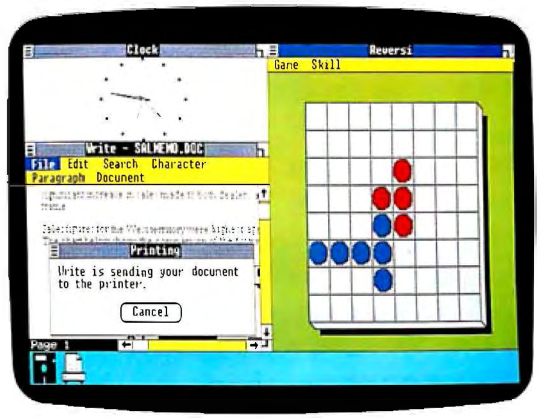




10:30 AM. You've squeezed everything you can out of the numbers. Now open up Microsoft Chart. And let the pictures tell the story. When you've made a chart fit for presentation, capture it from the screen.

11:00 AM. Paste your finished chart into Windows Paint. Add borders, highlights, and illustrative detail. Not only more appealing, but more effective.





1:55 PM. No sooner do you hang up, than your Calendar alarm sounds. Checking the Calendar, you find you've got a meeting at 2.
3:00 PM. The meeting went on forever. About time you got back to that report. Copy the chart from Paint, and paste it into Write. It looks brilliant. Now write it so it *sounds* brilliant.

4:48 PM. Everything on screen is looking good. You're ready to print. Open Clock to confirm time. That's right, it's tight. Choose the Print command and send the document off to the printer. Open Reversi for a quick game while you wait. While you beat the clock you can try beating the computer.
5:00 PM. Report printed impeccably. Turn it in and shut down for the day. After all, you were in fifteen minutes early.

---

standard DOS applications, it's ready to handle any job you need to do today.

But Windows also represents a foundation for the future.

The Windows interface establishes a common set of command conventions, drop-down menus, dialog boxes, and icons to standardize operations for all forthcoming Windows applications. Which means once you've learned one Windows application, learning the next one will be deja vu, not start from scratch.

Windows Write and Windows Paint are the first examples of programs that embrace the standard.

In-a-Vision, an impressive computer-aided design program by Micrografx, Inc., is another example. Many more are now being written.

And because Windows runs standard DOS applications, you can look forward to the future.

But you don't have to wait for it.

The first reviews are in. Here's what they see in Windows.

Prominent reviewers and industry experts have been eagerly awaiting the arrival of Microsoft Windows.

Now they've had a good look. And we're pleased to record their responses to what they saw.

"I'll bet on Microsoft Windows."
Jonathan Sacks, West Coast editor of *Popular Computing* magazine.

"You've got a clear winner..."
Stewart Alsop, editor and publisher of *P.C. Letter.*

"...Windows looks very good..."
Peter Norton, in his column in *PC Week* 9/24/85.

Of course, all this is going to cost you: $99.

A price that makes Windows the most startling value ever offered in software.

A comparable collection of programs—a switching program, a graphic interface, desktop applications, a word processor, a drawing program—could easily cost hundreds of dollars more.

Windows will instantly deliver you a more productive present. And a leap into the future.

A future which, frankly, we have no interest in keeping exclusive. At this price, it looks to be arriving in a rush.

Integration features:

- Work with multiple applications and switch between them.
- Run more applications than fit in memory at one time.
- Consolidate information from standard DOS and Windows applications.

Applications included:

- MS-DOS Executive—DOS file management program. Run programs; format disks; copy, rename, delete files.
- Calendar—Set appointments with optional alarm reminders; daily or monthly view.
- Cardfile—Filing program; cards can include text or graphics, autodial capability.*
- Notepad—Text scratch pad/editor; time/date stamp option.
- Terminal—Telecommunications program; copy session data to other programs or capture to file; autodial capability.*
- Calculator—Common arithmetic operations, plus square root, percent, and memory.
- Clock—Can be displayed anywhere on the screen.
- Reversi—Strategy game; four levels of play.
- Control Panel—Set time, date, communication ports, colors, add/delete printers.
- Program Information File (PIF) Editor—Create or edit PIF files for standard applications.
- Print Spooler—Print files from Windows applications while running other programs.
- Clipboard—View information copied from applications.
- RAMDrive—Setup memory expansion cards as a RAM disk.

Introductory offer also includes:

- Windows Write—Graphics based word processor.
- Windows Paint—A full-featured drawing program.

*requires a Hayes compatible modem

Windows will open your eyes.

We invite you to visit your Microsoft Dealer and get a screenful of Microsoft Windows. We think you'll agree Windows is clearly a winner.

Microsoft Corporation
Bellevue, Washington USA

Microsoft GmbH
Munich DEUTSCHLAND

Microsoft Pty
Sydney NSW AUSTRALIA

Microsoft Ltd
Berks ENGLAND

Microsoft Canada Inc
Ontario CANADA

Microsoft AB
Sollentuna SWEDEN

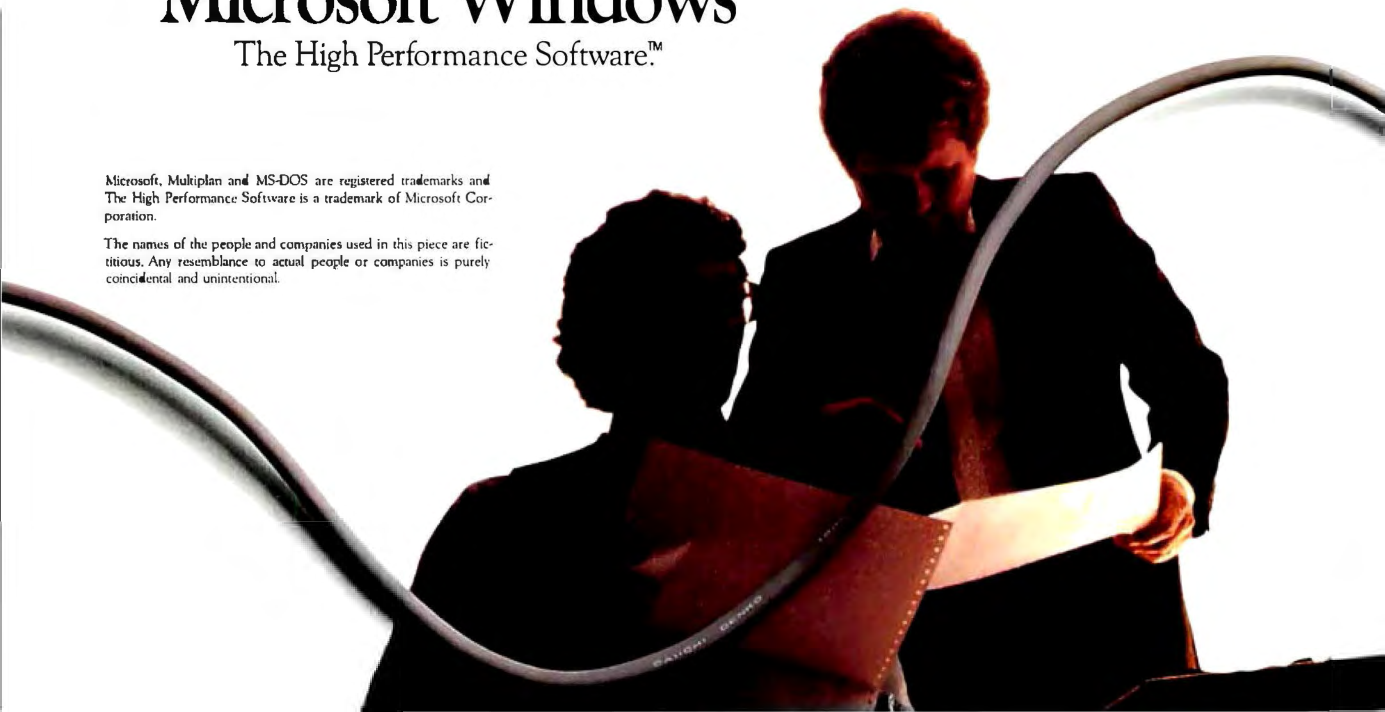
Microsoft SARL
Paris FRANCE

ONIX Microsoft
Seoul KOREA

Microsoft Far East
Tokyo JAPAN

Microsoft® Windows

The High Performance Software.™



F·I·X·E·S AND U·P·D·A·T·E·S

BYTE'S BUGS

Mac C Updated, QSORT Repaired

Consulair Corporation wrote regarding Tim Field's review of five C compilers for the Macintosh (see the November 1985 BYTE, page 275). One of the compilers he evaluated was Consulair's Mac C version 1.7. The company pointed out that Mac C version 4.0 came out in August 1985.

Consulair also noted an error in the QSORT benchmark (listing 7, page 292). Using its own version of a quicksort program, with 16-bit integers, Consulair benchmarked version 4.0, the results of which are shown below (times in seconds). The source code for Consulair's quicksort version is available on BYTEnet Listings; telephone (617) 861-9764.

	Normal	Register	File Size
FRAME	0.10	0.07	13056
POINTER	26.57	15.17	13056
INTMATH	5.05	2.68	13568
SIEVE	6.33	4.40	13056
QSORT	9.47	8.68	13312
FLOAT	289.90	155.90 (extended)	13568
FIB	29.93		13056

Sorry, ha!

Steve Ciarcia built a computer into a Fraggle Rock lunchbox (see the October 1985 Circuit Cellar, page 86). Fraggle Rock is part of the world of Muppets. Mr. Ciarcia's staff dutifully contacted Henson Associates (whose letterhead reads "ha!"), rightful owners of all Muppet likenesses and concepts, and asked for permission to use a photo of said lunchbox. The mavens of Muppetry graciously granted permission.

However, we failed to acknowledge ha!'s granting of permission. We apologize to Henson Associates for this oversight. (Now will you please call off those large nappy creatures we've seen lurking menacingly around the offices?)

Project Not Bug-Free

Several bugs wiggled into Jonathan Amsterdam's "Context-Free Parsing of Arithmetic Expressions" (August 1985 BYTE, page 138). Antonio Salvadori, associate professor of computing and information science at the University of Guelph in Ontario, sent us the following corrections.

On page 142, in the line that begins UNTIL c < >, there should be only one space inside the single quotation marks. Fourteen lines below that, a closing parenthesis is missing from the comment statement.

The variable savedChar should be initialized by savedChar := chr(empty); at the beginning of the main program.

Benchmark Bug

We go back a ways with this one. An error has been found in the Turbo Pascal benchmarks (July 1984 BYTE, page 267). The problem occurs in the Puzzle program (page 274), in a line near the bottom of the second column. The line reads

```
pieceMax[1] := 1+d*+d*d*3;
```

To correct it, insert 0 between the first asterisk and the plus sign.

BYTE'S BITS

A Paper-Tape Kind of Guy

Roberto Denis, a BYTE charter subscriber in Plantation, Florida, decoded some of the punched paper tape running across the page tops of our 10th anniversary issue (September 1985). The message reads: HOPE TO HERE [sic] FROM YOU HARD CORE PAPER TAPE PEOPLE ALL THIS TYPING BETTER BE WORTH IT.

Mr. Denis challenges readers who have copies of BYTE's early letterhead, which had paper tape running across the top, to decipher the message. If there is one.

San Francisco's Exploratorium Comes to New York

The staff of the Exploratorium in San Francisco is packing up more than 80 interactive exhibits and heading east, where they'll set up shop at the IBM Gallery of Science and Art in New York City. The exhibition is designed to help people increase their understanding of light, visual perception, and other phenomena of the physical world.

Among the wonders are the "Distorted Room," where people appear to shrink and grow in this room with no right angles, and the "Duck Into Kaleidoscope," which appears to create a crowd when only a few people are actually present.

The exhibit runs from January 31 through April 26. The IBM Gallery of Art and Science is located at 590 Madison Ave., New York, NY 10022, (212) 407-6100.

How To Access and Use BYTEnet Listings

To access BYTEnet Listings, call (617) 861-9764. When you get the carrier tone, enter two or three carriage returns so that our software can determine your operating parameters.

Optimum modem settings are 8 bits, [illegible] stop bit, and no parity at full duplex, [illegible] 7 bits, 1 stop bit, and even parity at half duplex. Acceptable operating speeds are 300 or 1200 bps. At this time, BYTEnet Listings does not support 2400-bps transmissions.

The BYTEnet Listings software itself is menu-driven. Programs may be downloaded using ASCII, Kermit, Tele-Link, and XMODEM protocols.

How to Save Money . . .

IBM PC SYSTEMS

MAINSTREET ENHANCED

PC $1965
with 10 MB Disk

- 360kb Tandon Floppy
- 10 MEG ADEPT Hard Disk
- 256K RAM
- All Controllers, Cables, Manual
- 1 Year Warranty

Same System with 20 MB Hard Disk **$2085**

Monitor Not Included   Many Options Available

IBM PC/AT

AT PLUS
$3860

20MB System Includes:
- 1.2 MB Floppy
- 360 KB Floppy
- 512K RAM
- 20 MB Hard Disk
- Serial/Clock
- All Cables, Controllers, Manual

Same System with 32 mb **$4071**

Monitor Not Included

MORE IBM PC SYSTEMS FROM MAINSTREET

SUPER PC
- 256K RAM
- 360K Floppy
- 10 MEG
- Tape Drive
- 135 Watt
- 640K RAM

Slot Saver
- 2-360K Floppies
- 20 MB Hard Disk
- Persyst Video Combo
- 3 Slots Available

SUPER PC+
- 640K RAM
- 2 Floppy
- 20 MEG HARD
- Tape Backup
- AST 6 PAK
- 135 Watt Power

PC 2/20
- 256K RAM
- 2-360K Floppies
- 20MB Hard Disk

CHIPS

64K - DRAMS **$8**
256K - DRAMS **$35**
8087-3-$129
80287-$250

Printers

SPECIAL PRICE

EPSON FX-80+	$299
EPSON LQ-1500	$929
EPSON FX-185	$499
EPSON LX-80	$220
TOSHIBA 1340	$569
TOSHIBA 351	$1099
TOSHIBA 1351	$999
TOSHIBA 341	$939
NEC E•L•F	$449
CITIZEN MSP-10	$299
OKIDATA 182	$239
OKIDATA 192	$349
OKIDATA 193	$549
OKIDATA 84	$759

BACK-UP POWER

ADEPT

DataShield AT 800 (Back up power 800 Watts)	$659
DataShield XT300	$369
DataShield PC200	$285
DataShield AT500	$559

SURGE Protection

DataShield S100	$59
DataShield S85	$49
DataShield S75	$36
Kensington Masterpiece	$95

Computer Accessories

COMPAQ DESKPRO™

20 MB System $2999

- FAST 8086 Processor
- 640K RAM
- 20 MB Hard Disk
- 2 - 360kb Floppy
- High Resolution Monitor
- Basic
- 1 Year Warranty

Tape Back Up
10 MB $590
20MB $739

TO PLACE YOUR ORDER CALL
1-800-426-MAIN

RODIME 10 MB
For Compaq
$475

PORTABLE

COMPAQ Portable
$2466
256K, 360KB Floppy, 10MB Hard Disk

MAINSTREET
COMPUTER CORPORATION

HOURS: 9am to 6 pm CST M-F   Sat 9-3

ORDERING INFO: All Mail: 1025 Main St., Bastrop TX 78602. We accept personal and corporate checks. No delay if driver's license and expiration included. Shipping is free on prepaid orders via UPS Ground. Air is extra. We accept VISA, MC. (Am. Exp. and Diner's Club = 3% surcharge.) We double manufacturer's warranty on all hardware. Software is not returnable. All goods are new.   Inquiry 221   B0186

Buy Mainstreet and Adept

ADEPT PC

$749

ADEPT Personal Computer

- 640K RAM
- 360Kb Floppy
- "Touch Type" Keyboard
- 1 Year Warranty
- Runs IBM™ Software

30 Day Trial / 100% Credit Towards IBM PC

ADEPT SYSTEMS

ADEPT AT

$1975

- 80286 Microprocessor
- 1 Megabyte Motherboard
- 1.2 MEG Floppy Drive
- Hard Disk Controller
- "Touch Type AT" Keyboard
- Runs IBM PC, XT, AT Software
- 8 Full-Size Expansion Slots
- 1 Year Warranty

Ask About Our 30 Day Trial Offer

Quick-Six Multifunction Board $139

- Serial Port
- Parallel
- 384K RAM
- Clock/Calendar
- RAM Disk Software
- Print Spooler

For A Limited Time

Includes SIDEKICK! $54.95 Value Free

AT E•X•P BOARD

- 3MB RAM
- Serial Port
- Parallel Port
- For IBM or ADEPT AT

$289

MONO/GRAPHICS BALANCE I
$229

- 720 x 348 Resolution
- Parallel
- Serial
- Runs 1-2-3

Balance II
$299
Mono/Color Graphics

HIGH SPEED TAPE BACK-UP

$739
20MB

Backs up 20 MB in less than 10 minutes

60 MB
$899

Similar to TECMAR QIC-60

HARD DISKS by ADEPT

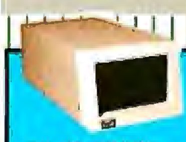
20MB
$490

- Half-Height
- Complete System
- Mounts Internally
- 1 Year Warranty

10 MB - $390
32MB - $695

For really FAST access, call our hard drive specialist — 800-426-6246

24 Hour Bulletin Board Service
UPLOAD
SIGS
MAIL
DOWNLOAD
ORDERING
512-321-7317
All Non-Order Calls
512-321-4406



10,20,32MB . . . From **$595**
10 MB

Combination Systems

HARD DRIVE	TAPE	PRICE
10 MEG	10 MEG	$1185
20 MEG	20 MEG	$1390
20 MEG	60 MEG	$1665
32 MEG	60 MEG	$1870

A perfect match! Colors and casing to conform with your IBM or ADEPT PC. In two convenient models to suit your space requirements. Add hard drives in 10, 20, 32 or 40 megabytes. Cartridge tape backup in 10, 20 or 60 megabytes. Combine hard drive and tape backup for complete storage solutions. All units come with power supply, cables, software and manual.

10,20,32MB . . . From **$635**
10 MB

Combination Systems

HARD DRIVE	TAPE	PRICE
10 MEG	10 MEG	$1225
20 MEG	20 MEG	$1430
20 MEG	60 MEG	$1705
32 MEG	60 MEG	$1915

IBM, XT and AT are trademarks of International Business Machines Corporation. Compaq is a trademark of the Compaq Corporation. All brands are registered trademarks. Prices are subject to change without notice.

800 426-6246
ORDERS
512 321-4406
Technical Assistance
Texas Residents, Inquiries

Mainstreet Computer
1025 Main St.
Bastrop, TX 78602
Hours:
Mon-Fri: 9 am-6 pm
Saturday: 9 am-3 pm

SOFTWARE—Many titles available 800 426-6246
Call for Latest Version and Price
Examples—Borland Superkey $35 Copy II PC $25 Multimate $238 Norton Utilities $49

HP Computer Compatible with IBM PC AT

The Vectra PC from Hewlett-Packard is an 80286-based computer compatible with the IBM PC AT. The Vectra's processor runs at 8 MHz, as opposed to 6 MHz for the AT. A socket is provided for an optional 80287 numeric coprocessor.

The base unit measures 16.7 by 15.4 by 6.3 inches, for a footprint approximately 30 percent smaller than that of the IBM PC AT. Inside, the Vectra PC has five full-size and two half-size expansion slots and room for three stacked disk drives. Drives from either HP or other manufacturers fit into plastic carriers that snap into the chassis, allowing for a wide assortment of mass-storage devices, including 3½-inch and 5¼-inch floppy-disk drives, 20- and 40-megabyte hard disks, and tape backup.

The keyboard has a bank of 10 function keys at the side for use with IBM PC-compatible software; a row of 8 additional function keys across the top provides compatibility with programs for earlier HP personal computers. Theoretically, all 18 keys could be used by a program. The keyboard is connected through the HP-HIL (Hewlett-Packard Human Interface Loop), which allows for multiple input devices without wasting either ports or expansion slots. Both a touchscreen bezel and a mouse are available.

The three basic configurations of the Vectra PC are the Model 25, with 256K bytes of RAM and one 360K-byte floppy-disk drive for $3199; the Model 35, with 256K bytes of RAM and a 1.2-megabyte drive for $3399; and the Model 45, with 640K bytes of RAM and a 1.2-megabyte drive for $3599. A floppy-disk controller is built into the system electronics. Prices include a color-graphics adapter but not a monitor. Prices do not cover MS-DOS 3.1, but if you buy the operating system, you also get HP's Personal Applications Manager. For further information, contact Hewlett-Packard Co., 1801 Embarcadero Rd., Palo Alto, CA 94304, (800) 367-4772.
Inquiry 550.


Hewlett-Packard's Vectra PC.

Memory-Resident Utilities for CP/M

Spectre Technologies' Presto! is a memory-resident pop-up utility program providing notepad, calendar, calculator, print-screen, and cut-and-paste functions for CP/M computers. Depending on the modules used, Presto! occupies from 6K to 12K bytes of RAM.

The notepad module creates an 11-line by 80-character window for editing or viewing files; to conserve memory, only the current 11 lines are stored in memory, with the rest of the file stored on disk. The notepad uses standard WordStar commands.

The calculator emulates a standard four-function memory calculator. To those capabilities it adds Boolean operators and support for binary, octal, decimal, and hexadecimal math as well as a character mode. A time pad provides a calendar and, on machines with a real-time clock, an alarm and timer. You can print the current text screen to a printer or a file in ASCII format, or you can save a graphics image to a file for later processing with Spectre's Rembrandt graphics program, which is available separately.

Presto! is initially available for the Osborne 1, Executive, and Vixen, and all Kaypro CP/M computers. Spectre plans to release versions for other popular CP/M computers soon.

List price of Presto! is $39.95. Contact Spectre Technologies, 22458 Ventura Blvd., Suite E, Woodland Hills, CA 91364, (818) 716-1655.
Inquiry 551.

Animation Generator for 64K Machines

Fantavision is a special effects/animation generator designed to help you create animated sequences with 64K-byte Apple IIs. Brøderbund says that with the software, you can produce studio-quality work.

Fantavision incorporates computer animation techniques such as tweening (the machine creates fluid-looking motion by instantly generating as many as 64 intermediate positions between objects) and transformation (an object in one frame can be transformed into a different object in the

(continued)

subsequent frame). You can superimpose special effects onto high-resolution backgrounds available on the program disk or taken from other Apple graphics software. Sequences can be stored on disk.

Fantavision costs $49.95. Contact Brøderbund Software, 17 Paul Dr., San Rafael, CA 94903, (415) 479-1170.
Inquiry 552.

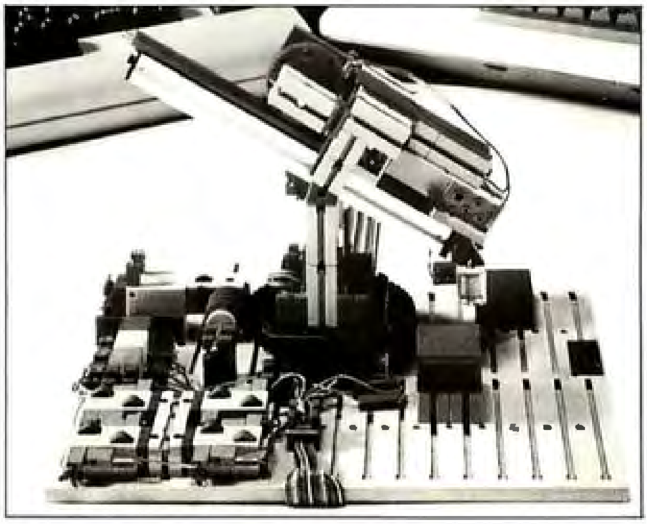
Add 320K to IBM PC

The IPC 320 RAM board gives you 320K bytes of CMOS RAM with battery backup on a standard IBM PC expansion card. You can divide the 320K bytes into bank-selectable 64K-byte blocks or address the extra memory as 320K bytes of contiguous storage space.

You can install as many as four boards in one IBM PC. If the card is used as a nonvolatile RAM disk, the PC can still address a full 640K bytes of main memory in addition to the 320K-byte RAM disk.

The IPC 320 is priced at $795, which includes RAM-disk software. Contact Diversified Technology Inc., POB 748, Ridgeland, MS 39158, (601) 856-4121.
Inquiry 553.

Logitech's Logimouse C7.



Robotic Computing Kit from Parsec Research.

Mouse Needs No External Power Supply

Logitech's Logimouse C7 is a CMOS mouse that uses a maximum of 5 mA of electric current. This low power requirement means the mouse does not need an external power supply; instead it runs on power from the RTS and DTR control lines of the host system's serial port. It has a voltage tolerance of 6 to 15 volts, so it can be used with most computer systems.

The standard C7 comes with a resolution of 200 dots per inch (a 320-dpi version is also available) and a programmable data-transmission rate of up to 9600 bps. You can buy it with either a 25-pin RS-232C connector for the IBM PC, XT, and compatibles or a 9-pin serial connector compatible with the IBM PC AT. Logitech will also customize connectors.

Logitech says the Logimouse C7 is protocol-compatible with all existing serial mice and will run with most software packages. It costs $99. Contact Logitech Inc., 805 Veterans Blvd., Redwood City, CA 94063, (415) 365-9852.
Inquiry 554.

PortaFile Puts Handle on 20 Megabytes

The PortaFile 20 incorporates a 20-megabyte external hard disk and power supply shock-mounted in a portable case with a carry handle. Packaged with the drive is an IBM PC hard-disk–controller expansion card (which can work with one internal hard disk as well as the PortaFile) and cable.

The PortaFile 20 is scheduled to be available in February for $1295. For additional information, contact Western Digital, 2445 McCabe Way, Irvine, CA 92714, (714) 863-0102.
Inquiry 555.

Robotic Computing Kit

Parsec Research has taken a robot construction kit made by fischertechnik of Germany and equipped it with a FORTH-based control language called PaRCL (pronounced "parkul"). The kit contains 10 projects designed to teach you the fundamentals of robotics while you build a plotter, sorting system, or other automated devices.

The fischertechnik package (249 pieces in all) comes with two motors, two gears, one electromagnet, three lamps, eight pushbuttons, and two potentiometers. The computer interface has four outputs for connection of motors and other components, eight digital inputs, two analog inputs, and a program disk.

PaRCL is modeled after advanced industrial and laboratory standards. Parsec said the language uses no complex codes; commands are written in English. The routines reportedly run much faster than BASIC equivalents.

After you've constructed your device, you can control it with an Apple II, Commodore VIC-20, or Commodore 64. Besides a plotter and sorting system, other projects in the kit let you build a materials lift, an aerial rotor, a graphics panel, and a teachable robot.

The Robotic Computing Kit sells for $199. The plastic pieces snap together, so assembly requires just a screwdriver. To power the models, you need a 6- to 10-volt DC supply with a minimum of 500 milliamps. Contact Parsec Research, Drawer 1766, Fremont, CA 94538, (800) 633-6335; in California, (415) 651-3160.
Inquiry 556.

(continued)

Borland Introduces Reflex, The Greatest Analytical Tool Since The Couch

INTRODUCING REFLEX, THE ANALYST.

If you use Lotus 1-2-3™, dBASE® or PFS File™, you need Reflex™—because it's a totally new way to look at your data. It shows you patterns, relationships and interrelationships you didn't know were there, because they were hidden in data and numbers.

Reflex is the first database that separates the trees from the forest. The first database that understands that what you see depends on how you look at it.

The first database that probes relationships—then shows them to you in various graphic forms—scatter, line, bar, stacked bar and pie charts.

The first database to break the bonds of traditional DBMS (Data Base Management Systems) and give a dramatic visual turn to data analysis.

Reflex makes graphic leaps far beyond 1-2-3. With Reflex, when you look, you see.

HOW THE CRITICS REACT TO REFLEX

"The next generation of software has officially arrived."

Peter Norton, PC Week

"Reflex is one of the most powerful database programs on the market; its multiple views, interactive windows and graphics, great report writer, pull-down menus and cross tabulation make this one of the best programs we have seen in a long time...The program is easy to use and not intimidating to the novice...Reflex not only handles the usual database functions such as sorting and searching, but also "what-if" and statistical analysis...it can create interactive graphics with the graphics module. The separate report module is one of the best we've ever seen."

Marc Stern, InfoWorld

"What you see, then, is an interesting hybrid of a database and a spreadsheet that is ideal for analyzing tabular data."

Adam B. Green, InfoWorld

"More flexible than spreadsheets, this easy-to-use database analysis package presents information with visual clarity...Reflex is for you. The flexibility of switching between different views of the data lets you see relationships you may have previously overlooked...Without "what-if" analysis, key variables—such as cost of goods sold or travel expenses—may be out of hand but unnoticed. The type of analysis to uncover such a foible is awkward to do on a spreadsheet; yet, it may mean the difference between success and failure in a competitive situation."

Ira H. Krakow, Business Computer Systems

REFLEX OPENS MULTIPLE WINDOWS WITH NEW VIEWS AND GRAPHIC INSIGHTS.

You use Reflex's Form View to build your database; the List View lets you put data in tabular List form; the Graph View gives you instant interactive graphic representations; the CrossTab View gives you amazing "cross-referenced" pictures of the links and relationships hidden in your data. Report View allows you to import and export data to and from Reflex, 1-2-3, dBASE, PFS File and other applications and prints out information in the formats you want. In fact, Report View is probably the best 1-2-3 report generator you can buy today. It's also the cheapest—and you're getting all the other features free.

The commands for all five Views are consistent—so you're not stuck learning five different ways to get something done. And because Reflex uses advanced windowing techniques, you can see several views on the screen at the same time—without having to switch back and forth. You get the picture—and the pictures—all at once—if that's the way you want to look at things.

Modify a number and all your Views—List, Form and Graph—are immediately updated, on-screen. Changing a number changes the picture—which is mighty handy when you're analyzing (let's say) sales figures by salesperson; or you're in "What-If?" country asking yourself "What if we could add 2.5% in January sales?" "Show me."

"Give me the picture." "Show me what happens when we shift 11% of Nebraska's inventory to the new store in Hawaii." "Show me how many Gizmo 28's we have in every store in every state as of midnight last night and what happens to our East Coast stocks if the shipping strike lasts more than a week." "Show me."

So Reflex shows you. Instant answers. Instant pictures. Instant analysis. Instant understanding.

HOW IN THE WORLD CAN BORLAND SELL A PHENOMENAL PRODUCT LIKE REFLEX FOR ONLY $99.95?

At $495.00, Analytica's original price, Reflex was a bargain. Acclaimed by critics and praised by users, Reflex also got our attention at Borland International. We were so impressed by Reflex that we bought the company!

To celebrate that, we're making business software history by offering Reflex—FOR A LIMITED TIME—for ONLY $99.95! (Offer good through March 31, 1986).

That's $395.05 off the original price—which is a pretty good return on your toll-free phone call.

We think Reflex should be an "automatic product," a "standard" that every PC owner should own. That's why we priced it at $99.95. Naturally we've added our 60-day money-back guarantee and Borland's Reflex is not copy-protected.

4585 Scotts Valley Drive, Scotts Valley CA 95066
Phone (408) 438-8400 Telex 172373

Inquiry 40 for End-Users.
Inquiry 41 for DEALERS ONLY.

32-bit Floating-Point Processor

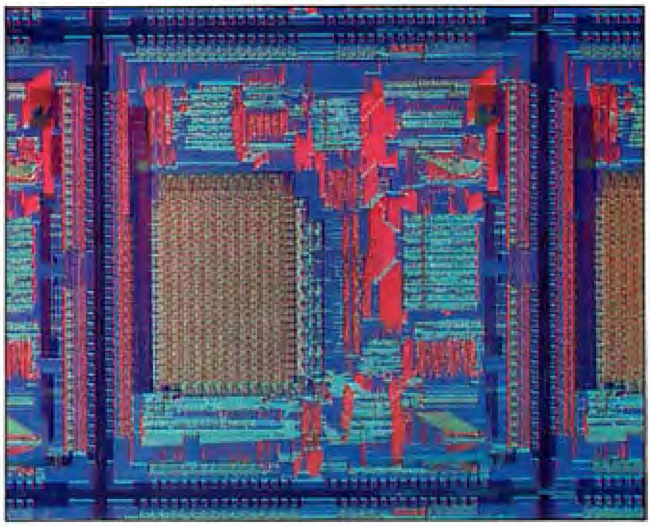
Advanced Micro Devices has developed a single-chip floating-point processor (FPP) that can perform 32-bit floating-point addition, subtraction, or multiplication within a single 150-nanosecond clock cycle. The Am29325 FPP has a flow-through architecture that features two 32-bit input buses and one 32-bit output bus.

This FPP is the first member of the planned Am29300 family of 32-bit bipolar microprocessors. It can perform a single-precision floating-point operation within 150 ns in the flow-through mode or 135 ns in the clocked mode. The chip can be employed in systems based on other microprocessors.

The Am29325 can perform arithmetic using either the IEEE floating-point standard P754 or the DEC single-precision floating-point format. It can also convert numbers between the IEEE and DEC formats and between 32-bit integer and floating-point formats.

In addition to the standard I/O configuration already described, the Am29325 can be selected for a 32-bit, two-bus architecture or a 16-bit, three-bus structure for use with 16-bit microprocessors. The input and output registers can be made transparent so the system designer can use external registers with no system speed penalty.

The Am29325 FPP comes in a 144-pin pin-grid-array package and is priced at $695 each in 100-unit quantities. Contact Advanced Micro Devices Inc., 901 Thompson Place, POB 3453, Sunnyvale, CA 94088, (408) 732-2400.
Inquiry 557.



The Am29325 floating-point processor from Advanced Micro Devices.

Low-Cost Word Processor

DAC Software's DAC Easy Word runs on the IBM Personal Computer and compatible machines. Commands are entered either by selecting options presented in a series of nested menus or by typing mnemonic Alt-key combinations.

The program can maintain up to four windows at a time, can import and export ASCII text, and has mail-merge capabilities. It supports margins up to 127 characters and can scroll horizontally. Other features include automatic hyphenation with a dictionary of more than 3000 cases, a 60-line buffer from which deleted text can be retrieved, access to DOS commands, word counting, and a spelling checker with a 70,000-word expandable dictionary.

DAC Easy Word requires at least 256K bytes of RAM and DOS 2.0 or higher. With 256K bytes of memory, the program can handle about 70 pages of text. It costs $49.95. Contact DAC Software Inc., 4801 Spring Valley Rd., Building 110-B, Dallas, TX 75244, (214) 458-60038.
Inquiry 558.

CAD Software for the IBM PC

Generic CADD from Generic Software is a $99.95 program for computer-aided design and drafting with the IBM PC. You can use it to design and draft in two dimensions on the computer screen using multiple layers, multiple line types, rubber-banding of lines and windows, user-definable video and digitizer menus, and component libraries. You draw with a mouse, digitizer, or keystroke commands.

The program features absolute or relative coordinate input, floating-point-based data, and unlimited picture size. The number of entities in a single drawing is limited only by memory size (640K bytes of RAM will allow approximately 40K lines).

You can choose from point, straight-line, rectangle, regular-polygon, circle, arc, ellipse, and curve (B-spline) drawing entities. You can select 256 layers, 256 colors, and 256 line types. The program provides for measurement of lengths, angles, and areas. Text placed in drawings can be scaled or rotated; multiple fonts are available.

Component libraries in Generic CADD can hold up to 256 different components for a single drawing. Such components can be included on menus and can be rotated, scaled, stretched, shrunk, or mirrored.

Generic CADD requires an IBM PC or compatible with at least 256K bytes of RAM, a video graphics board, an 8087 coprocessor (or an 80287 for an IBM AT), two floppy-disk drives, and DOS 2.0 or above. The recommended system configuration is a PC with 512K bytes or more of RAM, a medium-resolution video graphics board (720 by 350 monochrome or 640 by 400 color), a 10-megabyte hard-disk drive, a 12- by 12-inch digitizer, and a plotter. Generic CADD is priced at $99.95 with a 60-day unconditional money-back guarantee. Contact Generic Software Inc., 6 Lake Bellevue #203, Bellevue, WA 98005, (206) 462-1944.
Inquiry 559.

Macintosh Telecommunications

MicroPhone is a Macintosh telecommunications program written by Dennis Brothers, author of the public-domain program MacTEP. MicroPhone can emulate DEC VT-100, VT-52, and TTY-type terminals and provides ASCII and XMODEM file-transfer capabilities. Apple's Switcher is packaged with MicroPhone so that other applications

(continued)

NEW FROM BORLAND!

Borland introduces *Turbo* Lightning™ the fastest, most amazing information system since your brain

You can now find out everything in a flash. With instant access to electronic versions of the 83,000 word *Turbo* Lightning™ Random House® Speller & Word List; the 50,000-word *Turbo* Lightning Random House Thesaurus™ and the soon-to-be-released *Turbo* Lightning Encyclopedia™ — and to an astonishing array of electronic reference books which form Borland's new *Turbo* Lightning Library™.

Hitting one key on your IBM® personal computer — taps you into this new electronic age of instant information.

You get the right word, the right spelling, the right name, the right address, right now.

What we've done has been called "Artificial Intelligence," we simply call it "*Turbo* Lightning." This information revolution — driven by *Turbo* Lightning — means that the way you look things up is definitely looking up.

No matter what program you're running, *Turbo* Lightning instantly checks your spelling *as you type*. You could be running WordStar®, MultiMate™, SideKick®, Microsoft® Word, MCI Mail®, CompuServe®, or whatever, because as you work, as you write, *Turbo* Lightning is waiting in the wings, watching how you spell every word, but not getting in the way of what you're doing.

So how does it work? Let's say the word you meant to type was "RIGHT," but you accidentally typed 'RIHGT,' which is wrong. What happens then?

You immediately *hear* a '*beep*,' so you know there was a boo-boo. You instantly *see* a window, that doesn't list "RIHGT" but it does list 'RIGHT' and its sound-alike words. So your screen looks like this:

```
rihgt
Sound Alike Words
A: r i g h t
B: rights
C: righted
D: rightly
E: relight
F: righter
G. Add word to auxiliary dictionary
PgUp or PgDn for more words
```

So you move your cursor to "A," which is the right "right," hit Return and the spelling mistake is instantly fixed. And the program you were working on has continued to run while you did a little spelling sidetrip with *Turbo* Lightning. *(If you'd rather not remember your Spelling grades in school, the beep might make you nuts, but you can choose the "whole page" option. Which means that when you finish writing the entire page, any spelling mistakes will be highlighted. You go in and straighten things out straight away.)*

Lightning never goes away, is 100% concurrent, reliable, accurate and cannot, does not, will not 'crash & burn.'

Your document, letter, report, spreadsheet is word perfect and no one ever knows that you can't spell for *beens*.

***Turbo* Lightning does a lot more than spell "right" right, it also gives you instant synonyms.** Because you also have *Turbo* Lightning's Random House Thesaurus at your fingertips, you can really get to know your 'rights.' So back to the word "Right," but this time in the thesaurus. Type in "Right" and what you see in the on-screen window is:

```
right
Synonyms
-Adjective-
A:straight
B: true
C: accurate
D: s o u n d
E: normal
-Noun-
F: claim
G: title
H: due
I: ownership
PgUp or PgDn for more words
```

So you instantly know more than one way to say, "The Boss is always right," which is handy if you get cornered and have to lie like that.

Introduce yourself to *Turbo* Lightning and it will never ever forget your name. It's conceivable, if unfair, that your name is not in the dictionary already, but you can instantly teach *Turbo* Lightning your name and all the other names and words it needs to know to help run your business or personal life.

Once you've taught *Turbo* Lightning what it needs to know, you'll never blow it with a letter to the *Joint Cheefs of Staff*, the *Raygan White Howse* or mess something up on your IMB PC. (IMB PC is not a trademark of International Business Machine Corp!)

Not $500, not $400, not $300, not $200, not $100, just $99.95 for this instant electronic miracle. Our success is pretty simple. We're not greedy. We believe that it is better to sell hundreds of thousands of software programs at a reasonable price—instead of a few at prices that would make Jesse James blush.

Just $99.95 gets you into the *Turbo* Lightning Library—which is an incredible deal when you look at what you're getting. You're getting the 'access system'—*Turbo* Lightning—which is the "engine" that powers the whole *Turbo* Lightning Library. You're getting the "engine" plus the 83,000-word *Turbo* Lightning Random House Speller and Word List; the 50,000-word *Turbo* Lightning Random House Thesaurus. And you're getting all that for an *incredible* $99.95!

If you ever *write* a word, *think* a word or *say* a word, you need *Turbo* Lightning. We give you a 60-day money-back guarantee and of course there's no copy protection. $99.95 isn't much to pay for a mistake-free life. Not to mention an education. No matter who you are or what you do, you need *Turbo* Lightning. That $99.95 will be the best $99.95 you ever spent on yourself or your company.

Do yourself, your assistants, your secretary, your boss, your readers, your audience and your career a favor, get *Turbo* Lightning today!

NOT COPY-PROTECTED

TURBO Lightning

To order by Credit Card call (800) 255-8008, CA (800) 742-1133.
Available at better dealers nationwide. Call (800) 556-2283 for the dealer nearest you.

60-DAY MONEY-BACK GUARANTEE!

System Requirements:
128K IBM PC or 100% compatible computer, with 2 floppy disk drives.

Name ______
Shipping Address ______
City ______
State ______ Zip ______
Telephone ______

YES! Rush Turbo Lightning to me
Send me ____ copies

$99.95

This price includes shipping to all U.S. cities. All foreign orders add $10 per product ordered.

Subtotal ______
(CA res. add $6 tax per copy) ______
Amount Enclosed ______
Payment VISA MC BankDraft Check
Credit Card Exp. Date ______
Card # ______

L15

COD's and Purchase Orders WILL NOT be accepted by Borland. California residents add 6% sales tax. Outside USA add $10 and make payment by bank draft, payable in US dollars drawn on a US bank.

BORLAND INTERNATIONAL
4585 SCOTTS VALLEY DRIVE, SCOTTS VALLEY, CA 95066 PHONE (408) 438-8400 TELEX 172373

Inquiry 42 for End-Users. Inquiry 43 for DEALERS ONLY.

can be coresident with the program.

With MicroPhone, the Macintosh can automatically log on to a remote system, send and receive mail, transfer files, and log off, all without human intervention. Simpler macros can be activated with a single keystroke. Macros can be created using MicroPhone's "Watch Me" mode—in which the program observes prompts and keystrokes—or by using the program's Script window menus, or a combination of the two.

MicroPhone has a list price of $74.95. For more information, contact Software Ventures Corp., 2907 Claremont Ave., Suite 220, Berkeley, CA 94705, (800) 336-6477; in California, (800) 336-6478; in Canada, (800) 336-6479.

Inquiry 560.

Equity II and Equity III

Epson's Equity II (right) and Equity III.

Epson has released the Equity II, an IBM PC-compatible, and the Equity III, which is compatible with the PC AT.

The Equity II is based on NEC's 8086-compatible V30 microprocessor. While the Equity II normally operates at 7.16 MHz, it can also run timing-critical software at the same 4.77-MHz clock speed as the IBM PC. The Equity II includes a keyboard similar to the one shipped with IBM's PC AT, but without LEDs. For operator convenience, the power switch, volume control, and all DIP switches are located behind a drop-down front panel.

A combined monochrome/color-graphics controller, floppy-disk controller, serial and parallel ports, and 640K bytes of RAM are on the main system board. A 100-watt power supply, five open expansion slots, and space for up to two half-height disk drives allow for additional hardware. The system power can be turned on with the front-panel power switch or optionally by a preset timer or whenever the serial port detects a ring-detect signal. Power can be turned off manually or through a software command.

Like the PC AT, the Equity III includes eight expansion slots, a single 1.2-megabyte disk drive, serial and parallel ports, and room for up to four internal half-height disk drives. A hard-disk controller and 640K-byte RAM are also standard.

The Equity II with one 360K-byte disk drive will retail for under $1900. The Equity III with one 1.2-megabyte drive will be priced under $3500. Contact Epson America, Computer Products Division, 2780 Lomita Blvd., Torrance, CA 90505, (213) 539-9140.

Inquiry 561.

Data-Compression Units Multiply Modem Speed

Adaptive Computer Technologies now offers the ACT-1200A and the ACT-2400A, data-compression units for use with 1200- and 2400-bps full-duplex modems. These devices are stand-alone boxes that interface not only to modems but to terminals and computers through an RS-232C cable. They can be used for modem file transfer, transmission to a printer, or general, interactive terminal-to-computer work. To compress data, you need to have an ACT unit at each end of the line. However, the units do have a transparent mode that does not compress data but simply passes it along.

The ACT compression units analyze transmitted data and use statistical characteristics about that data to select a compression scheme. The units can stay with built-in tables, or they can invoke a dynamic history feature and agree to work with a new table based on the last few thousand characters. Because the units will derive the same new table, one doesn't have to send the entire table to the other; a short message suffices.

Repetitive strings are compressed using variable bit-length encoding. The compression ratio is not directly related to the type of file: Database files and text files will see the same sorts of compression. Compression factors range as high as 5:1, but 2:1 or 3:1 is typical. Encoding and decoding also incorporate a full CRC-16 error-correction process.

A series of menus lets you set certain compatibility and transmission options, which are then stored in nonvolatile memory inside the unit. You can modify the handshaking that alerts the units to the presence or absence of another compressor at the other end of the line.

The ACT-1200A costs $595. The ACT-2400A costs $795. Contact Adaptive Computer Technologies, 97 Boston Ave., Suite 103, San Jose, CA 95128, (408) 279-3993.

Inquiry 562.

Synthesizer Attaches to Parallel Port

Rayna Systems has developed a high-performance music synthesizer that can attach to almost any computer through a parallel printer port. The synthesizer has 59 oscillators, all of which have programmable frequency, volume, and waveform.

These oscillators can be combined to produce a varied collection of sounds. In addition, output can be channeled into any of four output jacks to provide quadraphonic sound. A sample BASIC program shows how the synthesizer can be set up. For CP/M systems, additional software is available, including a $150 program that allows you to edit musical note sequences and instrument characteristics in real time.

The price of the Rayna Synth-in-a-Box is $850. As an S-100 board, the product costs $650. Contact Rayna Systems, 460 9th St., Brooklyn, NY 11215, (718) 499-8457.

Inquiry 563.

(*continued on page* 408)

FOR THE FIRST TIME... HIGH PERFORMANCE BACKUP AT A FLOPPY TAPE PRICE

WHO NEEDS FLOPPY TAPE !!

The Everex EXCEL STREAM-20 Cassette Backup System

- No extra expansion slot needed
- High Speed—up to 10MB in just 2 minutes
- No time-consuming pre-formatting
- 20MB backup capacity
- Same price as 10MB floppy tape systems
- Internal and external models for the PC, XT and AT

	EVEREX EXCEL STREAM-20	Floppy Tape	Sysgen Image
Capacity	20MB	10MB	10MB
No extra slot needed	•	•	
Backup time for 10MB	2min.	16min.	4min.
Automatic Verification	•		•
Automatic formatting	•		•
File-by-File Restore from Image Backup	•		
Internal Model	•	•	

Replace your floppy disk controller with Everex's combination cassette AND floppy disk controller—no extra cost, no extra slot needed. Data is *automatically* verified/corrected and the tape is pre-formatted during backup—saving you the 30 minutes you waste to format and verify with a floppy tape system. The STREAM-20 includes the most advanced backup/restore software. The choice is simple—the Everex EXCEL STREAM-20 Cassette backup system—High Performance backup at a floppy tape price. Visit your local Everex Dealer today and ask to see the STREAM-20 in action. For the name of your nearest Everex Dealer, please call 415-498-1111.

Address: 47777 Warm Springs Blvd.,
Fremont, CA 94539
TELEX: 5101000590 EVEREX
FAX: 415-651-0728

Dealer Hotline: (800) 821-0806
In CA (800) 821-0807

EVEREX
EVER for EXcellence

A·S·K B·Y·T·E

Conducted by Steve Ciarcia

RAM FOR APPLE

Dear Steve,

I have a 294K-byte RAM card made by "Syntex, Redmond" for the Apple II. Apparently, the company was originally located in the state of Washington and merged with another company.

I need information on installation and use of the product. Any help you could give me would be appreciated.

STAN REED
Eagle River, AK

There was a company called Syntex in Redmond, Washington, that made a RAM card for the Apple called Flashcard. That company, however, is no longer in business. An Apple Pascal 1.2 driver to configure the Flashcard as a soft disk drive is available from

A.P.P.L.E. Co-op
290 Southwest 43rd St.
Renton, WA 98055

ProDOS drivers are available from

Microseeds
20 Goodell Rd.
Stafford Springs, CT 06076

—Steve

6502 MATH

Dear Steve,

Do you know of a book that explains 6502 math utilities? I need something that develops the algorithms for floating point, random numbers, rounding errors, trigonometric functions, logarithms, powers, roots, and so on.

I'm in prison here in Texas, and I work in the electronics shop. I use an Apple IIe and would like to write my own math functions, but I've been hampered by the lack of proper algorithms. I managed to figure out a floating-point format using a 64-bit mantissa, a 15-bit characteristic, and a sign bit. After that, the only algorithm I could find was a Taylor power series in a calculator book.

It is very frustrating to order computer books by mail without any recommendations. I don't have any reference library except the one I have put together myself.

MICHAEL SANDERS
Huntsville, TX

Three good sources of the kind of information you are seeking are

Ahl, David H. Computers in Mathematics: A Sourcebook of Ideas *(Creative Computing Press)*

Bennett, William. Scientific and Engineering Problem-Solving with the Computer *(Prentice-Hall)*

Knuth, Donald E. The Art of Computer Programming, Volume 2: Semi-Numerical Algorithms *(Addison-Wesley)*

Current prices and relevant ordering information can be obtained by writing directly to the publishers.—Steve

JUST ONE MINOR QUESTION

Dear Steve,

Could you advise me on how to learn more about microcomputers? I do have some computer background: I've taken graduate physics courses in micros and courses in FORTRAN, assembly language, and the use of BASIC and machine language. I've also used RCA and DEC mainframe computers.

I am looking for a way to make an Atari run Commodore and Apple programs, since they all use the 6502 processor. Can you use tristate buffers to switch to different operating-system ROMs, I/O ports, etc.? This leads me to ask about emulation—is it an advanced program lookup table (what *is* a lookup table?) that makes the processor think it is in a different machine? Or does it just translate the program to the other machine's requirements? Can an emulation ROM be bank-switched in to translate the program?

I've read that an operating system has been written in the C programming language. How? I've looked at a couple of operating-system programs, but I admit I don't know much about the subject. I couldn't write my own, and I have only a vague concept of the BIOS. How can I learn lots more?

How does the Commodore C-128 tie together the 6502 and the Z80? Using a coprocessor? (What is a coprocessor?) How does the Heath/Zenith H-89 use one Z80 to control a second Z80 in a processor/slave arrangement? Where can I learn how to use a Z80 or a 6502 to control a 68000? How does the operating system control parallel processors, such as an 8086 with an 8087?

I'm not sure I understand the DMA concept or how a cache memory works. How are programs (and the operating system) written to handle a RAM disk? A bubble memory? Can dynamic memory be used in the RAM disk? How is refreshing handled?

MSX is being promoted as an 8-bit operating-system standard. Where can I find out more? Can I convert an old Radio Shack computer to use MSX? How? Where can I find an operating-system ROM?

I think I know some basics about micros, but where do I go for an intermediate education? I do try to read BYTE regularly—especially your articles—but sometimes I have more questions than understanding.

MERLE RUMMEL
Liberty, IN

Mr. Rummel, you ask a lotta questions.

Your letter is filled with questions ranging from basics to advanced hardware/software techniques. As a beginning, the best way to learn a subject is to read and experiment. You should have some computer-related textbooks left over from college that would provide a good start. In addition, a trip to your library and a well-stocked bookstore will provide a wealth of computer-related information. You can select books that furnish information at a level you can understand.

Making a series of computers that utilize the same microprocessor chip (and therefore the same instruction set) is not as simple as changing an operating-system ROM. The address locations of the I/O ports on one machine are usually different from those on another. This means that you have to change one machine's operating system's port addresses to fit the new machine. Device addresses, memory addresses, etc., are set by hardware, not software. Consequently, a program that runs on an Apple will not load and run successfully on a Commodore or Atari computer, even though they all share the same microprocessor.

An operating system can be written in

(continued)

Clipper gives dBASE III™ users more time to do more. Or less.

Clipper™ allows you to run all dBASE III™ programs 2 to 20 times faster than they do with the standard dBASE interpreter.

That frees up extra time you're wasting if you're running dBASE III programs without Clipper.

Extra time to think. To create. To produce. To use as you choose.

You see, Clipper is the first true compiler for dBASE III. Clipper eliminates the time-consuming translation which the dBASE interpreter performs line after line whenever a program is run.

With Clipper, once you've debugged your source code, it's compiled into more efficient machine code.

And Clipper compiles all your dBASE III programs. The ones you have today. The ones you'll have tomorrow. But don't wait until tomorrow to order Clipper.

Today, Clipper has already been purchased to speed up dBASE run time at 3M and Touche Ross. At Exxon and NASA. In the Harvard Physics Department. For the State of Arizona and TRW.

And that's just a few of the installations worldwide. From Greece to Venezuela to Canada to Europe.

So stop wasting time. Call our toll-free 800 number and get Clipper.

You'll spend less time running dBASE III and more time running the rest of your life.

nantucket™

Inquiry 259 for End-Users. Inquiry 260 for DEALERS ONLY.

5995 S. Sepulveda Blvd., Culver City, CA 90230 (800)251-8438 In California (213)390-7923

C, FORTRAN, COBOL, Pascal, etc. An operating system tells the microprocessor how to talk to a computer system's various components, like disk drives, printers, terminals, parallel ports, serial ports, etc. This can be done in any language, provided it is eventually compiled into the machine instructions required by a particular microprocessor.

A coprocessor is used to assist the main processor or to perform a task more efficiently than the main processor can. An example is the 8087 math coprocessor used with the 8088/86 series of microprocessors. The 8087 performs mathematical computations many times faster than the 8088/86. Since a coprocessor usually shares the same data and address bus as the main processor, special hardware is required to assure that only one processor has control of the bus at any given time.

DMA (direct memory access) is a method by which a device reads and writes directly to RAM without intervention or help from the main processor. This allows high-speed data transfer and is usually provided by a dedicated DMA controller chip or a separate processor.

A RAM disk is a program that sets aside a portion of memory for use as a disk drive. It does this by fooling the operating system into "thinking" that this RAM is a physical drive. Dynamic RAM can be used as a RAM disk, as can bubble memory and static RAM. The operating system and RAM-disk program don't care if the memory is dynamic, bubble, or static; these are all handled by hardware.

Since dynamic memory is based on charge-storage in capacitors, rather than

(continued)

The C for Microcomputers

AZTEC C

PC-DOS, MS-DOS, CP/M-86, Macintosh, Amiga, Apple II, CP/M-80, Radio Shack, Commodore, XENIX, ROM, and Cross Development systems

MS-DOS, PC-DOS, CP/M-86, XENIX, 8086/80x86 ROM

Manx Aztec C86

"A compiler that has many strengths ... quite valuable for serious work"

Computer Language review, February 1985

Great Code: Manx Aztec C86 generates fast executing compact code. The benchmark results below are from a study conducted by Manx. The Dhrystone benchmark (CACM 10/84 27:10 p1018) measures performance for a systems software instruction mix. The results are without register variables. With register variables, Manx, Microsoft, and Mark Williams run proportionately faster, Lattice and Computer Innovations show no improvement.

	Execution Time	Code Size	Compile/ Link Time
Dhrystone Benchmark			
Manx Aztec C86 3.3	34 secs	5,760	93 secs
Microsoft C 3.0	34 secs	7,146	119 secs
Optimized C86 2.20J	53 secs	11,009	172 secs
Mark Williams 2.0	56 secs	12,980	113 secs
Lattice 2.14	89 secs	20,404	117 secs

Great Features: Manx Aztec C86 is bundled with a powerful array of well documented productivity tools, library routines and features.

Optimized C compiler	Symbolic Debugger
AS86 Macro Assembler	LN86 Overlay Linker
80186/80286 Support	Librarian
8087/80287 Sensing Lib	Profiler
Extensive UNIX Library	DOS, Screen, & Graphics Lib
Large Memory Model	Intel Object Option
Z (vi) Source Editor -c	CP/M-86 Library -c
ROM Support Package -c	INTEL HEX Utility -c
Library Source Code -c	Mixed memory models -c
MAKE, DIFF, and GREP -c	Source Debugger -c
One year of updates -c	CP/M-86 Library -c

Manx offers two commercial development systems, Aztec C86-c and Aztec C86-d. Items marked -c are special features of the Aztec C86-c system.

Aztec C86-c Commercial System	**$499**
Aztec C86-d Developer's System	**$299**
Aztec C86-p Personal System	**$199**
Aztec C86-a Apprentice System	**$49**

All systems are upgradable by paying the difference in price plus $10.

Third Party Software: There are a number of high quality support packages for Manx Aztec C86 for screen management, graphics, database management, and software development.

C-tree $395	**Greenleaf $185**
PHACT $250	**PC-lint $98**
HALO $250	**Amber Windows $59**
PRE-C $395	**Windows for C $195**
WindScreen $149	**FirsTime $295**
SunScreen $99	**C Util Lib $185**
PANEL $295	**Plink-86 $395**

MACINTOSH, AMIGA, XENIX, CP/M-68K, 68k ROM

Manx Aztec C68k

"Library handling is very flexible ... documentation is excellent ... the shell a pleasure to work in ... blows away the competition for pure compile speed ... an excellent effort."

Computer Language review, April 1985

Aztec C68k is the most widely used commercial C compiler for the Macintosh. Its quality, performance, and completeness place Manx Aztec C68k in a position beyond comparison. It is available in several upgradable versions.

Optimized C	Creates Clickable Applications
Macro Assembler	Mouse Enhanced SHELL
Overlay Linker	Easy Access to Mac Toolbox
Resource Compiler	UNIX Library Functions
Debuggers	Terminal Emulator (Source)
Librarian	Clear Detailed Documentation
Source Editor	C-Stuff Library
MacRam Disk -c	UniTools (vi,make,diff,grep) -c
Library Source -c	One Year of Updates -c

Items marked -c are available only in the Manx Aztec C86-c system. Other features are in both the Aztec C86-d and Aztec C86-c systems.

Aztec C68k-c Commercial System	**$499**
Aztec C68d-d Developer's System	**$299**
Aztec C68k-p Personal System	**$199**
C-tree database (source)	**$399**
AMIGA, CP/M-68k, 68k UNIX	**call**

Apple II, Commodore, 65xx, 65C02 ROM

Manx Aztec C65

"The AZTEC C system is one of the finest software packages I have seen"

NIBBLE review, July 1984

A vast amount of business, consumer, and educational software is implemented in Manx Aztec C65. The quality and comprehensiveness of this system is competitive with 16 bit C systems. The system includes a full optimized C compiler, 6502 assembler, linkage editor, UNIX library, screen and graphics libraries, shell, and much more. The Apple II version runs under DOS 3.3, and ProDOS, Cross versions are available.

The Aztec C65-c/128 Commodore system runs under the C128 CP/M environment and generates programs for the C64, C128, and CP/M environments. Call for prices and availability of Apprentice, Personal and Developer versions for the Commodore 64 and 128 machines.

Aztec C65-c ProDOS & DOS 3.3	**$399**
Aztec C65-d Apple DOS 3.3	**$199**
Aztec C65-p Apple Personal system	**$99**
Aztec C65-a for learning C	**$49**
Aztec C65-c/128 C64, C128, CP/M	**$399**

Distribution of Manx Aztec C

In the USA, Manx Software Systems is the sole and exclusive distributor of Aztec C. Any telephone or mail order sales other than through Manx are unauthorized.

Manx Cross Development Systems

Cross developed programs are edited, compiled, assembled, and linked on one machine (the HOST) and transferred to another machine (the TARGET) for execution. This method is useful where the target machine is slower or more limited than the HOST, Manx cross compilers are used heavily to develop software for business, consumer, scientific, industrial, research, and educational applications.

HOSTS: VAX UNIX ($3000), PDP-11 UNIX ($2000), MS-DOS ($750), CP/M ($750), MACINTOSH ($750), CP/M-68k ($750), XENIX ($750).

TARGETS: MS-DOS, CP/M-86, Macintosh, CP/M-68k, CP/M-80, TRS-80 3 & 4, Apple II, Commodore C64, 8086/80x86 ROM, 68xxx ROM, 8080/8085/Z80 ROM, 65xx ROM.

The first TARGET is included in the price of the HOST system. Additional TARGETS are $300 to $500 (non VAX) or $1000 (VAX).

Call Manx for information on cross development to the 68000, 65816, Amiga, C128, CP/M-68K, VRTX, and others.

CP/M, Radio Shack, 8080/8085/Z80 ROM

Manx Aztec CII

"I've had a lot of experience with different C compilers, but the Aztec C80 Compiler and Professional Development System is the best I've seen."

80-Micro, December, 1984, John B. Harrell III

Aztec C II-c (CP/M & ROM)	**$349**
Aztec C II-d (CP/M)	**$199**
C-tree database (source)	**$399**
Aztec C80-c (TRS-80 3 & 4)	**$299**
Aztec C80-d (TRS-80 3 & 4)	**$199**

How To Become an Aztec C User

To become an Aztec C user call 1-800-221-0440 or call 1-800-832-9273 (800-TEC WARE). In NJ or outside the USA call 201-530-7997. Orders can also be telexed to 4995812.

Payment can be by check, COD, American Express, VISA, Master Card, or Net 30 to qualified customers.

Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

How To Get More Information

To get more information on Manx Aztec C and related products, call 1-800-221-0440, or 201-530-7997, or write to Manx Software Systems.

30 Day Guarantee

Any Manx Aztec C development system can be returned within 30 days for a refund if it fails to meet your needs. The only restrictions are that the original purchase must be directly from Manx, shipped within the USA, and the package must be in resalable condition. Returned items must be received by Manx within 30 days. A small restocking fee may be required.

Discounts

There are special discounts available to professors, students, and consultants. A discount is also available on a "trade in" basis for users of competing systems. Call for information.

Inquiry 222

MANX

To order or for information call:

800-221-0440

a flip-flop circuit (as in static memory), dynamic RAM requires a periodic refresh pulse to offset the effects of the capacitor's leakage. This refresh pulse is provided either by the processor (such as the Z80's refresh pin) or some other timed-pulse generating circuitry.

As far as converting a Radio Shack computer to run an operating system other than what it was designed for, I suggest you visit your local Radio Shack computer store and discuss the details of this with them.—Steve

VERSACARD

Dear Steve,

I have a problem with my Prometheus VERSAcard in my Apple II. I've sent several letters to the manufacturer with no reply.

When I use my Signalman Mark XII modem at 1200 bps, the VERSAcard drops between five and eight characters following each carriage return. This occurs in either a 40- or 80-column display. I've tried four terminal programs with the same result. I've also tried the modem on two other computers with no problem. Do you have any ideas?

STEVE NELSON
Euless, TX

This type of problem is frequently due to incompatible or inadequate handshaking signals: The VERSAcard and the modem may not know who's going to do what, and when. I would suspect the DTR (data terminal ready) signal, pin 20, on the standard DB-25 connector. On the VERSAcard, this line is tied permanently high. The Signalman modem, in its default configuration, uses this line to determine when the VERSAcard is ready for more data.

As characters are received through the modem and serial card, the terminal program stores them in a buffer (frequently, the Apple's keyboard-input buffer is used for this purpose). When a carriage-return character is received, the terminal program signals the modem to stop sending data and processes this buffer. If the modem doesn't receive this signal, it will continue sending characters and the terminal program will miss some characters.

If the DTR signal is the cause of your problem, the solution is probably attained most easily in software. You should configure your modem to ignore the DTR line, then implement a suitable software handshaking protocol, like the XON/XOFF protocol. The terminal program you are using will determine which software protocols you can use. Two terminal programs that work well with the VERSAcard/Signalman combination are ASCII Express, from United Software, and Modem Magician, available from A.P.P.L.E. Co-op, 290 Southwest 43rd St., Renton, WA 98055.—Steve

MUSIC, MUSIC, MUSIC

Dear Steve,

Some friends and I are developing software for producing printed output in musical notation from data input by a musical keyboard. At the moment, we are using a Wersi organ because it delivers logical MIDI (musical instrument digital interface) data in physical RS-232C format. This organ is very expensive, and we would like to use a much cheaper MIDI keyboard. Since the computer we are using has only an RS-232C serial interface, we will need a MIDI-to-RS-232C converter. Do you know of any such converter?

ERICH NEUWIRTH
Vienna, Austria

Ferro Productions (228 Washington Ave., Belleville, NJ 07109, (201) 751-6238) has written several tutorials on the MIDI and music synthesis. According to a company source, they will be releasing a new MIDI course in the next few months. In addition, a book will be available that also covers this subject. Contact the company for information concerning the course.

The book, MIDI and Related Interfaces, *will be available through*

Cherry Lane Music
POB 430
Port Chester, NY 10573
(914) 937-8601

You should also check into MIDI boards that plug directly into most personal computers. Cherry Lane Music carries such hardware, as does

Syntech Corporation
23958 Craftsman Rd.
Calabasas, CA 91302
(818) 704-8509

—Steve

HARDWARE EDUCATION

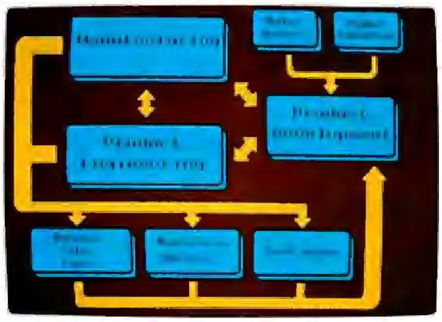
Dear Steve,

I have been in the computer field for about six years and have done mostly software work. My only hardware project was building an S-100 system for my own use.

(continued)

PC Paintbrush.™ Because life is too short for monochrome pie charts.

Go on, live a little.



Fun is the best thing to have.

With PC Paintbrush, you can add color, flair, dimension and creativity to a chart, a presentation, or an otherwise dull day. From charts and graphs to serious computer art, our newest generation 3.0 PC Paintbrush will cheer you on with features no other graphics package can match.

Best of all, it's easy to use. You don't have to learn up to sixty commands, like you do with some products. If you can understand icons as simple as scissors, paintbrush, spray can and paint roller, you're ready to start using PC Paintbrush.

The pen is mightier than the keyboard.

None of history's great artists drew with a keyboard, and you shouldn't have to either. So PC Paintbrush is now available with a cordless PenMouse, to give you complete freedom of expression. Of course, it also supports regular mice, joysticks, graphics tablets, and is compatible with most graphics cards.

PC Paintbrush also has a beautiful way with words. The text icon lets you write in any of eleven fonts, in nine sizes, with italics, outline, shadow and boldface variations.

What's more, with the new 3.0 PC Paintbrush, you can draw rounded boxes, rubber band curves and circles, and edit pictures many times larger than the screen.

Are we making fun of 1-2-3®? Why not?

For Lotus™ users, PC Paintbrush's new PIC interpreter loads 1-2-3™ and Symphony™ charts and graphs at your equipment's best resolution, from an IBM EGA™ (640 X 350 X 16 colors) to a Number Nine Revolution™ (512 X 512 X 256 colors).

With our FRIEZE™ frame grabber you can pull graphics created by any program right off the screen into PC Paintbrush. So you can take your Paintbrush and pallette anywhere, improving the looks of things as you go. And having a lot of fun on the way. In addition, our optional presentation package, PC PRESENTATION, allows you to program your graphics into a first class presentation with fades, zooms, quick cuts and animation.

PC Paintbrush supports 19 video graphics cards and 30 printers and plotters.

For more information on PC Paintbrush, call or write us at the address below, or ask your computer dealer for a demonstration.

Z·SOFT
PC Paintbrush

Corporate Headquarters:
ZSoft Corporation, 1950 Spectrum Circle, Suite A 495, Marietta, GA 30067, 404/980-1950
West Coast Sales Office:
160 Sir Francis Drake Blvd., San Anselmo, CA 94960, 415/456-0955

Inquiry 401 for End-Users. Inquiry 402 for DEALERS ONLY.

I am writing for some advice on how I can learn about hardware, enough so that I will be able to troubleshoot and repair microprocessor systems.

If you could recommend some books or courses, I would greatly appreciate it.

LEONARD SIMON
Kenvil, NJ

A good way to learn a subject is to familiarize yourself with the selection of books at your local library on the topic of interest. This is also an inexpensive approach since you don't have to purchase books that are either too technical or too basic for you. In addition, authors and publishers of a book that is useful for a particular subject generally publish related works, a handy source for contacts. You can also stop by a well-stocked bookstore and browse through its selection of electronics and computer-related publications. I have found many interesting books this way.

Howard W. Sams publishes a set of five books called Basic Electricity and Electronics. *Each book sells for $10.95. A few more useful books from Sams are* Digital Logic Circuits: Tests and Analysis *by Robert G. Middleton ($16.95) and* Microprocessor Circuits *by Edward M. Noll ($9.95 for each of two volumes). All these books can be obtained from the publisher or from the following company:*

Hughes-Peters Inc.
481 East Eleventh Ave.
Columbus, OH 43211
(614) 294-5351

The use of home-study courses and technical schools provides for the best training. You are offered assistance when required and receive feedback as to your progress and knowledge in the form of grades.—Steve ■

IN ASK BYTE, Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to

Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury, CT 06033

Due to the high volume of inquiries, personal replies cannot be given. All letters and photographs become the property of Steve Ciarcia and cannot be returned. Be sure to include "Ask BYTE" in the address.

The Ask BYTE staff includes manager Harv Weiner and researchers Larry Bregoli, Bill Curlew, Jeannette Dojan, Jon Elson, Roger James, Frank Kuechmann, Dick Sawyer, Andy Siska, and Robert Stek.

MICROSOFT LANGUAGES NEWSLETTER Vol. 1-1

News about the Microsoft Language Family

Faster Macro Assembler 4.00 release developed in Microsoft C

By porting the new Macro Assembler 4.00 release to Microsoft C, it assembles programs from 2 to 3 times faster than the previous Microsoft 3.00 and IBM® 2.00 releases. The mixed language and memory model support unique to Microsoft C allowed the new assembler to be written as a small model program using the more efficient Pascal calling conversions for all internal functions. Macro text, symbol names and file buffers were moved out of the 64K "near" workspace into "far" memory allowing much larger programs to be assembled. Additional performance tuning was possible in C by using register variables throughout the assembler. Final profiling identified a few critical small routines to write in assembly language.

The source symbolic debugger, SYMDEB, has been enhanced to include screen swapping, stack backtracing, DOS command execution, better source display and debugging features making this the ideal tool for debugging programs. The 25% faster LINK and the EXEPACK utility can compress executable files by removing common sequences and optimizing the relocation tables. The MAKE utility now supports macros and inference rules.

We are committed to making the complete Macro Assembler product the best value in PC development tools.

News for Microsoft and IBM COBOL users

The new Microsoft® COBOL 2.1 release for MS-DOS® and XENIX® features faster execution and support for the new COBOL Tools package which contains VIEWCOB, COBREF, Menu Handler, and CBMOUSE (MS-DOS only). VIEWCOB is an interactive symbolic debugger with an easy-to-learn, menu-driven user interface which supports on-line help and up to 10 windows on your source text, variables, memory, and procedu re traces. The COBOL trace mode highlights each statement as it is executed. COBREF is an advanced COBOL cross reference generator that displays lists of files, variables with types, and procedures. Menu Handler and CBMOUSE allow the COBOL programmer to create menu-driven applications to interface to the Microsoft Mouse.

Microsoft C Selected for the IBM personal computer C compiler

The IBM C compiler is a repackaging of the Microsoft C Compiler with a few utilities from the Microsoft Macro Assembler product. A XENIX version of the same compiler is part of Microsoft's XENIX system V release. IBM also distributes Microsoft BASIC, COBOL, FORTRAN, and Pascal compilers, BASIC interpreter and Macro Assembler under its own logo. Microsoft offers special upgrade pricing to owners of certain Microsoft languages purchased through IBM. Call us for more information.

Write to: MICROSOFT Languages Newsletter
10700 Northup Way, Box 97200
Bellevue, WA 98009 for product update and information.
Or phone:
(800) 426-9400. In Washington State and Alaska,
(206) 828-8088. In Canada, call (416) 673-7638.

Latest DOS Versions:	
C	3.00
COBOL	2.10
FORTRAN	3.31
Macro Assembler	4.00
Pascal	3.31
QuickBASIC	1.00

Inquiry 88 for Apple. Inquiry 89 for IBM Peripherals. Inquiry 90 for all others.

LA POINTE[SM] INC.

#B33

LOW PRICES TO PROFESSIONALS WHO KNOW WHAT THEY WANT AND KNOW HOW TO USE IT!

TO ORDER, CALL (800) 547-1289

gift wrapping available. Just ask!

FOR YOUR IBM-PC, XT, AT or JR

COMPUTER SYSTEMS

MAGNUM

8088-2 PC/XT-2 **$995**

640K, Two 360K Drives

Plus: MS-DOS 2.11, Parallel Port, 2 Serial Ports (RS 232C), Clock/Calendar, Floppy Drive & Tape Backup Controller, 5 slots, 135 Watt Power Supply, 8087-2 optional, Selectric PC/AT Style Keyboard.

w/1 Floppy & 10 meg Hard Drive **$1595**

Please call for other configurations
Above prices do not include video card or monitor

IBM-PC
256K, 2 360K Disk Drives — IN STOCK

OTHER HARDWARE

	LIST	CONROY
AST, SixPak Plus, 64K	$ 395	$ 239
SixPak Plus, 256K, S/P/CC+S/W	$ 695	$ 259
SixPak Plus, 384K, S/P/CC+S/W	$ 895	$ 269
Preview™ Graphics Card w/para, 64K	$ 399	$ 249
Advantage™ Multif. Bd. for AT, 128K	$ 595	$ 445
I/O Plus II, S/P/CC	$ 215	$ 169
I/O Plus II, S/P/CC/G	$ 265	$ 225
Port Kits - ser, para, or game, ea.	$ 50	$ 35
CENTRAL POINT, PC Option Board	$ 95	$ 81
COMX, 130 Watt Power Supply	$ 179	$ 93
Selectric PC/AT Style Keyboard	$ 195	$ 95
CURTIS, Command Center	$ 180	$ 119
EVEREX, The Edge, Color/Mono Brd	$ 399	$ 269
HAUPPAGE (HCW), 8087 Chip	$ 175	$ 125
8087 Math Pak (Chip & softw.)	$ 295	$ 219
80287, Fast-5	$ 295	$ 239
HAYES, Mach II Joystick	$ 45	$ 29
Mach III (PC or Jr.)	$ 55	$ 35
HERCULES, Color Card w/para.	$ 245	$ 159
Mono Graphics Card	$ 499	$ 309
IMSI, Mouse with Paintbrush	$ 220	$ 129
KENSINGTON, Masterpiece™	$ 140	$ 92
Masterpiece Plus	$ 180	$ 137
KEY TRONIC, KB5151, Std. Keyboard	$ 255	$ 189
KB 5153 Keyboard w/Touch Tab	$ 400	$ 325
KOALA, Speed Key Software	$ 100	$ 63
Speed Key System (Tab w/ softw)	$ 200	$ 115

OTHER HARDWARE

	LIST PRICE	CONROY PRICE
KOALA, Koala Pad w/PC Design	$ 150	$ 85
MAYNARD, SAND STAR SERIES IN STOCK		CALL
Multifunction (6) Card	$ 89	$ 79
Memory Card no RAM	$ 199	$ 139
Serial Port Module	$ 95	$ 79
Para or Clock Cal. Module, ea.	$ 59	$ 49
MICROSOFT, Mouse (for PC)	$ 195	$ 129
Serial Mouse	$ 195	$ 145
MOUSE SYSTEMS, PC Mouse & Paint	$ 220	$ 145
PARADISE, Modular Graphics Card	$ 395	$ 295
Parallel or Serial Port, ea.	$ 95	$ 66
256K Module w/clock	$ 195	$ 165
PERSYST, PC/Mono Board, w/para	$ 250	$ 159
PC/Color Graphics Board	$ 244	$ 176
QUADRAM, Quadboard, no RAM, to 384K	$ 295	$ 195
Quadboard 64K, to 384K, S/P/CC/G	$ 395	$ 239
Quadboard 256K, to 384K, S/P/CC	$ 675	$ 269
Quadboard, 384K (full), S/P/CC/G	$ 795	$ 279
Quadboard II, no RAM, to 256K	$ 295	$ 215
Quadboard II, 256K, 2S/CC	$ 595	$ 395
Quad 512 + 64K w/serial port	$ 325	$ 245
Quadcolor I, board, 4 colors	$ 295	$ 175
Upgrade Quadcolor I to II kit	$ 275	$ 149
Quadnet VI	$1995	$1045
Quadlink	$ 495	$ 375
Quadsprint	$ 645	$ 495
TALLTREE, J RAM II Board	$ 219	$ 159
JRAM II Modules		IN STOCK
JRAM III, 256K Board	$ 399	$ 309
TECMAR, Maestro, 128K to 3MB, S/P for AT	$ 589	$ 459
Graphics Master	$ 695	$ 519
TITAN, 128K PC Accelerator	$ 795	$ 595
VIDEO 7, Mono Graphics Card	$ 250	$ 179
MGC w/ Parallel Port	$ 300	$ 215
VEGA Board (EGA Compatible)	$ 599	$ 429
WICO, Smartboard Keyboard	$ 400	$ 279

★ ★ FOR YOUR PC-JR ★ ★

	LIST	CONROY
KEY TRONIC, KB5151 Jr. Keyboard	$ 255	$ 189
Numeric Keypad	$ 69	$ 52
KOALA, Touch Tablet for Jr.	$ 125	$ 75
MOUSE SYSTEMS, Mouse w/software	$ 220	$ 138
QUADRAM, Expansion Chassis	$ 695	$ 540
Memory Expansion Board 128K	$ 275	$ 215
RACORE, Expansion Chassis	$ 675	$ 449
128K Expansion Board	$ 275	$ 189
TECMAR, Jr. Captain	$ 395	$ 309

MEMORY

256K KIT **$32**

64K KIT **$7**

128K KIT **$39**

90 Day Warranty by us

CALL FOR QUANTITY PRICES

MAGNUM

EconoRAM™ 384K Single Function Board

LIST $99 **$89**

With Fastrak™, RAMdisk and Print Spooler. Requires 256K of memory already installed.

PC MASTERCARD™

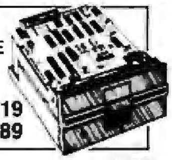
The Only Multifunction RAM Card Expandable to 1.5 MB

	LIST	CONROY
"0" KB	$169	$139
384 KB	$199	$179
1.5MB	$399	$349

Works like AST SixPak™ except includes game port. Also has serial port, parallel port, clock/calendar, 1.5 MB RAMdisk, 1.5 MB print spooler, 1.5 MB bank switching development and utility software: SiliconBullet.™ 1 Year Limited Warranty.

FLOPPY, HARD & TAPE DRIVES

CDC, 360K DS/DD DISK DRIVE
Limited 30 day warranty
Call for quantity prices



Full Height **$119**
Half Height **$ 89**

	LIST	CONROY
CDC, (39 msec. access time)		
Internal 20 meg kit FOR AT	$1695	$1195
CORE INT'L, (39 msec. access time)		
ATplus 20 meg kit FOR AT	$1395	$1095
ATplus 30 meg kit FOR AT	$1595	$1245

	LIST	CONROY
IRWIN,		
10 meg tape backup system	$ 795	$ 449
10 meg tape cartridges (by 3M)	$ 25	$ 19
KAMERMAN,		
10 meg kit w/controller	$ 895	$ 579
20 meg kit w/controller	$ 995	$ 695
Masterflight 10 meg w/tape	$2295	$1795
SEAGATE,		
10 meg w/controller	$ 745	$ 459
20 meg w/controller	$ 895	$ 489
TALLGRASS,		
24 meg disk, 10 meg tape	$3495	$2490

SOFTWARE FOR YOUR IBM-PC, XT, AT or JR

BUSINESS

	LIST PRICE	CONROY PRICE
ASHTON-TATE, Framework II	$ 695	$ 415
dBase III	$ 695	$ 395
dBase II, (req. PC-DOS & 128K)	$ 495	$ 289
BORLAND, Reflex: The Analyst	$ 99	$ 59
BPI, General Acctg. AR, AP, or PR, ea	$ 595	$ 365
BREAKTHROUGH, Timeline	$ 495	$ 295
BRODERBUND, Bank St. Writer (PC or Jr.)	$ 80	$ 51
CDEX, Advanced Training for Lotus 1-2-3	$ 70	$ 45
CONTINENTAL, Ultrafile	$ 195	$ 115
Tax Advantage	$ 70	$ 40
Property Management	$ 495	$ 295
DATA TRANS., Fontrix	$ 155	$ 99
Font Packs, each	$ 20	$ 19
DOW JONES, Market Manager Plus	$ 249	$ 159
Market Analyzer	$ 349	$ 229
Spread Sheet Link	$ 249	$ 159
FOX & GELLER, Quickcode III	$ 295	$ 185
HARVARD, Total Project Manager	$ 495	$ 295
HOWARD SOFT, '86 Tax Preparer	$ 295	$ 199
HUMAN EDGE, Mind Prober (PC or Jr.)	$ 50	$ 29
Sales Edge or Management Edge, ea.	$ 250	$ 139
Negotiation Edge	$ 295	$ 165
INFOCOM, Cornerstone	$ 495	$ 309
LIFETREE, Volkswriter Deluxe	$ 295	$ 159
LIVING VIDEOTEXT, Think Tank	$ 195	$ 109
LOTUS, 1-2-3 *NEW VERSION!*	$ 495	$ 329
Symphony	$ 695	$ 449
MDBS, Knowledgeman II	$ 595	$ 395
MECA, Managing Your Money (PC)	$ 199	$ 105
MICROPRO, Easy *NEW*	$ 150	$ 99
WordStar (PC)	$ 350	$ 189
WordStar Professional, 4 Pak	$ 495	$ 265

BUSINESS

	LIST PRICE	CONROY PRICE
MICROPRO, WordStar 2000 (copiable)	$ 495	$ 265
WordStar 2000 Plus (copiable)	$ 595	$ 295
WordStar Professional, 4 Pak	$ 495	$ 265
MICRORIM, R:Base Series 5000	$ 695	$ 385
R:Base 4000	$ 495	$ 259
R:Base Clout	$ 249	$ 133
Extended Report Writer	$ 150	$ 92
MICROSOFT, Multiplan (PC or Jr)	$ 195	$ 129
Chart	$ 300	$ 199
Project	$ 395	$ 265
Word	$ 375	$ 239
MOSAIC, Twin	$ 145	$ 89
MULTIMATE, Multimate Ver. 3.3	$ 495	$ 229
PALADIN, FlashCalc	$ 129	$ 86
PEACHTREE, Back to Basics	$ 395	$ 229
Peach Pak (GL/AR/AP)	$ 395	$ 219
PRENTICE HALL, Inside the IBM, by P. Norton	$ 22	$ 17
QUE, Using 1-2-3 (book)	$ 18	$ 14
1-2-3 for Business (book)	$ 17	$ 13
Using Symphony (book)	$ 20	$ 15
SAMNA, Word III	$ 550	$ 295
SATELLITE, WordPerfect (PC)	$ 495	$ 219
WordPerfect (Jr)	$ 69	$ 46
SOFTW. ARTS, Spotlight	$ 150	$ 95
SOFTWARE GROUP, Enable	$ 695	$ 385
SOFTWARE PUBL., PFS:Report	$ 125	$ 75
PFS:Write, File or Graph, each	$ 140	$ 84
PFS:Plan or Access, each	$ 140	$ 84
PFS:Proof	$ 95	$ 57
SOFTWARE PUBL., First Success (F/R/W)	$ 350	$ 299
Best Sellers Combo	$ 350	$ 225
SORCIM, SuperCalc III	$ 395	$ 229
Superwriter	$ 295	$ 195

BUSINESS

	LIST PRICE	CONROY PRICE
SPRINGBOARD, Newsroom	$ 50	$ 32
THORN EMI, Perfect Pak (Jr) (Write/Spell/Thesaurus)	$ 139	$ 89
UNISON, Print Master	$ 60	$ 40
WARNER, Desk Organizer (PC or Jr)	$ 99	$ 63
XANARO, Ability	$ 495	$ 319

UTILITIES

	LIST PRICE	CONROY PRICE
BORLAND, Turbo Editor Toolbox	$ 65	$ 40
Turbo GameWorks	$ 70	$ 40
Turbo New Pack	$ 95	$ 50
Turbo Jumbo Pack	$ 245	$ 130
Superkey/Sidekick Pkg.	$ 125	$ 65
Turbo Holiday Pack	$ 125	$ 69
BOURBAKI, Onedir	$ 95	$ 62
CENTRAL POINT, Copy II PC	$ 40	$ 22
PC Tools	$ 40	$ 22
DIGITAL RES., Gem Draw	$ 150	$ 95
Gem Collection	$ 199	$ 125
Gem Desktop	$ 50	$ 32
CP/M-86™ (PC/XT)	$ 100	$ 64
FUNK SOFTWARE, Sideways	$ 60	$ 37
LIFEBOAT, Lattice C	$ 495	$ 279
Dr. Halo	$ 100	$ 59
MAGNUM, Fastrak™, RAM/Disk & spooler	$ 50	$ 39
MICROSOFT, Macro Assembler	$ 150	$ 99
QuickBASIC	$ 99	$ 69
Access	$ 250	$ 169
BASIC Compiler	$ 395	$ 269
C Compiler	$ 500	$ 339
Business BASIC Compiler	$ 450	$ 299
COBOL Compiler	$ 700	$ 475
FORTRAN Compiler	$ 350	$ 235
PASCAL Compiler	$ 300	$ 199

UTILITIES

	LIST PRICE	CONROY PRICE
MICROSOFT, Windows	$ 95	$ 69
MICROSTUF, Crosstalk XVI (PC or Jr)	$ 195	$ 110
Remote	$ 195	$ 125
MOUSE SYSTEMS, PC Paint	$ 99	$ 69
NORTON, Utilities (14 prgms) v 3.0	$ 100	$ 56
POLYTRON, Polywindows (copiable)	$ 65	$ 45
ROSESOFT, Prokey (New Version)	$ 130	$ 80
WESTERN UNION, Easy Link Mail Mgr	$ 95	$ 59

HOME & EDUCATIONAL

	LIST PRICE	CONROY PRICE
BPI, Personal Accounting	$ 99	$ 63
BRODERBUND, Print Shop	$ 60	$ 36
CONTINENTAL, Home Accountant (Jr)	$ 75	$ 45
Home Accountant Plus (PC)	$ 150	$ 90
DAVIDSON, Spell It	$ 50	$ 30
MINDSCAPE, Crossword Magic	$ 50	$ 35
MONOGRAM, Dollars & Sense w/forecast	$ 180	$ 100
SCARBOROUGH, MasterType (PC or Jr)	$ 40	$ 25
Your Personal Net Worth	$ 100	$ 63
SIMON & SCHUSTER, Typing Tutor III	$ 50	$ 33

RECREATIONAL

	LIST PRICE	CONROY PRICE
BLUECHIP, Millionaire, Barron, Tycoon, ea.	$ 60	$ 35
BRODERBUND, Large Inventory In Stock		CALL
ELECTRONIC ARTS, Large Inventory In Stock		CALL
HAYDEN, Sargon III (Chess)	$ 50	$ 34
INFOCOM, Hitchhiker's Guide	$ 40	$ 25
Zork I, II or III, each	$ 40	$ 29
MICROPROSE, Strike Eagle	$ 35	$ 23
MICROSOFT, Flight Simulator (PC or Jr)	$ 50	$ 33
ORIGIN, Ultima III (PC or Jr)	$ 60	$ 39
SIERRA/ON-LINE, Ultima II (PC or Jr.)	$ 60	$ 43
SPECTRUM HOLOBYTE, Gato	$ 40	$ 25
SPINNAKER, Amazon, Dragon, each	$ 40	$ 25
SUBLOGIC, Jet	$ 50	$ 32

CONROY-LAPOINTE COMPUTER STORES, INC.
Retail Sales only. Store prices may vary.
SAN FRANCISCO — 550 Washington Street (at Montgomery, opposite the Pyramid). Interstate 80 to Highway 480; take Washington Street Exit. CALL (415) 982-6212.
PORTLAND, OREGON — At Park 217, Tigard at intersection of Highways 217 and 99W. CALL (503) 620-5595.
SEATTLE, WASH. — NEW LOCATION! 1105 Bellevue Way N.E. in Belgate Plaza, 2 blocks north of Bellevue Square. CALL (206) 641-4736.

OUR REFERENCES:
We have been in computers and electronics since 1958, a computer dealer since 1978 and in computer mail order since 1980. Banks: 1st Interstate Bank, (503) 643-4678. We belong to the Chamber of Commerce (503) 228-9411, and Direct Marketing Association; call Dun and Bradstreet if you are a subscriber. Recipient of OREGON BUSINESS MAGAZINE's 1984 Enterprise Award.

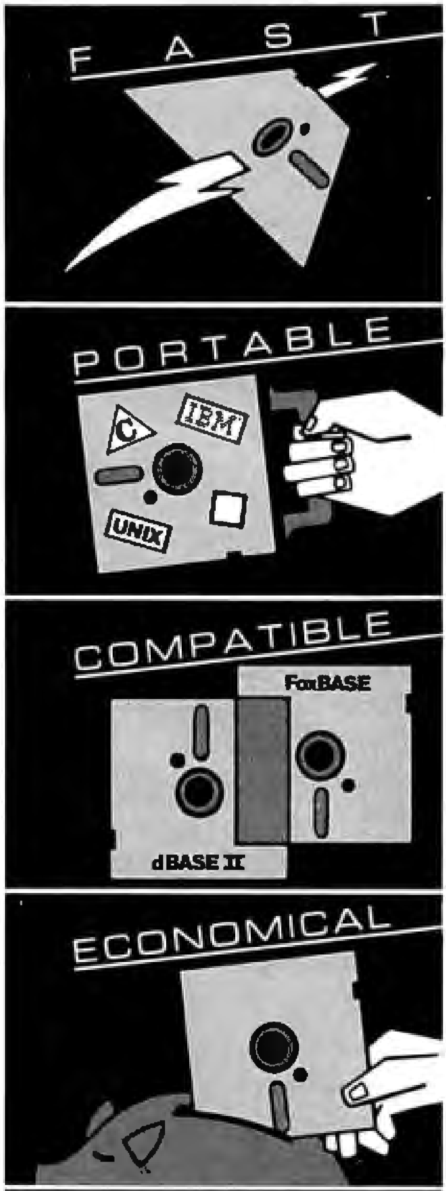
MasterCard — VISA — CONROY-LAPOINTE CARD

NO SALES TAX

CALL (800) 547-1289
In Oregon: (800) 451-5151
Foreign & Portland Residents Call (503) 620-9877

QUESTIONS (503) 620-9878
8:00 AM - 5:00 PM (PST) Weekdays Only

ORDER DESK HOURS
Mon-Fri 6am to 6pm (PST)
Saturday 8am to 4pm (PST)
(6 am here is 9 am in New York)



C·L·U·B·S A·N·D N·E·W·S·L·E·T·T·E·R·S

THE AMERICAN MEDICAL STUDENT ASSOCIATION (AMSA) COMPUTERS IN MEDICINE TASK FORCE (CIMTF), James Hornig-Rohan, Box 189-APH, Medical College of Pennsylvania, 3300 Henry Ave., Philadelphia, PA 19129, (215) 732-1845. Newsletter and access to medical software. Annual fee: $3.50, AMSA members; $6, nonmembers.

THE GUELPH PC USERS GROUP, Michael McKinnie, 47 Woodborough Rd., Guelph, Ontario N1G 3L7, Canada, (519) 836-9006. Monthly meetings and newsletter, public-domain software.

P. F. FLYER, George Stewart, Program Factory, POB 137, Hancock, NH 03449. Newsletter with programs listed or on disk. Annual subscription: $16.

THE NATIONAL AMIGA USERS GROUP (NAMUG), POB 151, Oakland Gardens, NY 11364. Newsletter, more services to come. Membership: $20.

HEWLETT-PACKARD WASHINGTON DESKTOP USERS CLUB, Bruce Baxter, IRS D:R:R:M, 1111 Constitution Ave. NW, Washington, DC 20224, (202) 566-3252. Meetings in Rockville, MD, seminars, library, BBS.

AMIGA USERS GROUP (AUG), 10668 Ellen St., El Monte, CA 91731. Monthly newsletter, public-domain software to come.

KAYPRO USERS OF TORONTO AND ENVIRONS (KUTE), Box 66, Station A, Toronto, Ontario M5W 1A2, Canada. Newsletter, library, SIGs, BBS.

SILVER STATE COMPUTER USERS GROUP, POB 81075, Las Vegas, NV 89180. For users of IBM PC, compatibles, and Commodore. Meetings, newsletter, public-domain library. Dues: $4 per month.

GENEVA MAC CLUB, CP 13, 1211 Geneva 12, Switzerland. Monthly meetings and returnable disks. Annual fee: 100 Swiss francs or about $40.

MICROPRO USERS GROUP OF AMERICA (MUGA), 140 Riverside Dr., New York, NY 10024, (212) 595-4811. Monthly newsletter, program coverage. Annual dues: $20.

APPLE ENTHUSIASTS SOCIETY OF OAK PARK (AESOP), Patt Chase, POB 4111, Oak Park, IL 60303, (312) 366-7864. Monthly meetings, Mac SIG, support. Annual dues: $24.

ATARI COMPUTER ASSOCIATION OF ORANGE COUNTY (ACAOC), POB 9419, Fountain Valley, CA 92708. Monthly newsletter, BBS at (714) 731-6523. Annual dues: $24.

SACRAMENTO MICROCOMPUTER USER'S GROUP (SMUG), POB 161513, Sacramento, CA 95816. Monthly newsletter and meetings, public-domain software. Annual dues: $12.

BULLETIN BOARD SYSTEMS, Meckler Publishing, 11 Ferry Lane W. Westport, CT 06880, (203) 226-6967. Formerly called *Plumb*. 8 issues: $26.

MODEM TIMES, Pikes Peak Macintosh Group, 15 North 14th St., Colorado Springs, CO 80904, (303) 471-2126. An online arts magazine for the Mac. Annual membership: $18.

NATIONSERV, RR #5, POB 391, Fairfield, IL 62837-0391, (618) 847-2381. Multipurpose 24-hour BBS at 300 or 1200 bps at (618) 847-2291. Annual fee: $10.

THE NATIONAL LOGO EXCHANGE, Tom Lough, POB 5341, Charlottesville, VA 22905. Logo reference material for teachers. 9 issues: $25; $30, foreign.

THE SPE (SOCIETY OF PETROLEUM ENGINEERS) MICROCOMPUTER USER GROUP, Wes Eckles, 9424 Hunters Creek, Dallas, TX 75234. Produces bimonthly publication for professionals in energy resources.

DENVER AREA TI USERS' GROUP, 2760 South Havana, POB 14056, Aurora, CO 80014. Monthly meetings, BBS, newsletter. Annual membership: $24. ■

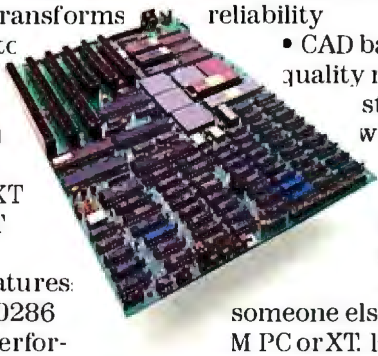
CLUBS AND NEWSLETTERS *is an acknowledgment of new clubs and newsletters received at* BYTE. *Please allow at least four months for your club's mention to appear. Send information to* BYTE, *Clubs and Newsletters,* POB 372, *Hancock,* NH 03449.

It's still a great system—in perfect condition. But now you're ready to make a deal on your IBM PC or XT.

Maybe your business needs have grown, or your new application package runs too slow.

Don't dump your present IBM system. Red River Technology has a better offer—ATlas—a single-board plug-in package that transforms your IBM PC or XT intc a super-AT.

ATlas isn't a semi-compatible plug-in cai but completely transforms your PC or PC XT into a 100% IBM PC AT compatible system.



Consider these features:

- 8 or 10 Mhz 80286 CPU. 50-100% more performance than IBM's PC AT (switch selectable—6, 8, or 10 Mhz)
- IEEE 802.3 standard LAN option on the base board (your choice, StarLAN or Ethernet)
- IBM compatible serial port
- IBM compatible parallel port
- 512K memory standard, expandable to 1.0 megabyte without using precious IO expansion slots
- Three 8-bit slots, use more of your existing add-in boards
- Five CMOS VLSI gate arrays eliminate over 60 chips to lower power consumption and improve reliability
- CAD based design, highest quality multi-layer board stalls in 10 minutes with nothing but a regular screwdriver.

Red River Technology has defined e-of-the-art in board-nputers. So don't take someone else's best offer for your M PC or XT. Red River Technology believes an upgrade path should not be a dead end.

For more information on the ATlas single-board computers, call us today, at 817-571-5714.

Assembled and tested board:
$1295 (8 Mhz CPU) **$2395** (10 Mhz CPU)
(Specify PC or XT version)
Kit form (includes board, 5 gate arrays, 8 Mhz 80286) **$595** (8 Mhz CPU)

Complete Kit	$ 795
Complete System	CALL

CALL 817•571-5714

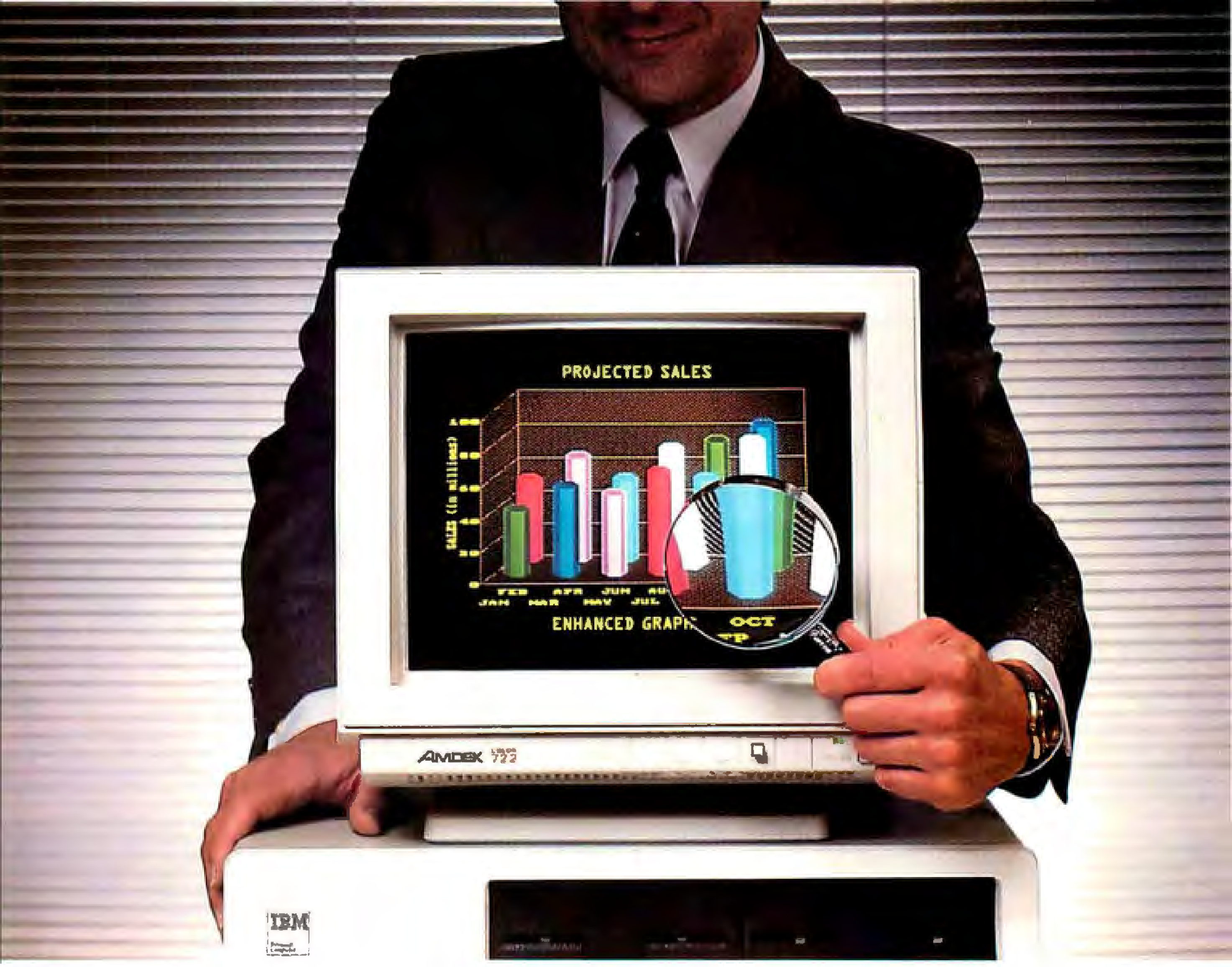
Quantity discounts available. Dealer and OEM inquiries welcome. Other unique 8088 and 80186 boards also available. Write for details.

TERMS: VISA, MASTERCARD, AMERICAN EXPRESS, CHECK, MONEY ORDER. $5 SHIPPING AND HANDLING PER ORDER. TEXAS RESIDENTS ADD 6% SALES TAX.

Red River Technology, Inc.

Red River Technology, Inc., DFW West, 4001 W. Airport Fwy., Suite 500, Bedford, Texas 76021

IBM is a registered trademark of International Business Machines Corporation. ATlas is a trademark of Red River Technology, Inc.



Amdek challenges you to read between the lines.

All 350 of 'em.

Not all monitors are created equal. And no monitor in this price range can equal the new Amdek Color 722.

What makes the 722 RGB monitor so distinctive? For one, a dual frequency output that is capable of supporting IBM's Enhanced Graphics Adaptor. The result is 350 lines of resolution, assuring you of a sharper, crisper image that makes your graphs and charts look more like a work of art, and less like a rough sketch. For another, the fact that the 722 is made by Amdek —where monitors are our only line, not just a sideline.

The high performance 722 features an etched glass, non-glare screen that's easy on the eyes, plus front-mounted controls that are easy on the operator. This means less eye fatigue and greater productivity.

What's more, the 3-position text switch enables you to choose green, amber or full-color type — up to 80 characters in width x 25 lines of text. There's even an optional tilt/swivel stand that allows you to select a viewing angle that's most comfortable for you.

It all adds up to more monitor for the money, and is backed by more warranty for your peace of mind. Amdek's warranty protects your investment for three full years on the CRT, and two years on all other parts and labor. No other monitor warranty offers you more.

For high resolution performance, see the new Amdek Color 722. We know you'll be impressed. After all, everytime an Amdek monitor is sold, we know that we are putting our image on the line.

AMDEK Inquiry 15

Clearly the finest in monitors.

IBM is a registered trademark of International Business Machine Corp

2201 Lively Boulevard, Elk Grove Village, IL 60007. Phone: 312/364-1180. TLX: 280-803

B·O·O·K R·E·V·I·E·W·S

INTRODUCTION
TO ROBOTICS
Arthur J. Critchlow
Macmillan Publishing Co.
New York: 1985
528 pages, $35

THE MICROCOMPUTER
IN CELL AND
NEUROBIOLOGY
RESEARCH
R. Ranney Mize, editor
Elsevier Science
Publishing
New York: 1985
498 pages, $49.50

DATA BASE
MANAGEMENT
Fred R. McFadden and
Jeffrey A. Hoffer
Benjamin/Cummings
Menlo Park, CA: 1985
558 pages, $36.95

INTRODUCTION TO ROBOTICS

Reviewed by Larry Clark

The history behind the development of robots, their operational characteristics, and the benefits of their use are the focus of *Introduction to Robotics*. Arthur J. Critchlow prepared the chapters so that the first portion of each can be read casually; there's not an extreme amount of technical detail. An introductory course could even be gleaned from these parts of the book. He then closes the chapters with valuable technical matter for advanced readers. Although some repetition is evident, the dual level of presentation would have been impossible without it.

The book is designed so that readers who did not major in robotics can still understand the subject. Critchlow recognized that the field of robotics attracts and involves people from a variety of disciplines and wrote to the whole audience. Nearly any engineering major would find the section on analysis of robot arm links interesting and lucid, even though it uses advanced analysis tools like Denavit-Hartenberg matrices.

In my estimation, the book was written for the junior and senior levels of college and is for those people who want to familiarize themselves with robotics or those who intend to become involved in robot applications. Critchlow explains robots from a design standpoint so that the reader can understand why robots exhibit certain characteristics. He explains features that researchers are currently developing and what needs these features will serve. For instance, a factory of the future will have robots that are programmed "off line" directly from CAD (computer-aided design) data so that programming does not take up valuable production time. For off-line programming to become practical, hurdles (collisions, for example) must be overcome. The author describes these problems in detail.

Critchlow reviews research efforts by corporations and universities. The results describe an exciting array of mobile robots, advanced controls and sensors, and language developments that include artificial intelligence.

The references at the end of all chapters indicate that each section is based on extensive research. A reader could use this book as a complete reference resource to locate original papers on robotics topics (such as works of Denavit and Hartenberg), even those that were written early in the robotics era and may now be hard to get. Extensive excerpts or summaries are taken from the refer-

(continued)

ILLUSTRATED BY DAVID GOTHARD

ences and more than support the author's statements. Many of the illustrations are also taken from these references.

Critchlow's unusual and refreshing introduction to robotics begins with European mechanical developments in the 1700s and mentions Karel Capek's coining the word "robot" in 1921. By doing this, Critchlow shows that many basic ideas used in robotics, like mechanical-cam programming, existed for hundreds of years before the word "robot" came into existence.

The author discusses kinematic analysis using homogeneous matrices and, as an exception to the purpose of an introduction, goes on to give numerical examples of their use that are excellent. A reader will immediately see the complexity involved and how maximum performance is demanded from a control computer. Compliant end effectors and end-of-arm tooling schemes are described (compliant tooling offers several advantages despite the added complexity). Mechanical power-drive mechanisms are explained in terms of how they are specially suited to the rigorous needs of robots. Hydraulic, pneumatic, and electric drives are detailed.

Microprocessors are introduced briefly using the 8080 as an example. The reader is given definitions of some of the terminology; fortunately, Critchlow reviews logic gates before moving on to describe microprocessor programming and architecture.

Software capabilities are detailed for several commercial robots. I have seldom seen this much data on the characteristics of robot programming. A total of 14 language systems are reviewed, including VAL, a structured language.

Sensors are evaluated in terms of the signals they produce, how they operate, and the best uses to which they can be put. Vision sensing is introduced in an especially thorough manner in a chapter of its own. Critchlow provides extensive examples of elementary mathematical-analysis methods. You can see for yourself how lines and edges are identified in an image and how their slope and intercept values are determined. Because vision algorithms are complex and quickly exceed the scope of an introduction, the reader is sent to the references that appear at the end of each chapter for more information. But by this time you will know what you want to learn more about and where to find further information. Vision, undoubtedly one of the more important sensing methods, remains largely undeveloped. The reader is shown what vision systems are capable of doing now and what capabilities remain to be developed.

ERRORS

The book contains several errors that you should be prepared to recognize and ignore. I will describe two so that you can sense their nature. (Other small errors such as incorrect references to figures were obvious and not significant.) Though the errors described here do not

(continued)

Those who insist on C compiler performance are very big on Mark Williams.

And the compiler is just part of our total C Programming System.

NEW 3.0 ENHANCEMENTS

These and other powerful utilities now *included* in the C Programming System:

- make: compiles only what's necessary from multiple modules, a powerful programming discipline
- diff: identifies differences between two files
- m4: macroprocessor expression editing and substitution
- egrep: extended pattern search
- MicroEMACS: full screen editor with source

COMPILER FEATURES

- Runs under MS-DOS
- Full Kernighan & Ritchie C with recent extensions including void and enum
- Register variables for fast, compact code
- Full UNIX™ compatibility and complete libraries
- Large and small memory models
- MS-DOS linker compatibility
- 8087 Support
- One-step compiling
- English error messages
- ROMable code
- Linker, assembler, archiver
- Extensive third party library support

csd C SOURCE DEBUGGER

- Debugs at C source level without assembly language
- Separate evaluation, source, program and history windows
- Can execute any C expression
- Capabilities of a C interpreter, but runs in real time
- Set trace points on any statement or variable

Mark Williams' C compiler has earned a place in some very big companies for some very good reasons: it proves the benchmarks right with the speed, code density, consistent performance and expert support required in professional development environments.

But a total development tool shouldn't stop with compiling. Or go on and on with extras that add up and up.

Only Mark Williams' C Programming Systems *includes* the csd C Source Debugger with true source level debugging to speed your programming job.

And only Mark Williams' new 3.0 version *includes* utilities like "make" to make quick work of even the largest projects.

From source code to final product, only one takes you all the way: Mark Williams' C Programming System. All for only $495. Ask about our 30-day money back guarantee when you call **1-800-692-1700** to order today.* You'll be big on the total C Programming System from Mark Williams, too.

*In Illinois call 312-472-6659.

Mark Williams Company
1430 West Wrightwood
Chicago, Illinois 60614

Inquiry 223

destroy the book's value, they limit its audience to those who wouldn't be misled by them.

The chapter on controls analysis contains a significant error that would certainly confuse the uninitiated. Beginning engineering students would be confused by reading that feedback forces the output of a closed control loop to be equal to its input (that is, their ratio is unity), then seeing the classic development of the closed-loop transfer function. The transfer function, $G(s)/(1+G(s)H(s))$, equation #4 on page 168, is correctly given as the ratio of output to input and is clearly not equal to unity as stated earlier. If the author has an explanation for the differences this literal interpretation of his writing brings to light, he does not say. I can imagine the number of questions a group of students would have about this discrepancy.

I found another error in an extensive description of the General Motors Consight vision system. The Consight system, as described on page 374, was said to be able to accurately measure the height of a part on a conveyor belt even though only a linear diode array camera was being used. Further, the system was described as a two-dimensional system that could provide both a part's height and location on a conveyor belt.

I checked the original reference and found that the Consight system did provide 2-D silhouettes but did not provide height data; it only detected height in finding the outline of the part. I learned enough from Critchlow's writing about solid-state cameras to find this anomaly. In fact, I found it worthwhile to look beyond the errors to appreciate the wide range of information offered in this book on advanced robot controls, software, sensors (especially vision), and applications. The author's work represents a worthy effort, though the errors are annoying.

The book offers a good overall view of the robotics field for someone who wants either a light introduction or a starting point that gives detailed references to original works in robotics and related fields. To me, the most interesting portions of the book are its sections on kinematics and analysis of vision problems. Although errors are significant, they would affect only a fraction of the book's potential audience.

Larry Clark (8103 Thornewood Dr., Hixson, TN 37343) is involved in robotics applications development and teaches robotics after-hours as an adjunct professor at Chattanooga State Technical Community College. His hobbies include building microcomputers and working with a FORTH compiler he wrote.

THE MICROCOMPUTER IN CELL AND NEUROBIOLOGY RESEARCH

Reviewed by David A. Price

The Microcomputer in Cell and Neurobiology Research presents advice for biologists who want to use microcomputers to control experiments and analyze the results. Although

(continued)

Mark Williams

Now the biggest name in C compilers comes in a size everybody can afford.

Let's C.™

Introducing Mark Williams' $75 C compiler. Want to explore C programming for the first time? Or just on your own time? Now you can do it in a big way without spending that way. With Let's C.

This is no little beginner's model. Let's C is a powerful programming tool, packed with all the essentials of the famous Mark Williams C Programming System. The one chosen by Intel, DEC, Wang and thousands of professional programmers. The one that wins the benchmarks and the reviewers' praise:

"(This compiler) has the most professional feel of any package we tested..."—BYTE

"Of all the compilers reviewed, (it) would be my first choice for product development."—David W. Smith, PC WORLD

And now for more big news. Get our revolutionary csd C Source Debugger for just $75, too. You can breeze through debugging at the C source level ignoring clunky assembler code.

Affordable, powerful, debuggable. Mark Williams Let's C is the big name C compiler at a price you can handle. Get your hands on it now.

Mark Williams Let's C

- For the IBM-PC and MS-DOS
- Fast compact code plus register variables
- Full Kernighan & Ritchie C and extensions
- Full UNIX™ compatibility and complete libraries
- Small memory model
- Many powerful utilities including linker, assembler, archiver, cc one-step compiling, egrep, pr, tail, wc
- MicroEMACS full screen editor with source
- Supported by dozens of third party libraries
- Upgradeable to C Programming System for large scale applications development

Let's C Benchmark Done on an IBM-PC/XT, no 8087. Program: Floating Point from BYTE, August, 1983.

	Exec Time in Seconds
Let's C	134.20
MS 3.0	347.45

Use this coupon or charge by calling toll-free: 1-800-MWC-1700. In Ill. call 312-472-6659.

Mark Williams Let's C

$75

Please send me:

____ copies of Let's C and ____ copies of csd (C Source Debugger) at $75 each. (Ill. residents add 7% sales tax.)

☐ Check ☐ Money Order ☐ Visa, MasterCard or American Express

Name ____________

Address ____________

City ____________ State ______ Zip ______

Card # ____________ Exp. Date ______

Signature ____________

Mark Williams Company
1430 West Wrightwood
Chicago, Illinois 60614

Inquiry 224

biologists have long used minicomputers and mainframes for these purposes, the advent of microcomputers and lab-oriented microcomputer peripherals (such as high-speed analog-to-digital converters and video "frame grabbers") has made laboratory automation less costly and more convenient. R. Ranney Mize, the editor, selected a diverse range of application areas, with chapters written by researchers who have implemented microcomputer systems for their own labs. They have practical knowledge to share, but their contributions vary widely in quality.

The application areas covered include light and electron microscopy, morphometry (measuring the sizes and shapes of cells and organelles), serial section reconstruction (drawing the original three-dimensional form of an object based on a series of two-dimensional tissue slices), image analysis, and electrophysiology (recording electrical activity in the nervous system). In each of these areas, the potential contribution of lab computers is inestimable. Morphometric analysis, for example, is highly tedious work if the researcher must rely on manual methods. One typical approach is to trace a picture of a cell, cut it out, and weigh the cutout—an approach that one of the authors describes as "exhausting." With a video display or a digitizing tablet, the researcher can partly automate the process, thereby making morphometric information not only less costly but also more accurate.

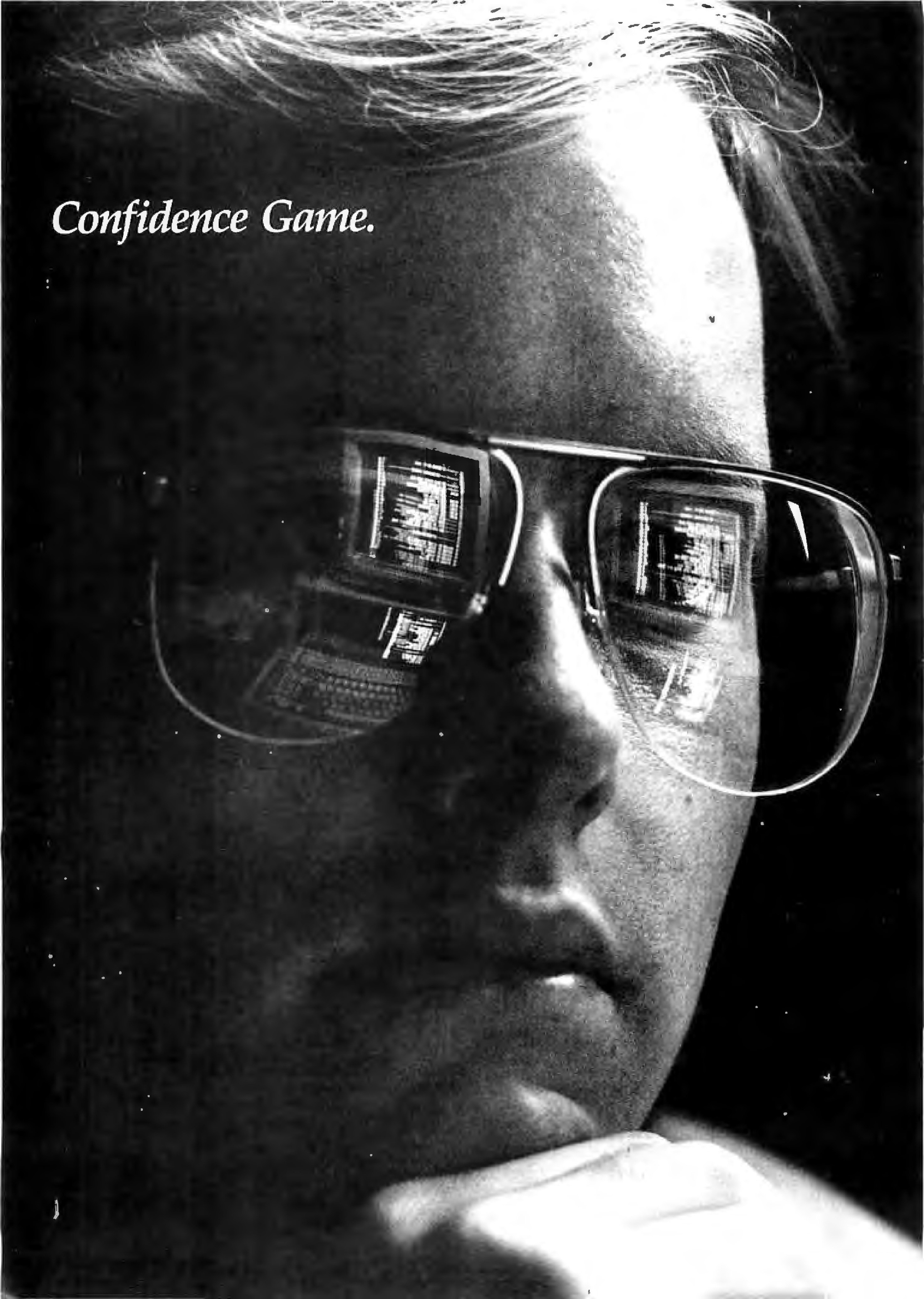
Researchers using autoradiography (that is, tracing blood flow and other activity using radioactive solutions in animal bloodstreams) have benefited from image-analysis systems. (An autoradiograph is a photographic print of a slice of tissue, with varying levels of gray for varying concentrations of radioactive solution.) After using a video camera or a scanning densitometer to put an autoradiograph into a computer, a researcher can make the gray levels easier to distinguish by having the computer assign "false colors" to each of the gray levels and then displaying the autoradiograph on a color monitor. The researcher can then compare different autoradiographs either visually or with precise, computer-generated statistics.

RESEARCHERS WRITING FOR RESEARCHERS

Because a large number of researchers contributed to the book, it does not focus exclusively on a particular machine; systems described in the book are based on the Apple II, the IBM Personal Computer, the DEC LSI-11, and many other microcomputers. The choice of languages, similarly, includes assembly, BASIC, FORTRAN, FORTH, and C. Most of the contributors describe in precise detail the hardware and software they used to build their systems, as well as the considerations that led them to choose as they did.

The fact that the authors are researchers writing for other researchers has both good and bad effects. A good effect is that their point of view differs sharply from a computer specialist's: The authors place a higher value on simplicity and practicality than on impressive specs. (Some

(continued)


Confidence Game.

It's knowing that the friendly voice at the other end of the line understands what you're saying. Can answer your technical questions, verify prices and shipping schedules. Or make good suggestions.

Join the Micro Mart Confidence Game.

Trust Micro Mart for immediate information and advice on almost any microcomputer product. Our 15 million dollar inventory is on-line to our mainframe so we can verify, order, deliver and service. Without delay.

Call us with confidence.

COMPUTERS

AT&T Color and Mono Systems in stock ____ **Start at $1795**

MULTIFUNCTION BOARDS

We have a complete line of Multifunction Boards compatible with the Portable, XT/AT.

SIX PAK 64-384K, multifunc. ____

I/O MINNIE I/O shortboard for Portable & AT ____ **New Low Price!**

ADVANTAGE 128K-3Mb, expansion for AT ____

QUADRAM Quadboard Loaded, 384K ____ **$269**

QUADRAM Goldboard, 384K **$459**

TECMAR Captain 0-384K, multifunc. ____ **$175**

TALLTREE J-RAM II ____ **New Low Price!**

GRAPHIC CARDS

HERCULES Mono & Color Graphics cards ____ **New Low Price!**

TECMAR Graphics Master, HiRes Color & Mono supports Lotus **$449**

QUADRAM Quadcolor I & II color cards ____

PARADISE Multi-display or modular graphics cards ____ **From $199**

STB Chauffeur & Colorific ____ **$289 & $189**

SIGMA Color 400 for PGS SR-12 ____ **New Low Price!**

FLOPPY DISK DRIVES

TANDON TM 100-2, DD/DS, 360K ____ **New low, low price!**

1/2 HEIGHT Disk Drives from Shugart, Mitsubishi, TEAC and Toshiba. PC, XT & AT Compatible ____ **From $99**

BEST SUPPLY ON EAST COAST

HARD DISCS

IRWIN/TANDBERG Tape back-up systems ____ **From $495**

SEAGATE Fast 10, 20, 30 and 75 Meg. for PC & AT ____ **From $495**

SYSGEN Complete line ____ **Call for our special Sysgen pricing!**

BERNOULLI TECHNOLOGY Hard disc Subsystems ____ **From $2595**

PRIAM Superfast 40 & 60 Meg. for AT ____ **Call!**

Best availability of voice coil and stepper motor hard drives with high quality controllers ____ From $495

SOFTWARE

ACCOUNTING SPREADSHEETS & INTEGRATED PACKAGES

SORCIM/IUS Complete line including Windows **From $289/each**

SORCIM SuperCalc 3, vers. 2.0 ____ **New Low Price!**

ENHANCEMENTS & UTILITIES

FOX & GELLER Complete line for dBase II/III, RBase 4000 ____

NORTON Utilities 3.0 ____ **$69**

ROSESOFT ProKey 3.0 ____ **$89**

CENTRAL POINT SOFTWARE Copy II PC ____ **$35**

SOFTSTYLE Set FX+ and Printworks, printer control ____

SIDEWAYS Inverts printout ____ **$35**

BORLAND SideKick and SuperKey ____ **From $40**

COMPILERS & LANGUAGE TOOLS

LATTICE C-Compilers ____ **$279**

MICROSOFT Complete line ____

MICROSOFT QuickBasic ____ **New Low Price!**

BORLAND Turbo Pascal, Turbo Toolbox & more ____ **From $35/each**

GRAPHICS

Z-SOFT PC Paintbrush, mouse graphics ____ **$95**

DECISION RESOURCES ChartMaster ____ **Latest Version $239**

MICROSOFT Chart ____ **$169**

COMMUNICATIONS

MICROSTUF Crosstalk XVI, Latest version ____ **$99**

HAYES Smartcom II ____ **$85**

WORD PROCESSING

MULTIMATE w/spelling checker & tutorial ____ **New Low Price!**

SAMN ____ **$350**

MICROSOFT Word. New version ____ **New Low Price!**

LIFETREE Volkswriter Deluxe **$169**

SSI WordPerfect, version 4.1 **$249**

MICROPRO WordStar Professional series ____ **New Low Price!**

OFFICE & PROJECT PLANNING

HARVARD Total Project Manager ____ **$299**

SORCIM/IUS Super Project ____ **$199**

MICROSOFT Project ____ **$175**

DATA BASE MANAGERS

Call for unadvertised Data Base Managers ____

MICRORIM 5000, Report Writer & Clout ____ **New Low Price!**

WARNEF ARE The Desk Organizer ____ **$145**

MICROSTUF Infoscope ____ **$99**

NETWORKING/ PROTOCOL CONVERSION

SNA & BISYNC 3780, 5251. Mod 11 & 12, 3274, 3278 ____

PC TURBO 186/187 board, 128K, 8087 Serial Board attached ____ **$875**

IRMA Complete line ____ **From $849**

TECHLAND Blue Lynx. Complete line ____ **Call!**

PRINTERS

We have thousands in stock.

DOT MATRIX

EPSON FX85/185 ____ **NEW!**

EPSON LX80/LQ1500 ____

OKIDATA 192 & 193, ML84, Pacemark 2410 ____

TOSHIBA P-341, P-351 & 1340 ____ **New Low Prices!**

NEC New P-5 ____ **Introductory Low Price!**

LETTER QUALITY

NEC Spinwriters 2050, 3550, 8850 ____ **New Low Prices!**

EPSON DX10, DX20, & DX35 ____ **New Letter Quality Printers!**

We carry a full range of form handling options.

CHIPS

All our chips are tested and priced for quick sale. Call us!

INTEL 8087, 80287, high speed coproc. ____ **From $119**

64K-256K RAMCHIPS ____ **Call for Market Price.**

128K Piggy-back chips for your AT ____ **Call for Market Price.**

MODEMS

HAYES Smartmodem 300, 1200, 1200B & 2400. We have the best stock in the USA ____ **Call!**

VEN-TEL 1200 B w/Crosstalk ____ **$399**

PEACHTREE TECHNOLOGIES P-1200 ext. with Crosstalk ____ **$319**

MISCELLANEOUS

MAXELL Diskettes ____ **$25**

DYSAN Diskettes at the lowest price in the USA ____ **Call!**

MOUSE SYSTEMS PC Mouse, optical w/software ____ **$139**

MICROSOFT Mouse, bus or serial mechanical ____ **New Model In Stock!**

KEYTRONICS 5151 keyboards **$149**

KENSINGTON MICROWARE MasterPiece ____ **$99**

CURTIS Accessories, Pedestals, cables, etc. ____

GRAVIS Joysticks ____ **$45**

QUADRAM Microfazer print buffer 8–128K ____ **From $129**

TRIPPELITE ISOBAR surge protectors, 4 & 8 plug ____ **From $49**

POLAROID Palette ____ **$1245**

MONITORS AND CRTS

PGS Max12 (E), HX12, HX12(E), & SR-12 ____ **New Low Prices!**

QUADRAM Quadchrome, 690 dot RGB ____ **$429**

AMDEK Color 600 ____ **$379**

AMDEK 722, New alternative to IBM enhanced monitor ____ **$569**

AMDEK 300A/300G/310A ____ **$129/$119/$165**

Technology Corporate Campus
3159 Campus Drive
Norcross, Georgia 30071

Prices are subject to change without notice and are similar, but may vary at over 20 Micro Mart Retail Stores.

Leasing and financing options are available. MasterCard/VISA or ask for Micro Mart Blue Chip Credit.

BT 1-86

(404) 449-8089

Orders only

1-800-241-8149

MICRO MART

America's PC Specialist

Inquiry 278

exceptions stand out, though; a handful of the writers are obviously dazzled by fine technical differences of questionable importance.) Another good effect is that each author provides an extensive bibliography to which readers can refer for further information about algorithms, lab techniques, and equipment. A bad effect is that the text, like most scientific writing, has many awkward moments; the passive voice reigns supreme.

The topics covered are especially well chosen because they not only relate to a variety of applications but also present a variety of engineering problems. The chapters on microscopy and morphometry describe some challenging problems of pattern recognition. The parts covering serial section reconstruction show how some programmers have tackled the representation, manipulation, and display of three-dimensional line drawings. The chapters on autoradiographic image analysis discuss various ways to digitize an image and enhance it. Sections on electrophysiology focus on numerical and graphic analyses of electrical signals. Others provide helpful descriptions of algorithms, and one chapter even includes a lengthy BASIC listing.

Many of the contributions are excellent. The chapter by Sing and Salin, for example, provides a clear overview of popular computer languages and the issues involved in choosing a language for lab use. The chapter on hardware selection by Poler, Akeson, and Flaming includes a useful discussion of technical support; it gives a much-needed warning of the fact that computer dealers are generally unfamiliar with the special requirements of laboratories. The chapters on autoradiographic image analysis are consistently first-rate, as is the chapter by Park on neurophysiological recording.

FLAWS

Some of the contributions, however, fall short. The first chapter, intended as an introduction to microcomputer hardware, says little of importance to researchers. Giving short shrift to the vital topic of interfacing, it consists mainly of a daunting discussion of bus and processor architectures. Some contributors present long and boring recitals of technical data ("The 9845B has dual 16-bit NMOS-II microprocessors, 187 KB of RAM memory, a medium-resolution graphics screen. . .") as a substitute for insight and analysis.

A more serious difficulty is that several of the contributors wrote article-length advertisements, in essence, for products in which they appear to have a proprietary interest. Although the developers of a product are, of course, suited to describe it for interested users, the possibility for abuse is obvious. First, the writer (or editor) does not alert the reader to the pertinent facts. Unless you read the material carefully, you might not realize that the author who is lauding system X also happens to own the company that sells it. When an author has a commercial interest in a product, he or she should say so forth-

(continued)

 Inquiry 383

rightly. Even if the writer is candid about the shortcomings of the product, a reader deserves to know about the potential conflict of interest.

Second, the problem is worse because the offending authors in this book give one-sided, congratulatory views of their products. Their chapters are sprinkled with such adjectives as "powerful," "user-friendly," and "ideal." One author, after describing a system based on a severely dated and now almost unknown microcomputer and on a nonstandard operating system, informs the reader unblinkingly that the system "defies obsolescence."

The book is also marred by some unfortunate omissions of important topics. It gives little attention to managerial issues—for example, deciding whether to write one's own lab software, hire a programmer, or buy a canned package. It omits any discussion of software testing, which is vital in a laboratory because mistakes are costly and often hard to detect.

These flaws aside, *The Microcomputer in Cell and Neurobiology Research* is a worthwhile source of information for researchers with an interest in bringing microcomputers into their laboratories. For researchers considering so substantial an investment, every source of information should be welcome.

David A. Price (57 Roseland St. #2, Somerville, MA 02143), formerly a programmer in physiology and neurobiology laboratories, is a third-year law student at Harvard University.

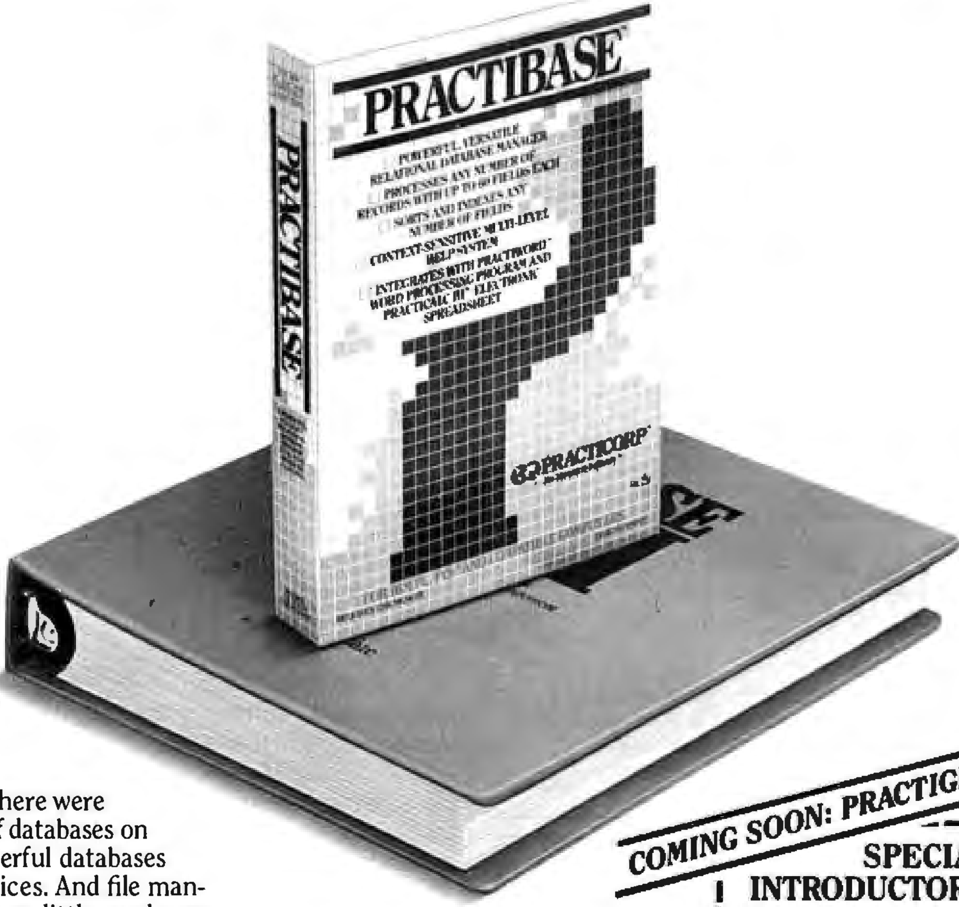
DATA BASE MANAGEMENT
Reviewed by Joseph A. Benderavage

Databases grow slowly, often over a period of years. Plan one to meet the needs of your organization, for both today and the next decade. This is the underlying principle of *Data Base Management* as seen by the authors, Fred R. McFadden and Jeffrey A. Hoffer. They describe very complete, detailed design rules that are easy to follow. They cite methodology for top-down planning developed by IBM, and they frequently refer to that company.

DATABASE DESIGN
Lack of standardization for semantic controls (commands), among other reasons, led to a conference that laid down guidelines for designing network databases. The Data Base Task Group (DBTG) of the Conference of Data System Languages (CODASYL) formulated the principles listed in the book. All manufacturers, with the exception of IBM, tried to meet CODASYL's specifications. Relational databases, on the other hand, lack uniform index-maintenance procedures and process data one file at a time, not one record at a time. The startling admission that the authors do not know how a relational database implements relationships surfaces amid an ocean of specific and precise definition.

(continued)

dPOWER without dPRICE.



Until now, there were only two kinds of databases on the market. Powerful databases with powerful prices. And file managers that cost very little–and gave you very little in return.

Now you can get the power you want at the price you want to pay. With PractiBase® The first inexpensive database that truly compares with *any* base at *any* price–especially at its introductory price of $69.95.

Skeptical? We don't blame you. But consider some of PractiBase's features:

- A powerful relational database management system, including memo writer, forms generator, entry forms and page report generator
- Advanced dBase II*-compatible programming language–including JOIN, UPDATE and TOTAL commands
- Reads and writes dBase II files
- Runs dBase II programs! (.PRG and .FMT files)
- Sorts on multiple keys in a single operation
- Handles up to three data files at one time
- Menu- or command-driven (you never have to stare at a dot!)
- Includes time-saving abbreviation macros
- Context-sensitive, multi-level HELP
- Includes 200-page manual, case study and command summary card
- NOT copy-protected
- For the IBM PC, XT, AT* and compatibles
- Requires 256K minimum (hard disk optional)

Whether you're a first-time user or a power user, we believe you'll find PractiBase the equal of databases costing up to *ten times* its price.

You can buy PractiBase alone. Or save even more by buying it with PractiWord®–our full-featured word processor that gives you all the power of WordStar*–for a combined price of only $99.95.

Either way, you'll get dPower you need. Without dStroying your budget.

PRACTICORP™

No-Nonsense Software™

The Silk Mill, 44 Oak Street, Newton
Upper Falls, MA 02164 (617) 965-9870

*The following are registered trademarks of the respective companies indicated: dBase and dBase II, Ashton-Tate; WordStar, Micro-Pro International; IBM, PC, XT and AT, International Business Machines Corp. PractiCorp, PractiBase and PractiWord are registered trademarks of PractiCorp International Inc.

COMING SOON: PRACTIGRAPH!™

SPECIAL INTRODUCTORY OFFER!

LIMITED TIME ONLY!

To order by mail: Complete this coupon and return to PractiCorp International, The Silk Mill, 44 Oak Street, Newton Upper Falls, MA 02164

To order by phone: Call TOLL FREE 1-800-858-2727 or call 617-965-9870

Yes! Rush PractiBase to me:

Quantity		Price
______	PractiBase @ $69.95 each	$______
______	PractiWord @ $69.95 each	______
______	PractiBase/PractiWord bundle @ $99.95 each	______
	Subtotal	______
	MA residents add 5% sales tax	______
	Shipping and handling	$5.00
	TOTAL	$______

Payment: ☐ Check ☐ Visa ☐ MasterCard

Card No. ______________________

Expiration Date ______________________

Signature ______________________

Name ______________________

Shipping address ______________________

City ______________ State ______ Zip ______

Phone no. (   ) ______________

Allow four weeks for delivery. Outside U.S.A., add $10 and make payment by bank draft in U.S. dollars only.

B186

Inquiry 284

Many of the rules in this book are for designing databases, yet there is a reference to using software programs to accomplish this. The authors go to great lengths to identify the symbols and data input for the Data Designer program. They also include a list of costs and benefits that would be useful in the investigative phase of systems analysis and design.

The choice of software for management of data is of paramount importance to design. Although a database management system (DBMS) requires many more steps than a conventional file-processing system to perform a simple task, and although input/output (I/O) operations are slower, McFadden and Hoffer assert that general productivity will be higher. Usually a DBMS has a control system and a storage system, and it interfaces with user programs, compiled representations of data (called schemas), and access methods. This complexity is revealed in an intricate illustration that describes the loading of management-system components connected by a linkage editor into the main memory of a computer. It also shows the communication that occurs between a user program and its schema and, consequently, its data definitions. The authors explain the central role of the data dictionary/directory and its link with schema at length. Many example schemas are mapped out; so too are subschemas, which give customized views of a database and are independent of application programs.

File Design

McFadden and Hoffer's helpful rule of thumb for designers suggests that an index referencing more than 10 percent of the records in a file will not work as efficiently as a complete sequential file scan. A compact table, impressive in its coverage and scope, presents guidelines for identifying secondary and primary keys to further assist in file design. The authors' explanation of random access to ISAM (indexed sequential access method) files is very lucid, as is that for hashing algorithms and hashed file designs. I discovered that the access-speed hashing algorithm was 80 percent of maximum access speed, a factor certain to influence your choice of access method.

The chapter on data models (hierarchical, relational and network, and the hybrids) clearly demonstrates the reduction of complex user views to a set of small data structures. This is the strongest part of the book. Normalization is extensively documented and lists the criteria for first, second, and third normal forms and beyond.

A useful tip I gleaned is the 80-20 rule, which declares that 20 percent of all data items accounts for 80 percent of I/O operations.

The authors make few concrete analogies. I appreciated one that introduced the grouping of intrarecord data structures with a folk saying: Don't put all your eggs in one basket. Another analogy compares inverted lists with the task of consulting a library file catalogue.

McFadden and Hoffer refer to the concept of virtual

(continued)

THE PROFESSIONAL'S CHOICE

NEW Lotus 1-2-3	NEW Lotus Symphony	dBase III	FrameWork NEW II	MultiMate	NEW Word Perfect 4·1
$319	$439	$369	$369	$219	$209

Software

Word Processing Editors

FANCY FONT	$139
FINAL WORD	$179
MICROSOFT WORD	$219
MULTIMATE	$219
MULTIMATE ADVANTAGE	$269
OFFICE WRITER/SPELLER	$239
PFS: WRITE	$ 89
SAMNA WORD III	$259
VOLKSWRITER DELUXE	$159
VOLKSWRITER SCIENTIFIC	$269
WORD PERFECT 4.1	$209
WORDSTAR	$189
WORDSTAR 2000	$249
WORDSTAR 2000+	$289
WORDSTAR PRO	$259
XYWRITE II+	$189

Database Systems

ALPHA DATA BASE MANAGER II	$179
CLIPPER	$389
CLOUT V 2.0	$139
CONDOR III	$329
CORNERSTONE	$279
DBASE III	$369
KNOWLEDGEMAN 2	$329
PARADOX	$Call
PC FOCUS	$1139
PFS: FILE/PFS: REPORT	$169
POWERBASE	$219
QUICKCODE III	$159
QUICKREPORT	$159
R BASE 5000	$359
REFLEX	$79
REVELATION	$629

Spreadsheets/Integrated Packages

ELECTRIC DESK	$209
ENABLE	$349
FRAMEWORK II	$369
JAZZ	$399
LOTUS 1-2-3	$319
MULTIPLAN	$135
OPEN ACCESS	$359
SMART SYSTEM	$529
SPREADSHEET AUDITOR	$109
SUPERCALC 3	$209
SYMPHONY	$439

Graphics

BPS BUSINESS GRAPHICS	$229
CHARTMASTER	$219
CHARTSTAR	$169
DIAGRAM MASTER	$215
EXECUVISION	$249
ENERGRAPHICS	$189
FREELANCE	$239
GEM DRAW	$ 95
GRAPHWRITER COMBO	$339
IN-A-VISION	$319
MS CHART -NEW	$189
OVERHEAD EXPRESS	$109
PC DRAW	$249
PC PAINTBRUSH	$ 89
PFS: GRAPH	$ 89
SIGNMASTER	$159

Project Management

HARVARD TOTAL PROJECT MANAGER	$279
MICROSOFT PROJECT-NEW	$249
PROJECT SCHEDULER NETWORK	$339
SUPERPROJECT	$209
TIMELINE 2.0	$289

Desktop Environments

DESK ORGANIZER	$ 69
GEM DESKTOP	$ 39
SIDEKICK	$ 39

Communications/Productivity Tools

CROSSTALK	$ 99
CROSSTALK MKIV	$149
PROKEY	$ 89
KEYWORKS	$ 59
RELAY GOLD	$Call
REMOTE	$119
SMARTERM	$Call
SMARTCOM II	$ 99
SUPERKEY	$ 55

Statistics

SPSS/PC	$695
STATPAK-NWA	$329
STATPAC-WALONICK	$349
SYSTAT	$419

Professional Development

LIGHTYEAR	$319
THINK TANK	$109

Languages/Utilities

CONCURRENT DOS	$189
C86 C COMPILER	$299
DR FORTRAN 77	$219
FASTBACK	$119
LATTICE C COMPILER	$289
MARK WILLIAMS C	$319
MICROSOFT C COMPILER	$249
MS BASIC COMPILER	$249
MS FORTRAN	$229
NORTON UTILITIES	$ 59
QUICK BASIC	$ 79
TURBO PASCAL	$ 49
XENIX	$Call

Accounting

BPI	$299
GREAT PLAINS	$479
IUS EASYBUSINESS	$319
ONE WRITE PLUS	$179
OPEN SYSTEMS	$359
PEACHTREE	$289
REAL WORLD	$369
STAR ACCOUNTING PARTNER	$249
STAR ACCOUNTING PARTNER II	$529

Hardware*

Display Boards

AST PREVIEW	$279
EVEREX EDGE	$309
EVEREX GRAPHICS EDGE	$319
GENDA SPECTRUM	$Call
HERCULES GRAPHICS CARD	$299
HERCULES COLOR CARD	$159
PARADISE MODULAR GRAPHICS	$275
PARADISE MULTIDISPLAY CARD	$285
SIGMA COLOR 400	$489
STB CHAUFFER	$279
TECMAR GRAPHICS MASTER	$459
TSENG ULTRA PAK	$429
TSENG ULTRA PAK-S	$369

Multifunction Boards

AST ADVANTAGE	$389
AST 6 PAK PLUS (64K)	$229
AST 6 PAK PLUS (384K)	$249
GOLD QUADBOARD (0K)	$419
ORCHID BLOSSOM (0K)	$199
ORCHID BLOSSOM (384K)	$249
ORCHID PC TURBO (256K)	$699
PERSYST TIME SPECTRUM (0K)	$199
PERSYST TIME SPECTRUM (384K)	$249
QUADBOARD (0K)	$189
QUADBOARD (384K)	$219
SILVER QUADBOARD (0K)	$219
TECMAR CAPTAIN (0K)	$189
TECMAR CAPTAIN (384K)	$229
TECMAR JR CAPTAIN (128K)	$289
TECMAR WAVE (64K)	$209

Emulation Boards

AST 5251-11	$599
AST5251-12	$549
AST BSC	$469
AST SNA	$599
CXI 3278/9 Plus	$959
IRMA	$799
IRMALINE	$999

Networks

AST PC NET	$Call
CORVUS NET	$Call
ORCHID PC NET	$Call
3 COM	$Call

Mass Storage/Backup

EXCEL STREAM 60 TAPE (INT)	$899
IOMEGA BERNOULLI BOX-NEW!	$2445
IRWIN 310A 10MB TAPE (EXT)	$850
IRWIN 110O 10MB TAPE (INT)	$499
MAYNSTREAM 60MB TAPE (INT)	$1199
MOUNTAIN DRIVECARD 10MB	$789
TALLGRASS	$Call
TECMAR QIC-60AT TAPE (INT)	$1199

Monitors

AMDEK 310A	$169
AMDEK 300/500	$249/349
AMDEK 600/710	$449/469
PRINCETON HX-12	$459
PRINCETON MAX-12E	$179
PRINCETON SR-12	$579
PRINCETON HX-12E	$559
PRINCETON HX-9	$529
TAXAN 122 AMBER	$159
TAXAN 630/640	$469/539

Modems

AST REACH 1200	$389
HAYES 1200	$389
HAYES 1200B	$349
HAYES 2400	$579
TRANSNET 1000	$299
VENTEL 1200 HALF CARD	$389
WATSON	$489

Printers/Plotters

BROTHER TWINWRITER	$939
DIABLO	$Call
EPSON FX-85	$389
EPSON FX-185	$499
EPSON LQ-1500	$999
HP 7475A	$Call
JUKI 6300	$699
NEC ELF 350	$439
NEC 3550	$1139
OKIDATA 193	$539
QUME SPRINT 1155	$1569
SWEET P 600	$839
TI 855	$799
TOSHIBA P351	$1129

Input Devices

KEYTRONIC 5151	$179
KOALA	$109
MICROSOFT MOUSE	$129
PC MOUSE W PAINTBRUSH	$129

Accessories

CURTIS SURGE PROTECTORS	$Call
DATASHIELD BACKUP POWER	$Call
GILTRONIX SWITCHES	$Call
MASTERPIECE PLUS	$135
MICROFAZER INLINE (64K)	$219
TRIPPLITE BACKUP POWER	$Call
258K RAM SET	$ 39
8087 MATH CHIP	$135

Helcules Graphics Card	Mountain Drivecard 10	Quadboard 384K	Six Pak Plus 384K	Smartmodem 1200B	Smartmodem 2400
$299	$789	$219	$249	$349	$579

*CALL FOR SHIPPING COSTS

FREE SHIPPING on all credit card or prepaid orders and all orders over $1000

LOWEST PRICE GUARANTEE!!

We will match current nationally advertised prices on most products. Call and compare.

free! Diskette Library Case with your order

1-800-221-1260

In New York State call (718) 438-6057

TERMS:
Checks—allow 14 days to clear. Credit processing—add 3%. COD orders—cash, M.O or certified check—add $5.00. Shipping and handling UPS surface—add $3.00 per item (UPS Blue $8.00 per item). NY State Residents—add applicable sales tax. All prices subject to change.

Softline

MasterCard VISA

MON.-THURS. 9:00AM-8:00PM
SUN. & FRI. 9:00AM-4:00PM

Softline Corporation
P.O. Box 729, Brooklyn, N.Y. 11230
TELEX: 421047 ATLN UI
FAX: 718-972-8346

For thousands of years, man used personal computers without decent tape backup.

storage frequently, but they explain it rather cursorily, mainly with diagrams.

PROGRAM LANGUAGES AND ILLUSTRATIONS

Why not program in English? Excessive overhead and absent update facilities in network-database processing constitute the predominant reasons for not doing so. Nonprofessionals currently interacting with a database may use codified query languages, but they still must know syntax and vocabulary. The authors use pseudocode in a great number of sample programs, while they use a variety of languages for the algorithms throughout the latter part of the book, especially programs for the hierarchical database systems IMS, DL/1, and System 2000/80. However, the authors affirm a trend toward natural languages.

Each chapter includes an introduction, narrative, summary, exercises, and a review filled with stimulating problems and questions. A lengthy bibliography closes each chapter, while a cumbrous index completes the book. Highly visible symbols in the margin of the text keynote case examples. A supplementary classroom package available to instructors contains answers, teaching suggestions, questions, and transparencies. Another supplement contains case studies for course projects.

REFERENCE TOOL

Must textbooks always be dull and tedious? While parts of this book read easily, much of it is slow and dry. Nevertheless, the style is smooth, even-tempered, unequivocal, and consistently serious (except for a startlingly funny simile likening a data model diagram to an explosion at a spaghetti factory).

The authors tested this book in an introductory course on database management and in management programs. Generally, they provide reasons for their teaching method; they itemize, prioritize, and categorize the logic of doing things their way. The text is chock-full of definitions, with new terms conspicuous in boldface print. They define buzzwords, Latin phrases, and ambiguous terms in parentheses and often use outline formats. Examples and "what if" situations abound, including a definition of "real world" as one of the realms of abstraction. They list many advantages of the personal computer and ascribe a positive outlook to it in data-management strategy.

Data Base Management begins on a dense, abstract, and theoretical level. If you are in tune with the authors' idiom, you will derive the full worth of the book. While it is a textbook for upper-division university and graduate students as well as data-processing managers, system designers will find the tome a valuable tool that contains numerous relevant cross-references. It incorporates sound advice and practical suggestions for consultants, too. ■

Joseph A. Benderavage (POB 1974, Peterborough, Ontario K9J 7X7, Canada), a member of the Royal Astronomical Society, is a freelance book reviewer published frequently in Canadian computer magazines.

ORDER LINE 800-354-7330

LOWEST PRICES

NO SURCHARGE ON BANK CARDS

SILICON SPECIALTIES

ZENITH COMPUTERS
Always the lowest prices.
Call us for a quote.

HARDWARE

PRINTERS

Anadex All Models — Save
Brother All Models — Save
Cannon Laser Printer — $2099
Citizen MSP-10 — $255
MSP-15 or MSP-20 — $349
MSP-20 — $319
MSP-25 — $489
Datasouth All Printer Models — Save
Diablo D-25 — $549
635 — $1079
Other Printer Models — Save
Epson All Printer Models — Save
Juki 6000 — $169
6100 — $349
6300 — $679
NEC 2010, 2015, 2050 — $629
3510, 3550 — $989
3515 — $1009
3530 — $935
8810, 8830, 8850 — $1379
P2, P3 — Save
EII 360 — $399
EII 370 — $389
Okidata All Printer Models — Save
Panasonic 1091 — $235
1092 — $349
1093 — $429
KXP3151 — $409
Star Micronics
All Printer Models — Save
Silver Reed
EXP400 Parallel — $205
EXP500 Parallel or Serial — $279
EXP550 Parallel or Serial — $389
EXP770 Parallel or Serial — $699

TOSHIBA PRINTERS SPECIAL

1340 Parallel — $449
1340 Serial — $449
341 Parallel — $829
341 Serial & Parallel — $879
351 Serial & Parallel — $985

MONITORS

Amdex All Monitors — Save
NEC All Monitors — Save
Princeton Graphics — Save
Taxan All Models — Save
Zenith All Models — Save

BOARDS

AST Advantage — $389
Six Pack Plus — $219
Everex Boards — Save
Hercules Color Card — $149
Graphic Card — $299
Paradise Modular Graphic 06-1 — $259
Five Pak — $119
Quadram
Quadlink — $325
Tec Mar Graphics Master — $445
Captain No Memory — $155

COMPUTERS

Zenith
Z-158 All Models — Save
Z-138 All Models — Save
Z-148 All Models — Save
Z-171 — Save
Z-200 — Save

VIDEO TERMINALS

Altos Smart III — $599
IBM 3161 & 3163 Series — Save
Qume QVT Green 101 — $299
QVT Amber 101 — $314
Wyse 30 — $299
50 — $419
75 — $559
Wyse 85 — $579
Wyse 350 — $859
Zenith Z-22 — $455
Z-29 — $599
Z-49 — Save

DISK DRIVES

Alpha Omega Turbo 10 — $529
Turbo 20 — $529
Turbo 30 — $729
Everex All Hard Disks — Save
Haba Macintosh 400K — $279
Macintosh 800K — $409
Iomega
Bernoulli Boxes for IBM — Save
Bernoulli Boxes for Macintosh — Save
Paradise Macintosh Hard Disk — Save

MODEMS

AT&T
4000 External — $309
Anchor Automation
Anchor Express — $229
Mark XII — $229
Hayes Smartmodem 300 Baud — Save
Smartmodem 1200 Baud — Save
Smartmodem 1200B (IBM) — Save
Smartmodem 2400 Baud — Save
Micromodem IIE (Apple) — Save
Novation Smart Cat Plus — $279
Prometheus All Models — Save
US Robotics Courier 2400 — $389
Password 1200 — $189
Microlink 2400 — $389

KEYBOARDS

Keytronics 5151 — $159
5151 Jr. — $179
Other Models — Save

DISKETTES

Maxell MD-2 Plastic Box (Qty 100) — $159
MD-20 Plastic Box (Qty 100) — $158
Sony MD/2 (Qty 100) — $158

PLOTTERS

Enter Sweet-P600 — $749
Epson HI-80 — Save

SOFTWARE

IBM PC and 100% Compatibles

WORD PROCESSORS

Leading Edge Word Processor — $50
Leading Edge W/P with Spell & Mail — $137
Microsoft Word — Save
Multimate 3.3 — $206
PFS-Write — $78
Wordstar w/Tutor — $169
Wordstar Pro Pack — $239

Word Perfect (Ver.4.1) — $199
Wordstar 2000 — $239
Wordstar 2000 Plus — $285

GRAPHICS

Chartmaster — $206
PC Paintbrush — $62
Turbo Graphix Tool Box — $28
Diagram Master — 190
Dr. Halo — $55
Energraphics — $165
Energraphics w Plotter Option — $214
Microsoft Chart — $172
PC Draw — $203
PC Draw Light Pen — $104
PC Point w Mouse — $123
PC Mouse w Paintbrush — $107
PFS Graph — $78
Printmaster — $30
Signmaster — $135

LANGUAGES

C Compiler (Microsoft) — $235
Fortran Compiler (Microsoft) — $209
Macro Assembler — $89
Pascal Compiler (Microsoft) — $178
Turbo Pascal 3.0 — $35
Lattice C Compiler — Save
Run C Interpreter — $85
Quick Basic — $59
Turbo Tool Box — $28

UTILITIES

1 DIR — $48
Copy II PC — $19
Norton Utilities 3.1 — $49
Sidekick — $28
Sidekick (Unprotected) — $43
Sideways — $31
Superkey — $35
Printworks — $36
Spotlight — $43
Sidekick—Superkey (Bundle) — $65

TRAINING

Flight Simulator — $30
Typing Instructor — $29
Typing Tutor III — $29

MONEY MANAGEMENT

Dollars & Sense w/Forcost — $95
Tobias Managing Your Money — $95

Gem Collection — $115
Gem Desktop — $29
Gem Draw — Save

PROJECT MANAGEMENT

Harvard Total Project Manager — $239
Microsoft Project — Save
Super Project — $182
Timeline 2.0 — $249

COMMUNICATIONS

CompuServe Starter Kit — $17
Crosstalk XVI — $94
PFS Access — $78
Remote — $94

INTEGRATIVE SOFTWARE

Enable 1.1 — $329
Framework — Save
Smart Software System — $459
Symphony — Save

SPREADSHEETS

Lotus 1-2-3 — Save
Multiplan — $114
Spreadsheet Auditor 2.0 — $83

Supercalc 3 (Ver.2.1) — $AVE

DATA BASE MANAGEMENT

Cornerstone — $255
dBase II — Save
dBase III — Save
Nutshell — Save
PFS:File — $78
PFS:Report — $70
Quickcode — $139
QuickReport — $139
Extended Report Writer — $80
Think Tank — $93
Clipper — $355
Knowledgemon II — Save
Knowledgemon Upgrade Kit — Save
Powerbase
(New Ver. Reb. 320K) — $205

R:Base 5000 — $335

MasterCard VISA AMERICAN EXPRESS

Prices reflect 3% to 5% cash discount. Product shipped in factory cartons with manufacturer's warranty. Please add $10.00 per order for UPS shipping. Prices & availability subject to change without notice. Send cashier's check or money order... all other checks will delay shipping two weeks.

Inquiry 321 for MS-DOS Products. Inquiry 322 for all others.

SILICON SPECIALTIES
2034 WEST SOUTHERN
MESA, ARIZONA 85202
602-969-0909

CWSS-1185

This is for all the power users technologies before they

Other than Steve Wozniak and Jonathan Rotenberg, there are probably only 2,998 personal computer users who qualify as trend setters. They're the people who owned Apples® when everyone else thought Apple® was a record label. People who were called hackers when a hacker was someone no one wanted to play golf with.

However many of you there are, this ad is for you. It's been designed and written to introduce you to a new technology without using superlatives or words like revolutionary. (We're saving those words for future ads targeted at the general consumer.)

The new technology is called the Softstrip™ System. This ad tells you what it's all about.

THE SOFTSTRIP SYSTEM ENCODES DATA ONTO PAPER.

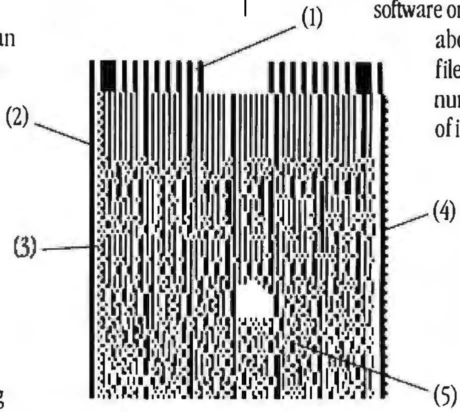
Softstrip technology allows text, graphics, even digitized sound to be encoded on a strip of paper. Providing an alternative to magnetic media and telecommunications for the recording, distribution and retrieving of information.

These data strips, each a structured pattern of black and white rectangles that look something like a condensed bar code, can be encoded with special software and read with a scanning device called the Cauzin Softstrip System Reader. The reader optically scans the strip, translates its contents into 8-bit code and feeds it into a personal computer's serial or cassette port, enabling automatic, error-free entry of printed data without using a keyboard.

One Softstrip data strip, typically $5/8'' \times 9\frac{1}{2}''$, can contain up to 5,500 bytes of information. (For example, you could fit this entire ad on two strips.)

Strips can be printed by using a photographic negative (ideal for book and magazine publishers), or by using a laser or dot matrix printer and special software (appropriate for personal or business use).

If you want, you can generate strips that can be reproduced on a copier or versions that can't be. Either way, any data strip, whether it's printed in a newspaper, magazine or personal letterhead, can survive pen marks, scratches, even coffee stains.



Basically, anything you can put on a magnetic disk you can put on a Softstrip data strip, which should suggest numerous application possibilities.

Starting in the next two months, data strips will appear in magazines, journals and books. These strips will contain program listings, tables of contents, new product demonstrations and data.

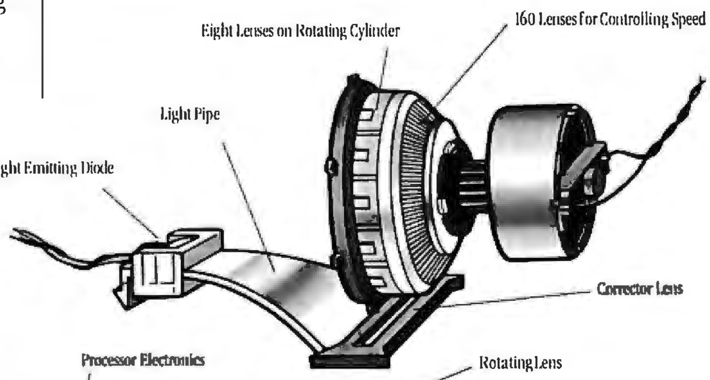
Eventually, strips may be used for everything from bank statements to sheet music.

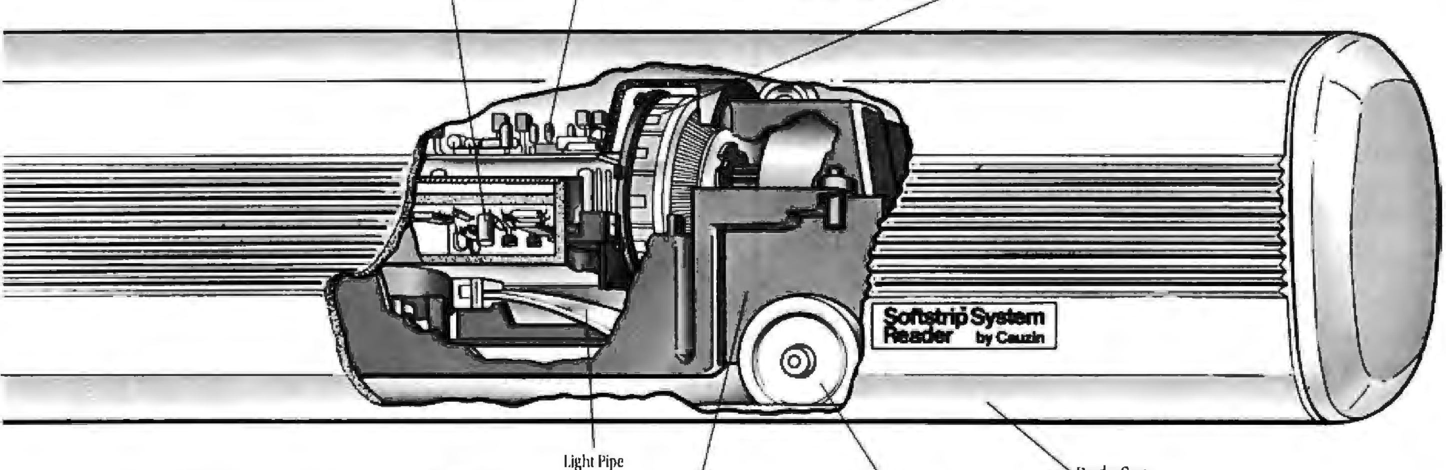
THE ANATOMY OF A STRIP.

A Softstrip data strip contains not only software or data, but also information about its content, including file types, file name and the number of strips. Because of its inherent technology, strips are as accurate as any magnetic medium. And they can be entered into an IBM PC,® Apple II® or Macintosh® computer using the same reader with only slightly modified communications software.

Strips encode data bit by bit using highly structured optical patterns. The bits are each composed of two rectangles called di-bits. They function as optical on/off signals. White/black equals 1. Black/white equals 0.

Data is organized in lines. Each line, between 0.01 and 0.04 inches high and from 0.5 to 0.76 inches wide, contains from two to six bytes of data. Line width and height are varied depending upon the quality of the paper and printing process. The reader scans each data line with a series of raster scans 0.0025 inches apart providing between four and sixteen scans per line.

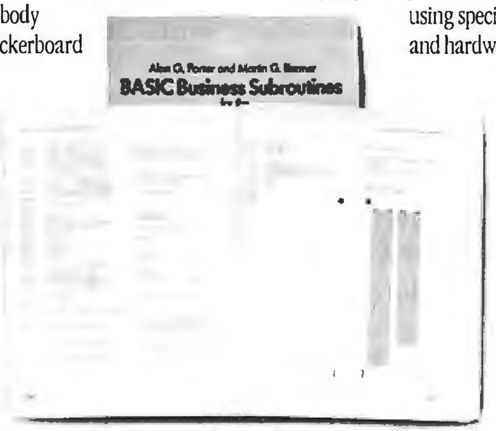




who want to know about new become household words.

A close-up view of a strip reveals five distinct sections. The header (1) at the top tells the reader the number of bytes in a line, the height of each line, and the paper to ink contrast level. Running vertically down the sides of the strip are the startline (2), the checkerboard (3) and the rack (4). They identify the boundaries of every horizontal line to be read. They also work in tandem to feed the reader alignment information.

Contained within the body of the strip, between the checkerboard and rack, is the file's data area (5).



Strip data accuracy is checked and error correction is provided by parity bits at the beginning and end of every data line, as well as by a strip checksum. There is also an optional 16 bit CRC. Combined, this design results in an undetected bit error rate of less than one bit error per 10,000,000,000 bits.

IT TOOK GUTS TO BUILD THE READER.

Rated for 25,000 reads, the reader is an equally impressive technology. It's composed of two key components: the case and the truck. While the case sits still, the truck moves uniformly down the length of the strip making a complete scan of the strip's di-bit lines every 0.0025 inches.

As the truck moves down the strip, it tracks its own lateral movement within five microns. Alignment is controlled by two servo mechanisms. As the truck moves, it illuminates the area to be scanned using near infra-red light beamed through a light pipe. (The infra-red technique permits the reader to see through colors, stains, and spills.)

The reader's optical scanning system, containing eight rotating cylindrical lenses and an aspherical corrector lens, forms an F.12 optical system with a depth of field between 0.05 and 0.08 inches. A set of 160 additional cylindrical lenses on the rotating lens allow the system to control scanning speed.

Inside the reader, the mechanical system uses six AGMA-7 high precision plastic molded gears to provide very accurate truck movement. One gear system even allows for a 4000 to 1 angle reduction with no backlash for corrector lens alignment.

A TMS 7040 8-bit processor and Cauzin's own custom VLSI chip provide reader logic, control and communications using four nested phase locked loops and several hardware and software servos. The reader transmits data to the host at 4800 baud burst rates with throughput of 1500 baud.

HOW TO CREATE YOUR OWN STRIPS.

There are two ways to create Softstrip™ data strips. For large volume and greater density– up to 5500 bytes per strip – a film negative is created using special Cauzin software and hardware. This is ideal for book, magazine, newsletter, data base and commercial software publishers who can reproduce a strip in volume using web, offset, gravure or similar processes.

For personal or business applications, 500 to 1000 byte strips can be generated using Cauzin licensed software on dot matrix printers; up to 3400 byte strips can be generated using other Cauzin licensed software and laser printers.

In the next few months, you should start to see data strips appear in popular computer magazines, some new computer books, and those consumer ads we told you about earlier. They'll look exactly like the working strip you see here, a medium density strip with an ASCII text file on it.

Of course you'll be able to purchase a reader at most computer dealers. They'll be selling for about $200.00. Contact your dealer soon for a demonstration. Or call us directly at 203-573-0150.

Apple® and Macintosh® are registered trademarks of Apple Computer Inc.

Apple® is a registered trademark of Apple Records, Inc.

Softstrip® and the Softstrip® System Reader are trademarks of Cauzin Systems, Inc.

Softstrip

Softstrip
COMPUTER READABLE PRINT

Cauzin Systems, Inc.,
835 South Main St., Waterbury, CT 06706

Inquiry 55

E·V·E·N·T Q·U·E·U·E

January 1986

INTRODUCTION TO DIGITAL SIGNAL PROCESSING & FILTERING; MINI- AND MICROCOMPUTER CONCEPTS; AND MICROPROCESSOR HARDWARE AND SOFTWARE—AN INTRODUCTION, Milwaukee, WI. John T. Snedeker, University of Wisconsin-Milwaukee/Extension, 929 North Sixth St., Milwaukee, WI 53203, (414) 224-4193. *January*

MICROCOMPUTER AND COMMUNICATIONS SEMINARS, various sites throughout the U.S. Center for Advanced Professional Education, Suite 110, 1820 East Garry St., Santa Ana, CA 92705, (714) 261-0240. *January*

MICRO SHOWS AND FLEA-MARKETS, Philadelphia, PA, Secaucus, NJ, and Boston, MA. Ken Gordon Productions Inc., POB 13, Franklin Park, NJ 08823, (201) 297-2526. *January*

ROBOTICS: FUTURE TRENDS IN THE 1980s, Des Moines, IA. The Des Moines Center of Science and Industry, 4500 Grand Ave., Des Moines, IA 50312, (515) 274-4138. *January*

COMMUNICATIONS/MICROCOMPUTER CURRICULUM, various sites throughout the U.S. Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 328-2776. *January–February*

INTENSIVE SEMINARS FOR PROFESSIONAL DEVELOPMENT, Boston, MA, area. Kathy Shaw, Office of Continuing Education/Higgins House, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517. *January–March*

SYMPHONY SEMINARS, various sites throughout the U.S. Automated Digital Offices, 4555 MacArthur Blvd., Washington, DC 20007, (202) 337-1393. *January–March*

COMPUTER COMPETENCE SEMINARS, Boston, MA, area. Boston University Metropolitan College, 755 Commonwealth Ave., Boston, MA 02215, (800) 255-1080; in Massachusetts, (617) 738-5020. *January–April*

COMPUTER SHORT COURSES, various sites throughout the U.S. Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (800) 421-8166; in California, (800) 352-8251 or (213) 417-8888. *January–April*

SYSTEMS SEMINARS, various sites throughout the U.S. Ken Orr & Associates Inc., 1725 Gage Blvd., Topeka, KS 66604-3379, (800) 255-2459; in Kansas, (913) 273-0653. *January–April*

MICROCOMPUTER/ENGINEERING COURSES, various sites throughout the U.S. Continuing Engineering Education, The George Washington University, Washington, DC 20052, (800) 424-9773; in Washington, (202) 676-6106; in Canada, (800) 535-4567. *January–May*

1986 INTERNATIONAL WINTER CONSUMER ELECTRONICS SHOW, Las Vegas, NV. Consumer Electronics Shows, 2001 Eye St. NW, Washington, DC 20006, (202) 457-8700. *January* 9–12

INTERFACING SENSORS WITH THE IBM PC, Madison, WI. E. K. Greenwald, Department of Engineering Professional Development, University of Wisconsin-Madison, 432 North Lake St., Madison, WI 53706, (608) 262-0573. *January* 13–15

MOS ANALOG/DIGITAL INTERFACE CIRCUIT DESIGN FOR VLSI DIGITAL SYSTEMS, San Francisco, CA. Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151. *January* 13–15

DATA RECOVERY: WHAT TO DO WHEN IT ALL GOES WRONG, Phoenix, AZ. Independent Computer Consultants Association, POB 32115, Phoenix, AZ 85064. *January* 14

MACWORLD EXPOSITION, San Francisco, CA. World Expositions, Mitch Hall Associates, POB 155, Westwood, MA 02090, (617) 329-7466. *January* 16–18

ADVANCED SEMICONDUCTOR EQUIPMENT EXPOSITION & TECHNICAL CONFERENCE, San Jose, CA. ASEE '86 Show Manager, Cartlidge & Associates Inc., Suite M259, 1101 South Winchester Blvd., San Jose, CA 95128, (408) 554-6644. *January* 21–23

WRITING BETTER COMPUTER SOFTWARE DOCUMENTATION FOR USERS, Research Triangle Park, NC. Trish Stolton, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332-0385, (404) 894-2547. *January* 21–23

SIXTH ANNUAL FLORIDA INSTRUCTIONAL COMPUTING CONFERENCE, Orlando, FL. Jill Draper, Florida Department of Education, Educational Technology Section, Knott Building, Tallahassee, FL 32301. *January* 21–24

ANIMATING ESCHER WITH COMPUTER GRAPHICS; SPECIAL EFFECTS; AND FRACTALS, COMPUTERS, AND DNA, New York, NY. Gideon Nettler, Department of Mathematics and Computer Science, Montclair State College, Upper Montclair, NJ 07043, (201) 893-4294. *January* 22

MAKING SENSE OF DATA COMMUNICATIONS; T-1 FACILITIES AND NETWORKING, Orlando, FL. Timeplex Inc., 400 Chestnut Ridge Rd., Woodcliff, NJ 07675, (201) 391-1111. *January* 22–23

1986 MEASUREMENT SCIENCE CONFERENCE, Marriott Hotel, Irvine, CA. Dennis Pinnecker, Measurement Science Conference, POB 1294, Corona, CA 91718, (714) 632-3923. *January* 23–24

COMMUNICATIONS NETWORKS '86, Washington, DC. CW Conference Management Group, Box 880, Framingham, MA 01701, (800) 225-4698; in Massachusetts, (617) 879-0700. *January* 28–30 ■

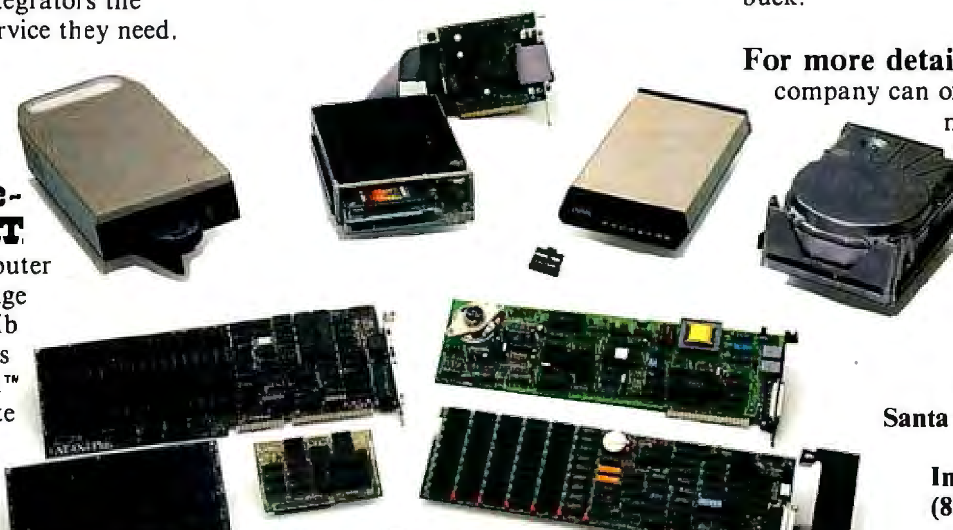
IF YOU WANT *your organization's public activities listed in* BYTE's *Event Queue, we need to know about them at least four months in advance. Send information about computer conferences, seminars, workshops, and courses to* BYTE, *Event Queue*, POB 372, *Hancock*, NH 03449.

Pick A Racehorse, A Workhorse, Or Your Choice Of Saddles

VAR's & VAD's now have a choice of PC and AT compatible computers and a complete range of enhancement products all in one place. And you won't be dealing with rookies either. Basic Time has been a computer manufacturer and distributor since 1975. We have the experience and proven ability to offer systems integratoı s the products and service they need.

Run With Our Racehorse- The BT/AT. This 80286 computer with 28ms average access time 44Mb drive runs circles around the IBM™ AT. It's complete with Hercules compatible monochrome monitor (color optional), a fistful of I/O ports, keyboard, 1.2 Mb/360k floppy, and 640k of RAM, MS-DOS and GW-BASIC. All this and more at the lowest price available for an AT compatible*.

Try Our Workhorse- The BT/XT. A new standard in price/performance for an 8088 computer. 8 slots, 256k RAM, AT type keyboard, Hercules compatible monochrome monitor and adapter, 20 Meg hard disk, floppy drive, 130 watt power supply, MS-DOS, and full PC compatibility.



Your Choice Of Saddles. Either horse you choose we can outfit you completely. Our HR series monitors support monochrome, color, or EGA adapters. Communication is easy with Basic Time internal or external modems. Hard disk storage is simple and reliable with our 20 Mb systems for PC's and BT44 and BT70 Mb drives for AT's. Tape backup systems are available to secure your data too. Need more memory and I/O ports? The BT6Plus and AT4x4Plus multifunction boards give you unrivaled bang for your buck.

For more details on how your company can offer it's customers more performance while you concentrate on one vendor instead of five, call or write:

Department B
3350 Scott Blvd.,
Bldg. 52
Santa Clara, Ca. 95054

Inside California
(800) 841-2474

Outside California
(800) 323-8437

basic time

*Infoworld Sept. 2, 1985, Page 1.

Inquiry 33

PC NETWORK

BUY HARDWARE AND SOFTWARE AT WHOLESALE +8%, AND GET 14-30 DAY SOFTWARE RENTALS†...

Listed below are just a few of the over 30,000 products available at our EVERYDAY LOW PRICES! *The Network* carries products for Apple, IBM, CP/M and most other popular computer families.

GAMES & EDUCATIONAL SOFTWARE FOR YOUR APPLE // & MACINTOSH

(Please add $1 shipping and handling for each title ordered from below.)

	Wholesale
Arrays *Home Accountant-Mac Only*	$65.00*
Axlon *Art Portfolio & Card Shoppe*	31.00*
Bluechip *Baron/Millionaire/Tycoon*	26.00*
Broderbund *Loadrunner*	19.75*
Broderbund *Choplifter*	19.00*
Broderbund *Print Shop*	28.75*
Broderbund *Dazzle Draw*	31.97*
CBS *Mastering the GRE*	53.50*
CBS *Murder by the Dozen*	20.97*
CBS *Goren Bridge Made Easy*	45.00*
Counterpoint *The News Room*	26.97*
Davidson *Speed Reader II*	37.97*
Davidson *Math Blaster*	29.97*
Davidson *Word Attack!*	29.97*
1st Byte *Smooth Talker-Mac Only*	47.00*
Hayden *DaVinci-House/Interiors/Landscapes*	24.75*
Hayden *Sargon III*	25.75*
Infocom *Deadline or Suspended*	24.00*
Infocom *Enchanter, Planetfall Cutthroats, Witness or Zork I*	20.00*
Infocom *Hitchiker's Guide or Seastalker*	20.00*
Infocom *Suspect, Sorcerer or Infidel*	22.00*
Infocom *Zork II or III*	22.00*
Layered *Front Desk-Mac Only*	65.00*
Mirage Concepts *Trivia*	11.00*
Miles Computing *Mac Attack-Mac Only*	$23.00*
Palatir *Mac Type-Mac Only*	23.50*
Penguin *Graphics Magician*	28.97*
Penguin *Pensate or Xyphus*	20.00*
Penguin *Transylvania-Mac Only*	20.00*
Professional Software *Trivia Fever*	19.00*
Pryority Software *Forbidden Quest*	21.00*
Scarborough *Master Type*	26.50*
Scarborough *Run for the Money*	26.00*
Simon & Schuster *Typing Tutor III*	28.25*
Sir-Tech *Wizardry*	26.97*
Sir-Tech *Knight of Diamonds*	18.97*
Sir-Tech *Rescue Raiders*	18.97*
Sublogic *Night Mission Pinball*	20.00*
Sublogic *Flight Simulator II*	27.25*
▶Spinnaker *Alphabet Zoo, Face Maker, Kinder Comp, Hey Diddle Diddle, Rhymes & Riddles, Story Machine*	15.97*
▶Spinnaker *The Most Amazing Thing*	20.77*
▶Spinnaker *Delta Drawing*	24.97*
T/Maker *Click Art-Mac Only*	25.00*
Warner *Desk Organizer*	65.00*
Videx *Fun Pack-Mac Only*	19.77*
Videx *Mac Checkers & Reversal*	25.17*
Virtual Combinatics *Micro Cookbook*	21.00*

BUSINESS SOFTWARE FOR YOUR APPLE // & MACINTOSH

(Please add $2.50 shipping and handling for each title ordered from below.)

	Wholesale
▶Apple *Apple Works*	$160.00*
Borland International *Turbo Pascal*	30.00*
BPI *GL, AP, AR, PR, or INV*	205.00*
Broderbund *Bank Street Writer*	40.00*
Central Point *Copy II Plus or Copy II Mac*	20.00*
Funk Software *Sideways*	34.00*
Funsoft *Macasm*	60.00*
Haba *Habadex*	40.00*
Haba *Quartet*	101.95*
Harvard *Mac Manager*	29.95*
▶Human Edge *Mind Prober*	24.00*
▶Human Edge *Sales Edge*	110.00*
Human Edge *Communication Edge*	98.00*
▶Living Videotext *Think Tank-Mac Too!*	65.00*
Main Street *Filer-Mac Only*	67.00*
MECA *Managing your Money*	105.50*
▶Microsoft *Word for Macintosh*	$102.00*
▶Microsoft *File for Macintosh*	102.00*
▶Microsoft *Multiplan for Macintosh*	102.00*
Microsoft *Basic for Macintosh*	79.00*
Microsoft *Chart for Macintosh*	66.00*
Monogram *Dollars & Sense for Apple IIc*	55.00*
Monogram *Dollars & Sense for Macintosh*	70.00*
Odesta *Helix for Macintosh Reg's 512K*	200.00*
Provue *Overvue-Mac Only*	135.00*
Sensible Software *Sensible Speller IV*	67.50*
Softcraft *Fancy Fonts*	125.00*
Softech Microsystems *UCSD Pascal*	140.00*
Software Arts *TK Solver! for Mac*	134.00*
Software Publishing *PFS: File, Write, or Graph*	68.00*
Stoneware *DB Master-Mac Tool*	95.00*
Telos *Filevision for Mac*	87.50*

HARDWARE FOR YOUR APPLE // & MACINTOSH

(Please add shipping and handling charges found in italics next to price.)

DISK DRIVES

	Wholesale	
Alps *AP-100A Dual Apple Drives in OneCase*	$309.00*	*(7.00)*
Apple *MAC 400KB External Drive*	349.95*	*(7.50)*
Corvus *5 5MB Hard Drive*	939.00*	*(20.28)*
IOmega *Macnoulli 5MG Removable Drive for Macintosh*	1,250.00*	*(27.00)*
MicroSci *A2 143KB Drive Just like Apple's Own*	150.00*	*(5.00)*
Micro Sci *Floppy Controller*	55.00*	*(2.50)*
▶Paradise *Mac 10MB Hard Drive Subsystem*	750.00*	*(16.20)*
▶Paradise *Mac 20MB Hard Drive Subsystem*	950.00*	*(20.52)*
▶PC Network *140K External Drive for Apple IIc*	95.00*	*(2.50)*
Rana *Elite I 163K Drive*	225.00*	*(5.00)*
Tecmar *5MB Removable Drive for MAC*	999.00*	*(21.58)*
Tecmar *10MB MAC Drive*	999.00*	*(21.58)*
Tecmar *5MB MAC Drive Upgrade*	1,235.00*	*(26.68)*

BOARDS AND BUFFERS

	Wholesale	
ALSZ-*Engine*	$115.00*	*(2.50)*
AST *Multi I/O—2 serial/Clock*	155.00*	*(2.50)*
Microsoft *Premium Softcard IIe*	243.67*	*(2.50)*
Microtek *Dumpling/GX*	55.00*	*(2.50)*
Orange Micro *Grappler +*	66.00*	*(2.50)*
Orange Micro *Serial Grappler*	66.00*	*(2.50)*
PC Network *Z80 Card*	35.00*	*(2.50)*
Quadram *APIC/G Graphics Interface*	62.00*	*(2.50)*
Quadram *e RAM-80*	88.00*	*(2.50)*
Quadram *Multicore—1 Parallel/1 Serial/Clock Expandable to 256K*	140.00*	*(2.50)*
Thunderware *Thunderclock*	104.00*	*(2.50)*

MODEMS

	Wholesale	
Hayes *Micromodem IIe w/Smartcom*	$125.00*	*(2.50)*
Novation *Apple Cat II*	174.45*	*(3.50)*
Prometheus *1200A Low Cost 1200 Baud Internal Modem for Apple II*	276.00*	*(6.00)*
Prometheus *Promodem 1200 w/MacPack*	299.00*	*(6.00)*
Zoom *Zoom/Modem IIe Micromodem Compatible-Free Dow Jones*	90.00*	*(2.50)*

ACCESSORIES

	Wholesale	
Apple *Macintosh Carrying Case*	$69.00*	*(1.49)*
Apple *Macintosh Security Kit*	29.00*	*(1.50)*
Apple *Macintosh Numeric Keypad*	69.00*	*(2.50)*
Hayes *Mach III Joystick w/Fire Button for IIe*	31.00*	*(1.50)*
Kensington *Dust Cover for MAC or Imagewriter*	8.25*	*(1.50)*
Kensington *Starter Pack*	54.00*	*(3.00)*
Kensington *Surge Protector*	33.47*	*(2.50)*
Kensington *System Saver Fan*	56.97*	*(1.50)*
▶Koala *MacVision*	158.00*	*(3.00)*
Koala *Koalapad Touch Tablet*	78.00*	*(1.50)*
M&R *Sup-R-Mod RF Modulation*	44.00*	*(1.50)*
PC Network *Cooling Fan with Surge Protector & Dual Outlets*	25.00*	*(2.50)*
PC Network *SS/DD Diskettes (Box of 10)*	7.95*	*(1.00)*
PC Network *Macintosh Diskettes Includes Free Flip & File Case*	21.95*	*(1.50)*
These Diskettes are Guaranteed for Life! No Generics!		
Sony *MAC Diskettes (Box of 10)*	22.95*	*(1.50)*

GAMES & EDUCATIONAL SOFTWARE FOR YOUR IBM

(Please add $1 shipping and handling for each title ordered from below.)

	Wholesale
ATI *Intro to PC DOS Vol. I & II*	$23.00*
ATI *Intro to BASIC*	23.00*
Bluebush *Chess (Your Toughest Opponent)*	34.00*
Bluechip *Millionaire/Oil Baron or Tycoon*	28.25*
Broderbund *Lode Runner*	19.75*
CBS *Goren-Bridge Made Easy*	40.00*
CBS *Mastering the SAT*	50.00*
CDEX *Training for Word Star*	37.25*
Comprehensive *Intro to Personal Computing*	32.00*
Davidson *Math Blaster, Word Attack!*	26.50*
Davidson *Speed Reader II*	36.50*
Hayden *Sargon III*	25.75*
Individual *Professor DOS*	32.50*
Individual *The Instructor*	24.50*
▶Infocom *Zork I or Witness*	20.00*
▶Infocom *Deadline, or Suspended*	$24.00*
Microsoft *Flight Simulator*	27.00*
Mouse Systems *PC Paint—Turn your PC into A Color Macintosh!*	59.95*
Scarborough *Mastertype*	27.00*
Sierra On-Line *King's Quest II*	27.00*
Sierra On-Line *Crossfire*	18.00*
Spectrum Holobyte *GATO*	18.00*
▶Spinnaker *Alphabet Zoo, Kinder Comp, Story Machine, Face Maker, Hey Diddle, Diddle, Rhymes & Riddles*	15.97*
▶Spinnaker *Delta Drawing*	24.97*
▶Spinnaker *Most Amazing Thing*	20.77*
Sublogic *Night Mission Pinball*	20.00*
Virtual Combinatics *Micro Cookbook*	21.00*

BUSINESS SOFTWARE FOR YOUR IBM

(Please add $2.50 shipping and handling for each title ordered from below.)

	Wholesale
▶Ashton-Tate *DBase II*	$365.00*
▶Ashton-Tate *Framework II*	365.00*
Borland *Turbo Pascal*	25.75*
Borland *Side Kick (Protected)*	26.00*
Borland *Superkey*	32.00*
BPI *G/L, A/R or A/P*	305.00*
BPI *Aura*	265.00*
BPI *Personal Accounting*	48.00*
Breakthrough *Timeline*	230.00*
▶Central Point *Copy II PC*	20.00*
Conceptual Instruments *Desk Organizer*	157.00*
Digital Research *DR Logo*	75.00*
Digital Research *Gem Desktop*	25.00*
Digital Research *Gem Draw*	73.00*
Enertronics *Energraphics with Plotter Option*	190.00*
Funk Software *Sideways*	34.00*
▶Harvard *Harvard Project Manager*	175.00*
Harvard *Total Project Manager*	225.00*
▶Hayes *Smartcom II—New VT100 Emulator*	68.00*
▶Human Edge *The Management Edge*	137.50*
▶Human Edge *The Sales Edge*	110.00*
▶Human Edge *Mind Prober*	26.50*
Lifetree *Volkswriter Delux*	135.00*
▶Lotus Development *Lotus 1-2-3*	285.00*
MDBS *Knowledgeman/2*	295.00*
MicroPro *Wordstar 2000*	219.00*
MicroPro *Wordstar 2000+*	$262.00*
MicroRim *RBase 5000*	300.00*
Microsoft *C Compiler*	220.00*
Microsoft *Word—Latest Version 2.0*	205.00*
Microsoft *Multiplan*	95.00*
Microsoft *Mouse*	107.00*
Monogram *Dollars & Sense*	95.00*
▶Multimate *Multimate (Latest Version)*	190.00*
Norton *Norton Utilities 3.0*	46.00*
Oasis *The Word Plus*	75.00*
Open Systems *P/O Sales A/R INV G/L A/P Team Mgr.*	ea. 275.00*
PowerBase *PowerBase*	197.00*
Real World *G/L A/P A/R or OE/INV*	ea. 275.00*
Rosesoft *Prokey Version 3*	65.00*
Ryan McFarland *RMCOBOL (Dev. System)*	520.00*
▶Samna *Samna III Word Processor*	227.00*
▶Samna *Word +*	320.00*
▶Satelite Software *Word Perfect*	190.00*
Softcraft *Fancy Fonts*	125.00*
Software Arts *TK!Solver*	200.00*
Software Publishing *PFS: File, Write, Graph*	68.00*
Software Publishing *PFS: Report*	64.00*
Sorcim *Supercalc III*	169.00*
Xanaro *Ability*	247.50*

HARDWARE FOR YOUR IBM

(Please add shipping and handling charges found in italics next to price.)

DISK DRIVES

	Wholesale	
IOmega *Bernoulli Box Dual 10MG Drives*	$2,149.00*	*(46.42)*
Maynard *WS-1 10MB Internal Hard Disk*	730.00*	*(15.77)*
Maynard *WS-2 same as WS-1 but with Sandstaar Floppy Controller (uses 1 slot)*	930.00*	*(20.30)*
▶PC Network *10MB INTERNAL Height Autoboot Drive. New lower price Drives by Shugart or Tandon*	330.00*	*(7.13)*
PC Network *10MB Tape Backup Same unit used in Compaq's DeskPro!*	460.00*	*(8.94)*
▶PC Network *Half Height DS/DD Drives*	59.00*	*(1.27)*
▶Tandon *TM 100-2 Full Height DS/DD Drives*	93.00*	*(2.20)*
Tallgrass *25MB External Hard Disk with 60MB Tape Backup*	2,375.00*	*(51.30)*
▶Teac *FD 55-B Half Height DS/DD Drives*	90.00*	*(1.94)*
▶Teac *1.2MB Half Height Disk Drive for AT*	110.00*	*(2.40)*

MULTIFUNCTION CARDS

	Wholesale	
Apparat *AT Ram Expansion card*	$139.00*	*(2.50)*
▶AST *Six-PackPlus With 64K*	195.00*	*(2.50)*
AST *I/O Plus II*	120.00*	*(2.50)*
AST *Advantage for AT*	355.00*	*(2.50)*
Everex *MagicCard/64K*	160.00*	*(2.50)*
▶PC Network *512K Memory Board w/0K*	69.00*	*(2.50)*
PC Network *Six-Pack Clone w/0K Full Six-Pack Features—Same Port Standard Direct Import from Taiwan at a Fabulous price! 1 year Warranty—Money back Guarantee*	89.00*	*(2.50)*
▶PC Network *I/O Plus II Clone Ser/Par/Game/Clock standard*	69.00*	*(2.50)*
Quadram *Improved Quadboard w/0K*	170.00*	*(2.50)*
Tecmar *Captain Multifunction Card w/0K*	146.00*	*(2.50)*

MODEMS

	Wholesale	
AST *Reach! Short Slot 1200 Baud Internal Modem*	$345.00*	*(2.50)*
Hayes *Smartmodem 1200B with New Smartcom II/VT100 Emulator*	317.00*	*(2.50)*
Hayes *Smartmodem 1200B Alone*	265.00*	*(2.50)*
Prometheus *Promodem 1200B Internal*	225.00*	*(2.50)*
Quadram *Quadmodem II 1200 Baud Half Card w/Crosstalk XVI*	275.00*	*(2.50)*

VIDEO CARDS

	Wholesale	
Hercules *ColorCard w/Parallel Port*	$142.00*	*(2.50)*
▶Hercules *Monochrome Graphics Card*	263.00*	*(2.50)*
Paradise *Modular Graphics Card*	235.00*	*(2.50)*
▶PC Network *Hercules Mono Card Clone 100% Hercules Compatible!*	99.00*	*(2.50)*
▶PC Network *Color Card*	69.00*	*(2.50)*
Persyst *Bob Card Ultra High Res Color*	299.00*	*(2.50)*
▶STB *Graphix Plus II (simultaneous Mono Graphics & Color)*	199.00*	*(2.50)*

ACCESSORIES

	Wholesale	
▶Brand Name *DS/DD Diskettes Guaranteed for Life! Not Generic!*	$8.95*	*(1.00)*
▶DS/DD Bulk Rate Special *Packaged in 50 with sleeves and labels Guaranteed for Life!*	.59* ea.	
▶PC Network *Replacement 130 Watt IBM-PC Power Supply—Gives your PC the same Capacity as an XT. Good for add in Tape Drives (without need for a piggyback unit) and large capacity disk drives.*	76.00*	*(2.70)*
SMA *PC Doucumate; Keyboard Templates for Lotus/DBase/Multimate and others (Each)*	9.99*	*(1.00)*

MEMORY CHIPS

(All Memory Chips Guaranteed for Life!)

	Wholesale	
▶64K Memory Upgrade Kits *(9 Chips) Quantity Discounts Available!*	$5.40*	*(1.00)*
▶64K Dynamic Ram Chips *(Each)*	.60*	*(1.00)*
▶256K Dynamic Ram Chips *(Each)*	3.00*	*(1.00)*
▶128K IBM AT Piggyback Chips *(Each)*	4.00*	*(1.00)*

EXTERNAL MODEMS

	Wholesale	
Anchor *Signalman Express*	$205.00*	*(5.00)*
Hayes *Smartmodem 300*	125.00*	*(5.00)*
Hayes *Smartmodem 1200*	340.00*	*(5.00)*
Hayes *Smartmodem 1200B with new Smartcom II VT100 Emulator*	317.00*	*(2.50)*
Hayes *Smartmodem 1200B Alone*	265.00*	*(2.50)*
▶Hayes *Smartmodem 2400*	535.00*	*(5.00)*
Prometheus *Promodem 1200 External 100% Hayes Compatible*	276.00*	*(6.00)*
▶U.S. Robotics *Courier 2400BPS Modem*	450.00*	*(5.00)*
▶U.S. Robotics *Password LOWEST PRICE 1200BPS Modem!*	195.00*	*(4.00)*

MONITORS

	Wholesale	
Amdek *Video 300G Composite Green*	$110.00*	*(3.00)*
Amdek *Video 300A Composite Amber*	120.00*	*(3.00)*
Amdek *Video 310A IBM Type Amber*	130.00*	*(3.00)*
Amdek *Color 300—Composite*	215.00*	*(4.64)*
Amdek *Color 600—High Res RGB*	365.00*	*(7.88)*
Amdek *Color 700—Ultra High Res*	455.00*	*(9.83)*
Amdek *Color 710—700 w/Non Glare Long Phosphor*	475.99*	*(10.48)*
Princeton *HX-12 RGB Monitor*	CALL	
Princeton *MAX-12e Work with Color or Mono Card!*	CALL	
Quadram *Quadchrome II New! 640X200 RGB w/14" Screen! Black, Phosphor Mask/IBM Case*	350.00*	*(7.56)*
▶Samsung *12" TTL IBM Type Amber A great looking/performing monochrome from the manufacturer of IBM's own color monitor*	85.00*	*(5.00)*
Taxan *440 Super Hi Res RGB Currently Available works with Persyst Bob Card*	495.00*	*(10.69)*
Zenith *ZVM 1230A Green Hi Res/Non Glare*	81.00*	*(1.75)*

TERMS & CONDITIONS

*PC NETWORK—Members pay just 8% above the wholesale price, plus shipping. All prices reflect a 3% cash discount. Minimum shipping $2.50 per order International orders call for shipping & handling charges Money Orders, personal and company checks please allow 10 working days to clear All prices subject to change without notice!

†RENT BEFORE YOU BUY—Members are eligible to join the NETWORK's Business and Game software Rental Libraries and evaluate products for a full 14 (Regular) or 30 (VIP) days to see if it meets your needs. And The NETWORK's rental charges are far less than other software rental services—Just 20% OF THE MEMBER WHOLESALE PRICE. Rental titles available in IBM/Apple/MAC and CP/M Formats. Hardware prices highlited by ▶ reflect recent major price reductions.

COMPLETE SYSTEMS

	Wholesale	
Apple *Macintosh Base Systems*	CALL	
AT&T *6300 PC CPU2 128K/2 Floppy/1 Serial/1 Parallel*	$1,575.00*	*(34.02)*
AT&T *7300 Unix PC 10MB Hard Disk/1 Floppy/512K*	3,699.00*	*(79.90)*
COMPAQ *DeskPro/Tape Backup System w/640K/1 Floppy/10MB Hard Disk/10MB Tape Drive/Monitor*	2,951.94*	*(63.70)*
▶COMPAQ *Hard Disk Portable 10MB Hard Disk/Floppy/256K*	$2,235.00*	*(48.28)*
▶IBM *PC Base System 2DSDD/FDC/256K*	1,425.00*	*(30.78)*
▶IBM *PC Professional Hard Disk*	1,709.00*	*(36.91)*
IBM *PC/AT Base System—1.2MB Floppy/256K*	2,795.00*	*(60.37)*
IBM *AT Professional System 1.2MB Floppy/20MB Hard Disk/1 Ser/1 Par/512K*	CALL	

PRINTERS

	Wholesale	
▶Citizen *MSP-10 NEW! 160CPS/80COL/Fric + Trac*	$265.00*	*(5.72)*
▶Citizen *MSP-15 NEW! 160CPS/132COL/Fric + Trac*	350.00*	*(7.56)*
▶Citizen *MSP-20 NEW! 200CPS/80COL/Fric + Trac*	350.00*	*(7.56)*
▶Citizen *MSP-25 NEW! 200CPS/132COL/Fric + Trac*	499.00*	*(10.76)*
▶Citizen *Premiere 35 NEW! 35CPS Daiseywheel/132COL/Fric + Trac*	569.00*	*(12.29)*
▶Epson *LX-80 100CPS 80COL LO Mode New Model!!*	199.00*	*(4.30)*
▶Epson *FX-85*	299.00*	*(6.46)*
▶Epson *FX-185*	429.00*	*(9.27)*
Epson *LQ-1500*	799.00*	*(17.26)*
Epson *SQ2000 NEW! Inkjet Printer 106CPS LO Model/176CPS Draft/132COL*	1,359.00*	*(29.35)*
Epson *DX-35 35CPS Letter Quality Printer*	589.00*	*(12.29)*
▶NEC *2030 20CPS LO Parallel*	605.00*	*(13.00)*
▶NEC *2050 20CPS Letter Quality Printer*	605.00*	*(13.00)*
▶NEC *3530 33CPS LO Parallel*	$888.00*	*(19.18)*
▶NEC *3550 33CPS Letter Quality Printer*	920.00*	*(19.87)*
▶NEC *8850 55CPS Printer*	1,330.00*	*(28.73)*
▶NEC *Pinwriter 2 New! Color Dot Matrix*	599.00*	*(12.94)*
Okidata *ML 182 New 120CPS/LO Model Fric/IBM Graphics + more*	CALL	
Okidata *ML 192 New Sleek Design! 160CPS/LO Model Fric/IBM Graphics*	CALL	
Okidata *Color 20 80CPS/100 + Colors/LO Mode/IBM Graphics + More (Requires Interface)*	CALL	
Okidata *IBM Interface for Okimate Color 20*	CALL	
Okidata *ML84P 200CPS 132COL*	CALL	
Okidata *ML93P 160CPS Wide Platen*	CALL	
Okidata *2410P Pacemark 350COL*	CALL	
Qume *Sprint 11/40 40CPS Letter Quality*	1,155.00*	*(24.00)*
Star Micronics *Power type 18CPS Letter Quality*	300.00*	*(6.48)*
Toshiba *P1340 80COL/144CPS*	450.00*	*(9.72)*
Toshiba *P351 New! 288CPS/132COL*	975.00*	*(21.00)*

PC NETWORK • MEMBERSHIP APPLICATION

YES! Please enroll me as a member in the PC NETWORK™ and send my catalog featuring thousands of computer products, all at just 8% above DEALER WHOLESALE PRICES. I will also periodically receive "THE PRINTOUT", a special up-date on merchandise at prices BELOW even those in my wholesale catalog, and all the other exclusive, money-saving services available to Members.

I am under no obligation to buy anything. My complete satisfaction is guaranteed.
Please check (✔) all boxes that apply: **316**

● Basic Membership
With 14 Day Rentals

- ☐ One-year membership for $8
- ☐ Two-year membership for $15 (SAVE $1)
- ☐ Business Software Rental Library for $25 add'l. per year—members only
- ☐ Games Software Rental Library for $10 add'l. per year—members only

● Special V.I.P. Membership
With 30 Day Rentals

- ☐ One-year membership for $15
- ☐ Two-year membership for $25 (SAVE $5)
- ☐ BOTH Business and Game Software Rental Libraries for $30 add'l. per year—V.I.P. members only

☐ Bill my credit card: ☐ VISA ☐ MasterCard ☐ American Express

Account Number: ______________________ Exp. Date ________ mo. year

☐ Check or money order enclosed for $ ____________.

Name ____

Address __________________________________ Apt. No. __________

City ______________________ State ____________ Zip ____________

Telephone (________) ________________

My computer(s) is: ☐ IBM PC ☐ IBM-XT ☐ IBM-AT ☐ Apple II ☐ Macintosh ☐ Other ________

Signature ✔ ____
(Signature required to validate membership)

PC NETWORK • MEMBERSHIP APPLICATION

YES! Please enroll me as a member in the PC NETWORK™ and send my catalog featuring thousands of computer products, all at just 8% above DEALER WHOLESALE PRICES. I will also periodically receive "THE PRINTOUT", a special up-date on merchandise at prices BELOW even those in my wholesale catalog, and all the other exclusive, money-saving services available to Members.

I am under no obligation to buy anything. My complete satisfaction is guaranteed.
Please check (✔) all boxes that apply: **316**

● Basic Membership
With 14 Day Rentals

- ☐ One-year membership for $8
- ☐ Two-year membership for $15 (SAVE $1)
- ☐ Business Software Rental Library for $25 add'l. per year—members only
- ☐ Games Software Rental Library for $10 add'l. per year—members only

● Special V.I.P. Membership
With 30 Day Rentals

- ☐ One-year membership for $15
- ☐ Two-year membership for $25 (SAVE $5)
- ☐ BOTH Business and Game Software Rental Libraries for $30 add'l. per year—V.I.P. members only

☐ Bill my credit card: ☐ VISA ☐ MasterCard ☐ American Express

Account Number: ______________________ Exp. Date ________ mo. year

☐ Check or money order enclosed for $ ____________.

Name ____

Address __________________________________ Apt. No. __________

City ______________________ State ____________ Zip ____________

Telephone (________) ________________

My computer(s) is: ☐ IBM PC ☐ IBM-XT ☐ IBM-AT ☐ Apple II ☐ Macintosh ☐ Other ________

Signature ✔ ____
(Signature required to validate membership)

Copyright © 1985, PC NETWORK INC.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 14823 Chicago, IL

POSTAGE WILL BE PAID BY ADDRESSEE

PC NETWORK
320 West Ohio
Chicago, Illinois 60610

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 14823 Chicago, IL

POSTAGE WILL BE PAID BY ADDRESSEE

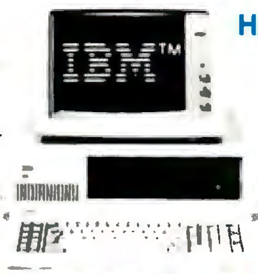
PC NETWORK
320 West Ohio
Chicago, Illinois 60610

COMPLETE SYSTEMS
(Optional local warranty service available in most major metro areas)

IBM PC BASE SYSTEM
IBM PC w/256K
Floppy Drive Controller
2 Double Sided Double Density Disk Drives
Mix and Match with your Favorite Monitor and Printer!

$1,425.00*

CALL FOR LATEST IBM ANNOUNCEMENTS



IBM PC HARD DISK SYSTEM
IBM PC w/256K
Floppy Drive Controller
1 Double Sided Double Density Disk Drive
Half Height 10MB Disk Subsystem

$1,709.00*

CUSTOM CONFIGURATIONS WELCOME

COMPAQ™

PORTABLE HARD DISK SYSTEM
w256K/1 Floppy/10MB Hard Disk

$2,235.00* w/10MB
$2,369.00* w/20MB

DESKPRO SYSTEM WITH TAPE BACKUP
640K CPU/1 Floppy/10MB Hard Disk
10MB Tape Drive/Monitor

$2,951.94* w/10MB
$3,151.94* w/20MB

APPLE IIc / APPLE IIe / MACINTOSH SYSTEMS

64K IBM PC MEMORY EXPANSION KITS
Quantity Discounts Available.
Guaranteed for Life!

Quantity of 100 Sets **$3.96*** per set
Set of 9 Chips **$5.40***

DISKETTES
Guaranteed for Life!
Brand name diskettes available in boxes of 10 or in bulk packs of 50

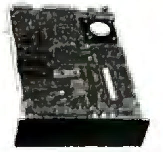
5¼" DS/DD	5¼" SS/DD	3½" SS/DD
$8.95* Bx. 10 / Bx. 50 .59* ea.	$7.95* Bx. 10 / Bx. 50 .47* ea.	Bx. 10 $21.95* Free Flip & File Case

1/2 HEIGHT DS/DD DISK DRIVES

The Network buys direct and makes fantastic deals with manufacturers like MPI/ Tandon/CDC/Shugart/Qume/ TEAC and others to bring you fantastic prices on Name Brand drives for your PC/AT/ XT/jr/or Compatible.

$59.00*
Quantity Discounts Available

INTERNAL PC HARD DISK
Low Power/Automatic Boot. Works on standard PC's and Compatibles. Includes drive/controller/cables/ mounting hardware and instructions.



Full one year warranty!
10MB **$330.00***
20MB **$420.00***
Quantity Discount Available

Lotus™ 1-2-3™
$285.00*
Recent Price Increase by Lotus

WordPerfect
$190.00*
MultiMate™

***Members pay 8% above this wholesale price plus shipping.**

CALL TOLL FREE 1-800-621-S-A-V-E (orders and memberships)
In Illinois call (312) 280-0002 Validation code: B316

TM & R—Registered trademark of IBM/COMPAQ/APPLE

Inquiry 273

PC NETWORK

GET *THE NETWORK* ADVANTAGE!!!

SEE WHY OVER 100,000 HAVE JOINED MAKING US THE NATION'S #1 SOURCE FOR EVERYTHING IN COMPUTING...

- ***Our 600 Page Wholesale Catalog***
  Over 30,000 products priced at Wholesale + 8%. Anything you will ever need at a Consistent low price...
- ***Quarterly Catalog Updates***
  Your Catalog is never obsolete! Keep on top of the newest products and latest price changes.
- ***The Printout***
  Our newsletter gives you fantastic specials along with unbiased analysis of new products and industry trends.
- ***10 Day Returns on any Hardware!!***
  If you don't like any hardware product—for any reason —return it for a refund.
- ***1000 + Title Rental Library***
  14 to 30 day rentals on over 1000 different titles. Try before you buy!!
- ***Size-Strength and Stability***
  The Network has over 100 employees, 40,000 square feet of office and warehouse, inventory valued in excess of $15,000,000 and is ranked the largest computer product supplier in the Nation!! Our commitment is to serve our customers and our 90% repeat business rate is proof!!

CALL TOLL FREE 1-800-621-S-A-V-E

NEW HOLIDAY HOURS
M-F 7:30 AM–9:00 PM CST
SAT 9:00 AM–7:00 PM CST

In Illinois call (312) 280-0002
Your Membership Validation Number **B316**

You can validate your membership number and, if you wish, place your first money-saving order over the phone by using your VISA, MASTERCARD or AMERICAN EXPRESS. Our knowledgeable service consultants are on duty Mon.-Fri. 7:30 AM to 9 PM, SAT. 9AM to 7 PM CST.

PERSONAL COMPUTER NETWORK
320 West Ohio
Chicago, Illinois 60610

Call now...Join the PC NETWORK and start saving today!

PC NETWORK • MEMBERSHIP APPLICATION

YES! Please enroll me as a member in the PC NETWORK™ and rush my catalog featuring thousands of computer products, all at just 8% above DEALER WHOLESALE PRICES. I will also periodically receive "THE PRINTOUT", a special up-date on merchandise at prices BELOW even those in my wholesale catalog, and all the other exclusive, money-saving services available to Members.

316 ☐

I am under no obligation to buy anything. My complete satisfaction is guaranteed. Please check (✓) all boxes that apply:

Basic Membership
With 14 Days Rental
- ☐ One-year membership for $8
- ☐ Two-year membership for $15 (SAVE $1)
- ☐ Business Software Rental Library for $25 add'l. per year—with 14 day rentals
- ☐ Games Software Rental Library for $10 add'l. per year

Special V.I.P. Membership*
With 30 Days Rental.
- ☐ One-year membership for $15
- ☐ Two-year membership for $25 (SAVE $5)
- ☐ BOTH Business and Game Software Rental Libraries for $30 add'l. per year—with 30 day rentals

*VIP members receive advance notice on limited quantity merchandise specials

☐ Bill my credit card: ☐ VISA ☐ MasterCard ☐ American Express

Account Number: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Exp. Date ____________
mo. year

☐ Check or money order enclosed for $ ____________

Name ____________

Address ____________ Apt. No. ______

City ____________ State ______ Zip ______

Telephone ( ) ____________

My computer(s) is: ☐ IBM PC ☐ IBM-XT ☐ IBM-AT ☐ Apple II ☐ Macintosh ☐ Other ______

Signature ____________
(Signature required to validate membership)

Features

THREE BYTE STAFF MEMBERS, Jon Edwards, Phillip Robinson, and Brenda McLaughlin, have put together a preliminary but detailed evaluation of the Atari 520ST. They summarize the hardware of the 520ST as "the 68000 unbounded." Among the features they were impressed with are the quality of video output (though you must choose between monochrome and color), the speed of the disk I/O, and the variety of ports. An unfinished operating system and minimal application software did not dampen their overall impression.

The subject of analog-to-digital conversion is one that Steve Ciarcia returns to every few years. He does this largely so that new readers can learn the basics. For readers who have been around for a while, he also includes the latest conversion interface. This month's column is no exception. Steve discusses the basics and then describes a 16-channel 12-bit high-speed A/D converter.

"Q&A" is a product preview about an integrated software package that combines word processing and file management with a full macro facility and an effective natural-language interface—your Intelligent Assistant. By entering normal English phrases and sentences, you can carry on a conversation with your Assistant and get a lot of information into and out of your database. Jon Edwards provides a sample session in "Q&A," discusses some of its drawbacks, and compares it with other natural-language database products.

Last month, Jonathan Amsterdam began a three-part article on a compiler for his high-level language called SIMPL. This month, he describes the part of the compiler that handles procedures and functions, also known as routines. The routines of SIMPL are similar to those of Pascal, and like most routines, they're useful for programmers but difficult to compile.

Large software projects can be undertaken by simply reusing the same modules of code in different programs. Modula-2 imposes some restrictions to this method, and Namir Clement Shammas, author of "Create Reusable Modules," offers a program strategy as a solution. The strategy involves the creation of capsule editors, the advantages of which include customization of programs, lowered costs, and increased reliability.

Creating three-dimensional graphics on microcomputers has been a popular subject with both BYTE readers and authors. In "Budget 3-D Graphics" (March 1985), author Tom Clune looked at the program SURF, which includes such advantages as hidden-line removal and the ability to rotate the plot around three axes. This month we have "Easy 3-D Graphics" by Henning Mittelbach. The author has written a low-cost, three-dimensional graphics program for the IBM Personal Computer, the Apple Macintosh, and the Apple II family.

THE ATARI 520ST

The 68000 *unbounded*

Editor's note: The following is a BYTE product description. It is not a review—for several reasons. Some of the equipment we received, such as the hard-disk drive, were prototypes, and at the time of this writing, software is scarce. Atari has not yet completed its BASIC interpreter, and the operating system, TOS, remains unfinished. Nonetheless, we are as intensely interested as our readership in new technology, and we feel we have learned enough to share some of the results of our investigations. We began our work on this description as soon as we were able to get a system from Atari. A full review will follow in a subsequent issue.

For many years the public has equated the Atari name with arcade games and joysticks. In truth, the Atari 400/800/XL computer line is technically at least comparable if not better than other 8-bit machines, so it should not be a surprise that the company's latest venture, the 520ST (see photo 1), is a competitive 68000 system. Indeed, we are most impressed with the clarity of the graphics, with the speed of the disk I/O (input/output), and with the 520ST's value.

The system is not without its problems. The desktop is less effective than the Macintosh's, the keyboard has an awkward feel, and the current operating system makes it impossible to switch between high-resolution monochrome and low- or medium-resolution color without installing the other monitor and rebooting. Nonetheless, we are left with a very favorable impression; several software-development languages are already available, including FORTH, Modula-2, and C. With them, you can tap the power of the 68000 at a most reasonable price.

SYSTEM DESCRIPTION

The Atari 520ST is a keyboard computer. Like the Commodore 64 and the Atari 400/800, the 520ST keyboard unit contains the microprocessor, the memory, the video and sound circuitry, and so on. The power supply, disk drives, and monitor are external devices. The 520ST has a variety of ports, but there are no internal expansion slots.

The In Brief box on page 90 summarizes the features of the Atari 520ST. For $799, you get the CPU, a 12-inch diagonal monochrome monitor, and one external single-sided double-density floppy-disk drive. For $999, you get the same system with a 12-inch RGB analog monitor in place of the monochrome monitor (see photo 1). Both systems provide 512K bytes of RAM (random-access read/write memory), a Motorola 68000 microprocessor, MIDI ports with a transfer rate of 31,250 bps (bits per second), a DMA (direct memory access) port with a transfer rate of 10 megabits per second for a hard disk or CD-ROM (compact-disk read-only memory), and much, much more. To be sure, owners will make some sacrifices. The unit does not have an RF (radio frequency) modulator for television output, every peripheral has a separate power supply (wire haters beware), and the operating system currently rests in RAM, stealing over 200K bytes from your workspace. We have summarized other problems below, but almost all are insignificant when you consider what you do get for the money. And rest assured, the system works. Our first system, like most of the first production units, had to have several chips reseated. It now functions properly, and we have not heard of any similar quality-control problems on the latest 520STs.

THE HARDWARE DESIGN

The heart of the 520ST is the MC68000, with its 16-bit data bus and 24-bit address bus, running at 8 MHz (see figure 1). The rest of the system was designed to stay out of the 68000's way. (See the 520ST motherboard in photo 2.)

The Atari design team began work on the 520ST in May 1984. From the start, they had several specific goals in mind. The first was to choose a fast microprocessor and do everything to let it run effectively at full speed. To the Atari team, that meant maximizing bus bandwidth and relegating as

(continued)

Jon R. Edwards is a technical editor, Phillip Robinson is a senior technical editor, and Brenda McLaughlin is an associate news editor for BYTE. They can be contacted at BYTE, POB 372, Hancock, NH 03449.

BY JON R. EDWARDS, PHILLIP ROBINSON, AND BRENDA MCLAUGHLIN

Photo 1: *The Atari 520ST, shown here with the color monitor and two single-sided double-density disk drives. (a) On the right side of the keyboard unit are two joystick/mouse ports. (b) On the left is the 128K-byte ROM cartridge port. (c) The rear of the disk drives has specific ports for I/O in and I/O out.*

many mundane tasks as possible from the microprocessor to other chips. Second, according to Shiraz Shivji, Atari's vice president for research and development, "We didn't want to reinvent the wheel . . . things that were available that could offload the processor—we wanted to use." A direct result of that goal was the use of several standard chips (such as the Western Digital WD1772 for floppy-disk-drive control) and use of custom CMOS (complementary metal-oxide semiconductor) chips for performance, reliability, and manufacturability. All four custom chips—Glue, the Memory Controller, the Video Shifter, and the DMA chip—share many of the 520ST's duties.

Third, the 520ST had to provide high-quality color displays. Finally, the design team wanted to give the 520ST excellent I/O capabilities. That goal is reflected in both the variety of ports that surround the 520ST and in the high speed of the DMA (hard-disk) port.

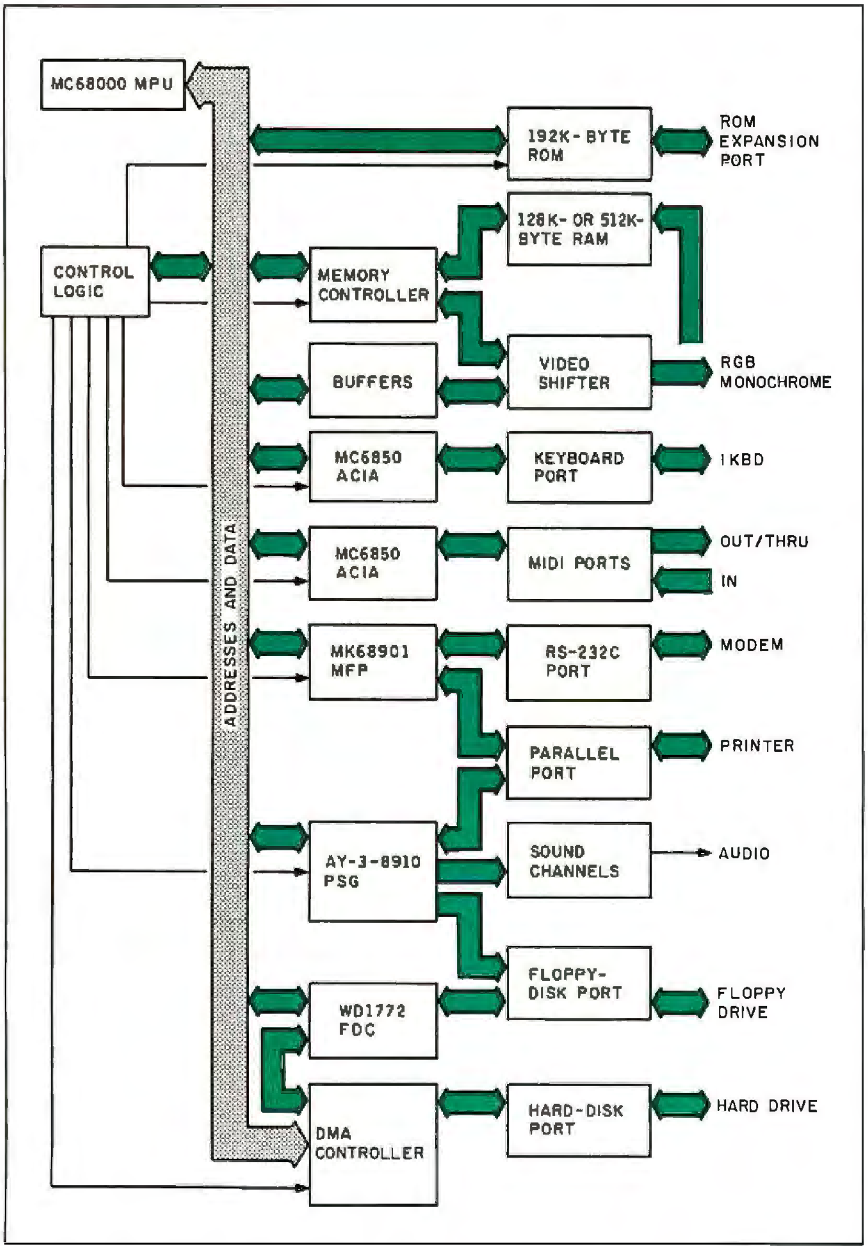


Figure 1: *The system block diagram for the Atari 520ST.*

MEMORY

The 520ST currently includes 512K bytes of RAM and 16K bytes of ROM. The RAM consists of sixteen 256K-bit dynamic RAM chips that are rated at 150 ns (nanoseconds). Atari is already talking about 1-megabyte and 2-megabyte (RAM) versions of this same computer. The 68000 CPU (central processing unit) can directly address up to 16 megabytes of ROM and RAM, but the present Memory Controller chip can only work with 4 megabytes. The circuit board has room, but it will need a slight redesign to use the 1-megabit dynamic RAMs when they become available. (The 1-megabit chips have two more pins than the 16-pin 256K-bit chips they would replace and also would have some of the signals on different pins. This change would require a small modification in manufacturing.)

Memory is configured as five 64K-byte sets of ROM and one configurable bank of 128K bytes, 512K bytes, or 2 megabytes of RAM. (Early in 1985, Atari mentioned a possible 128K-byte RAM version of the ST.) Software determines the ROM configuration. A shadow-test algorithm that loads a Memory Configuration register determines the RAM configuration. When the computer is turned on, this algorithm tries to write to and read from memory addresses unique to the possible configurations.

The memory map is shown in figure 2. The first 2K bytes (lowest address values) are reserved for the exception vector table and the supervisor stack. These 2K bytes—and the I/O space—are protected: They can only be accessed when the CPU is in supervisor mode. Four words of ROM are shadowed at the start of RAM for the reset stack pointer and the program counter.

VIDEO MEMORY

The Atari 520ST offers three display resolutions. The highest resolution is a noninterlaced monochrome 640- by

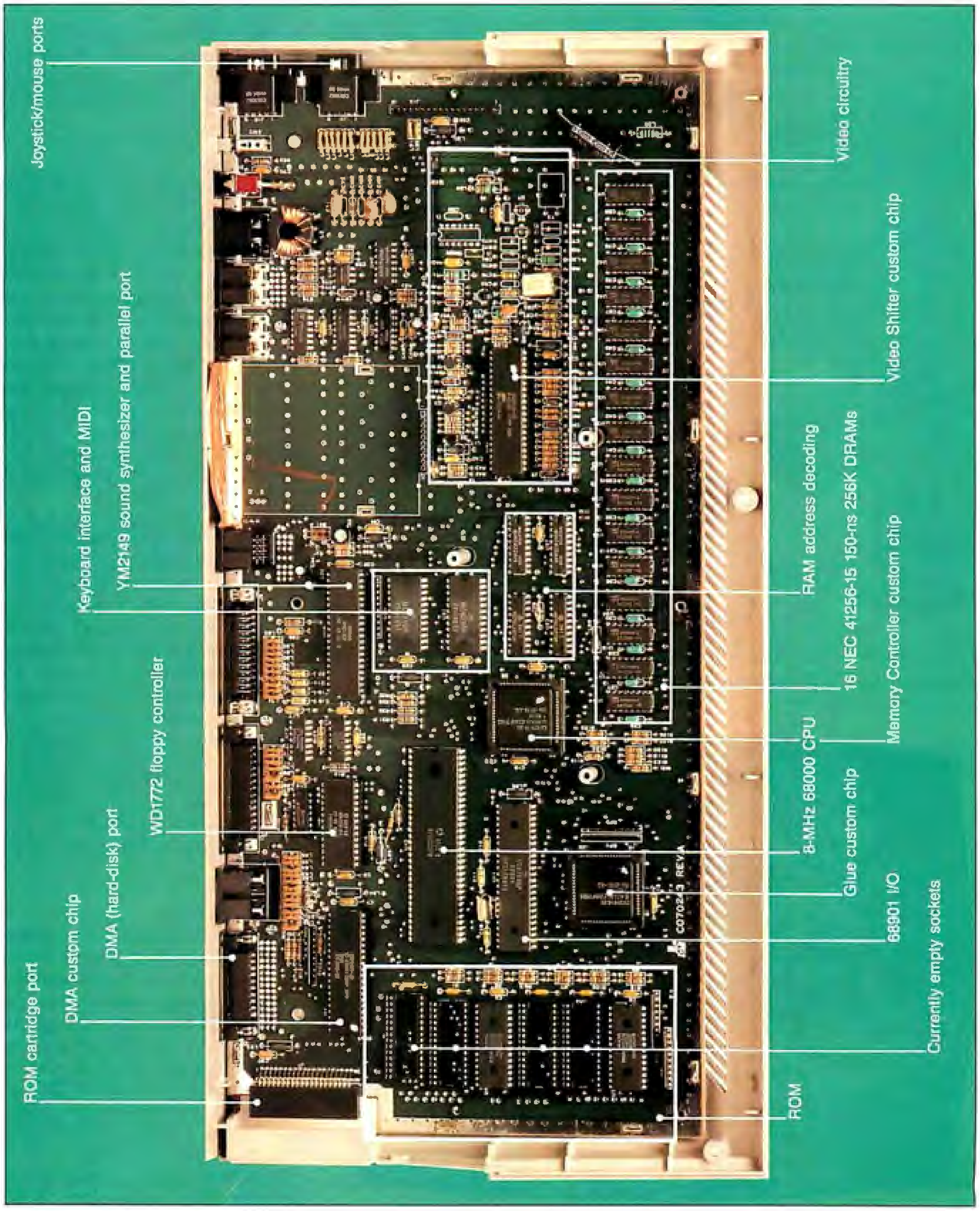


Photo 2: *The Atari 520ST motherboard.*

```
--ST MEMORY MAP- ----

00 0000 | ROM | RESET: SUPERVISOR STACK POINTER
00 0004 | ROM | RESET: PROGRAM COUNTER
00 0008 | RAM | 0K-BYTE RAM
          .
02 0000 | RAM | 128K-BYTE RAM

08 0000 | RAM | 512K-BYTE RAM
          .
          .
          .
fa 0000 | ROM | 320K-BYTE ROM
          .
fc 0000 | ROM | RESET: SUPERVISOR STACK POINTER
fc 0004 | ROM | RESET: PROGRAM COUNTER
fc 0008 | ROM | 192K-BYTE ROM
fe ffff | ROM | 0K-BYTE ROM
          .
          .
          .
ff 8000 | I/O | CONFIGURATION REGISTERS
ff 8200 | I/O | DISPLAY REGISTERS
ff 8400 | I/O | RESERVED
ff 8600 | I/O | DMA/DISK REGISTERS
ff 8800 | I/O | SOUND REGISTERS
          .
ff fa00 | I/O | MC68XXX REGISTERS
ff fc00 | I/O | MC68XX REGISTERS
```

Figure 2: *The* 520ST *memory map.*

Photo 3: *Low-resolution graphics offer* 16 *colors in a* 320- *by* 200-*pixel array.*

400-pixel mode that is output at 70 Hz. The maximum color resolution, "medium resolution," is 640 by 200 pixels with 4 colors (see photo 3). Low-resolution color is 320 by 200 pixels with 16 colors.

Bit maps in the main RAM store all of the displayed images (see figure 3). A special interleaving scheme, managed by the Memory Controller chip, allows the CPU and video to share memory efficiently. Each display mode uses a 32K-byte bit map in memory, each starting at a 256-byte half-page boundary in RAM. This memory is a contiguous chunk configured as *n* logical planes of 16-bit words. The Video Base Address register holds the starting address of display memory, a value that is loaded into the Video Address Counter register and incremented to determine which plane a word is in.

These registers make video programming straightforward. You choose a mode, select the address for the start of the screen, and then you have a bit-map screen in memory that is affected only by the color palette.

The Video Shifter chip takes words from video-display memory (in general RAM) and combines them according to the mode selected and the position of the word (see figure 4). It then interprets the bits as an index to the color lookup palette. That information is then shifted out to 3-bit digital-to-analog converters that produce the analog RGB (red-green-blue) output.

Color Palette

The 320- by 200-pixel color resolution uses four planes, the 640 by 200 color resolution uses two planes, and the 640 by 400 monochrome uses one plane. The 16-bit color lookup palette has 9 bits of color per entry, 3 bits each of red, green, and blue aligned on low-nybble boundaries. This arrangement generates eight levels each of red, green, and blue, for a total of 512 possible colors.

The 320 by 200 (four-plane) mode can index all 16 palette colors, but the 640 by 200 (two-plane) mode works with only the first 4 palette entries.

The 640 by 400 monochrome mode bypasses the palette, instead employing an inverter for inverse video. The inverter is controlled by bit 0 of palette color 0. Palette color 0 also assigns a border color in multiplane mode and a white or black border in monochrome mode.

A single call to BIOS (basic input/output system) can change the colors in the palette registers. You could show all 512 colors on a single screen by making such calls on the fly. The 520ST does not have any hardware provision for sprites or player-objects, graphics tools that are found in the Commodore 64, Amiga, and Atari 800. It does have bit-blitting, but only in the GEM software.

16-BIT WORD					
4 PLANE	PLANE 0	PLANE 1	PLANE 2	PLANE 3	PLANE 0
2 PLANE	PLANE 0	PLANE 1	PLANE 0	PLANE 1	PLANE 0
1 PLANE	PLANE 0	PLANE 0	PLANE 0	PLANE 0	PLANE 0

Figure 3: *Organization of bit-plane data in memory.*

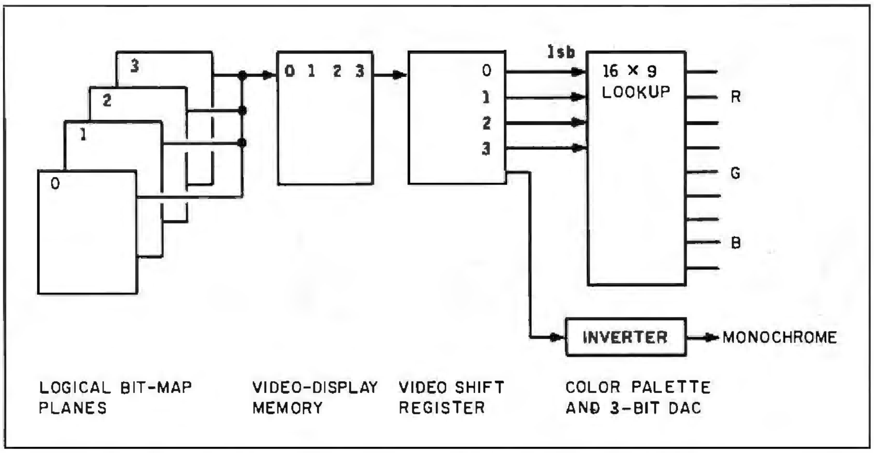


Figure 4: *The flow of data from video memory to analog* RGB *output.*

MEMORY CONTROLLER

Using the data bus efficiently was an absolute priority in the design of the 520ST. The CPU makes frequent use of the bus: The designers noticed that between 30 and 40 percent of program instructions would be store and load types. And the video display needs constant refreshing from memory. After all, in a bit-mapped system such as this, the display on the screen is virtually an image of what is in the RAM chips.

A 68000 running at 8 MHz takes 500 ns for each memory-access cycle. But during the first 250 ns of that time, it isn't looking at the data bus. Instead, it is just setting up the address bus and performing handshaking functions. Shivji explains that his team decided to use memory chips that could be read in a 250-ns slot, and then to put a Memory Controller custom chip between the CPU and memory. The same controller also sits between the Video Shifter custom chip and memory.

During the first 250 ns of the 68000's 500-ns read cycle, the Memory Controller gives the Video Shifter access to RAM. Then, when the 68000 is ready—during the second 250 ns of the read cycle—the Memory Controller turns RAM access over to the CPU. The Video Shifter and CPU keep taking turns. Because the RAM is twice as fast as the microprocessor, the 68000 can run at full speed and read or write to RAM as it desires without disturbing the refreshing of the display. More important, CPU tasks won't be put on hold while the video circuitry makes heavy demands on memory for high-resolution data.

Occasionally, because the 68000 has an asynchronous bus that you cannot lock exactly with the video circuitry, missed cycles will occur. All that happens is that the CPU has to wait one 250-ns cycle, a rare event according to Shivji.

GLUE

The Glue chip reduces the overall chip count on the board by integrating the functions of many smaller chips into one device. Glue generates chip selects, handles handshaking (for parts that aren't 68000-bus-oriented), and generates both the video timing and the interrupt controls. Although the 68901 handles part of the interrupt management task, Glue takes the interrupt from the 68901 and determines its priority with respect to the vertical and horizontal interrupts. Glue also handles the actual interrupt acknowledge cycles.

I/O CHIP

The 68901 MFP (multifunction peripheral) chip is a standard member of the 68000 family and provides serial I/O, parallel I/O, timers, and counters. It has eight parallel I/O pins; a 16-source interrupt controller with programmable service modes, including polling and vector generation; four separate timers with individually programmable prescaling; and a single-channel, full-duplex USART (universal synchronous/asynchronous receiver/transmitter).

SOUND

The Yamaha YM2149 sound chip has three independent monophonic voices and uses a 2-MHz clock input

(continued)

IN BRIEF

Name
Atari 520ST

Company
Atari Corp.
1196 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2000

Price

Monochrome system	$799
Color system	$999

Microprocessor
Motorola 68000, a 32-/16-bit microprocessor (32-bit internal architecture with 24-bit, nonsegmented, external data bus) running at 8 MHz

Main Memory
512K bytes of dynamic RAM. Expansion to 4 megabytes may be possible in the future through the use of a planned 8-slot expansion interface.

ROM
Current models contain 16K bytes of boot-up ROM. Atari intends to release TOS on ROM for $20, upgrading ROM to 192K bytes and freeing up that amount of RAM.

Graphics
Three modes: 640- by 400-pixel monochrome, 320 by 200 with 16 colors, and 640 by 200 with 4 colors

Sound
Three independent sound channels from 30 Hz to 125 kHz

Floppy-Disk Drive
Bundled, external 3½-inch single-sided double-density drive with capacity of 360K bytes. System supports maximum of two floppy-disk drives.

Keyboard
94-key Selectric-style QWERTY keyboard with numeric keypad, cursor controls, and rhomboid function keys

Interfaces
MIDI in and MIDI out ports
Monitor port (supports RGB analog, high-resolution monochrome)
Centronics parallel printer port (supports Epson-compatible printers)
RS-232C serial port
Floppy-disk port
Hard-disk port (10-megabit-per-second DMA transfer rate)
128K-byte ROM cartridge port
Ports for mouse or two joysticks

Bundled Software
TOS, including GEM
[illegible] Logo
BASIC, when completed

Optional Peripherals/Expansion

SF354 single-sided drive	$199
SF314 double-sided drive	$299
1-megabyte RAM upgrade (Lemon Micro, Redondo Beach, CA)	$300

Planned Peripherals
SMM801 dot-matrix printer, SDM121 daisy-wheel printer, 10-megabyte fixed disk, RAM disk for cartridge port, 8-slot expansion interface, local-area network for MIDI port, CD-ROM

to produce tones from 30 Hz up to 125 kHz—more than the human audio range. The chip also has a noise channel. Atari documentation calls this chip the PSG (Programmable Sound Generator). The three channels of output are mixed, converted by a built-in digital-to-analog converter, and sent to a monitor speaker. The designers were also able to use some ports and registers on the PSG for activities completely unrelated to sound generation, such as controlling parts of the parallel and serial ports.

The registers for the voices control a basic square wave while the Noise Generator register controls a frequency-modulated square wave of pseudorandom pulse width. You can mix tones and noise over individual channels by using the Mixer Control register. Amplitude registers allow you to choose fixed or variable (Envelope-register-determined) amplitude.

DMA PORT

The 520ST ports fill the entire back and sides of the keyboard unit (see photo 4). One of the strongest features of the 520ST is the built-in DMA port. Using a CPU to move large blocks of data between memory and external devices is neither fast nor efficient. DMA was created to provide a speedy channel for such transfers and to leave the CPU free to calculate. Without help from the CPU, the Atari's DMA port can move data at 10 megabits per second, a rate twice the standard hard-disk transfer rate and much higher, for example, than the Macintosh, which must make do with a much slower serial port. In addition, the port can handle up to eight daisy-chained devices and is the opening to practical use of CD-ROMs and many other devices.

DMA CONTROLLER

The Memory Controller and Glue custom chips contain parts of the DMA function, but it is the DMA custom chip that directs the high-speed data transfer through the DMA port. The DMA controller and the CPU have equal access to the bus: A

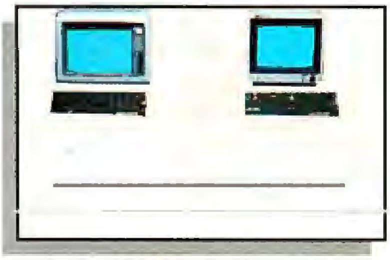
(continued)

TAXAN 600 SERIES

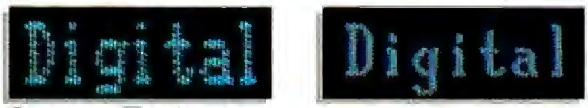
Industry Standards Upgraded!

The Models 630 And 640 Are 100% Compatible With The AT&T 6300 and 6300 Plus!

A perfect upgrade/replacement for the standard IBM color graphics monitor and card, the Taxan model 630 and 555®create a **higher resolution at a greater savings!**



IBM TAXAN



Screen Test—This actual unretouched photograph demonstrates the superior text resolution created by the TAXAN 630 monitor and 555 color card! **For maximum resolution and ease of viewing, Taxan's the winner!**

630

Superior Text and Graphics Beyond IBM.

640(H) x 200(V) Resolution
(640(H) x 400(V) Non-Interlaced Resolution

0.37mm Dot Pitch
24.75Khz Scan Frequency
100% compatible with IBM PC, XT, and AT® when used with the Taxan 555 board.
$675.00 Suggested Retail

Compatible with AT&T 6300 Computer

555

The Taxan 555 is basically equivalent to the IBM standard color board. This means that **the 555 is 100% compatible with all IBM software!**

RGB Color, and FOUR Monochrome Capabilities in One Monitor!

RGB

No one else offers the monochrome options available with the new Taxan 600 series!

The Taxan 630 & 640 monitors offer Green, Amber, B&W Reverse, and a White on Blue Background as their total spectrum of monochrome options.

Only Taxan offers such a wide variety of monochrome capabilities.

Total CAD/CAM Compatibility 720 x 400 Resolution!

640

The Taxan 640 The Ultimate In Monitor Resolution.

640(H) x 400(V) Non-Interlaced Resolution

4,000 Character Display Capability

0.31mm Dot Pitch

24.75Khz Scan Frequency

Compatible with AT&T 6300 Computer

100% Compatible with the new generation of graphics boards Taxan (555), Persyst B.O.B.®, Sigma 400®, Artist II®, STB 400® and others for the IBM PC, XT, and AT.

$775.00 Suggested Retail

TAXAN

TAXAN CORPORATION
18005 CORTNEY CT.,
INDUSTRY, CA 91748 (818) 810-1291

TAXAN EAST, MIDDLESEX BUSINESS CTR.
111 CORPORATE BLVD. SUITE E
S. PLAINSFIELD, NJ 07080 (201)769-6500

Inquiry 404 for End-Users. Inquiry 405 for DEALERS ONLY.

first-come, first-served scheme handles contention. Only one DMA operation can take place at a time. A DMA operation depends on the base address, the count, and the read/write status values the program loads into the DMA Base Address and Counter register. In addition, two bits are used as address lines to steer the output of the DMA to the floppy-disk port or to the hard-disk port.

DMA occurs in bursts, with the DMA chip storing information in its 32-byte FIFO (first-in/first-out) buffer and then sending it in a hurry to either RAM or to the outside world. The DMA chip and the 68000 CPU have equal access to RAM and compete for the same cycles. The DMA chip's 10-megabit-per-second rate is equivalent to 1.25 megabytes per second or 625K words per second. (The transfers to and from memory in the 520ST are handled in 16-bit words.) The 68000 can access memory every 500 ns. That means its maximum bus use is 2,000,000 words per second. A worst-case calculation (dividing the 625K words/second rate by the 2,000,000 words/second rate) shows that DMA cannot use more than 33 percent of the CPU bus cycles.

A more realistic calculation assumes a 5-megabit-per-second rate for DMA (the standard rate for hard-disk drives) and does not assume that the highest-speed bursts of DMA would run continuously, or that the CPU would reach for memory in every cycle. With these assumptions, the DMA would rarely borrow even 5 percent of the 68000's RAM access cycles.

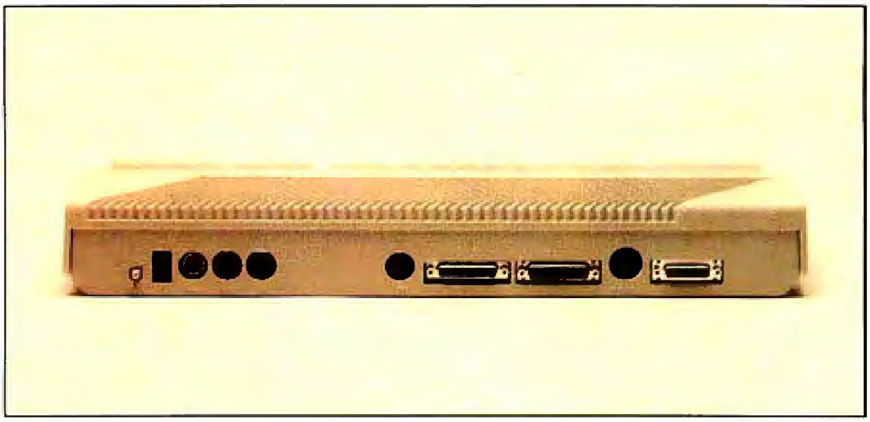


Photo 4: *The back panel of the 520ST. From left to right are a reset button, the on/off switch, power cable, MIDI out and MIDI in, the monitor port, 25-pin Centronics parallel printer port, an RS-232C serial port, the floppy-disk port, and the hard-disk (DMA) port. Out of view, on the sides, are the joystick/mouse ports and the 128K-byte ROM cartridge port. Unfortunately for left-handed users, the attachment cables for the disk drives and for the mouse are short. All but the most inventive users will place the drives on the left and the mouse on the right.*

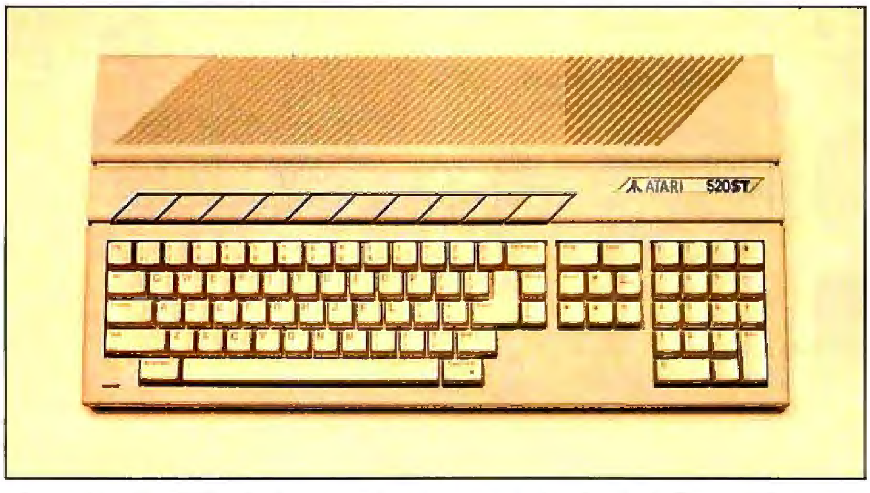


Photo 5: *The 520ST keyboard. Wider keytops and the rhomboid shape of the function keys lessen the utility of an otherwise full-featured, well-designed layout.*

PORTS

The serial port is a standard RS-232C interface. Some of its signals come from I/O port A of the sound chip, while others are routed through the 68901 chip. The serial port can work with asynchronous data-transfer rates from 50 to 19,200 bps.

The parallel port supports the strobe and busy signals of the Centronics parallel interface standard. Both I/O port B of the sound chip and the 68901 chip help control these lines and the eight read/write data bits. The parallel lines of the sound chip are bidirectional, which could lead to some interesting hacking. For example, you might convert a parallel printer into a scanning device to digitize information. The typical data-transfer rate is 4000 bytes per second.

The two MIDI (musical instrument digital interface) ports bear special attention. MIDI is an industry-standard interface for computers and musical peripherals. The MIDI ports will allow the 520ST to attach directly to external keyboards, synthesizers, and other equipment. Atari has even been investigating the possible use of the MIDI ports for inexpensive networking of 520STs. The interfaces work at 31,250 bps for serial transfer of information from the keyboard or a program to and from external devices. Data is organized as a start bit, eight data bits, and one stop bit.

One of the 6850 chips controls the MIDI serial communication. Up to 16 channels are allowed on the MIDI bus in one of three network addressing

(continued)

SOLVE PROGRAMMING PROBLEMS THE WAY YOU THINK.

PURE AND SYMBOL.

Introducing the new APL★PLUS® PC System, Release 5.0

The shortest distance between two points is a straight line. But unfortunately, that's not the case in programming.

Most languages require you to go through an enormous number of steps before an idea becomes reality.

That's why the APL★PLUS PC System is such a dramatic and exciting software tool for serious PC programmers and application developers.

Instead of requiring you to learn—and write—long-winded and complicated programs, APL is based on your instinctive ability to deal in symbols. And once you begin using APL's quick notations, you'll find it the ideal programming environment for all your application needs.

The incredible shortcuts you get with APL will let you spend less time on drudgery and more time creating. Intricate calculations and modeling on PC's are a snap.

The Release 5.0 version features:

- multi-window, full-screen editing
- graphics primitives, now with EGA support
- spreadsheet-like numeric editing
- fast Assembler library
- built-in terminal mode
- and report formatting.

Plus concise notation for programs like sorting, matrix inversions, string searching, and more. And the complete package price is just $595 with major credit cards accepted.

Act now, and we'll send you a free Convincer Kit. Contact your local dealer, or call 800-592-0050 (in Maryland, call 301-984-5123) to order your system, or for more information about our other APL★PLUS products—from our UNIX™ version to the new streamlined Pocket APL.™

Or write STSC, Inc.,
Software Publishing Group,
2115 East Jefferson St.,
Rockville, MD 20852.

You'll see how symbol PLUS★WARE products are to use, the very first time you use them.

Problem-solving at the speed of thought.™

STSC
A Contel Company

APL★PLUS PC System requires 256K and DOS 2.0 or later. A soft character set can be used for computers with IBM compatible graphics board. A character generator ROM or software is included for the IBM PC or selected compatibles.

PLUS★WARE and Pocket APL are trademarks of STSC, Inc. APL★PLUS is a registered trademark of STSC, Inc. UNIX is a trademark of AT&T Bell Laboratories.

Inquiry 339

modes. The Omni mode addresses all units simultaneously and is the default mode when the computer is first turned on. Poly mode addresses each unit separately. Mono mode addresses each unit voice separately.

KEYBOARD AND MOUSE

The documentation refers to the 94-key keyboard (see photo 5) as the Atari Intelligent Keyboard because it uses its own 1-MHz 6301 microprocessor with its own mask-programmed ROM. The device scans the keyboard and the joystick/mouse ports. It provides two-key rollover and sends keyboard, mouse, trackball, joystick, and time-of-day information to one of the 6850 ACIA (asynchronous communications interface adapter) chips on the main computer board. The lines are bidirectional, and the 6850 also sends commands to the keyboard.

The QWERTY keyboard has a standard Selectric-style layout with 10 rhomboid function keys, a numeric keypad, and four cursor-control keys. Many applications for the 520ST will use two special keys, Help and Undo. We found the keyboard layout pleasant in appearance and extremely functional. It closely resembles the DEC VT-100 layout. The Control and Return keys are well placed, and the Return key is a three-key-size reverse L shape and hard to miss. The shape of the function keys, however, may make it difficult to avoid hitting more than one.

More of a problem is the feel of the keyboard. Each keytop is ⅛-inch wider than the keytops on the Macintosh and IBM PC keyboards. As a result, the keys seem much more closely packed, and you may tend to press two at a time more often than usual. In addition, the keys on our unit required noticeably more pressure than do the keys on most other small systems. And, because connectors are attached to the rear of the unit, it is relatively difficult to adjust the keyboard.

The mechanical two-button mouse, which attaches to a port on the right side of the unit, has a resolution of 100 counts per inch and can handle a maximum velocity of 10 inches per second. It has a good feel. You will use the left button for most manipulations, including select and dragging within GEM. The right button is application-dependent. For example, NEO, a low-resolution paint program, uses the right button to copy images. There are keyboard alternatives to all mouse functions, though I suspect few of you will ever use them.

DISK DRIVES

We were impressed by the high data-transfer rate of both the floppy-disk

(continued)


The data you'll have to depend on tomorrow could depend on the disk you choose today.
BASF
BASF
FlexyDisk
2D
BASF QUALIMETRIC™ 5.25" FLEXYDISKS® CERTIFIED 100% ERROR-FREE AND WARRANTED...
FOREVER

drives and the hard-disk drives we tested with the 520ST. The speed is a tribute to the efficiency of the DMA custom chip and the WD1772 floppy controller. I/O is quick (no endless waiting during disk reads), and, unlike the Macintosh, you can remove disks easily at the touch of a button on the drive. The standard system currently includes one single-sided double-density drive with a capacity of 360K bytes. For $299, you can obtain a double-sided drive that can store up to 720K bytes. Setting up the drives is slightly more unforgiving than daisy-chaining on Atari's 8-bit systems in that you must use the designated in and out I/O ports on the back of the drives. Still, adding the second drive is a distinct plus. With it, you can copy an entire disk (without the four swaps required if you don't have one) in 99 seconds and copy a 32K-byte file in 16 seconds. The disk-copy operation does not automatically format the disks, which requires an additional 54 seconds for the single-sided disks.

The disk format employed is very similar (down to the file-allocation tables) to that of the MS-DOS disks used on the Data General/One portable computer. However, the formats are not absolutely identical. We took a disk from a DG/One that contained a text file and slipped it into the 520ST disk drive. The GEM desktop on the 520ST recognized the disk and showed it contained a file, but the 520ST wasn't able to open the file for printing or display. When questioned about this, Atari admitted that a utility will probably be necessary to read the files.

FLOPPY-DISK CONTROLLER

Atari didn't design the floppy-disk controller. The design team chose a chip with a built-in data separator, a modified version of the 1770 chip from Western Digital. The old chip worked with 6-, 12-, 20-, and 30-millisecond drives. Atari asked Western Digital to change some of the drives that they support, and the new chip—the 1772—can work with 2-, 3-, 5-, and 6-ms stepping speeds. Atari is using

(continued)

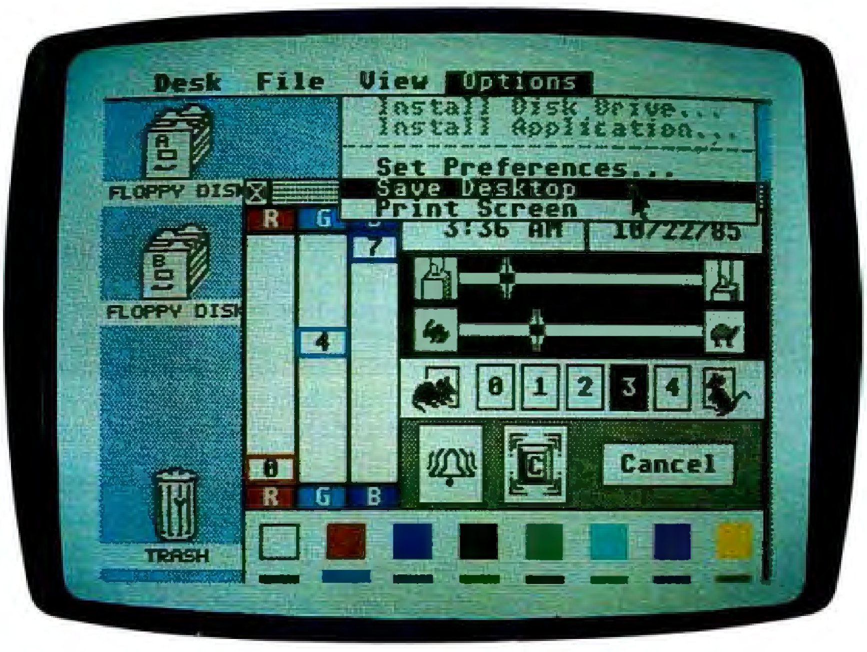


Photo 6: *The* 520ST *desktop in low resolution, showing the control panel and a customized background color. You can fix your choices by saving the desktop.*

3-ms drives. The chip uses the System/34 format. There is some incompatibility between the 1772 and the 765 controllers (the chip used in the IBM PC), although the format is the same.

The floppy interface will support a maximum of two daisy-chained floppy-disk drives. You send commands to the FDC (floppy-disk controller) by first writing to the DMA Mode Control register (to select the FDC internal command register) and then writing the desired 1-byte command to the Disk Controller register. The floppy controller works through the DMA controller custom chip, just as all hard-disk transfers do.

Hard Disk

Although Atari hasn't yet released its planned 3½-inch hard disk for the 520ST system, the company let us play with a 10-megabyte prototype, which transfers data at 5 megabits per second, the standard ST506 rate. Later drives will feature 15 megabytes and 7.5 megabits per second.

There is no hard-disk controller inside the 520ST. But the DMA custom chip makes for easy, fast interfacing. The AHDC (Atari hard-disk controller) will be in the hard-disk-drive unit. The DMA controller sends commands to the hard disk using the ANSI X3T9.*x* SCSI (small computer systems interface)-like command descriptor block protocol. The AHDC supports a minimal subset of SCSI commands that are sent to the AHDC in much the same way that commands are sent to the FDC. Both floppy- and hard-disk formats contain 512-byte data sectors.

Monitors

We used both the monochrome SM124 and RGB SC1224 monitors with excellent results. The color monitor supports low and medium resolution. You can use the monochrome monitor only for high resolution. All of the displays are clear, sharp, readable, and flicker-free, but we were particularly impressed by the clarity of the high-resolution monochrome.

The monitor you connect when you boot will determine the resolutions you will have available; there is only one monitor port, and you cannot unplug one and connect the other, since they have no compatible resolution. This may give some users a difficult choice, since much of the early software will work with one monitor or another but not both. For the moment, if you are interested in buying the 520ST for business or programming uses, you would be best served with the high-resolution monochrome system. Nonetheless, developers will undoubtedly make available resolution-independent software, in part because the developer's kit includes an appropriate directive.

TOS

TOS (the 520ST's operating system), including the GEM overlay, was to be in ROM and obviously would boot very quickly. As of this writing, however, it is in RAM where, in addition to taking up over 206K bytes of RAM, it requires 32 seconds to boot. Still, this leaves you with a reasonable amount of workspace until Atari releases the ROM version. In the meantime, 16K bytes of ROM (two 64K-bit ROM chips) hold the boot-up code for the computer. Four empty sockets within the 520ST await the new ROM chips.

The appearance of the desktop depends upon the monitor and the resolution (see photos 6 through 8). It has some unusual features and some annoyances, but for the most part, those familiar with the operation of the Macintosh will feel at home. The menu bar is at the top, you can use the mouse to resize and move windows and to work scroll bars and sliders, and you can click on file icons to format disks, to get directories, and to rename or get detailed information on files and folders. Like the Macintosh, you double-click on icons to open them, drag icons to copy files and disks, or use shift-clicks for multiple file copying. Undoubtedly, the most impressive aspect of the interface is the speed with which you are able to resize and move windows.

Those expecting a clone of the Macintosh interface, however, will be disappointed. And several of the differences are annoying. It takes slightly but noticeably longer to click on the boxes within the windows, and resizing, though quicker, is somewhat more awkward. For example, when you click on the Resize box, the new 520ST window automatically reduces in size. On the Macintosh, it stays the same size until you decide to alter it.

There are other important differences between the 520ST and Macintosh desktops. The trash can is actually an incinerator. Move a file or folder there and it's gone permanently. Unlike the Macintosh, whenever the pointer even touches the menu bar, you bring down the menus. To eliminate the menu, you have to bring the pointer off the menu and click the mouse button. It's amazing how often this happened to us by accident. The selection process would be much improved if only you had to press the button to select menus. Second, the 520ST desktop seems to have partitions into which icons can fit. Unlike the Macintosh, in which you can place icons where you wish, the icons have a finite number of possible locations. Third, there is no option to move files, folders, and applications. The only available options are copy and delete. Therefore, to move an icon into a folder you will need to copy it there and then delete the original. And, to move a file out of a folder, matters are further complicated by the fact that the folder opens to take over the window from which it derived. You would first have to move the file to a different disk, delete the original file from the folder, then copy the file back to the original disk but not within the folder, and then delete the first copy you made. It sounds difficult because it is.

From the current desktop, you have access to a VT-52 emulator, you can install your printer, you can configure the RS-232C port, and you can set any of several defaults on a control panel. For example, if you have the color system, you can alter the palette and thus affect, if you wish, the appearance of the desktop and other applications. In low resolution, you can modify all 16 colors from the palette of 512; in medium resolution, you can modify up to 4. You can also set when and at what rate the keys will repeat with the keyboard response selectors, you can alter the double-click response time, and you can activate or deactivate the keyboard click and the pleasant-sounding error warning bell. However, there are few editing amenities when resetting the time and date, a small annoyance since the 520ST has no internal battery maintaining the clock. Most of the time, you will have to type in the entire date and time string.

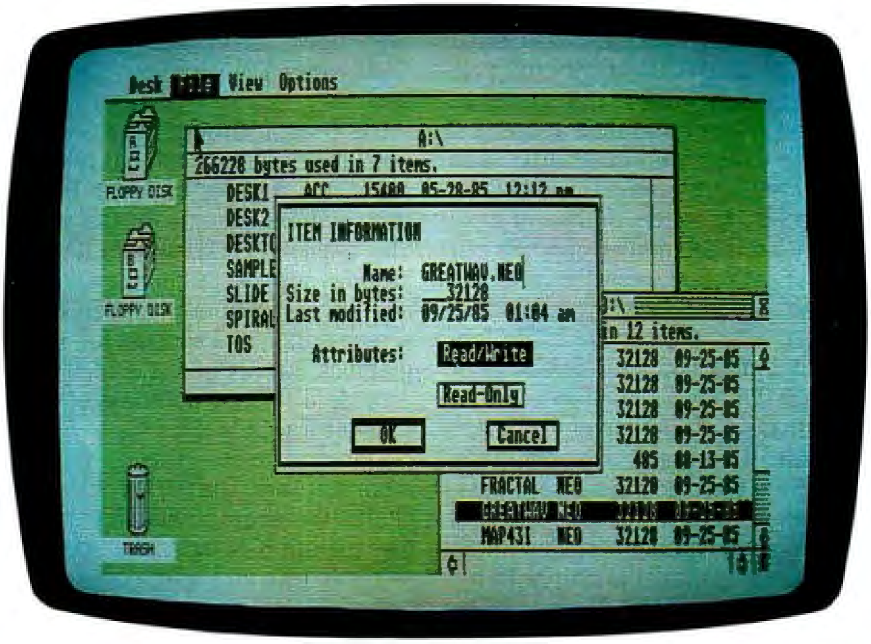


Photo 7: *The* 520ST *desktop in medium resolution. Icons are the default, but you can easily set your preference to text.*

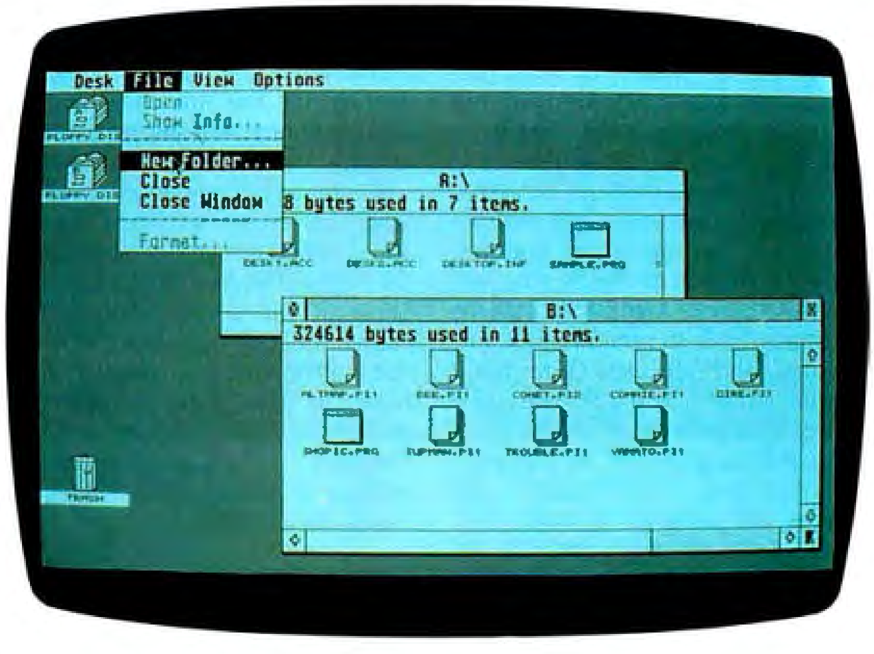


Photo 8: *The* 520ST *desktop in high resolution.*

(continued)

The RS232 Port Configuration window lets you fix the data-transmission rate, XON/XOFF, the parity, duplex, and the number of bits per character. The Install Printer window allows you to select between dot-matrix and daisy-wheel, between black-and-white and color, between draft and final quality, and the number of pixels per line. A Set Preferences window allows you to set the screen resolution, though your choices here are obviously limited by your selection of monitor. You can also choose not to confirm deletes and copies. Once you have set all your preferences, you can save them by selecting the save desktop option. The only absent option of importance is a command-line interface, which is available only with the 520ST developer's package.

SOFTWARE

The system comes bundled only with TOS and Atari Logo, and like other new systems, there is at present a dearth of software. Already, however, Atari has released NEO, a paint program, and ST Writer, a word processor, into the public domain, but both are surrogates until GEM Write and GEM Paint are available.

Atari Logo is surprisingly powerful. It makes full use of the GEM environment and, among many features, allows you to edit on the fly. Atari will soon also bundle Atari BASIC with the machine. Our beta version is fast, full-featured, and also uses GEM, but it was constricted by a 32K-byte workspace. Undoubtedly, however, most users will be attracted by the availability of serious development languages, the absence of which held back software development on Apple's Macintosh for most of its first year.

TDI Software Ltd. (29 Alma Vale Rd., Clifton, Bristol BS8 2HL, England) has released Modula-2/ST, a 32-bit development system that includes an editor, compiler, linker, and library facilities. TDI's Modula-2 is a full implementation, has complete libraries for TOS, and provides full access to the 520ST's graphics features. TDI is also marketing a version of UCSD Pascal with the p-System, which, however, does not include support for GEM. Both TDI products cost £195 each.

The Dragon Group (148 Poca Fork Rd., Elkview, WV 25071) has released 4xFORTH, a series of 32-bit FORTH development systems for the 520ST. The basic 4xFORTH system ($99.95) includes support for multitasking and multiuser access, a compiler, a full-screen editor, and support for 520ST graphics. For $149.95, 4xFORTH also provide a floating-point system and support for GEM calls.

Atari has released its C development software. The $300 package includes the entry points and C bindings to both TOS and to the operating system's text and graphics routines (such as text size, attributes, alignment, and angle, as well as circle drawing, area fill, and bit-blitting). The documentation also provides the "Hitchhiker's Guide to the BIOS," information on Kermit and MIDI, a C programmer's guide, and much more. Purchasers of Haba's Hippo-C, now available for the 520ST, should be warned that the Atari development documentation will still be essential reading.

Several other companies are promising interesting additions to the 520ST language group. Metacomco (26 Portland Square, Bristol BS2 8RZ, England) will soon distribute ISO Pascal, a 68000 assembler, and Lattice C. Philon Inc. (641 Avenue of the Americas, New York, NY 10011) is readying a BASIC compiler, a BASIC interpreter, and a C compiler. It is also working on compilers for FORTRAN, Pascal, and COBOL.

SYSTEM DOCUMENTATION

It is fortunate that the system is so easy to learn to use because the documentation is quite poor. The 80-page owner's manual has requisite sections on setting up the system, getting started, touring the GEM desktop, and managing disks, files and folders, but it has very little technical material. Materials with the disk drive and monitors are also sadly lacking. Undoubtedly, users will have to wait for the trickle of technical references on working with the hardware.

CONCLUSION

Judging from the conversations around the office and on BIX (BYTE Information Exchange), CompuServe, and The Source, there is a storm of interest in comparing the relative capabilities of the 520ST, the Amiga, and the Macintosh. There is, in fact, far more interest than there seemed to be in comparing the merits of the 8-bit computers from Atari, Apple, and Commodore. An upcoming special edition of BYTE on the 68000 will make comparisons of processor and application speeds, ease of development and portability, and user interfaces, but we are still left with our conclusion that these are very different machines, with very different markets.

The 520ST is an architecturally simple 68000 computer with high-quality video output and a high-speed DMA port. The easiest way to summarize our first look at the hardware is that the 520ST presents the 68000 unbounded. Not only does it offer an excellent price/performance ratio, but we expect it to produce some impressive benchmarks on tasks with heavy computation.

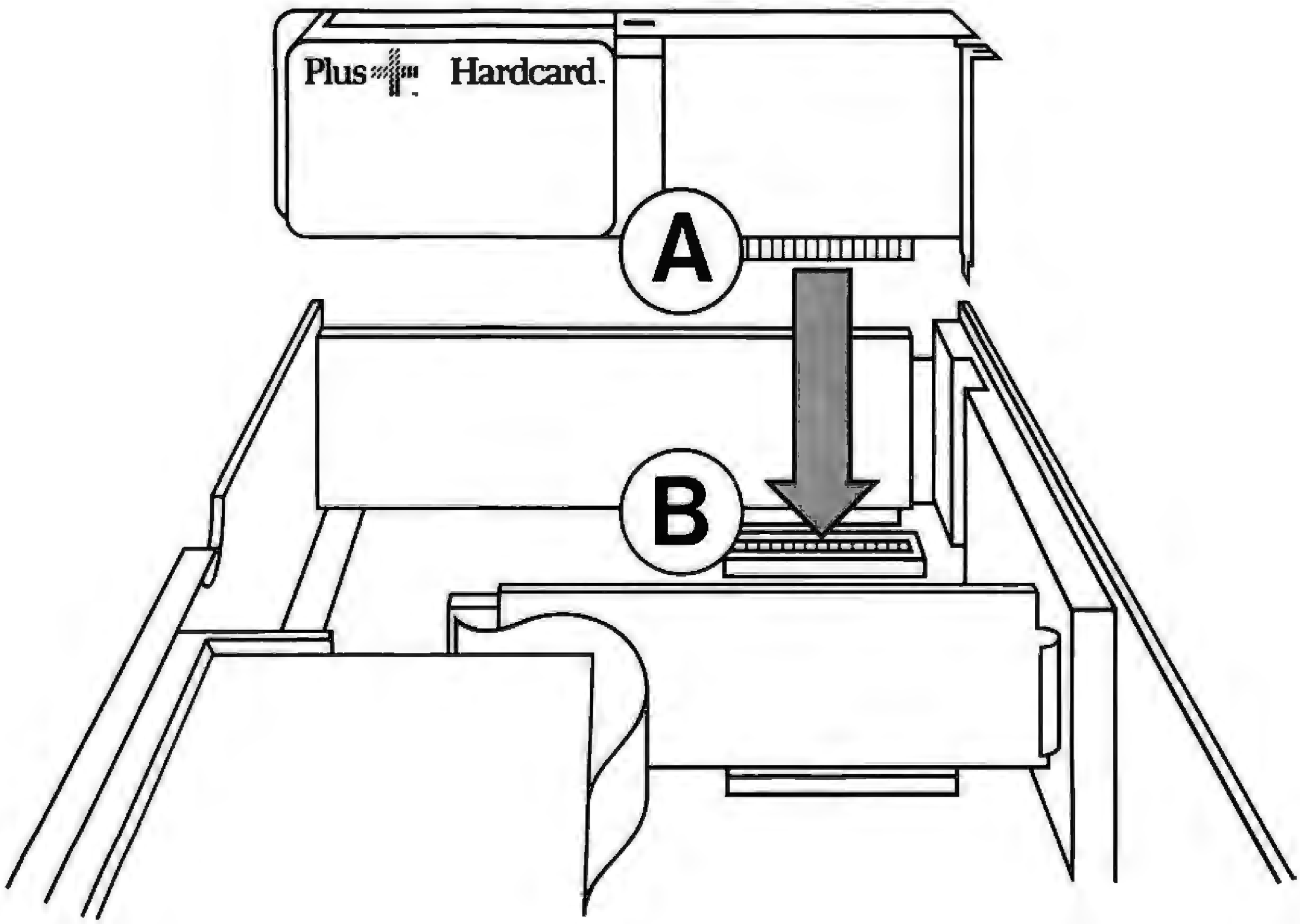
The 520ST's complete keyboard and impressive array of ports add up to an attractive system. Finally, the 520ST's use of standards (for example, 68000, MIDI, Yamaha sound chip, and Western Digital FDC) should make it easier to program, expand, and manufacture.

There are also the promised cheap, powerful peripherals: a 10-megabyte hard disk for $700, a ½-gigabyte CD-ROM optical disk for around $500, and a 1200-bps modem for $150.

The Atari 520ST is certainly an excellent value. For the moment, there is not much application software and you still have to deal with an unfinished operating system; but with the current availability of several high-level languages, the 520ST will undoubtedly provide many users with what they seek—a means to tap the power of the 68000 at a price they can afford. ■

Directions for converting a PC to an XT.

Insert tab A into slot B.



First you have to remove Hardcard™ from its box.

An operation that's about as simple as installing it in your PC.*

Using thumb and forefinger, lift the flap of the box. Now reach inside and grasp Hardcard. Slowly pull it out, making sure that your warranty information doesn't fall unnoticed to the floor.

And that's it. You're over the hump.

You've got 10 megabytes of hard disk storage in your hand. Everything—the drive, the controller, the electronics—is compressed onto a single card.

Allow yourself a moment to marvel at its size and weight. Just over 2 lbs. Measuring only 13 x 4 x 1 inches. With no connector cables. No additional power supply required. No adapter card to buy.

Now slip it into a single expansion slot inside your PC and forget it. Odds are you'll never have to fuss with it again.

Because it's so remarkably reliable. More than twice as reliable as the XT's built-in drive. Since Hardcard has fewer parts, there are fewer things that can go wrong.

On top of that, Hardcard is even faster than the XT's drive.

And it maintains PC compatibility with the most popular software programs. In fact, our special compatibility task force has spent many man-years making sure that Hardcard runs popular software trouble-free.

Hardcard also lets you keep both your floppies up and running. Which is something no other add-in drive can do.

All of which means that your PC can now be saved.

And that friendly, intelligent little machine can have its useful life extended.

You won't have to go to the expense of replacing it with an XT.

Or suffer the shortcomings of bulky, conventional hard disks. Which take hours or even days to install.

And when it comes to installing DOS, Hardcard is just as easy. Its special installation program loads your operating system and gets you ready to install your software in minutes.

And Hardcard's Directory Program lets you access those programs at the touch of a key.

Finally, since Hardcard is so much more reliable, we can give you a warranty that goes well beyond the usual 90 days.

We give you a full year.

Still, it's nice to know that if anything ever should go wrong, you can pick up a replacement Hardcard at your nearby authorized service center.

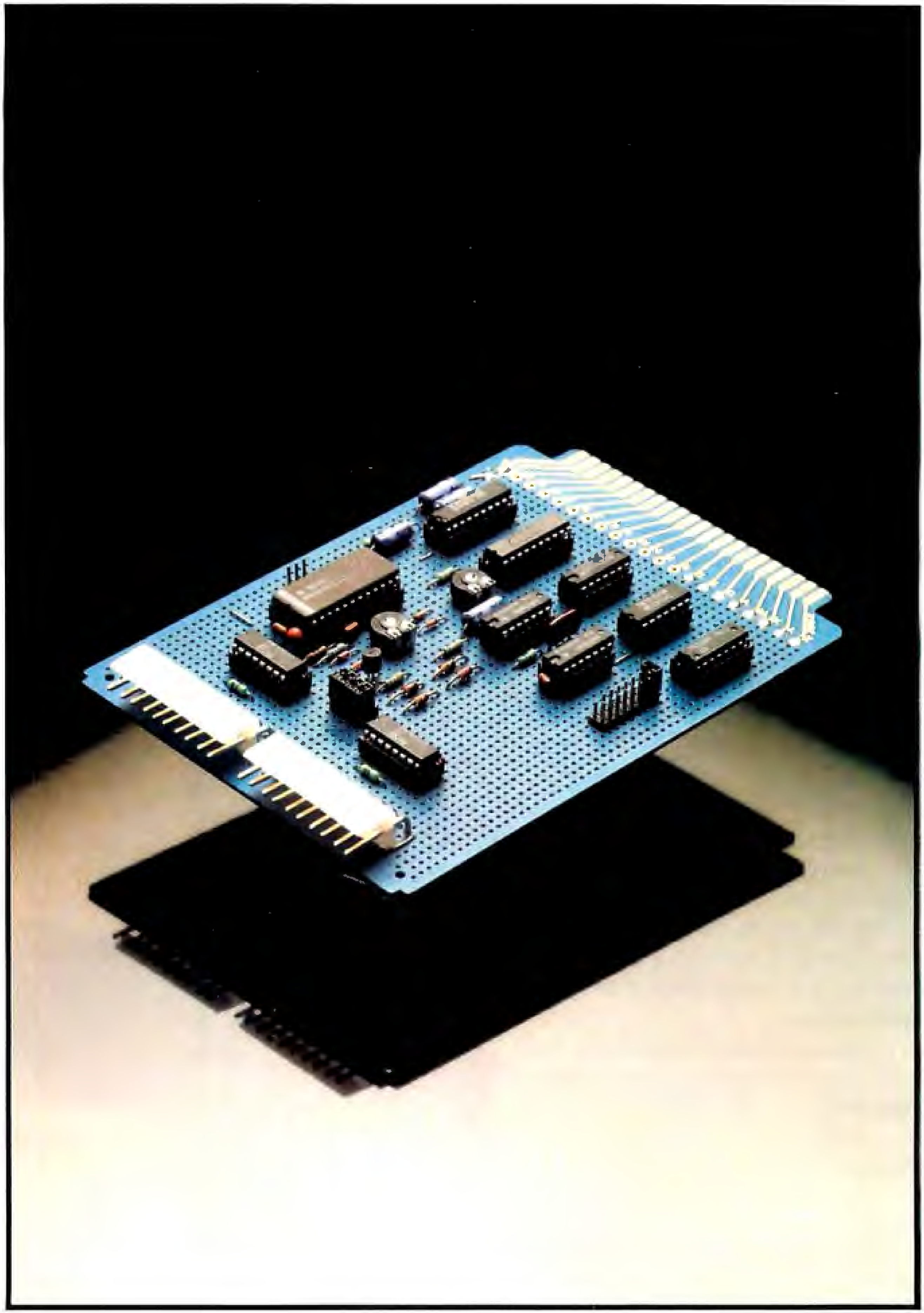
Hardcard is available now at major retailers nationwide. For the name of the one nearest you, call Plus at (408) 946-3700. Or write Plus Development Corporation, 1778 McCarthy Blvd., Milpitas, CA 95035.

And we'll give you all the directions you need to save your PC.

*Hardcard is compatible with IBM PC, IBM PC XT, Compaq Portable, Compaq Plus, AT&T PC 6300.

Hardcard
from Plus

Inquiry 282



PHOTOGRAPHED BY PAUL AVIS

BUILD AN ANALOG-TO-DIGITAL CONVERTER

BY STEVE CIARCIA

A 16-channel 12-bit high-speed A/D converter

It is evident that many applications for computer controls, including energy management, security, and environmental monitoring, require measurement inputs and control outputs in quantities not easily expressed in the 0- and +5-volt TTL (transistor-transistor logic) levels present in your computer.

An energy-management system, for example, may need to monitor a temperature range of 0 to 100° C with a resolution of 0.1 degree. The thermocouple sensing this temperature range might generate only 1 or 2 millivolts per degree. A proportional-drive pump motor in the same system might require a 2.40-V set-point control input to produce the proper flow rate throughout the system.

Continuous analog systems like these are in the real world, outside the binary logic-0 and logic-1 domain of digital computers. For the computer to interact with the real world, we need some scheme for translating analog measurements to and from quantized binary equivalents.

This is not the first time I have touched upon analog-to-digital and digital-to-analog conversion. I try to cover this topic every three or four years so that new readers can be brought up to speed on the basics. For the old-timers, however, I spice up the project with the latest whiz-bang conversion interface that can be cost-effectively produced.

The previous projects have all used 8-bit converters. However, the overwhelming response to the BASIC-52 computer/controller (BCC-52) presented in the August 1985 Circuit Cellar has created a demand for something more challenging. Thousands of BCC-52 industrial and end users are applying computer control to applications that ultimately require greater accuracy of measurement.

Presently, an 8-channel 8-bit A/D converter (10,000 samples per second, 0 to 10 V or −5 to +5 V, P/N BCC-13) is available for the BCC-52, but many measurements require more resolution. Therefore, it's time to dust off the old theoretical explanations and present an up-to-date, high-speed, high-resolution A/D interface for the BCC-52.

First, because one is an integral component of the other, I'll outline the basics of D/A conversion and then go on to A/D conversion. After a few circuit examples, I'll get

(continued)

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. He is the author of several books about electronics. You can write to him at POB 582, Glastonbury, CT 06033.

into the heavy stuff. Ultimately, this month's project is the design of a 16-channel (8-channel differential input) 12-bit plus sign bit, −5 to +5 V, 10,000 samples/sec, BCC-52/Z8 bus-compatible A/D converter board. In a few months, after I have presented a few more essential peripheral devices, I will demonstrate the configuration and application of a full-fledged data-acquisition and control system based on the BCC-52.

D/A CONVERSION

The D/A converter can be thought of as a digitally controlled programmable potentiometer that produces an analog output voltage. This output voltage (V_o) is the product of a digital signal D, a multiplier constant K (usually 1), and an analog reference voltage V_{ref}, related by the following equation:

$$V_o = KDV_{ref}$$

The binary value transmitted to the D/A converter by the computer is a binary fraction representing what portion of the full output voltage is emitted. The fraction is multiplied by a reference voltage, which can be either fixed or variable. D/A converters with variable reference voltages are often referred to as multiplying D/A converters, although all D/A converters can be said to multiply.

In finite binary fractions, the most significant bit (MSB) has a value of 1/2 (that is, 2^{-1}), the next most significant bit is 1/4 or 2^{-2}, and the least significant bit (LSB) is $(1/2)^n$ or 2^{-n}, where n is the number of bits in the binary fraction. If all the bits in the fraction are added, the sum approaches 1; the more bits in the fraction, the closer the sum is to 1. The difference between 1 and the approach to 1 is the quantitation error of the digital system. I'll discuss this later.

Different implementations of D/A and A/D converters use different formats for representing the binary digital quantities. One basic difference is how systems represent negative binary numbers and negative voltages; some can, and some can't. Analog interface systems that can manipulate positive and negative numbers and voltages are called bipolar converters; systems that can handle only positive voltages and quantities are called unipolar.

Unipolar converters chiefly use straight binary and binary-coded-decimal (BCD) representations of digital quantities. Bipolar converters use a variety of representations, including offset binary, one's- and two's-complement formats, and Gray code. For brevity, I will limit this discussion to converters using straight-binary and offset-binary representations. Later, I will get into two's-complement representations since the converter chip used in this project represents

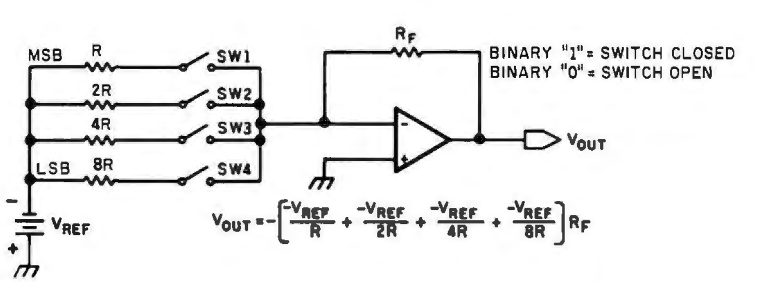


Figure 1: *A 4-bit weighted-resistor D/A converter. A 4-bit word is used to control four single-pole single-throw solid-state switches. Each switch is in series with a resistor. The resistor values are related as powers of 2. The other sides of the switches are connected together at the summing point of an op amp. Currents with magnitudes inversely proportional to the resistors are generated when the switches are closed. They are summed by the op amp and converted to a corresponding voltage.*

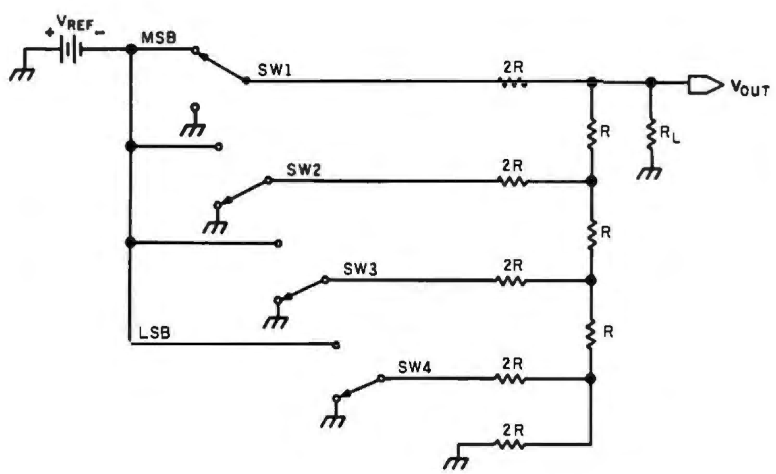


Figure 2: *A 4-bit R-2R-type resistor-ladder D/A converter. The topology of this network is such that the current flowing into any branch of a three-branch node will divide itself equally through the two remaining branches. Because of this, the current will divide itself in half as it passes through each node on its way to the end of the ladder.*

negative numbers in two's-complement form.

Offset binary differs from straight binary only slightly. In offset binary, a number consisting of all zeros represents the most negative possible quantity. The most obvious consequence of this is that the MSB acts as a sign bit, 0 for negative values and 1 for positive. For instance, in offset notation, the bit string 01000000 represents −64, while the bit string 11000000 stands for +64.

Frequently, offset notation is referred to as a resolution value plus sign bit, i.e., 12-bit plus sign converter. The sign bit, while performing as a thirteenth bit in bipolar operation, should not be confused with a 13-bit converter. The sign bit can be used to indicate only quantities above 0 V (in this case, sign bit=0) or below 0 V (sign bit=1) and not shifted in scale. Between −5 V and +5 V on a 12-bit plus sign converter, there will be 8192 divisions (13 bits). However, if the converter were to measure inputs only in the range of 0 to 5 V, only 4096 divisions (12 bits) can be represented. In this project, the A/D is set for −5 to +5 V and is therefore indistinguishable from a 13-bit converter between these limits and would be 1 bit better than a straight 12-bit converter used to measure the same range.

The translation of digital values to proportional analog values is performed by either of two basic D/A-conversion circuits: the weighted-resistor circuit or the R-2R circuit. The weighted-resistor converter is by far the simpler and more straightforward. This parallel decoder requires only one resistor per input bit.

In the weighted-resistor D/A converter, solid-state switches are driven directly from the signals that represent the digital number *D*. Individual currents with voltage magnitudes related by powers of 2 (magnitudes of 1/2, 1/4, 1/8, . . . , 2^{-n}) are generated and summed by connecting a network of resistors with values of R, 2R, 4R, . . . , 2^nR between the reference voltage $-V_{ref}$ and the summing point of an operational amplifier (op amp) by means of the set of electronic switches. After being summed, the various currents are converted to a voltage by the op amp, as shown in figure 1.

While this may appear to be a simple answer to an otherwise complex problem, this method has some significant drawbacks. The accuracy of this type of converter is a function of the combined accuracies of the resistors, switches (all switches have some resistance), and the op amp. In D/A-conversion systems of greater than 10 bits resolution, the values of the resistors become extremely large, and the resultant current flow is reduced to such a low value as to be lost in circuit noise.

For example, in an 8-bit D/A converter with R (the value of the resistor for the MSB) set to 10 kilohms, the value of the resistor for the LSB turns out to be 1.28 megohms. With a reference voltage of 10.00 V, only 7.8 microamperes would flow into the op amp. This current is significantly below the response threshold of most low-cost op amps and would not be detected. Lowering the value of R to 100 ohms creates the opposite problem. At a reference voltage of 10.00 V, the input current to the op amp would be 100 milliamperes, more than most op amps can handle.

A reasonable alternative to the weighted-resistor D/A converter is the R-2R D/A converter, often referred to as a resistor-ladder converter. This type is more widely used, even though it uses more components than the weighted-resistor type. A simple R-2R design is shown in figure 2, including the reference voltage, a set of binary switches, and an output amplifier. The basis of this converter is a ladder network constructed with resistors of two values: R and 2R.

In each bit position of the network, one resistor (2R) is in series with the bit switch, and the other (R) is in the summing line, so that the combination forms a pi network. This suggests that the impedances of the three branches of any node are equal, and that a current *i*, flowing into a node

(continued)

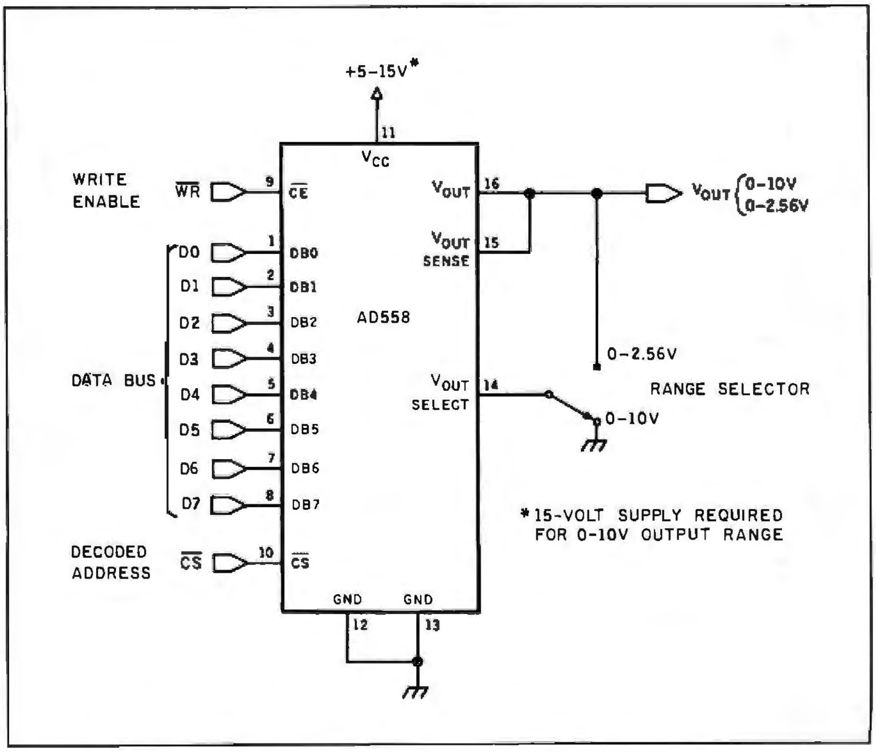


Figure 3: A *block diagram outlining a typical connection of the* AD558 *8-bit multiplying* D/A *converter.*

through one branch, flows out as $i/2$ through the other two branches. In other words, the current produced in the network by closing a bit switch is cut by half as it passes through each node on the way to the end of the ladder. Simply stated, the position of a switch with respect to the point where the current is measured determines the binary significance of the particular switch closure.

The R-2R D/A converter is easy to manufacture because only two resistor values are needed. The component stock can be reduced to one resistor value if two are used in series for each bit. Keeping matched resistor values that have the same temperature coefficients contributes to a stable design. Certain trade-offs are required between ladder resistance values and current flow to balance accuracy and noise.

One form of the R-2R ladder circuit is found in the multiplying D/A converter. This type of converter, which utilizes external-variable analog reference voltages, produces outputs that are directly proportional to the value of the digital input multiplied by this reference. Functionally, this type of converter is available as current- or voltage-output types. The current-output devices are faster and less complex because they do not include additional output-amplifier stages. Therefore, they cost less than voltage types.

An economical 8-bit multiplying D/A converter is the Analog Devices AD558. Shown in figure 3, it contains an 8-bit latch, R-2R ladder network, reference-voltage source, and output amplifier. The AD558 can run on a +5- to +15-V power supply and can be jumper-selected for 0- to 2.56-V or 0- to +10-V ranges. Using a separate op amp, you can configure an offset converter or modify the output of the range.

The AD558 can be used as a transparent D/A converter by holding the chip-enable and chip-select lines constantly low. However, it was primarily designed to be bus-operated and appear as a write-only location in memory or I/O (input/output) address space. Typical connections consist of a decoded address strobe, a write-enable signal, and the 8-bit data bus.

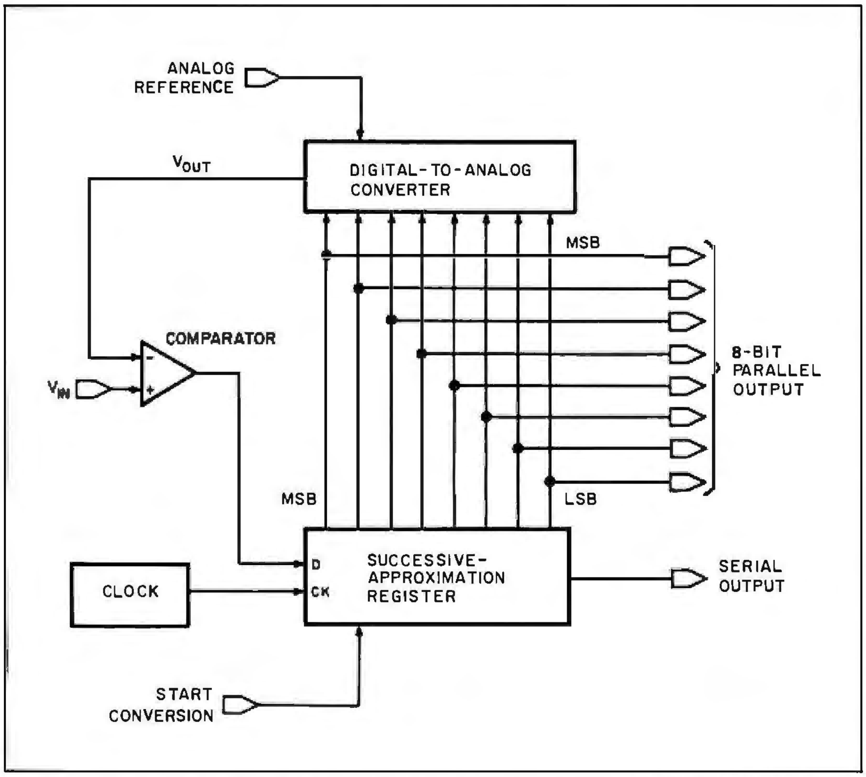


Figure 4: *A block diagram of a typical 8-bit successive-approximation A/D converter.*

A/D Converters

Virtually all high-resolution A/D converters incorporate a D/A converter as an integral component. That is why, even though our ultimate aim is A/D, I always discuss D/A converters first. Hopefully I have made you aware of the binary-conversion process, and you can appreciate the concepts of resolution and accuracy.

An A/D converter changes an analog voltage into a digital representation compatible with the computer's input needs. Akin to the 8-bit D/A converter, an A/D converter is subject to the same conversion rules. If you are trying to read a 10-V signal with an 8-bit converter, resolution is 1/256 of 10 V (approximately 40 mV), and accuracy will be ± 1/2 the LSB.

For greater resolution, more conversion bits are necessary. The number of bits does not set the input-voltage range of a converter; it only determines with what precision the output value is represented. An 8-bit converter (either A/D or D/A) can be set up just as easily to cover a range of 0 to +1 V as it can be to cover 0 to +1000 V. Often, the same circuitry is used with only a final amplification stage or resistor-divider network changed.

Note, however, that an 8-bit converter with a range of 1000 V has a resolution of only 4 V (1000/256), and it would be useless to measure 0- to 10-V signals. You can solve this problem in a number of ways. The easiest solution is to use a converter with more bits. A 16-bit converter, which has 65,536 steps instead of 256, would cover the same 1000-V range in 15-mV increments.

As a practical matter, though, a reasonable price/performance ratio is often more important than wide-range capability. A/D conversion is considerably more expensive than D/A conversion, and price is directly related to resolution and accuracy. If you intend to read 0- to 5-V input signals and you have to be accurate within only 35 mV, it hardly makes sense to use a 1000-V range 16-bit converter (probably costing $5000) when an 8-bit 0- to 5-V range unit ($150) would more than suffice.

The rule in choosing an A/D converter boils down to "be realistic." Assess the quality of the signal source (noise, rate of change of input, ground referenced or differential, etc.) when you choose your converter. Installing a converter with 1-microvolt (μV) resolution to measure an input signal buried in 200 mV of noise is pointless.

An A/D converter that scans thermistor probes and controls the ambient temperature in a large supermarket cannot encode video information from an optical scanner. A/D converters, much more than D/A converters, are specifically tailored to an application. Speed, accuracy, and resolution are variables in any converter design, but the blending of these choices can greatly affect the cost in A/D conversion.

Most confusing is the variety of A/D-converter designs. They range from very slow, inexpensive techniques to ultrafast, expensive ones. You get what you pay for. The two fastest techniques are flash conversion and successive approximation.

The flash converter is just that. It consists of a separate analog-input comparator for each incremental voltage it is to measure. An 8-bit flash A/D converter has 256 comparators with gating logic that outputs the binary code corresponding to the comparator triggered by the input voltage. Flash converters are very fast (1 million–100 million samples/sec), but they are also very expensive.

A somewhat slower (1000–1 million samples/sec) and more cost-effective alternative is the successive-approximation converter. Shown in figure 4, this type—like the binary-ramp-type A/D converter—uses a D/A converter in the feedback loop to compare a calculated D/A voltage to the unknown input voltage. In this implementation, the binary counters are replaced with a special successive-approximation register (SAR).

Initially, the outputs of the SAR and the mutually connected D/A converter are at a zero level. After a start-conversion pulse is received, the SAR enables its bits one at a time starting with the MSB. As each bit is enabled, the comparator gives an output signi-

(continued)

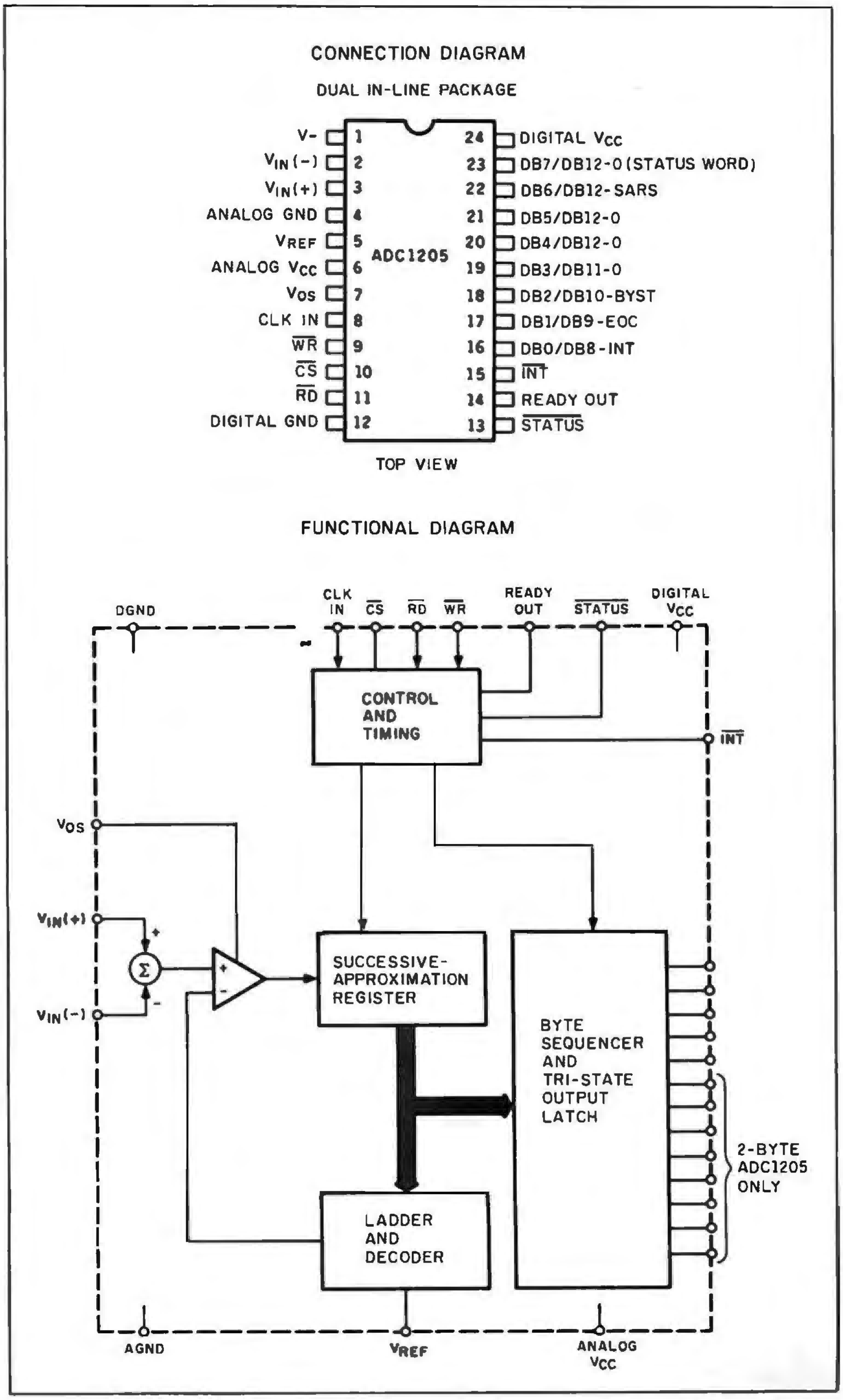


Figure 5: *Pin-out and block diagram of* National Semiconductor's ADC1205CCJ *12-bit plus sign* A/D *converter chip.*

fying that the input signal is greater or less in amplitude than the output of the D/A converter. If the D/A output is greater than the input signal, a 0 is set as the value of the corresponding output bit. If the D/A output is less than the input signal, the circuit sets the corresponding bit to a 1. The register successively moves to the next bit (retaining the settings on the previously tested bits) and performs the same test. After all the bits have been tested, the conversion cycle is complete. An 8-bit successive-approximation A/D converter takes only eight clock cycles to complete a conversion.

This one-to-one relationship between conversion resolution and SAR clock counts is generally true only for discrete-component SAR-based A/Ds. In higher-resolution integrated-circuit A/D converters, the clock cycle/conversion bit times are less distinct due to extensive housekeeping circuitry. Like many microprocessors with high clock-crystal frequencies, the actual system clock is much slower.

THE ADC1205

Figure 5 is the pin-out and block diagram of the National Semiconductor ADC1205CCJ 12-bit plus sign A/D converter chip. It operates on a single +5-V logic supply and 5.000-V reference input to provide a 12-bit conversion on 0- to 5-V inputs. With a 1.08-megahertz clock frequency, the ADC1205 will do 10,000 conversions per second (108 microseconds per conversion).

If an additional −5- to −15-V supply is connected to V− (pin 1), the ADC1205 will convert −5- to +5-V inputs using a thirteenth output bit. This MSB is the sign bit. It is a logic 0 for positive values and logic 1 for negative values.

Figure 6 shows the output characteristics of the converter. For 0- to 5-V inputs (sign bit=0), the codes range from binary 0000000000000 to 0111111111111, respectively. In a 5-V range, each bit represents 0.0012 V, or 1.2 mV resolution! If the output of the converter were binary 0000010111100 (hexadecimal 000BC), this would be (188)*(0.0012)=0.2256 V. Similarly, binary 0110101111000 (hexadecimal 00D78) is +4.1376 V.

Negative inputs are represented in two's-complement binary. For 0- to −5-V inputs (sign bit=1), the codes range from binary 1111111111111 to 1000000000000, respectively. The output code for negative values is represented as the magnitude of the difference from the unknown input to −5 V and not its distance from zero. An output code of 1000010111100 (100BC) is −((5.00)−(188)*(0.0012))= −4.7744 V. Similarly, 1110101111000 (10D78) is −((5.00)−(3448)*(0.0012))= −0.8624 V.

Under computer control, the conversion is relatively easy. At each reading, determine the absolute value of the 12-bit number by multiplying it by 0.0012 V. If the sign bit is a 0, add a plus sign to your calculation, and you have a positive output of that magnitude. If, on the other hand, the sign bit is a 1, subtract that value from 5.0 V and append a minus sign. You can see that watching the sign bit is important, and this is not as simple as offset binary.

One further consideration before presenting the entire schematic is the concept of single-ended and differential inputs. There is a significant difference between them. Most low-cost multichannel A/D converters have single-ended inputs.

All converters have a V_{in+} and a V_{in-} input. In a single-ended A/D converter, the V_{in-} line is connected to ground. Therefore, all measurements are referenced to a common ground. Even if an 8-channel multiplexer switches inputs to the V_{in+} line, all readings are referenced to a single ground, and voltages from two different systems cannot be monitored simultaneously unless their grounds are connected. This is often not the case, and conditions called ground loops result. Many of you no doubt remember "smoking" an early-generation oscilloscope by accidentally viewing the hot side of the AC line while referenced through the line cord to the other side (even today I still use an isolation transformer on my scopes).

Another consideration is trying to measure voltages that are not necessarily relative to ground. Perhaps resistor R_{tc} in figure 7 is a thermistor, and we wish to read the voltage drop across it to determine temperature. A single-ended A/D converter could not be connected directly across R_{tc} if both the circuit and the A/D converter have the same ground without shorting out one of the resistors. To read the thermistor, you would have to separately read the voltages at points B and C and subtract them. Further-

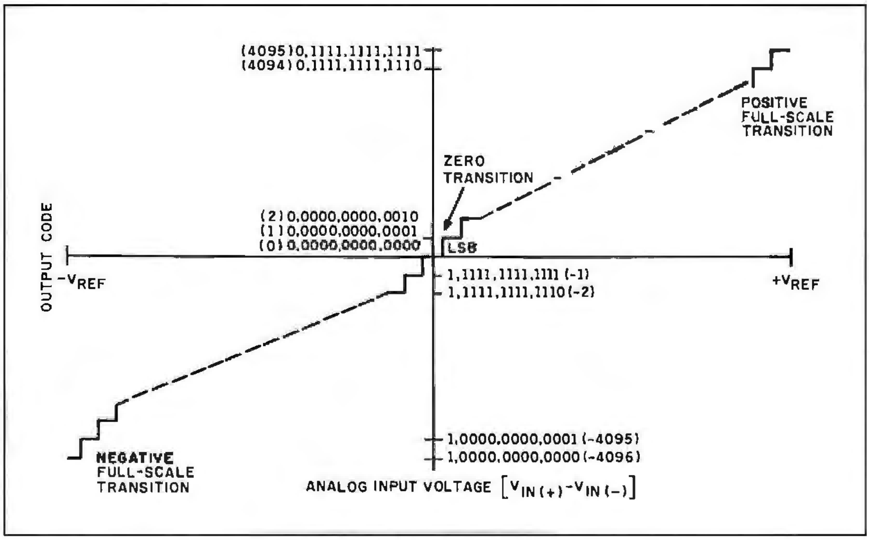


Figure 6: ADC1205 *output characteristics.*

more, unless you manually move the probes, the only way to do it is to increase the number of channels on the A/D converter. Hence, the proliferation of multichannel single-ended A/D converters.

Unfortunately, measurements referenced to ground often contain noise and power fluctuations from other components in the circuit. It is far better in some applications to simply measure the voltage between two points in a circuit irrespective of ground. Such a measurement is termed "differential." For lack of a better example, think of this as the two probes on a digital voltmeter (DVM). If the meter is battery-operated, it is completely isolated from ground, and the two probes measure absolute potential between them. Only when the V_{in-} probe is physically connected to the circuit ground are the readings then single-ended and ground-referenced.

The ADC1205, while being powered from ground-referenced power supplies, has analog input lines that are isolated from ground. These two lines are like the two probes on the DVM. In a multichannel single-ended A/D converter, only the V_{in+} line is multiplexed. The V_{in-} line is attached to ground. In a differential-input multichannel A/D converter, both the V_{in+} and V_{in-} lines are multiplexed, and neither is tied to ground. To read across R_{tc}, the V_{in+} line is attached to point B, and the V_{in-} line is connected to point C (in industry parlance, V_{in+} is V_{in} High and V_{in-} is V_{in} Low).

The ADC1205 is a 12-bit converter designed to attach directly to an 8-bit microcomputer bus. The system communicates with the chip as memory-mapped I/O through the $\overline{CS}$ (chip select bar) and $\overline{RD}$ (read bar) $\overline{WR}$ (write bar) signals. An additional $\overline{STATUS}$ (status bar) line is used as a signal to start conversion or check conversion progress.

The 12 bits and sign are read as 2 successive bytes. Data is right-justified with the most significant byte presented first (the 4 MSBs of the first byte all have the value of the sign bit). A second read to the chip automatically presents the least significant byte. The three possible interactions are given in table 1.

Communicating with this chip may look complicated, but it is much less so than you might think, especially if you are operating the converter in BASIC. I will demonstrate it shortly.

THE BCC-30 16-CHANNEL A/D CONVERTER BOARD

When you invent things, you get to name them. I called the BASIC-52 board the BCC-52. Since this A/D converter board is BCC-bus-compatible, I've decided to call it the BCC-30 (other more appropriate numbers are unfortunately taken). See photo 1. The schematic of the BCC-30 is shown in figure 8.

The configuration of the BCC-30 is as a bus-compatible peripheral device to the BCC-52 and the BCC-11 Z8-based computer/controller redesigned from the original presentation in July 1981. See photo 2. Both units and a number of expansion boards I've designed over the years share a common 44-pin bus sometimes called

(continued)

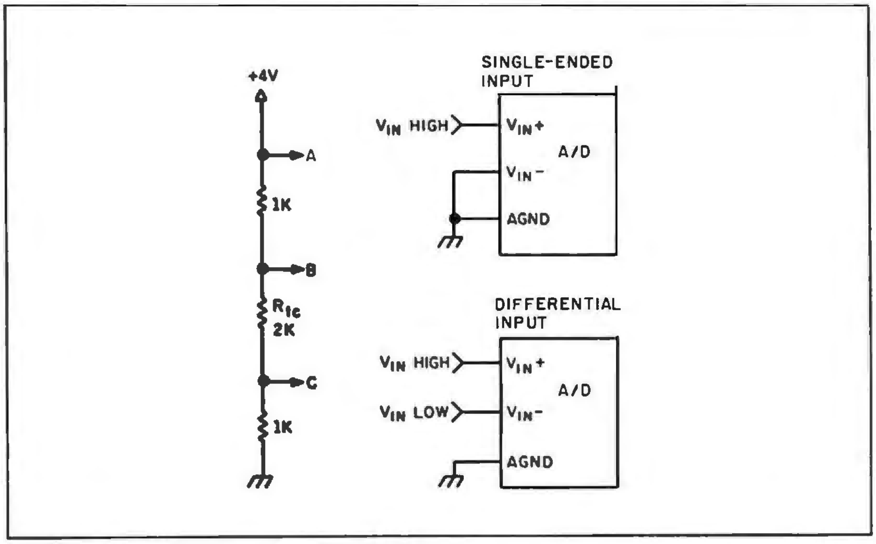


Figure 7: *Comparison of single-ended versus differential input connections.*

Table 1: *The three possible interactions with the* AC1205 A/D *converter chip.*

$\overline{CS}$	$\overline{F}$	$\overline{R}$	$\overline{STATUS}$	Function
0	1	1	0	Reset data-byte counter and start conversion.
0	0	1	1	Read data. First byte is sign and 4 MSBs; second byte is 8 LSBs.
0	0	1	0	Read status word.

Status-word format:

- Bit 0 High indicates conversion complete and data ready.
- Bit 1 — High indicates conversion complete.
- Bit 2 — High indicates next byte is 8 LSBs. Low indicates next byte is sign and 4 MSBs.
- Bit 6 — High indicates conversion still in progress.

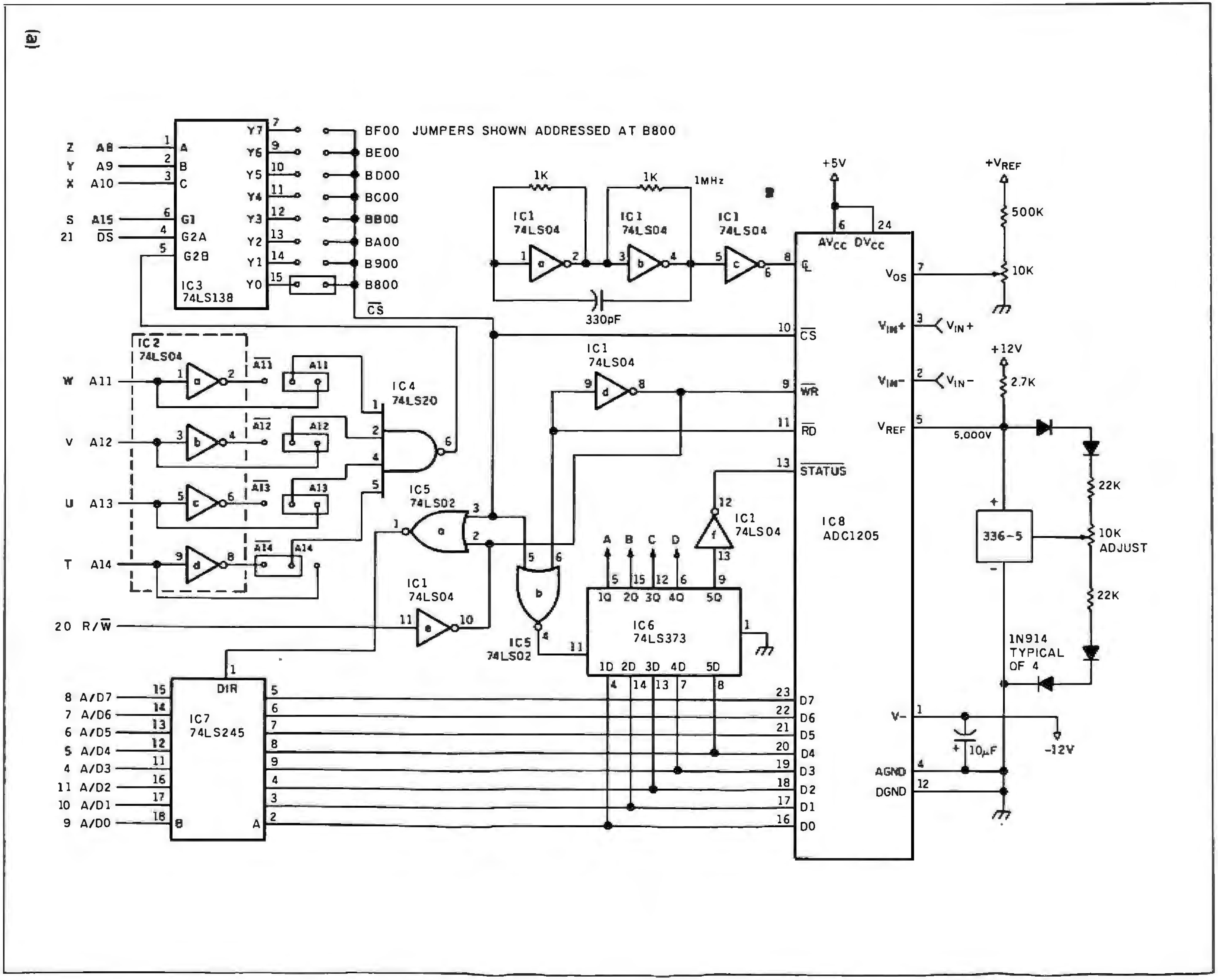
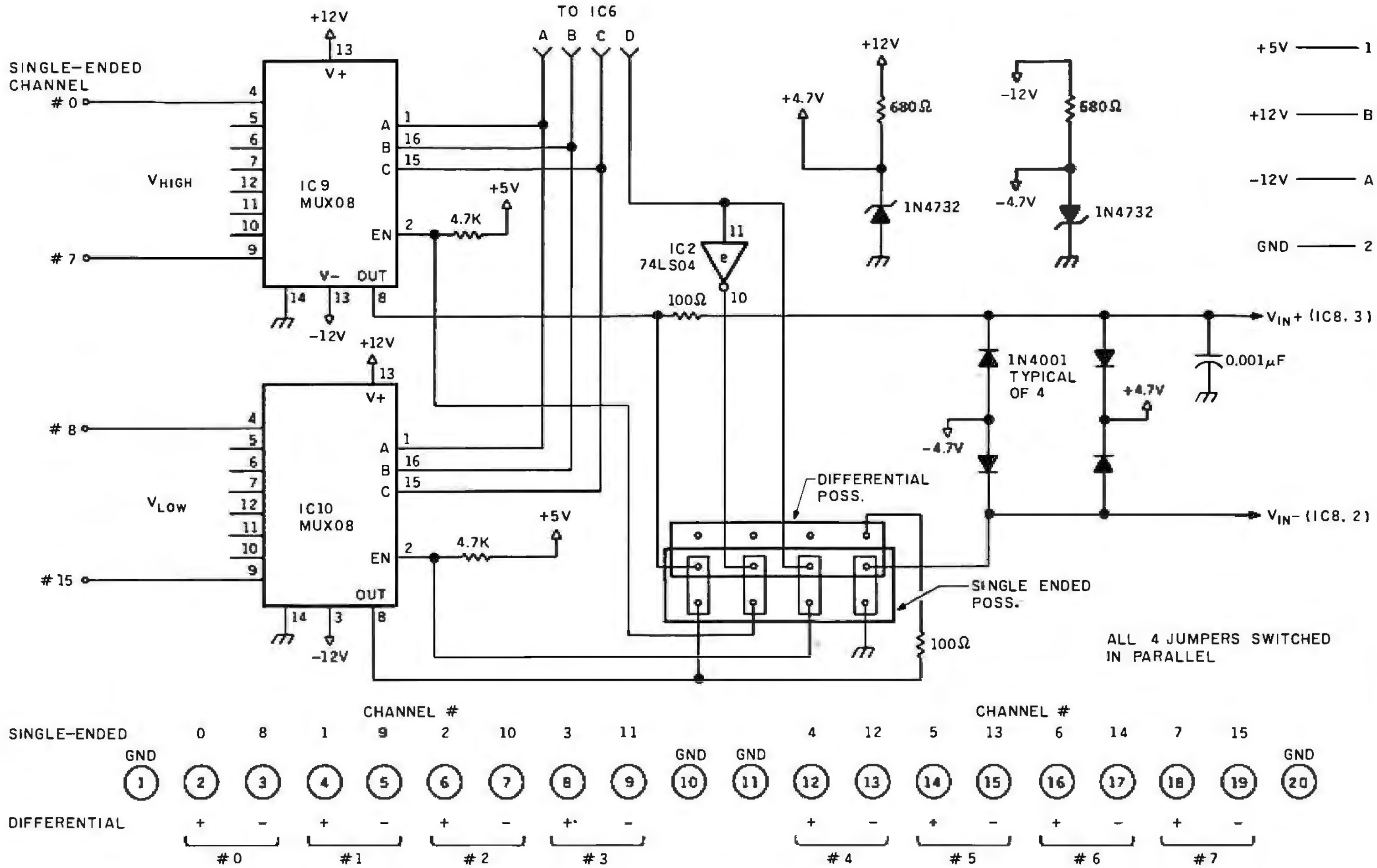


Figure 8: *Schematic diagram of the BCC-30 16-channel A/D converter board.*

(b)


SINGLE-ENDED
CHANNEL
0
7
8
15
+12V
V+
VHIGH
VLOW
IC9
MUX08
IC10
MUX08
EN
V-
OUT
-12V
+5V
4.7K
TO IC6
A B C D
IC2
74LS04
100Ω
+4.7V
680Ω
1N4732
-4.7V
+5V — 1
+12V — B
-12V — A
GND — 2
VIN+ (IC8, 3)
VIN- (IC8, 2)
1N4001
TYPICAL
OF 4
0.001μF
DIFFERENTIAL
POSS.
SINGLE ENDED
POSS.
ALL 4 JUMPERS SWITCHED
IN PARALLEL
CHANNEL #
SINGLE-ENDED
0 8 1 9 2 10 3 11
4 12 5 13 6 14 7 15
GND
DIFFERENTIAL
+ - + - + - + - + - + - + - + -
#0 #1 #2 #3 #4 #5 #6 #7

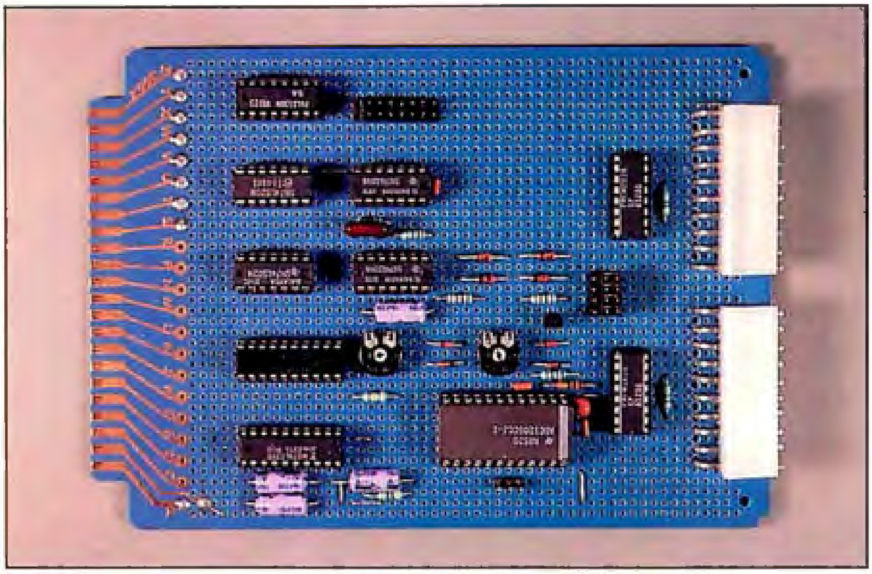


Photo 1: *Prototype of the Circuit Cellar 16-channel 12-bit plus sign A/D converter board.*

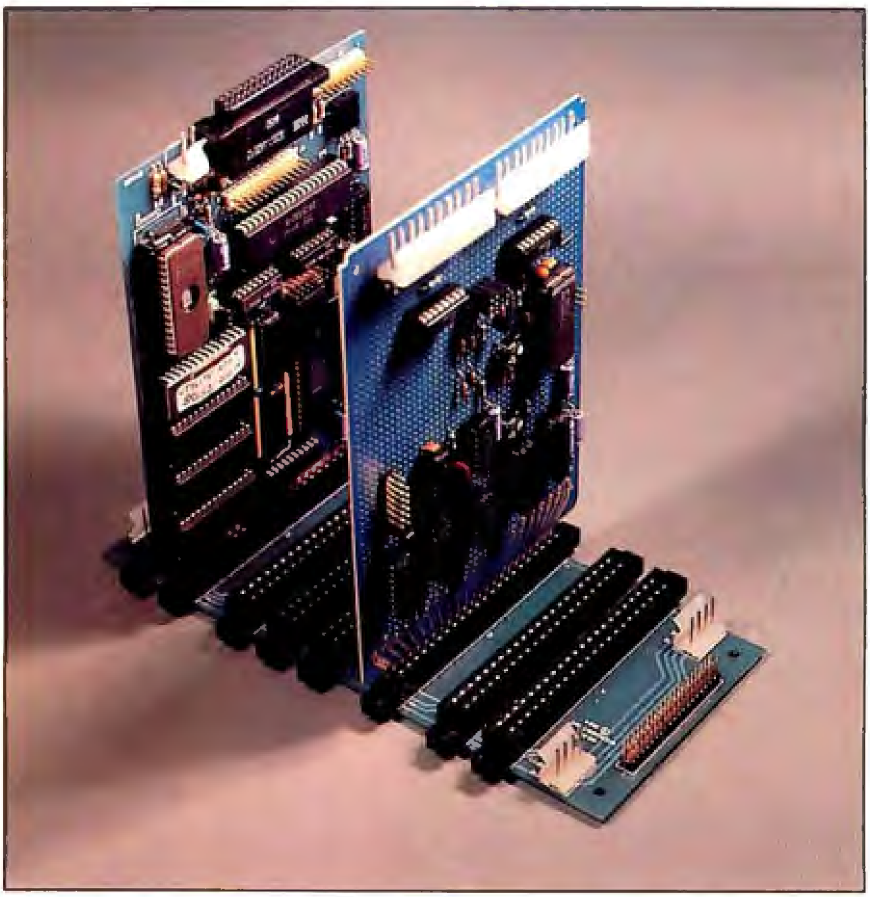


Photo 2: *The BCC-30 A/D board is bus-compatible with the BCC-52 controller board. The BCC-30 A/D prototype and BCC-52 are shown plugged into a backplane for use together.*

the "Z8 Bus" but more properly called the MMZ8 bus. Nothing is unique about the signals on this bus except perhaps their pin designations. It is a multiplexed address/data/control bus primarily oriented to 8-bit computers (16-bit address and 8-bit data).

The BCC-30 A/D board looks to the computer as a single address at any one of 128 predefined (jumper-selectable) locations. It can be configured either as 16 independent single-ended-input channels or 8 differential-input channels. Single-ended or differential operation is determined by the placement of jumpers JP1–4 and is therefore not under program control. The data byte sent by the computer to the board address defines which channel the input multiplexer is set for.

ICs 2, 3, 4, and 5 decode A8–A14 address bits to produce $\overline{CS}$ for the ADC1205 chip and latch data directed through buffer IC7 into the multiplexer address latch (IC6). The jumper positions selected in the schematic locate this address at B800 hexadecimal (47104 decimal). The 4 LSBs of this register control the input multiplexer while the fifth bit (b4) sets the $\overline{STATUS}$ level control line to the ADC1205.

Running the A/D board in BASIC is straightforward and consists of four sequential operations: set multiplexer address and reset A/D, start conversion, read most significant byte, and read least significant byte. While the status of the A/D is available as an output, a conversion takes only 100 microseconds and therefore could never be seen in BASIC (reading the status will be necessary if you are taking 10,000 samples/sec in an assembly-language program, however). It is simple enough to start the conversion and then go back immediately and read it since it will always be completed.

Executing an XBY(47104) = 18 in BASIC will load hexadecimal 12 into the address latch (the XBY() command in BASIC-52 is like PEEK and POKE in other BASICs). This corresponds to a multiplexer address of 2 and a status bit set to a logic 1 (reset). Resetting the status bit starts the conversion with an XBY(47104) = 2. The 2 bytes are then read as A1 = XBY(47104):A2 = XBY(47104). The most significant byte/least significant byte counter automatically increments on the successive reads. Summarizing, to read channel #2 (board address B800 hexadecimal), we execute code as outlined in figure 9.

A1 and A2 can then be combined to produce the desired output. I refer you to listing 1 for that procedure.

As mentioned earlier, four jumpers (JP1–4) decide whether the function of the A/D is 16-channel single-ended or 8-channel differential. All four jumpers are moved together, and all must occupy either the single-ended or differential jumper positions together. Each MUX08 (IC9 and 10) multiplexer is an 8-channel JFET-type analog switch. While CMOS (complementary metal-oxide semiconductor) switches might function in the circuit (and be about a tenth the cost), their I/O-transfer characteristics are not adequate for a 12-bit converter. The variations in resistance with input signal level would surface as measurement errors and instability. JFET multiplexers are specifically designed for this application and have very flat response curves.

Four bits from the multiplexer address latch (IC6) are directed through the jumpers to the multiplexer control lines. In the single-ended position, V_{in-} of the ADC1205 is physically grounded, and the two MUX08s sequentially address 16 input signals through it to the V_{in+}. When they are in the differential position, however, address line D is disabled, V_{in-} is removed from ground, and both V_{in+} and V_{in-} are switched through the input multiplexers. A differential input on channel #2, for example, would have V_{in} high on IC9 pin 6 and V_{in} low on IC10 pin 6 (setting channel #10 when using differential mode will enable channel #2 instead).

The remaining areas worth commenting about are the reference voltage and input protection. For a 12-bit A/D to be worth anything, it must have a precise, stable reference voltage for its internal D/A. In the BCC-30, the 5-V reference is supplied from an LM336-5 voltage reference chip. Additional diodes and a trim pot allow it to be precisely set at 5.000 V with virtually no temperature drift. Only a positive reference is required, even though the converter measures negative voltages as well.

The only "gotcha" in using the ADC1205 is input protection. While it measures +/− 5-V inputs, levels above or below +/− 5.3 V may damage the device. One method of protecting the inputs is through clamping diodes and current-limiting resistors. Using these techniques, I have connected V_{in+} and V_{in-} to a voltage source that will shunt damaging inputs away before they exceed 5.3 V. Unfortunately, if these diodes are connected to +/− 5 V, they will not begin conducting until +5.6 V and −5.6 V, respectively (germanium diodes with similar speed and power capabilities are much more expensive). I have chosen the least painful alternative by providing +/− 4.7-V Zener-generated sources to the clamping diodes that will start conducting at 5.3 V.

Presently, only a 100-ohm series

(continued)

BASIC Command	Function
XBY(47104) = 18	Set multiplexer channel #2 and set status line high to reset A/D converter.
XBY(47104) = 2	Retain multiplexer channel setting and set status line low to start conversion.
A1 = XBY(47104)	Read first (most significant) byte.
A2 = XBY(47104)	Read second (least significant) byte.

Figure 9: *Series of* BASIC-52 *statements used to read channel #2 of the* BCC-30.

Listing 1: A *sample* BASIC-52 *program to read and display channels* 0–7 *on the* BCC-30.

```
10   CLEAR
20   REM  READ AND DISPLAY A/D CHANNEL 0-7
30   REM  SINGLE-ENDED OR DIFFERENTIAL
40   REM  -5- TO +5-VOLT INPUT
50   REM
60   REM
70   N=47104 : REM BOARD ADDRESS
80   REM  STATUS BIT IS B5 - LOGIC 1 IS RESET
90   FOR A=0 TO 7 : REM  DO ALL CHANNELS 0-7
100  GOSUB 160 : REM  READ A CHANNEL
110  NEXT A : REM  NEXT CHANNEL
120  PRINT CHR(18),CHR(27),"Y" : REM  TERMITE — HOME AND CLEAR SCREEN
130  REM  DISPLAY ARRAY HOLDING CHANNEL 0-7 READINGS
140  PRINT USING (#.###),A(0),A(1),A(2),A(3),A(4),A(5),A(6),A(7),"VOLTS"
150  GOTO 20 : REM  DO IT ALL AGAIN
160  XBY (N) =A+16 : REM  RESET A/D AND SET MULTIPLEXER CHANNEL
170  XBY(N)=A : REM  CLEAR STATUS BIT TO READ DATA
180  D1 =XBY(N) : D2=XBY(N) : REM  READ 12 BITS AS TWO SUCCESSIVE WORDS
190  R=0.0012207 : REM  VOLTS PER COUNT
200  IF D1>=240 THEN GOTO 230
210  A(A)=R*((D1*256)+D2) : REM  SAVE POSITIVE READING IN ARRAY
220  RETURN
230  D1 =255-D1 : D2=255-D2 : REM  ADJUST D1 & D2 FOR
     TWO'S COMPLEMENT
240  A(A)= -1*R*((D1*256)+D2) : REM  SAVE NEGATIVE READING IN ARRAY
250  RETURN
```

resistor is used in each input line to dissipate any input overvoltage. The ADC1205 converter has about a 50-kilohm input impedance so this extra resistance is unnoticeable. The series resistance can be increased further for more protection, but the temperature drift of this resistor adds errors to the system. The quantity of error depends upon the signal source impedance.

Frankly speaking, I would much rather have added a clamped-output op-amp stage, but it would have been very expensive. Remember, we are talking about 1-mV signals and 20 parts per million maximum permissible temperature drift. It hardly makes sense to add an op amp with a 30-mV offset and 200 ppm temperature drift combined with piles of who-knows-what discrete components moving in all different directions. Low-drift, low-offset, high-speed op-amp circuits are expensive.

It would be easy for me to simply provide an untried schematic of a typical protection circuit, but, as a practical matter, a properly designed and tested circuit with no offset or drift would have been a bigger project than the whole A/D board. I suggest that you simply try to limit your input range to +5 to −5 V. Half-watt 100-ohm series resistors will protect the inputs up to +/- 12 V.

While faster diodes might eventually be required in the clamping circuits shown, they are reasonably priced and adequate protection for normal use. No one wants to pay what it would take to guard against all possible circumstances. Only an idiot would try to measure the voltage across the tips of an arc welder with this board.

CONCLUSION

The price/performance of A/D converters is a balance of speed and resolution. There are $200 4-bit 100 million samples/sec A/D chips and $9.95 12-bit 2 samples/sec units (I won't bother to tell you how much 12 bits at 100 million samples/sec would cost). In environmental systems that have slowly varying conditions, speed is not as important as accuracy. Room temperature, for example, doesn't change so fast that you need to sample it 500 times a second. The accelerometers on a shake table, however, may need to be sampled 20,000 times a second for accurate G-force event records.

The BCC-30 has more than enough performance for most data-acquisition situations and will be finding a home in industrial control applications along with the BCC-52.

CIRCUIT CELLAR FEEDBACK

This month's feedback is on page 403.

NEXT MONTH

I'll build a multichannel audio/video multiplexer. ■

The following items are available from

The Micromint Inc.
25 Terrace Dr.
Vernon, CT 06066
(800) 635-3355 for orders
(203) 871-6170 for information

1. BCC-30, 12-bit plus sign, 10,000 samples/sec, input range: −5 to +5 V, 16-channel A/D converter board.
assembled and tested BCC-30, $197
2. BCC-13, 8-bit, 12,000 samples/sec, input ranges: 0 to 10 V or −5 to +5 V, 8-channel A/D converter board.
assembled and tested BCC-13, $140
3. BCC-99 manual set. Includes all user's manuals and schematics for BCC-52, BCC-11, and BCC-21 computer/controllers and all currently available expansion boards, including serial, parallel I/O, AC/DC power I/O, and those listed above. Shipping weight 5 lbs.
. . . . BCC-99, $29.95

All the units above are bus-compatible with the BCC-52, BCC-11, and BCC-21 computer/controllers. All units come complete with user's manual.

Please include $4 for shipping and handling in the continental United States, $10 elsewhere. Connecticut residents please include 7.5 percent sales tax.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume* II covers December 1978 through June 1980. *Volume* III covers July 1980 through December 1981. *Volume* IV covers January 1982 through June 1983.

Introd
Lasog

The Xerox 4045 Laser CP.

A desktop laser printer that's also a copier.

XEROX

ucing
raphy.

About twenty-five years ago something happened that changed the world of information forever.

Xerox introduced the first plain paper copier, an achievement that brought xerography into almost every office.

TeamXerox

Since then, for more than a decade, Xerox has been applying the power of laser technology in high speed computer printing systems. Systems that produce superb documents of unsurpassed quality. Quickly, quietly and cost effectively.

Now, through this process which we've named Lasography, Xerox has come up with a revolutionary product that lets smaller offices and work groups enjoy these benefits, too.

Introducing the Xerox 4045 Laser Copier Printer.

It's the desktop copier/laser printer with a totally unique dual personality.

For one thing, it's a sophisticated laser printer. It can print up to ten pages a minute. Which is ten times faster than standard office printers.

And while other desktop printers serve primarily one workstation at a time, the Xerox 4045 Laser CP is designed to accommodate four.

All at the same time.

Not only that, but with the Laser CP's graphics capabilities you can merge all the forms, logos, texts and signatures you want printed and produce documents that anyone would be proud of.

But as we said before, the Laser CP has a dual personality. It doubles as a high quality convenience copier.

The Xerox 4045 Laser CP is only one example of what Lasography has to offer your office, remote or distributed data processing environments.

Because Xerox is already planning ways to apply Lasography toward an even wider selection of products.

All of which will put your office exactly where it belongs.

Light years ahead.

Call 1-800-TEAM-XRX, ext. 179 for information and product demonstration.

Please send me more information on Xerox Lasography.
☐ The 4045 Laser CP.
☐ The complete line of Lasographic printers.

Send this coupon to:
Xerox Corporation, P.O. Box 24, Rochester, NY 14692

NAME ____ TITLE ____
COMPANY ____
ADDRESS ____ CITY ____
STATE ____ ZIP ____ PHONE ____

If you can't wait, call:

1-800-TEAM-XRX, ext. 179

(1-800-832-6979, ext. 179)

179 192-1-86

FOR MORE INFORMATION ON XEROX LASOGRAPHIC PRINTERS, CIRCLE 390 ON THE READER SERVICE CARD.

Q&A

Integrated software with macros and an Intelligent Assistant

Editor's note: The following is a BYTE *product preview. It is not a review. We provide an advance look at this new product because we feel it is significant. A complete review will follow in a subsequent issue.*

Q&A is a new product from Symantec (see "In Brief" on page 122) that integrates word processing and file management with a full macro facility and an effective natural-language interface, your "Intelligent Assistant." The database and word-processing modules include data merge, comprehensive report capabilities, and context-sensitive help, but it is the Assistant that distinguishes the software. With it, you have the option of addressing the database intuitively and quickly by entering ordinary English phrases and sentences. You can carry on a conversation about the data in your database, to find forms, to ask questions of the database, to view or print reports, to run predefined reports, to perform calculations on the data, or to change the information in the database. And with macros, you can speed requests by defining keys as commonly used words and phrases. You can thus bypass the more formal searching, reporting, and updating procedures in most database applications and in Q&A's own database module.

YOUR INTELLIGENT ASSISTANT

The Assistant has a built-in vocabulary of over 400 words (see table 1 for a partial list), and it automatically learns field names and the contents of the database. If you desire, you can also train your Assistant to comprehend your parlance in eight quick lessons. By so doing, you can increase the number of words that the Assistant understands and provide for much more personalized sessions.

From the Assistant's main menu (see photo 1) you can get acquainted with your new helper through a series of short help screens (and you can rename it to your liking—I chose the name Duncan), you can elect to train or retrain the assistant, or you can ask it to do something.

A SAMPLE SESSION

Let's follow a session with the sample database, Realty, which contains addresses and descriptions of 47 bed-and-breakfast units in the United States. The fields include owner's name, address, number of beds, number of baths, rent, amenities, type, and commission.

After loading in the database, the Assistant asks you to type your request in English (see photo 2).

Me: Where can I get a room?
Duncan: Shall I do the following? Create a report showing the address, city, state, zip, and bed from *all* the forms?

The bottom of the screen presents my options. For example, you can dump the output to the screen or to a printer, edit individual forms, or focus the search further. Let's try something a bit more practical.

Me: Are there any units for rent with more than 1 bed and a pool?

After 10 seconds on an IBM AT, with Duncan highlighting its progress through the sentence, it responds:

Duncan: Shall I do the following? Create a report showing the monthly rent and the address and the city from the forms on which the bed>1 and the amenities include "pool" sorted by monthly rent?

I'm not sure why it sorted by rent, but I got the information I requested. The report included 17 units sorted from the highest to the lowest rent. Finally, I tried another approach.

Me: Show me the forms for the units with between 2 and 5 baths.
Duncan (7 seconds later): Shall I: Select and view the forms on which the bath is >=2 and <=5?

It's hard not to be impressed. The Assistant answers many "Are there. . ." questions with "Yes, press return to see the forms," and "How many. . ." questions with a numeric answer. You can perform calculations, ask follow-up questions, ask to see specific forms, ask date-related questions ("Who was hired after June 1, 1985?"), and sort. With a larger database, you might want to find the average number of beds in Boston, sort the cost of condominiums with two beds and a bath, or view the list of owners with last names beginning with "D."

And you can also use the Assistant to create or delete forms. For example, you could type "Fill in a new form with 5 Main Street in the address field" or "Delete all forms with no addresses" and the Assistant will comply. To modify a form, try "Change Paul John's street address to 5 Main Street," or "Increase all rents by $5."

Clearly, the possibilities are limitless, but I did have some problems. The Assistant tended to be a bit unforgiving with my typographical errors. It does permit you to edit or define words that it does not understand, but it does not have a built-in spelling checker to offer possible interpretations of your entry. Moreover, after you have corrected your error, it begins its interpretation of your request at the beginning, not where it encountered the problem. And if you are well accustomed to databases, you may long for faster access to the data. The File module, which I describe in detail later, permits more conventional inquiries. Although I found that by truncating my requests ("3 beds" or "sort beds by state") and by using abbreviations that the Assis-

(continued)

Jon R. Edwards is a BYTE *technical editor. He can be contacted at* POB 372, *Hancock,* NH 03449.

Display	Calculate	Search/Sort	Edit	Adjective	Comparative	Superlative
display	add	alphabetical	blank	big	above	biggest
find	difference	containing	enter	low	larger	least
get	divide	descending	erase	many	less	littlest
list	average	and	change	few	below	bottom
make	bottom	ascending	create	great	bigger	fewest
print	count	before	define	high	greater	greatest
report	half	early	expunge	much	littler	lowest
run	cut	begin	delete	large	fewer	highest
search	increase	excluding	new	small	lower	maximum
show	decrease	between	empty	little	higher	largest
table	maximum	fewer	remove		more	minimum
	mean	find	replace		over	most
	minimum	first	set		smaller	smallest
	multiply	get			under	top
	percent	greater				
	plus	higher				
	product	including				
	quotient	increasing				
	raise	last				
	ratio	late				
	remainder	least				
	subtract	lower				
	sum	not				
	total	or				
	twice	order				
		recent				
		reverse				
		search				
		start				
		through				
		top				
		under				

Table 1: *A list of some of Q&A's built-in vocabulary sorted into categories.*

tant understands ("WNIC" for "with no identification columns"), I got reports and got to the data quickly.

TEACHING YOUR ASSISTANT

One other problem was easy to solve. I asked about "radar ranges," but discovered that Duncan only understood "microwaves," the precise entry in the amenities field. Immediately, however, Duncan gave me an opportunity to look at all the words in its dictionary and to define the new word as a synonym for the term it knew. You can just as easily delete a synonym from the list. Alternatively, you can tell the Assistant to "Define 'radar range' as 'microwave'" or try more complex synonyms like "Define 'home' as 'address, city, state.'" One of the nicest features is using synonyms to define reports. For example, if you enter "Define 'bedsort' to be 'address, state, zip code, and rent, sorted by bed.'" you could later enter "bedsort in Massachusetts."

Formal schooling for your Assistant is only slightly more involved, but by conducting the lessons, you can personalize your relationship with the Assistant (see photo 3). The eight lessons involve teaching the Assistant about the database. You can identify units of measure, words that generally describe the purpose and nature of the database, words that are generally synonymous with each field name, and fields that hold locations, names, or values. You can also specify the default columns that you want displayed in every report.

Two lessons are more advanced. One teaches adjectives to the Assistant. For example, you could define "young" as a low age, or "rich" as a high income. In each case, the adjectives would apply to a specific field, allowing the Assistant to make judgments like younger ("Who is younger than Jackson?"), youngest, richer, and richest. The final lesson allows you to associate verbs with particular fields. For example, by associating "earn" with a salary field, you could ask the Assistant "Who earns more than $30,000?" The Assistant has provision for learning irregular verbs.

INTEGRATED MODULES

Q&A contains four other integrated modules, Write, File, Report, and Utilities. You select the module you want from Q&A's main menu. All of the modules use the screen format and menu structure of pfs:File.

Write provides a comfortable word-processing environment as well as "merge printing." From the main Write menu, you can define a new or edit an existing document; set page di-

(continued)

IN BRIEF

Name
Q&A

Type
Integrated software, including word processor, database manager, report generator, and a natural-language query system. Works with single flat data files.

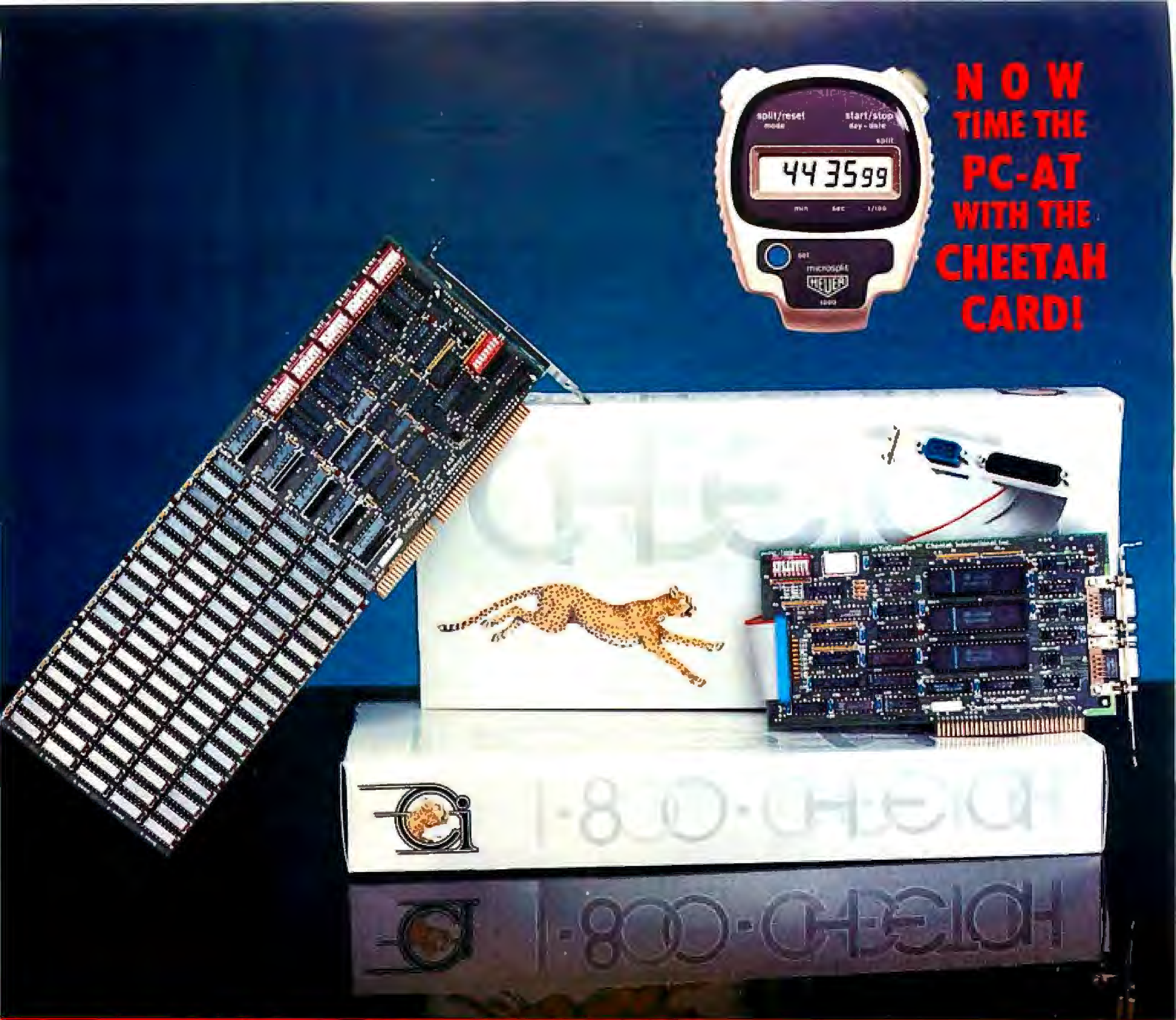
Manufacturer
Symantec Corporation
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600

Price
$295
$349 with a 256K-byte RAM board
$50 trade-in policy for some database managers

Format
Three 5¼-inch floppy disks

Computers
IBM PC, XT, AT, or compatibles with a minimum of 512K bytes of RAM and two disk drives. A hard disk is preferred.

Photo 1: *The* Q&A *main menu.*



AMAZING! OUR NEW 2.5 MB PC-AT MEMORY BOARD ACTUALLY ALLOWS YOUR AT TO RUN UP TO 30% FASTER

The memory in your IBM PC-AT, as well as the AST Advantage!™, Tecmar Maestro™, and other AT memory boards require three clock intervals per memory cycle to perform the same operation that the Cheetah Card™ can accomplish in only two!

Other memory boards must wait one full clock interval because their memory is too slow — one-third of the time is lost!

The Cheetah Card™ runs "NO WAIT STATE." Programs running in our memory run much faster. Up to a full 30% faster. (It's not possible to achieve a full one-third gain because of I/O operations, etc.)

You purchased an AT for speed. Do you really want to install a memory board that makes the AT run slow? Of course not!

For the first time, you now have a clear choice. You can choose a product that costs more, runs slower, and comes with less guarantee.

Or you can choose the 2.5MB Cheetah Card™ that allows the AT to perform up to 30% faster, comes with a full 3-year limited warranty, and retails for less than our competition!

Now that you have a new stopwatch — go by your local computer store and time the new Cheetah Card™. And while you are there — take a look at our versatile 3 serial, 1 parallel TriComPlus™ I/O board.

If your local dealer does not yet have the Cheetah Card™, then we will ship UPS PREPAID — direct to you. Purchase either the Cheetah Card™ or the TriComPlus™ and test them for up to 30 days! If you are not 100% satisfied, simply return ship C.O.D. for same day full refund!

Cheetah International, Inc.
107 Community Boulevard, Suite 5
Longview, Texas 75606 USA

TELEX: 510-600-4578 CHEETAH

2.5MB Cheetah Card™	**$945**
TriComPlus™	**$195**

CALL TODAY
1-800-CHEETAH
(1-800-243-3824)

TEXAS: 1-214-757-3001

AST Advantage!TM is a registered trademark of AST Research Inc. Tecmar MaestroTM is a registered trademark of Tecmar, Inc.

mensions, margins, and type size; clear a document from memory; print the document; or use three DOS functions (copy, delete, and rename). Write saves text in ASCII; therefore, you could, if you desire, use your favorite editor and only then make use of Q&A's merge capabilities. Nonetheless, Write is full-featured. In addition to most conventional features, like a range of block moves, headers and footers, integrating ASCII text within existing documents, and adequate printer support, Write includes on-screen page breaks, macros, word counts, context-sensitive help, a limit of approximately 30 pages of text per document, and line and box drawing. You can also customize commands in a default file. You can save a personalized default file in different directories for different kinds of documents. Windowing, footnoting, and columnar commands are the only conspicuous features that are missing.

Photo 2: *Using the Intelligent Assistant.*

Photo 3: *The third lesson for the Assistant.*

Write does not work directly with the Intelligent Assistant, but you can use the merge capabilities to insert Q&A data into Write documents. You need only place *field name* within the text to access the data, and there are a variety of text-formatting commands to smooth the printing of merged documents. To print the document, you select Print at the main Write menu. You can then select among several options, including the selection of the database to be used, the number of pages and copies, line spacing, and justification.

You can use File, a full-featured database, to build single flat files for use with the Intelligent Assistant or to search for and retrieve data directly. From the main File menu, you can design (or redesign) the database, add data, search, update, mass-update, copy, delete, and print. Forms can be up to 10 screen pages long; each screen page contains 21 lines, or three screen pages per 8½- by 11-inch sheet. You can have up to 1980 characters per field, 2400 fields per record, and up to 16 million records per file. Each field can be up to one screen in length. You can sort (ascending and descending) on up to 25 fields and index on up to 120 fields. Field types include text, number, money, keyword, date, hours, and yes/no.

File's procedures are more conventional and formal than the Intelligent Assistant's, but for data entry and some reports, you will undoubtedly prefer its options. Within File, you can add punctuation and symbols, you can perform date and time arithmetic, and you can include programming statements (including IF. . .THEN, IF. . .THEN. . .ELSE, AND, OR, NOT,

(continued)


HOW TO GET OVER $2000 WORTH OF NEW CAPABILITIES FOR YOUR COMMODORE 64™
FOR $599*
The Spartan™ is the Apple™ II+ emulator for your Commodore 64™ that will open up a whole new world of hardware and software for you! Imagine adding these features to your Commodore 64™ for the Spartan™ price of $599: ☐ Apple™ II+ hardware and software capabilities ☐ 64K RAM expansion ☐ four software selectable Commodore 64™ cartridge slots ☐ non-dedicated 8-bit parallel port ☐ standard audio cassette deck capabilities for your C-64™. The suggested retail value of comparable products offering only these capabilities is over $2200.00* — but the Spartan™ gives you much, much more! By building on your investment in your Commodore 64™— an excellent introductory computer — you create a whole new system with both C-64™ and Apple™ II+ capabilities. There is a whole other world out there! The huge selection of Apple™ II+ hardware and software is now yours to explore! Call toll free for the Spartan™ dealer nearest you.
MIMIC
FOR INFORMATION WRITE:
MIMIC SYSTEMS
1112 FORT ST., FL. 6H
VICTORIA, B.C.
CANADA V8V 4V2
TO ORDER CALL:
1-800-MODULAR
(663-8527)
*All prices quoted are in U.S. funds, freight and taxes not included. Value of components equivalent to the Spartan™ system are quoted from Apple™ II+ CPU and Apple™ II+ single disk drive 1983 list prices, and from current suggested list prices and component specifications of other peripheral manufacturers. Commodore 64™ and Commodore logo are trademarks of Commodore Electronics Ltd. and/or Commodore Business Machines, Inc. Apple™ II+ is a trademark of Apple Computer Inc. Spartan™ is a trademark of Mimic Systems Inc. and has no association with Commodore Electronics or Apple Computer Inc. The Spartan™ is manufactured by Mimic Systems under license granted by ATG Electronics Inc. of Victoria, B.C. Canada

and INT) to update fields conditionally or to control the order of data entry. You can customize field-specific help screens to provide context-sensitive aid in entering the data, a useful feature when fields restrict data in some way. You can also use colors, shading, and underlining, perhaps to set off the current field or the field labels. Lookup tables let you construct and edit a table of values; you could, for example, construct the table to hold relevant tax information for different states or countries. Entries in the table cannot exceed 69 characters. The Print feature is also more versatile than the Intelligent Assistant's. For example, like most database managers, File allows you to print mailing labels and to design and reuse specialized forms.

The Report module extends your reporting capability. From the main Report menu, you can design or redesign a report; print; set new headings; and rename, delete, or copy files. Like other report applications, Report sorts (up to 16 columns in ascending or descending order) and arranges the data from the database into a screen or printed display. Report allows you to do calculations and subcalculations on or within columns; to specify where you want page breaks; to include page numbers, headers, and footers; and to derive up to four new columns from existing data. You may want to create a report based on keywords or have several invisible columns that are not printed but that permit special sorting or particular derived columns.

From the main Utilities menu, you can import and export data and install a range of printers to support Q&A's advanced printing features. You can import data, or append data to the end of existing Q&A files, from either pfs:File or IBM Filing Assistant. To import data in DIF (Data Interchange Format) or ASCII, or from Lotus 1-2-3 or Symphony files, you must first have or prepare a Q&A file exactly matching the form template of the imported file. Menus guide you carefully through the process.

You can define a macro anytime within Q&A, or edit existing macros in the Write module. Pressing Shift-F2 brings the Macro Menu box to the bottom of the screen, with options to define, retrieve, save, and clear macros. Use them within the modules to set up your working environment, to perform common operations, or to ease tasks like printing or retrieving. Use them with the Assistant to personalize your relationship further. You could, for example, use macros to hasten the typing of your requests. Macro aficionados will appreciate the Escape key, which immediately stops the playback of the macro.

Q&A, which is written in C and ma-

(continued)

Inquiry 25

Inquiry 257 for End-Users.
Inquiry 258 for DEALERS ONLY. →

There's a Familar Face Behind the New Name

NANAO MONITORS. The name is new to the American market. That's because for the first time in history, a huge new line of computer monitors is available to the U.S.—factory direct. 26 different models offered in three series, bringing you a range of features broader than any other. Color resolution from 480 dots x 200 lines up to 720 dots x 480 lines. And Fh scanning from 15.75 to 24.75 KHz. But the truth is that Nanao has been around for a long time. For over a decade we've supplied OEM's worldwide, designing and manufacturing monitors recognized for their outstanding performance and reliability. Now that same quality, selection and value is yours—right from the source. Nanao. The old standby with a new name.

NANAO

NANAO USA CORPORATION
373 G. Vintage Park Drive
Foster City, California 94404
Phone (415) 341-7055

Distributor Inquiries Welcomed

chine language, requires an IBM PC, XT, AT, or compatible with a minimum of 512K bytes of RAM (random-access read/write memory) and two disk drives. Hard disks are clearly preferable for storing and accessing large databases. The suggested retail price is $295, or $349 packaged with a 256K-byte RAM board. Symantec will also provide a $50 trade-in for your commercial database software. The Q&A package includes substantial easy-to-follow documentation, a function key template, a quick-reference card, and four disks, which include a tutorial and a sample database.

CONCLUSION

Much research on natural-language query processing is centered on accessing data from relational databases in a multiuser, networked environment. Q&A draws from the research, though the software manipulates only single flat files and has no multiuser or networking capabilities.

There are other natural-language database products for the microcomputer market (see "CLOUT and SALVO" by George Bond, October 1984 BYTE, page 279), but most are either front ends or have much more restrictive features than Q&A. With full integration, macros, and an Intelligent Assistant capable of searching and sorting as well as updating the database, Q&A may go far in attracting users who are tired of the programming-like formalism often required to retrieve data and organize reports.

Nonetheless, natural-language query systems have inherent limitations. Processing the query takes time. It may be hard for some to justify the time required to teach the Assistant, and individual expert users will undoubtedly be better served by raw programming power. And Q&A is not the ultimate natural-language product, since it doesn't support relational queries and isn't meant for use in a multiuser environment. Still, with the Intelligent Assistant, you can effectively explore the relationships in your data without having to grumble about database syntax. Q&A gets the job done in an enjoyable way. ■

The Computer Book Club®

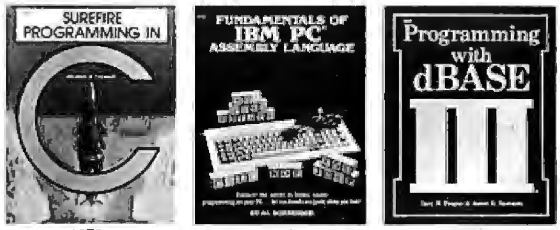
Recognized as the authoritative source for micro users!

Superior Performance, Practical Price!

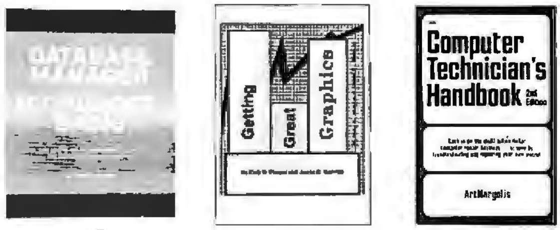
More programs, projects, ways to use your micro for home, hobby, education, and business!

Select 5 Books for Only $2.95

worth up to $132.75



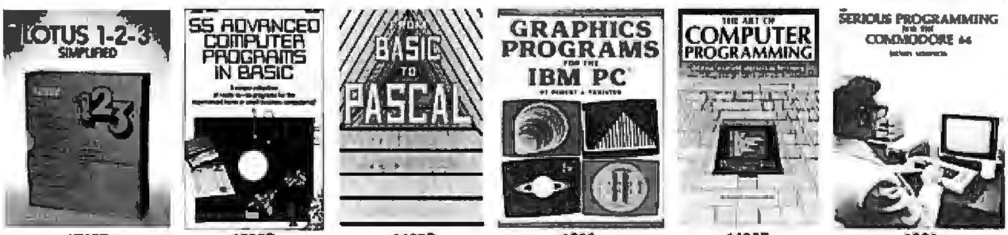
1873 List $21.95 | 1710 List $19.95 | 1976 List $26.95



1567 List $18.95 | 1876 List $25.95 | 1939 List $24.95

1921 List $21.95 | 1958 List $24.95 | 1160 List $14.95 | 1205P List $11.50 (paper) | 1874 List $21.95 | 1929 List $29.95 | 1539P List $15.95 (paper) | 1908 List $24.95

1501 List $21.95 | 1886 List $22.95 | 1742 List $24.95 | 1884 List $24.95 | 1789 List $21.95 | 1389P List $10.25 (paper) | 1852 List $21.95 | 1948 List $22.95



1748P List $10.95 (paper) | 1295P List $10.25 (paper) | 1466P List $18.95 | 1556 List $21.95 | 1455P List $10.95 (paper) | 1821 List $15.95

Free guide to BASIC Statements & Commands

Plus FREE For Joining →

7 very good reasons to join The Computer Book Club®

- **Big Savings.** Save 20% to 75% on books sure to increase your computer know-how
- **No-Risk Guarantee.** All books returnable within 10 days without obligation
- **Club News Bulletins.** All about current selections—mains, alternates, extras—plus bonus offers. Comes 13 times a year with hundreds of up-to-the-minute titles to pick from
- **"Automatic Order."** Do nothing, and the Main selection will be shipped automatically! But . . . if you want an Alternate selection—or no books at all—we'll follow the instructions you give on the reply form provided with every News Bulletin
- **Bonus Books.** Immediately get a Dividend Certificate with every book purchased and qualify for big discounts of 60% to 80%.
- **Extra Bonuses.** Take advantage of added-value promotions, plus special discounts on software, games, and more
- **Exceptional Quality.** All books are first-rate publisher's editions selected by our Editorial Board and filled with useful, up-to-the-minute information

The Computer Book Club®

P.O. Box 80, Blue Ridge Summit, PA 17214

Please accept my membership in The Computer Book Club® and send the 5 volumes circled below, *plus* my FREE copy of *BASIC Statements, Commands and Functions*, billing me only $2.95 plus shipping and handling charges. If not satisfied, I may return the books within ten days without obligation and have my membership canceled. I agree to purchase 4 or more books at regular Club prices (plus shipping/handling) during the next 12 months, and may resign any time thereafter.

1160 1205P 1295P 1389P 1455P 1466 1501 1539P 1556
1567 1710 1742 1748P 1789 1821 1852 1873 1874 1876
1884 1886 1908 1921 1929 1939 1948 1958 1976

Name ______________________________

Address ______________________________

City ______________________________

State ______________ Zip ________ Phone ______________

Valid for new members only. Foreign applicants will receive special ordering instructions. Canada must remit in U.S. Currency. This order subject to acceptance by The Computer Book Club®.

BY-186

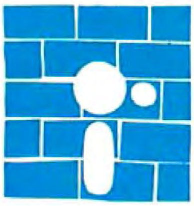
Inquiry 74

ILLUSTRATED BY JOHN S. DYKES

A SIMPL COMPILER PART 2: PROCEDURES AND FUNCTIONS

BY JONATHAN AMSTERDAM

Procedures and functions are a boon for programmers, but they're tricky to compile



Last month, I described the construction of a compiler for the high-level language SIMPL, but I omitted any description of the part of the compiler that handles procedures and functions. This month, I'll fill that gap.

The SIMPL compiler I wrote translates SIMPL, a Pascal-like language, into VM2 assembly language. VM2 is a hypothetical computer that I wrote a simulator for in "Building a Computer in Software" (October 1985 BYTE, page 112). I described an assembler for VM2 in my November 1985 article (page 112). The routines—my collective term for procedures and functions—of SIMPL are similar to those of Pascal, except that a value is returned from a function using a RETURN statement rather than by assignment to the function name. The syntax of routines is presented in figure 1, and a SIMPL program using a function can be found in listing 1a.

THE CHALLENGE OF ROUTINES

What makes compiling routines so difficult? Listing 1 shows a SIMPL program that calculates the factorial of a number, using a function called fact. The factorial of a nonnegative integer n is $n*(n-1)*(n-2)* \ldots *$ 1. The fact function is recursive; it says that the factorial of n is equal to n times the factorial of $n-1$ and that the factorial of 0 is defined to be 1. To see what has to be done to compile this program, first consider what the run-time behavior of the program ought to be. The following four things have to be done when calling fact.

1. When the statement WRITE(fact(n)) is executed, control has to transfer to the code constituting fact.
2. The argument n has to be passed to the function. Somehow, the actual parameter, the value of n in the call to fact, must be connected (or bound) to the formal parameter, n, that appears in the function definition.
3. It is necessary that fact return to the proper place in the main program and that its result be made available. A function call should act as if it were replaced by its result in the program text. If the call to fact produced the result 6, the program should behave as if the call to fact were simply replaced by the number 6, yielding the statement WRITE(6).
4. Storage has to be found for fact's local variable, temp.

(continued)

Jonathan Amsterdam is a graduate student at the Massachusetts Institute of Technology Artificial Intelligence Laboratory. He can be reached at 1643 Cambridge St. #34, Cambridge, MA 02138.

To handle the control transfer, a simple BRANCH instruction will suffice. If we provide fact with a return address—the memory address of the instruction just after the call—fact will know where to branch to when it's finished. That takes care of transferring control.

How about storage allocation? One solution, often used in FORTRAN compilers, is to allocate enough space with each procedure or function to hold that routine's arguments and locals, plus an additional word of storage for the result of a function. In this case, three words would be allocated: one for the argument *n*, one for temp, and one for fact's return value. The compiler would assign these memory locations while compiling fact; it would remember them in the symbol table and use them to generate references to the argument, local, and return value.

This design is simple and elegant. Unfortunately, it does not handle recursion. Because this scheme assigns a fixed amount of memory to each routine, it implicitly assumes that a routine can use only one set of arguments and locals at a time. Each time a routine is called recursively, a new invocation is set up using the same code but different values for the arguments and locals. In the simple scheme above, the values of the first invocation of a recursive routine will be overwritten by the values of the second invocation.

It is necessary to allocate new memory locations each time a recursive routine is called. But it's impossible for the compiler to predict the amount of storage a recursive routine might need, because the compiler can't determine how many recursive calls of a given routine would occur when the program is run. Therefore, this storage allocation must take place at run time, not compile time. You need to decide at compile time how to reference the arguments and locals of the routine and compile the references into the code for the routine. How can this be done?

Activation Records

The solution to this problem involves a data structure called an activation record, which is a contiguous region of memory that contains all the variable information needed for a routine's invocation. It holds the arguments, locals, and a space for the return value for functions. It also holds the return address and some pointers to other activation records I'll describe later. All the activation records for a given procedure have the same format, but their contents differ from invocation to invocation.

The run-time behavior of a program with routines is as follows: Each time a routine is called, storage for a new activation record is allocated. After the activation record is allocated, it is filled with the values of the arguments passed by the call and with the return address. Control then transfers to the called routine. When the routine

(continued)

```
routine    ::= proc | func
proc       ::= PROCEDURE id {formals} ; {vars} <routine> block;
func       ::= FUNCTION id {formals} : type ; {vars} <routine> block;
formals    ::= ( <decl ;> decl)
```

Figure 1: *The syntax of* SIMPL *routines. A block is a list of statements surrounded by* BEGIN *and* END*; a* decl *is a variable declaration; and vars indicate the keyword* VAR *followed by one or more* decls*. Curly braces around an item indicate that the item is optional. Angle brackets indicate zero or more repetitions of the item are permitted.*

Listing 1: *(a) A* SIMPL *program for calculating the factorial of a number. (b)* VM2 *assembler code generated by the compiler from (a).*

(a)

```
PROGRAM factorial;
VAR n:INTEGER;

FUNCTION fact(n:INTEGER):INTEGER;
VAR temp:INTEGER;
BEGIN
     IF n = 0 THEN
          RETURN 1;
     ELSE
          temp := fact(n-1);
          RETURN n*temp;
     END;
END;

BEGIN
     READ(n);
     WRITE(fact(n));
END.
```

(b)

```
     BRANCH factorial
n:   0
fact:
     SETSP     1
     PUSHL     0, 3      ; n
     PUSHC     0
     EQUAL
     BREQL     L1
     PUSHC     1
     FRETURN   1
     BRANCH    L2
L1:
     PUSHL     0, 3      ; n
     PUSHC     1
     SUB
     CALL      fact, 1
     POPL      0, -1     ; temp
     PUSHL     0, 3      ; n
     PUSHL     0, -1     ; temp
     MUL
     FRETURN   1
L2:
     PUSHC     0
     FRETURN   1
factorial:
     RDINT
     POPC      n
     PUSH      n
     CALL      fact, 0
     WRINT
     HALT
```

Listing 2: *(a)* A SIMPL *program illustrating nested routines.*
(b) VM2 *assembler code generated by the compiler from (a).*

(a)

```
PROGRAM P;
VAR a, b:INTEGER;

  PROCEDURE Q;
  VAR b, c:INTEGER;
    PROCEDURE R;
    VAR b, d:INTEGER;

    BEGIN { R }
      b := 3;
      d := 3;
      WRITE('\n','R',':',' ',a,b,c,d);
      IF c > 1 THEN
        c := c-1;
        R;
    END;
    END;

  BEGIN { Q }
    b := 2;
    c := 2;
    R;
    WRITE('\n','Q',':',' ',a,b,c);
  END;

BEGIN {P}
  a := 1;
  b := 1;
  Q;
  WRITE('\n','P',':',' ',a,b,'\n');
END.
```

(b)

```
    BRANCH  P
a:  0
b:  0
R0:
    SETSP   2
    PUSHC   3
    POPL    0, -2  ; b
    PUSHC   3
    POPL    0, -1  ; d
    PUSHC   '

    WRCHAR
    PUSHC   'R
    WRCHAR
    PUSHC   ':
    WRCHAR
    PUSHC   '
    WRCHAR
    PUSH    a
    WRINT
    PUSHL   0, -2  ; b
    WRINT
    PUSHL   1, -1  ; c
    WRINT
    PUSHL   0, -1  ; d
    WRINT
    PUSHL   1, -1  ; c
    PUSHC   1
    GREATER
    BREQL   L1
    PUSHL   1, -1  ; c
    PUSHC   1
    SUB
    POPL    1, -1  ; c
    CALL    R0, 1
L1:
    RETURN  0
Q:
    SETSP   2
    PUSHC   2
    POPL    0, -2  ; b
    PUSHC   2
    POPL    0, -1  ; c
    CALL    R0, 0
    PUSHC   '

    WRCHAR
    PUSHC   'Q
    WRCHAR
    PUSHC   ':
    WRCHAR
    PUSHC   '
    WRCHAR
    PUSH    a
    WRINT
    PUSHL   0, -2  ; b
    WRINT
    PUSHL   0, -1  ; c
    WRINT
    RETURN  0
P:
    PUSHC   1
    POPC    a
    PUSHC   1
    POPC    b
    CALL    Q, 0
    PUSHC   '

    WRCHAR
    PUSHC   'P
    WRCHAR
    PUSHC   ':
    WRCHAR
    PUSHC   '
    WRCHAR
    PUSH    a
    WRINT
    PUSH    b
    WRINT
    PUSHC   '

    WRCHAR
    HALT
```

returns, the storage for the activation record is deallocated.

How are references to arguments and locals handled? Instead of wiring an absolute address into the routine's code, the compiler generates an offset from the current activation record. The offset is added to the address of the current activation record to get the address of the variable being referenced. Since all activation records for a given routine have the same format, a given offset will pick out the same variable regardless of the invocation.

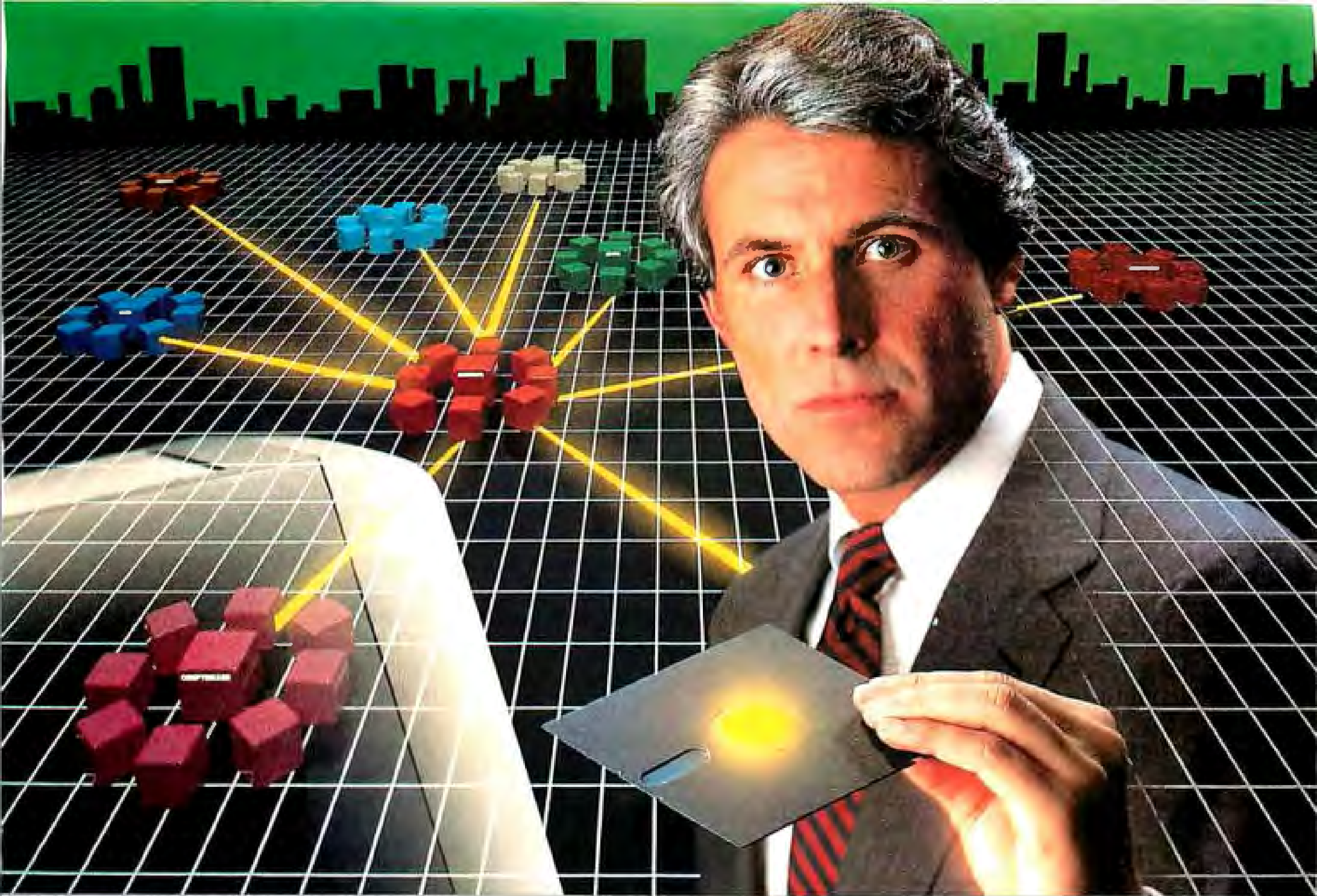
The current activation record is referenced with a new register I have added to the VM2 machine. This register is called the frame pointer (FP). The FP always points to the current activation record. Each time a routine is called, VM2 needs to save the current value of the FP and set the FP to point to the new activation record. It is convenient to save the old FP in the new activation record. When the routine returns, VM2 sets the FP back to the old value. These manipulations ensure that the FP always points to the activation record of the routine currently being executed.

A new activation record must be allocated on each call of a routine, and it should be freed when the routine returns, otherwise *all* the machine's memory would eventually be consumed. Activation records can be allocated on a stack—the same stack VM2 uses for almost everything else it does—and can be freed by simply popping the stack. In fact, another name for an activation record is a stack frame, from which the name "frame pointer" comes. You may recall from my discussion of stacks in "Building a Computer in Software" that pushing and popping involve little more than incrementing and decrementing the stack pointer. You could hardly hope for a more simple and efficient storage-allocation scheme.

Nested Routines

The scheme for compiling routines as outlined so far does not handle

(continued)



The Most Powerful LAN Fits on a Disk.

Network Power. You knew that someday there would be a powerful LAN that didn't need old-technology network boards. It would be fast, easy to install, and run 99% of PC-DOS software. It would be expandable, provide remote access, password-protection, and enable you to use inexpensive terminals as workstations in a PC-DOS environment.

Dream no more, because the power is here.

Its name is LANLink™.

A Software-Driven LAN Powerful Enough To Use RS-232 Ports for Network Communications. In development for over three years, LANLink™ represents the next generation of local area networks. All of the logic which has traditionally resided on network boards is on LANLink's Satellite and Server Diskettes.

No additional hardware is required. Inexpensive serial ports replace "Kilobuck" Network Interface Boards making installation costs one-third that of a board-driven network.

How To Configure a Smart Network...With Dumb Terminals, But Without Dedicated Servers. Boasting a wide variety of configurations, LANLink™ is most often set up as a "Star" having up to eight satellites connected to a central, nondedicated server. Larger networks can have multiple servers, supporting a total of 73 or more network users.

R-LAN™ (Remote-LAN) gives users the ability to interact with a LANLink™ network in real time via modem. Plus, if MultiLink Advanced™ is run on a Satellite, inexpensive dumb terminals can be used to access network disks, files, and programs.

99% of PC-DOS Applications Run In a Totally-Transparent Network Environment. If you know DOS, you already know how to use LANLink™. COPY transfers files among users, and a 2-drive PC Satellite boots 1-2-3 from the Server's hard disk with the entry c:lotus. Each satellite's access can be limited to specific disks, printers, and subdirectories. A wide variety of software including Lotus 1-2-3, dBASE III, and WordStar 2000 is fully compatible. LANLink™ has a collision-free data transfer rate which exceeds 115,000 BPS.

Power Up Your PCs Today. For complete details and the authorized dealer nearest you, call The Software Link TODAY. The LANLink™ Starter Kit is $495 and includes modules for both a Server and a Satellite. For a limited time, 50 feet of shielded RS-232 cable will be included free of charge. Additional Satellite Modules are only $195, each.

LANLink™ is immediately available and comes with a money-back guarantee. VISA, MC, AMEX accepted.

THE SOFTWARE LINK, INC./CANADA 400 Esna Park Drive, Suite 19
Toronto (Markham), Ont./L3R 3K2 CALL: 416/477-5480

LANLink,™ MultiLink Advanced™ & R-LAN™ are trademarks of The Software Link, Inc.

IBM, PC, & PC-DOS are trademarks of IBM Corp. WordStar 2000, dBASE III, and Lotus 1-2-3 are trademarks of MicroPro, Ashton-Tate, and Lotus Development Corp., respectively.

LANLink™

THE SOFTWARE LINK, INC.
Developers of LANLink™ and MultiLink Advanced™

8601 Dunwoody Place, Suite 632, Atlanta, GA 30338 Telex 4996147 SWLINK
CALL: 404/998-0700
Dealer Inquiries Invited

SIMPL's feature of nested routines. Take a look at the SIMPL program in listing 2a, which makes use of nested routines. It illustrates how you can place the definitions of other routines between the local-variable declarations and the body of a routine, just as you can place routines between the global-variable declarations and the main program body. Nesting affects the scope or visibility of identifiers, that is, which identifiers—variables and routine names—are available to different parts of the program. Let us define the lexical level of a point in the program as its depth of nesting. In listing 2a, global variables are declared at lexical level 0, variables local to procedure Q are at lexical level 1, and variables local to procedure R are at lexical level 2. Then, the rules governing scope in SIMPL are easily stated: A routine has available to it all identifiers declared in the routines that enclose it and none of the identifiers declared in routines nested within it. Furthermore, if two identifiers have the same name, the one at the highest lexical level is the one that is visible to a routine.

Running the program in listing 2a results in the following output:

```
R: 1323
R: 1313
Q: 121
P: 11
```

Procedure R, being the innermost procedure, can access the global variable *a*; the variable *c*, which is local to procedure Q; and its own local variables *b* and *d*. R can also call both itself and the procedure in which it is nested, Q (R does not call Q in this example). Q cannot access any of R's variables, but it can access *a* and its own locals, and it can call R. The main program can access only global variables and can call Q. The variable *b* provides an example of how variables with the same name hide, or shadow, one another. Each of the three occurrences of *b* in the program refers to a different variable. The appearances of *b* within R and Q refer to local variables of those procedures and have the values 3 and 2, respectively. The occurrence of *b* in the main program refers to the global variable *b*, and its value is 1.

R's access to *c* causes a problem for the routine-calling scheme I outlined above. If *c* were a global variable, it would be accessible directly by name; if it were local to R, it could be found at some fixed offset from the FP. But *c* is neither local to R nor globally visible from P. I have not indicated how such nonglobal nonlocal variables can be accessed.

Before I proceed to the solution, note that at the time it is accessed by R, the variable *c* must be residing somewhere on the stack because, by the visibility rules discussed above, Q has to be called before R can be; it is only from within the definition of Q that R is visible at all.

You may recall that the activation record for R contains the value of the FP for R's caller. In this case, R's caller is Q, so the old FP is a pointer into Q's activation record. It would seem you need only follow the old FP to get to nonlocal nonglobal variables.

This will not work, however, because other routines besides Q can call R; in particular, R can call itself. In this case, the old FP for the second invocation of R points to the activation

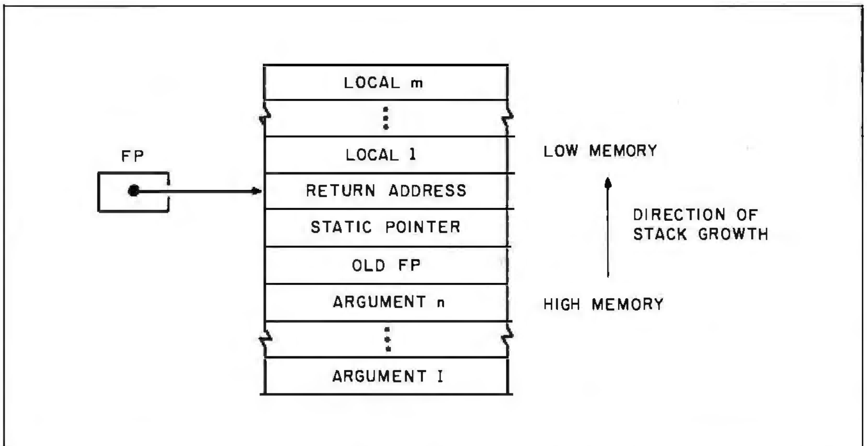


Figure 2: *The structure of an activation record for a routine with n arguments and m local variables.*

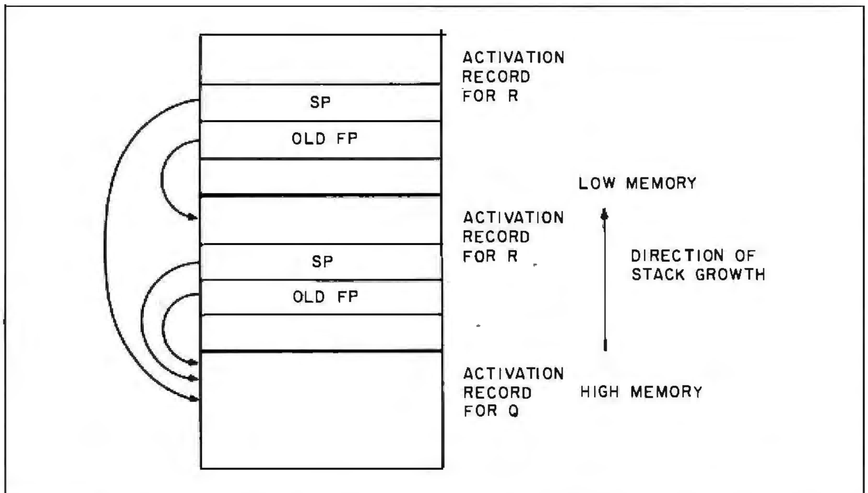


Figure 3: *The structure of the stack when* Q *calls* R *and then* R *calls itself showing the static* (SP) *and dynamic* (FP) *pointers.*

record for the first invocation of R, not to Q's activation record, so following the old FP would not get us to Q, but merely to another copy of R. We would need to follow the chain of frame pointers back twice to get to Q.

STATIC POINTERS

In essence, the problem with following the FPs to find nonlocal nonglobal variables is this: The saved FPs indicate the dynamic structure of the program, its run-time behavior: who calls whom. To find variables, the so-called static structure is needed: who's defined inside whom.

The solution I have adopted is to maintain a static pointer (SP) in each activation record in addition to the value of the caller's FP (sometimes called the dynamic pointer). The SP always points back to the most recent activation record of the routine in which the current routine was defined; for instance, the SP in R's activation record always points to an activation record for Q, regardless of who called R. The activation-record format for a routine with *n* arguments and *m* local variables is shown in figure 2. Figure 3 illustrates the structure of the stack when static and dynamic pointers are used. Note that it is sometimes necessary to follow several static pointers to get to the desired variable. For example, if a procedure S were defined inside R and accessed the variable *c*, the SP in S's activation record would be followed, leading to an activation record for R; then, R's SP would be followed, leading to the desired activation record for Q. The number of static pointers to follow is the difference in lexical levels between the point of call and the callee.

CALLING MECHANISM IN ACTION

Now that all the pieces of the routine-calling scheme have been described, let's put them into place by seeing what happens when the program in listing 2 is executed. You may want to glance at figure 4 during this discussion.

The main program begins by calling Q. First, the current value of the FP is pushed, followed by the SP, and the FP is set to the current value of the stack pointer. Since Q is called from the main program, it is not necessary to save the FP on the stack or to compute the SP, but I do it anyway since it's easier to implement this calling mechanism if a call from the main program isn't treated as a special case. Next, the return address, which can be calculated from the value of the program counter at the time of the call, is pushed onto the stack, and the computer branches to the beginning of Q (see figure 4a).

Q begins by pushing two zeros onto the stack. This serves to allocate a word on the stack for each of Q's local variables and at the same time to initialize those variables to 0. The body of Q begins execution by setting its local variables, *b* and *c*, to 2. Then, R is called by the same mechanism as before: First, the FP is pushed onto the stack, the SP is computed by following the chain of static pointers as many times as the difference in lexical levels between the point of call and R, and the value of the FP for the activation record at that place in the stack is pushed. Since the definition of R is at the same lexical level as the body of Q, no static pointers need be

(continued)

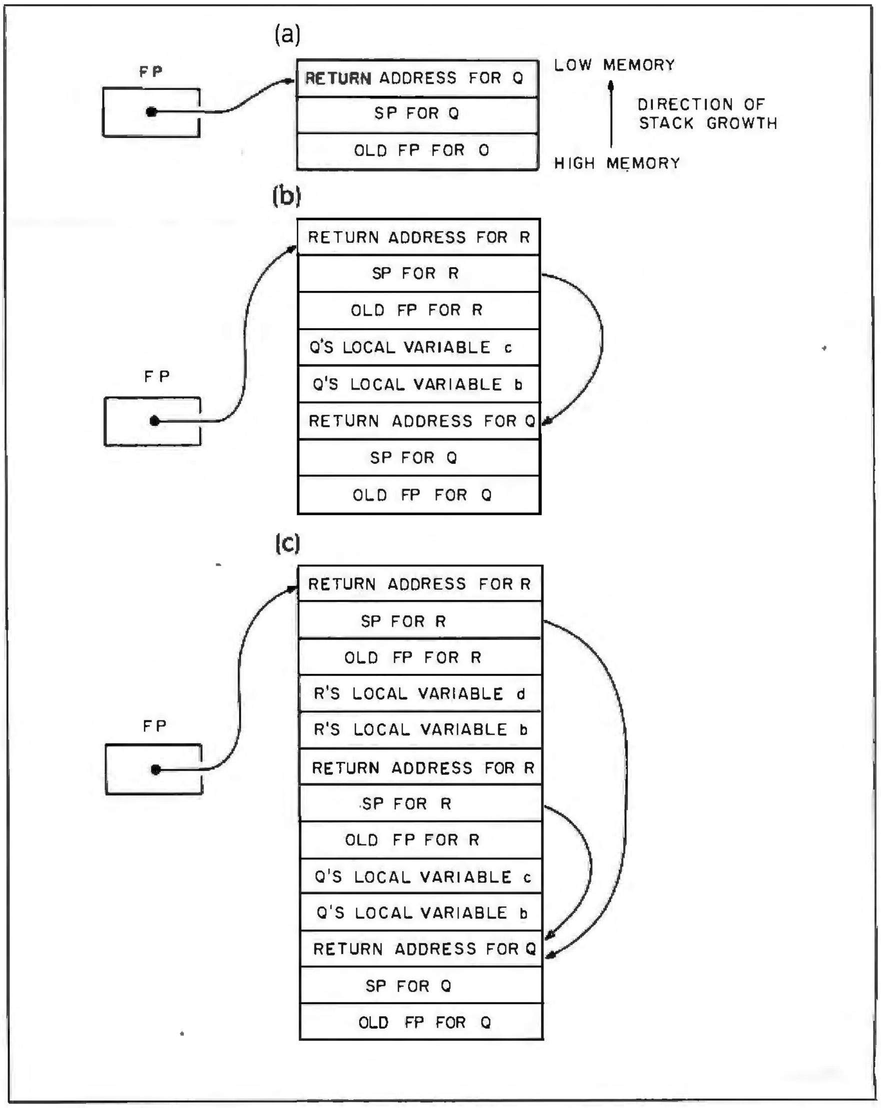


Figure 4: *The run-time behavior of the program in listing 2. See the text for details.*

followed, and the FP value for Q is pushed as the SP for R's activation record. FP is then set to the stack pointer, the return address is pushed, and control transfers to procedure R (see figure 4b).

After pushing and initializing its local variables, R executes its WRITE statement, then tests the value of Q's local variable *c*. Since Q set *c* to 2, the statements within the IF statement are executed. First, *c* is decremented, then R is called recursively. To begin the recursive call on R, the FP is again pushed onto the stack and the new SP calculated. Now, since this activation record for R is one lexical level deeper than R's definition, a single SP is followed; this leads back to Q's activation record, so the FP value for Q is again used as the SP for this second invocation of R. Note that although the activation record for each invocation of R has a different value for the old FP, they have the same value for the SP. Next, the FP is set to the current value of the stack pointer, the return address is pushed, and control transfers to the body of R for the second time (see figure 4c).

In the second invocation of R, R's local variables are pushed onto the stack and then the WRITE statement is again executed. R tests *c*, but this time it is not greater than 1, so the code within the IF statement isn't executed. The return process is the inverse of the call: The stack pointer is set back to where it was before the call, and the FP is restored to its old value. At this point, the stack again looks as it does in figure 4b.

Now that the second invocation of R has returned, the first invocation can also return. (The stack now appears as in figure 4a.) Then, Q executes its WRITE statement and returns, and finally the main program does a WRITE and the program ends.

What I've just described differs in two minor ways from the scheme as I originally presented it. First, although for reasons of conceptual simplicity I described the activation record as being allocated all at once, it in fact is allocated piecemeal, a push at a time: the arguments (although in this example there were none), the FP, the SP, and the return address. Second, it's somewhat more convenient for my purposes to have the FP point to the middle of the activation record instead of to the beginning. This means that some offsets from the FP will be negative and others positive.

SOME NEW INSTRUCTIONS

A compiled program's code would be long and messy indeed if it had to worry about every manipulation of static pointers and activation records. Instead, I'm going to push all this complexity down into the virtual machine, VM2, and hide it behind five new VM2 instructions.

The first and most complicated is CALL, which takes two arguments: the memory address of the beginning of the routine's code and the difference in lexical levels between the caller and callee. It performs all the operations necessary when one routine calls another: saving the return address and FP on the stack, setting the SP, setting the FP register, and branching to the routine. Because CALL is so complex, I have provided the Modula-2 source code for it in listing 3.

The instructions PUSHL and POPL are used to access all but global variables; the "L" is for "local." They each take two arguments: the difference in lexical levels between the variable and the accessing routine and the offset of the variable. Each follows the chain of static pointers a number of times equal to the difference in lexical levels and then uses the offset to access the variable. PUSHL pushes the value of the variable onto the stack; POPL pops the top of the stack into the variable.

(continued)

Listing 3: *The Modula-2 source code for the* SIMPL CALL *statement.*

```
(* CALL takes two arguments, the address to branch to and the difference
   in lexical levels. It does the following things:
   1. Pushes the current FP
   2. Computes and pushes the SP
   3. Pushes the return address
   4. Branches to the address. *)
PROCEDURE call;
BEGIN
    pushWord(framePtr);          (* save current FP *)
        (* use the difference in lexical levels (2nd arg) to set the SP *)
    pushWord(followSP(CARDINAL(memory[programCtr + 1])));
    framePtr := stackPtr;              (* FP will point to return address *)
    pushWord(programCtr + 2);  (* return address *)
    branch;
END call;

(* Follows the static-pointer chain. *)
PROCEDURE followSP(num:CARDINAL):address;
VAR fp:address;
    n:CARDINAL;
BEGIN
    fp := framePtr;
    FOR n := 1 TO num DO
        fp := address(memory[fp + SPoffset]);
    END;
    RETURN fp;
END followSP;

PROCEDURE branch;
BEGIN
    programCtr := address(memory[programCtr]);
END branch;
```

Princeton Graphic Systems Number One Again

Sharp resolution, full compatiblity, and rugged reliability. That's what you get in every Princeton Graphic Systems monitor. That's why Princeton Graphic Systems is number one in the minds of more and more personal computer owners every year.

Only Princeton Graphic Systems offers a complete family of quality personal computer displays. Our color and monochrome monitors outperform the competition every time. That's why, for the second year in a row, our HX-12 high resolution color monitor has been voted best in the world.*

So for the very best in personal computer monitors, pick the company that's number one. Princeton Graphic Systems.

*PC WORLD Magazine's 1985 World Class Survey.

PRINCETON®

GRAPHIC SYSTEMS

AN INTELLIGENT SYSTEMS COMPANY

601 Ewing Street, Bldg. A, Princeton, NJ 08540, (609) 683-1660, Telex: 821402 PGSPRIN, (800) 221-1490 Ext. 704

Two instructions, RETURN and FRETURN, handle returns. Both take one argument, the number of words of actual parameters (arguments) pushed onto the stack by the caller. They need this value to determine where to set the stack pointer. RETURN merely sets the stack pointer to where it was before the call, effectively popping the activation record off the stack. FRETURN (function return) first pops the top of the stack, which should contain the value to be returned by the function, then resets the stack pointer as with RETURN, and finally pushes the returned value back onto the stack.

To get a sense of the code generated by my compiler, you may want to look at listings 1b and 2b; they show the compiler's output for listings 1a and 2a, respectively.

COMPILER ISSUES

Paradoxically, I have spent nearly all the second part of the compiler project describing a mechanism that is implemented in VM2. Of course, the mechanism would have been unnecessary were it not for the peculiar problems that arise in compiling high-level languages with nested procedures and functions. But it is now time to move to the compiler proper.

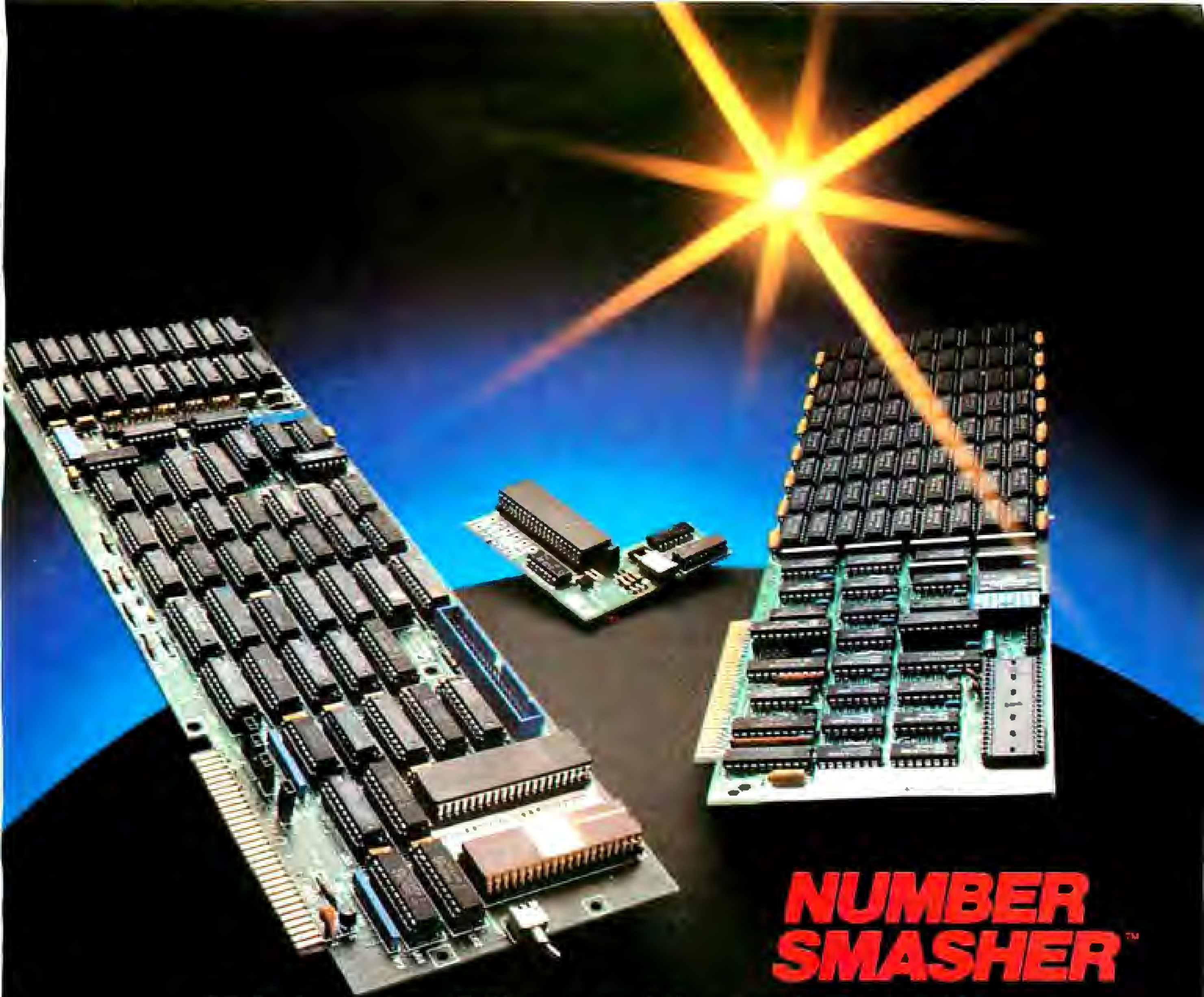
The basic action of the compiler when it sees a routine is as follows: First, the routine name is entered into the symbol table. Then, the list of formal parameters is parsed; each formal parameter is entered separately into the symbol table, and the whole list of formals is attached to the routine's symbol-table entry as well to aid in checking calls to make sure they supply the right number and types of arguments. If the routine is a function, its type is then parsed and placed in the routine's symbol-table entry. Next, the local variables are parsed and entered into the symbol table. The compiler's routine-compiling procedure then calls itself recursively to handle any nested routines.

Finally, the body of the routine is compiled. The compiler first outputs a label, which is the routine's name. Then, the code to place the local variables onto the stack is generated. I do this by outputting a PUSHC 0 instruction for each local; as I said earlier, it has the effects of allocating a word on the stack and initializing the variable to 0. Lastly, the code for the body is generated. In SIMPL, if no RETURN statement is executed in a procedure, that procedure returns after its last statement is executed; to handle this, the compiler needs to generate a RETURN instruction after the code for the procedure. Functions, on the other hand, have to return values explicitly. It should be an error if they don't.

A few things are needed to embellish this basic compiling process. First, the compiler needs to remember the lexical level at which each identifier in the program is defined. It does this by means of a counter, lexicalLevel, which starts at 0, is incremented whenever a routine definition occurs, and is decremented when the compiler has finished compiling a routine. Each time a routine name or variable is defined, the current lexical level is stored with it in its symbol-table record. In order to get the visibility of routine names right, the counter must be incremented just after the routine name is seen but just before the formals are. Formals are treated as being local to the routine in which they occur.

Second, formals and locals need to be given offsets from the FP. If you take a look at the form of an activation record in figure 2, you'll see that the first local variable is one word below where the FP points to, so it should be given an offset of −1. The second local should be given an offset of −2, and so on. Things are a bit more tricky with formals, however. The compiler handles the arguments in a routine call from left to right, pushing the first argument onto the stack first. Hence, the first argument will be farthest from the FP, so it should have the highest offset. To assign offsets to formals, the compiler must read them all in first, count how many there are, then go back through them and assign the offsets. Because

(continued)



Triple your PC speed for only $799!

8087 Upgrades™

MicroWay is the world leader in 8087 support. Our 8087 development software has been in use since 1982. By 1984 we had become Intel's 97th largest OEM account. When you buy from us, you can be confident that you will receive the 8087 chip designed for your PC and that our unique diagnostics will instantly verify that your processor works correctly as installed. Call for current prices.

287Turbo™

This card plugs into the 80287 socket on your AT or COMPAQ, doubling the 80287 clock from 4 to 8 Mhz. It does not change the 80286 clock speed or affect your warranty. The card comes with an 8 Mhz 80287 and has provisions for faster crystals as better 80287s become available. It also has a reset button and circuit that provide a hardware alternative to CNTRL-ALT-DEL.
287Turbo with Diagnostics and Reset **$395**

Number Smasher™

Number Smasher gives you AT speed and 100% compatibility with all PC software and hardware. It comes with a 10 Mhz 8086 and 512K of no wait state RAM. Most are shipped with an optional matched 10 Mhz 8087 and 128K daughterboard. The card runs programs a factor of 2.5 to 4.0 faster than the PC, XT or compatibles it runs in. Other features include FASTROM, a Ram Disk, Print Spooler and Disk Cache. Revision 2 of the Smasher is designed and manufactured by MicroWay in the U.S.A. and has the best service and support of any accelerator card.

MegaPage™

MicroWay's "Lotus/Intel" extended memory card has all the features of the others plus one: it uses low power, cool running CMOS DRAM. Ask for our pamphlet "Extended vs Expanded Memory" and learn why MegaPage is the right card for you.
MegaPage with 2 Megabytes CMOS **$549**

Micro Way

The World Leader in 8087 Support

P.O. Box 79, Kingston, Mass. 02364 USA (617) 746-7341
Tempo House, London, U.K. call 01-223-7662

of the way I've set up the activation record, the last argument—the one closest to where the FP points—will have an offset of 3.

One final consideration is that after the compiler is done with a routine, all identifiers local only to that routine should be removed from the symbol table. This is so that a later part of the program can't possibly succeed in referencing one of these identifiers. I'll now describe how to compile the various constructs that arise in dealing with routines.

Routine Calls

To compile a procedure or function call, the arguments are treated as expressions and each is compiled. When an expression is compiled, code is generated that will result in the value of the expression being left on the stack at run time, so compiling the arguments as expressions is just what the routine-calling mechanism requires. After the arguments are compiled, a CALL instruction is generated with the name of the routine being called and the difference between the lexical level of the called routine and the current lexical level. The compiler also performs several checks: The called routine must be a function if the call occurs in an expression, otherwise it must be a procedure; and the number of arguments and their types must match with the list of formal parameters.

SIMPL RETURN Statement

When the compiler sees a RETURN statement followed by an expression, it checks to make sure it is in the process of compiling a function; if so, it generates code for the expression (which will result in the expression's value being pushed onto the stack at run time) and generates an FRETURN instruction. When the compiler sees a RETURN statement with no following expression, it makes sure it is compiling a procedure, then it generates a VM2 RETURN instruction.

Variable Access

When a variable is used in the code, the compiler looks it up in the symbol table. If it is global, its name is used. If not, a PUSHL or POPL instruction is generated, as appropriate, with the variable's offset and the difference in lexical levels between the current one and the one in which the variable was defined.

Name Management

Two minor problems remain for the compiler, both having to do with managing the names of identifiers. The first one concerns routine name clashes. Say you have two routines, P and Q. Inside P you can define another routine, R, and inside Q you can also define a routine called R. The problem is that you can't use the routine names as labels in the assembly-language program, since then you would have two "R" labels, and that's illegal in my assembler. The easiest solution is to generate a new label for every routine and record the label in the routine's symbol-table entry for use when the routine is called.

(continued)

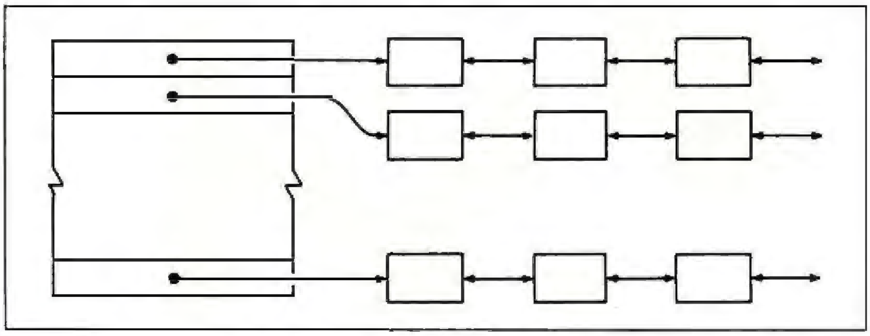
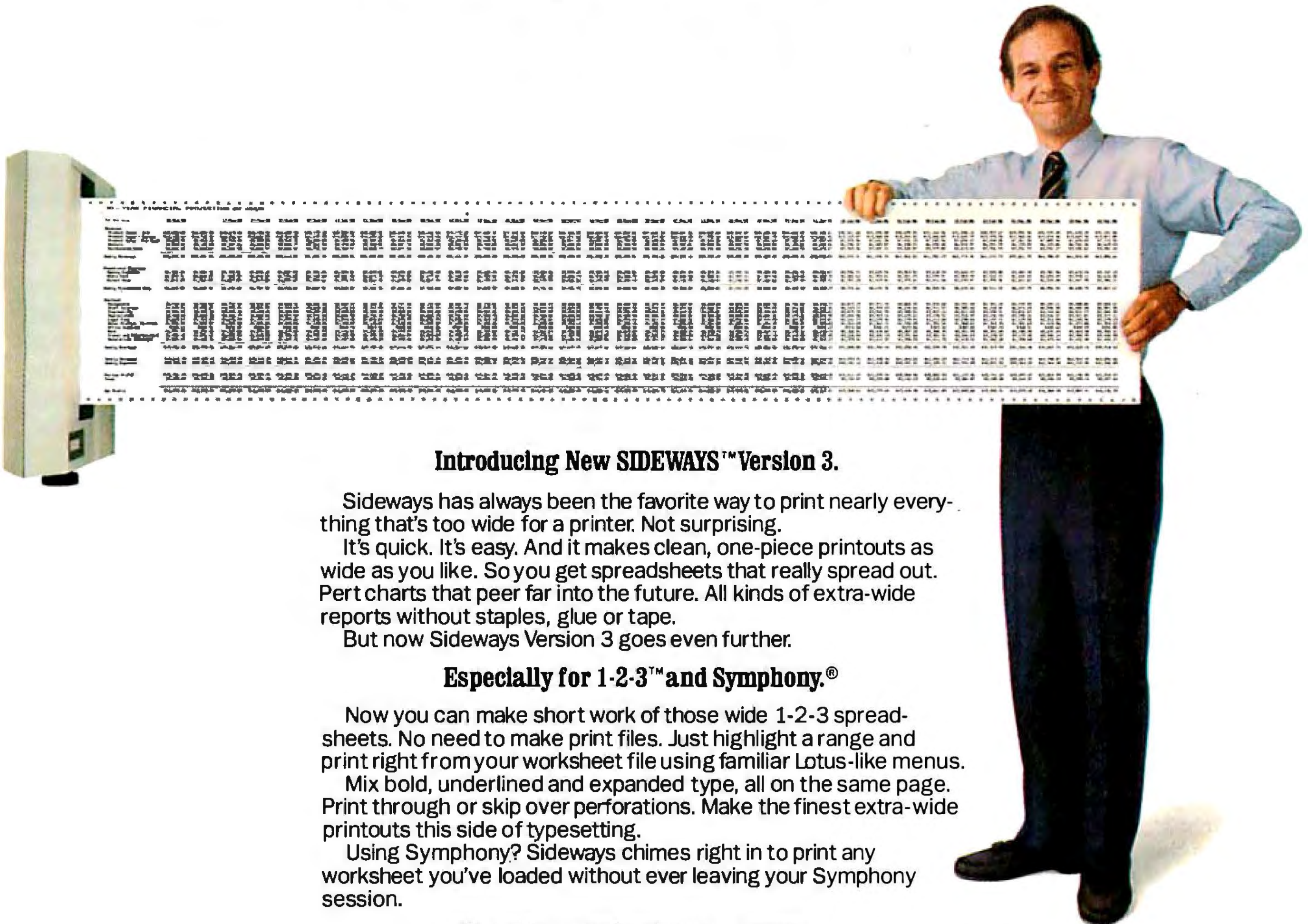


Figure 5: *The structure of the symbol table: an array of pointers to doubly linked lists of symbol-table entries.*

We've gone to great widths to make you look good.



Introducing New SIDEWAYS™ Version 3.

Sideways has always been the favorite way to print nearly everything that's too wide for a printer. Not surprising.

It's quick. It's easy. And it makes clean, one-piece printouts as wide as you like. So you get spreadsheets that really spread out. Pert charts that peer far into the future. All kinds of extra-wide reports without staples, glue or tape.

But now Sideways Version 3 goes even further.

Especially for 1-2-3™ and Symphony.®

Now you can make short work of those wide 1-2-3 spreadsheets. No need to make print files. Just highlight a range and print right from your worksheet file using familiar Lotus-like menus.

Mix bold, underlined and expanded type, all on the same page. Print through or skip over perforations. Make the finest extra-wide printouts this side of typesetting.

Using Symphony? Sideways chimes right in to print any worksheet you've loaded without ever leaving your Symphony session.

No matter what software you use.

Spreadsheets, databases, word processors, project planners. Whatever you use, you'll get more out of new Sideways.

Choose from nine different type sizes, from "minuscule" to "mammoth." Print bold, underlined or expanded – whatever your software can create. Even foreign language and line-drawing characters. Plus, there are so many ways to adjust margins, spacing and page size, it stretches the imagination.

Sideways Version 3 for the IBM® PC and all popular dot-matrix printers. Available now at computer dealers nationwide. Or directly from Funk Software with your check, Visa or Mastercard.

At just $69.95 a copy, you'll never want for width again.

Special upgrade offer!

Just send $20 along with your current Sideways program disk and manual directly to Funk Software. We'll send you Version 3 right away.

Funk Software, 222 Third Street, Cambridge, MA 02142. Phone (617) 497-6339.

The second problem concerns the process of looking up an identifier in the symbol table. Recall that the second scoping rule states that when an identifier that is declared in a nested routine is also declared inside the routine in which it is nested, the innermost identifier shadows the other. So the *b* referred to by procedure R in listing 2a is the variable local to R, not the ones local to Q or P. How can we implement the identifier lookup routine so that this scoping rule is enforced?

The obvious solution is to examine all the identifiers with the same name and choose the one defined at the highest lexical level. This solution will work, but a simpler one suggests itself if you notice that identifiers in lower lexical levels are declared before those in higher ones. That is, as the compiler reads the program from top to bottom, it will first install global variables into the symbol table, then variables at lexical level 1, and so on. If the symbol table were merely a list of entries, and if new tries were inserted at the beginning of the list, the lookup routine could simply take the first identifier whose name matched the one being looked up; since that identifier was the most recently inserted of all those with the same name, it must have been defined at the highest lexical level.

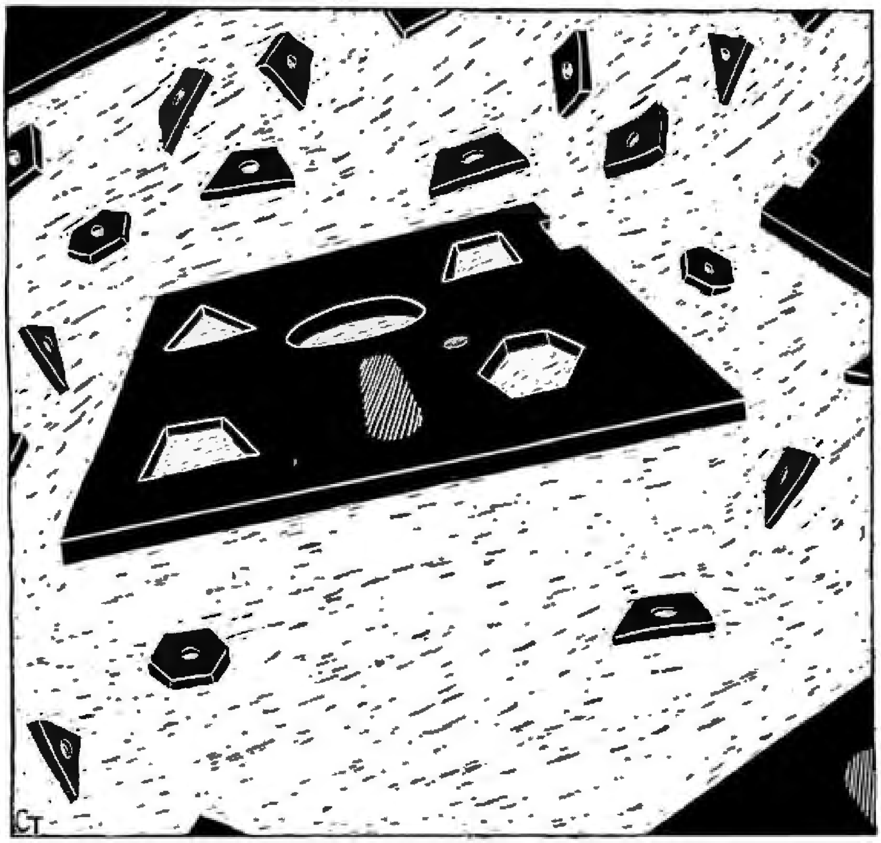
In practice, though, a single list is too inefficient a representation for a symbol table—the lookup time is proportional to the length of the list, and if there are many identifiers, the list will be long. It would be great if the symbol table could combine the efficiency of a hash table with the nice lookup property of a list. That's possible if each element of the hash table, instead of containing a single symbol entry, contains a pointer to a list of entries. Instead of one long list, the symbol table consists of an array of shorter lists; and since identical strings hash to the same location in the array, all the identifiers with the same name will be on the same list. The lookup routine hashes the name of the identifier it is searching for, indexes the array to find the appropriate list, and searches the list in order, taking the first match it finds. To facilitate the removal of entries, the list is doubly linked. The structure of the symbol table is illustrated in figure 5.

CONCLUSION

The Modula-2 source code for my SIMPL compiler, including the code to handle routines, along with the VM2 assembler and VM2 monitor, are available for downloading from BYTEnet Listings. The telephone number is (617) 861-9764. In part 3 next month, I'll extend the compiler by adding some useful features like arrays. ■

BY NAMIR CLEMENT SHAMMAS

CREATING REUSABLE MODULES



Capsule editors quickly customize modules in Modula-2

The advent of Modula-2 marked another step in the evolution of structured programming languages. Modula-2 evolved from Pascal and addresses some programming aspects more effectively than its predecessor. Most important is its ability to create separate modules that are procedure libraries. These libraries perform many related tasks. The concept of modules stresses the ability to tackle a big software project and apply (reuse) the same code in future programs. This cuts down on software development time, cost, and debugging. This article discusses module reusability—its limitations and remedies.

To reuse code, you must write procedures and modules that have some degree of freedom from the rest of the program. These modules carry out specific tasks while interchanging data with other parts of the program via global variables, call arguments, and data files. Modula-2, however, imposes some restrictions to prevent this freedom from turning chaotic.

Modula-2 requires that any variables passed to procedures be of the exact same *type* (i.e., you can't mix apples and oranges), and it allows no generic types. The language relaxes this somewhat for procedure calls for arrays. You can declare an open array without specifying its bound limits, which means that procedures can accept arrays of different sizes but not of different basic types. For example, you can have a procedure like this:

```
PROCEDURE SendString
(Name : ARRAY OF CHAR);
```

Notice that the variable Name is a character array whose dimensions are determined when the program calls the procedure SendString. Thus,

(continued)

Namir Clement Shammas (4814 Mill Park Court, Glen Allen, VA 23060) is a freelance writer and programmer. He is also a contributing editor to Computer Language *magazine.*

SendString can accept arrays of any size as long as they have the basic type CHAR and are one-dimensional. Hopefully, future language updates will expand the open-array feature. By comparison, the Ada language allows generic types but has stricter type checking. The C language, on the other hand, shows little or no type checking and allows the programmer a great deal of freedom—and responsibility.

Remedies for some of these limitations are available in the following programming strategy:

1. Write an incomplete program skeleton that constitutes the major portion of a procedure, function, or module. This *capsule* should include as much general code as possible.
2. Write another program, a *capsule editor*, that customizes the capsule and adds the last details by interacting with the user for the required information.

```
Enter the output filename ? c:sort1.tst
Enter new procedure name ? ZipSort
Enter record type name ? Mail
Is the sort based on one field ? Yes
Enter fieldname ? ZipCode
```

Figure 1: *The display from running* EditSort *for a single sort key.*

```
Enter the output filename ? c:sort2.tst
Enter new procedure name ? MailSort
Enter record type name ? Mail
Is the sort based on one field ? No
Enter number of fields used ? 3
Enter name for subkey # 1 ? ZipCode
Enter name for subkey # 2 ? State
Enter name for subkey # 3 ? Name
```

Figure 2: *The display from running* EditSort *for multiple sort keys.*

The resulting code produced by the capsule editor is correct and complete.

Capsule editors are entire programs that perform text editing, insertion, and addition on the code in the capsules. You can think of them as advanced processors that offer flexibility *before* you invoke the compiler. It is normal to have one capsule altered by one editor. However, you can have several capsule editors work on the same capsule (or the reverse), and you need not write the capsules and their editors in the same language.

The advantages of using capsule editors are

- easier and faster means of producing custom programs
- lower software development cost

(continued)

- increased reliability, and
- the ability to produce custom programs when the original software author is unavailable.

A DEMONSTRATION

This demonstration deals with a sort algorithm. I used Logitech's Modula-2/86 compiler, version 0.3c, which does not have floating-point implementation but does have reliable file I/O (input/output) operations. I used an IBM PC XT to test the program with all files located on drive C, the hard disk. The compiler did not have a string-manipulation library so I used Strlib1, a module I developed earlier. Reference 1 contains the code for this entire module.

The example is a capsule for the recursive QuickSort algorithm. [*Editor's note: Listings for* QUIKSORT.MD2 *and* EDITSORT.MD2 *can be downloaded from* BYTE*net listings at* (617) 861-9764.] This capsule is a procedure written with the following assumptions and remarks:

1. The data records to be sorted are of a dummy type called Item. The capsule editor changes this to match the desired custom record type.
2. The original capsule has one single dummy sort called key, which the capsule editor alters according to your input.
3. You can only sort on alphanumeric data fields (keys).
4. If you use a field as a sort key, you must use the entire field.

The capsule editor for the QuickSort capsule is the module EditSort. It performs the following functions:

- prompts for the output filename
- prompts for the output procedure name
- asks for the record type name that you intend to use throughout your program, and
- asks for the sort keys. (Based on the number of keys involved, the capsule editor decides how to edit QuickSort. The following two cases explain how this works.)

If you want to sort a mailing list, you could call your record type, Mail, and

(continued)

Listing 1: *The output code generated by running the* EditSort *capsule editor on the* QuickSort *capsule with a single sort key.*

```
PROCEDURE ZipSort( A : ARRAY OF Mail ; N : CARDINAL );

PROCEDURE Compare ( S1, S2 : ARRAY OF CHAR): BOOLEAN;
(* Compare two strings of the same maximum length.*)

CONST eos = 0C; (* end of string *)

VAR Less, Stop : BOOLEAN;
    i : CARDINAL;

BEGIN
    Less := FALSE;
    Stop := FALSE;
    i := 0;
    WHILE (i <= HIGH(S1)) AND (Less = FALSE) AND (Stop = FALSE) DO
        IF (S1[i] <> eos) AND (S2[i] <> eos)
          THEN (* Proceed in comparison *)
            IF (S1[i] < S2[i]) THEN Less := TRUE ELSE INC(i) END;
          ELSE Stop := TRUE (* Reached the end of string*)
        END;
    END;
    RETURN Less;
END Compare;

PROCEDURE Sort( L, R : CARDINAL);

VAR i, j : CARDINAL;
    X, W : Mail;

BEGIN
    X := A[(L+R) DIV 2];
    REPEAT
        WHILE Compare(A[i].ZipCode,X.ZipCode) DO INC(i) END;
        WHILE Compare(X.ZipCode,A[i].ZipCode) DO DEC(j) END;
        IF i <= j THEN
            W = A[i] := A[i] ; A[i] := A[j] ; A[j] := W ;
            INC(i) ; DEC(j)
        END;
    UNTIL i > j ;
    IF L < j THEN Sort(L,j) END;
    IF i < R THEN Sort(i,R) END;
END Sort;

BEGIN

    Sort(1,N)

END ZipSort;
```

A CROSSTALK® XVI Klone FOR $49.95

The Closer You Look, the Better We Look!

MIRROR is the mirror image of Crosstalk XVI, the industry standard in data communications software for small business computers. MIRROR's design closely reflects Crosstalk XVI's menus, commands and features. In fact, if you have used Crosstalk XVI before, you will feel right at home with MIRROR. The one thing you will not find reflected in MIRROR is Crosstalk XVI's $195.00 price. Because we control the reflection, MIRROR costs only $49.95.

If you are new to data communications, it makes sense to go with the industry standard in data communications software, but why pay the industry standard price. MIRROR lets you have the industry standard at 1/4 the price. If you or your company have already standardized on Crosstalk XVI, then consider MIRROR for future purchases and upgrades, you'll realize significant savings, without sacrificing on quality, standardization or features.

MIRROR even gives you features that Crosstalk XVI doesn't provide, such as background operation which lets MIRROR handle your communications while you are using other productivity packages. MIRROR includes a built-in Wordstar-like text editor, and many file transfer protocols such as: XMODEM, XMODEM MULTI-FILE, KERMIT, HAYES and of course, CROSSTALK.

With SoftKlone's 60-Day money back guarantee, you can't lose. Pick-up the phone and dial our toll-free number, or fill-out the coupon. EITHER WAY, DO-IT-TODAY!

MIRROR™

SOFTKLONE™ DISTRIBUTING CORP.
The Age of KloneWare Has Arrived

To Order Call Toll-Free:

VISA | master card | COD

1210 East Park Avenue
Tallahassee, Florida 32301

National:
1-800-538-8157
Ext. 848

California:
1-800-672-3470
Ext. 848

For Information Call: 1-904-878-8564

Site-Licensing Available

Yes, Please send me ________ copy(ies) of **MIRROR** at $49.95 plus $5.00 postage/handling ($8.00 for COD orders) ea.

MIRROR is available for the IBM PC/XT/AT and compatibles.

Payment Method:

[ ] VISA [ ] MC [ ] COD [ ] Check/Money Order

Credit Card #: ____________________

Card Expiration Date: ______ / ______

Sub-Total ____________

(Fl residents must add 6% sales tax) ____________

Shipping/Handling ____________

Amount Enclosed: ____________

Purchase Order and site license inquiries please call (904) 878-8564.

NOT COPY PROTECTED!

Name: ____________________

Shipping Address: ____________________

City: ____________ State: ____________

Zip Code: ____________ Telephone #: ____________

Signature: ____________________

Mail Coupon To: SoftKlone, 1210 East Park Avenue, Tallahassee, Florida 32301

Listing 2: *The output code generated by running the* EditSort *capsule editor on the* QuickSort *capsule with multiple sort keys.*

```
PROCEDURE MailSort( A : ARRAY OF Mail ; N : CARDINAL );

PROCEDURE Compare ( R1, R2 : Mail): BOOLEAN;
(* Compare two strings of the same maximum lengths.*)

CONST eos = 0C; (* end of string *)

VAR Less, Stop : BOOLEAN;
     i : CARDINAL;
     S1, S2 : ARRAY [1..YourMaxString] OF CHAR;

BEGIN
     Less := FALSE;
     Stop := FALSE;
     i := 0;
     StringIs(S1,R1.ZipCode) ; StringIs(S2,R2.ZipCode) ;
     StringAdd(S1,R1.State) ; StringAdd(S2,R2.State) ;
     StringAdd(S1,R1.Name) ; StringAdd(S2,R2.Name) ;
     WHILE (i <= HIGH(S1)) AND (Less = FALSE) AND (Stop = FALSE) DO
          IF (S1[i] <> eos) AND (S2[i] <> eos)
            THEN (* Proceed in comparison *)
               IF (S1[i] < S2[i]) THEN Less := TRUE ELSE INC(i) END;
            ELSE Stop := TRUE (* Reached the end of string*)
          END;
     END;
     RETURN Less;
END Compare;

PROCEDURE Sort( L, R : CARDINAL);

VAR i, j : CARDINAL;
     X, W : Mail;

BEGIN
     X := A[(L+R) DIV 2];
     REPEAT
          WHILE Compare(A[i],X) DO INC(i) END;
          WHILE Compare(X,A[i]) DO DEC(j) END;
          IF i <= j THEN
             W = A[i] := A[i] ; A[i] := A[j] ; A[j] := W ;
             INC(i) ; DEC(j)
          END;
     UNTIL i > j ;
     IF L < j THEN Sort(L,j) END;
     IF i < R THEN Sort(i,R) END;
END Sort;

BEGIN

     Sort(1,N)

END MailSort;
```

declare it as

```
TYPE Mail = RECORD
    Name : ARRAY [1..30] OF CHAR;
 Address : ARRAY [1..30] OF CHAR;
    City : ARRAY [1..20] OF CHAR;
   State : ARRAY [1..2] OF CHAR;
 ZipCode : ARRAY [1..9] OF CHAR
END;
```

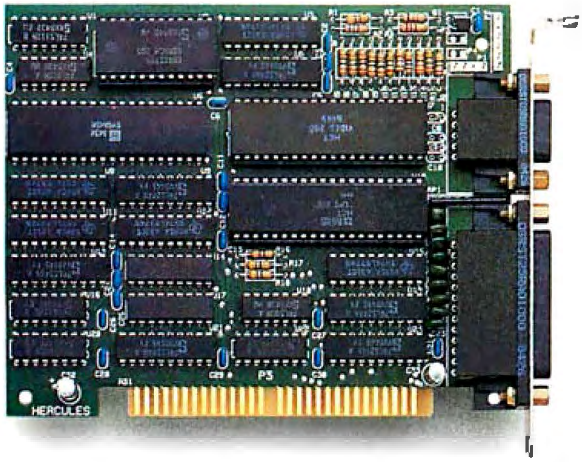
In the first case, you want to sort by zip code only. Create a new procedure named ZipSort, and store it in file c:sort1.tst. Figure 1 shows the display for this case and listing 1 shows the output file. If you compare it with the original capsule, you will see that the capsule editor alters only the procedure name, the record type name, and the sort key according to your input. *It adds no program lines!*

In the second case, you want to sort by three fields (zip code, state, and name). Call the new procedure MailSort, and save it in file c:sort2.tst. Figure 2 shows the display and listing 2 shows the output file. In this case, the action exceeds mere renaming. The capsule editor alters the argument calls of the procedure Compare; it takes records of type Mail instead of strings as arguments; it declares strings previously passed as local variables; and it adds enough code lines to build the sort strings. The capsule editor even alters the use of Compare in the procedure Sort, and it eliminates dummy key components altogether.

The strategy of using capsules provides you with a new kind of software tool. When applied to supercomputers, these tools create a new class of programmers. Modula-2 capsules offer an alternative to changing the code prior to compilation, one that allows modules to be quickly customized. ■

REFERENCES

1. Shammas, N., "Modula-2: No Strings Attached," *Journal of Pascal and Ada*, March/April 1984.
2. Wiener, R., "Generic Sorting in Modula-2," *Journal of Pascal and Ada*, January/February 1984.
3. Wirth, N., *Algorithms + Data Structures = Programs*. Englewood Cliffs, NJ: Prentice-Hall, 1976.

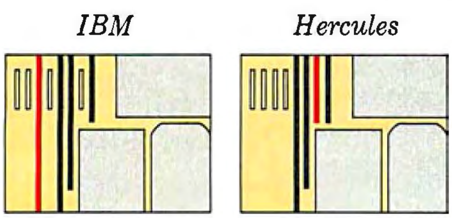


Why the Hercules Color Card is better for your XT than IBM's.

Did you know that there's a color graphics card specially designed for the XT™? It's called the Hercules™ Color Card. We think that it's better for your XT than the IBM® Color Graphics Adapter. Here's why.

The XT comes with an empty short slot. IBM's card is too long to fit in it, so you're forced to sacrifice a valuable long slot, while your XT's short slot goes unused.

The Hercules Color Card is designed to fit in this short slot. It's the smartest way to maximize the usable slots in an XT and provide for your future expansion needs.

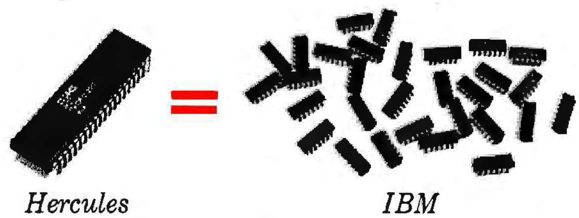


Notice how much more efficiently Hercules makes use of the XT's slots.

Our efficient use of an XT's slots is not the only reason to buy a Hercules Color Card instead of IBM's. We give you a parallel printer port at no extra cost. (IBM charges extra and takes up another slot.)

A lot of people wonder how Hercules can do everything that IBM can in a card less than half the size. We do it by designing our own graphics microchips. Just one of our chips packs the punch of dozens of IBM's, reducing by more than 50% the number of components that can fail.

And we'll do just about anything to make our products the most reliable you can buy.



Of course, you *will* have to give up something when you buy a Hercules Color Card. You'll have to give up software incompatibility. With Hercules, there is none. Every program that runs on the IBM color card will run on the Hercules Color Card.

You'll have to give up IBM's ninety day warranty. Ours is two years.

And you'll have to give up a dollar. The Hercules Color Card is $245—IBM's is $244.

Look into the Hercules Color Card for the XT, PC or AT™ Find out why the readers of *PC World* voted the Hercules Color Card 1985's best color graphics card—ahead of IBM's. Call **1 800 532-0600 Ext. 432** for the name of the dealer nearest you and we'll rush you our free info kit.

Inquiry 155

Hercules.

We're strong on graphics.

Address: 2550 Ninth St., Berkeley, CA 94710 Ph: 415 540-6000 Telex: 754063 **Trademarks/Owners:** Hercules/Hercules Computer Technology; IBM, XT, AT/IBM. Printer cable offer expires February 28, 1986. Good only in U.S.A., offer subject to change without notice.

Here there be Wizards.℠

In the distant past, stories were told of a breed of mysterious and powerful beings; beings that could weave magical spells, conjure spirits from the vasty deep, and calm the raging elements with subtle movements of the hand. They were called Wizards — the keepers of rare and special knowledge.

Today, they work their craft still: invoking daemons, executing spells, and controlling the very source of their environment. No magic, but wizardry nonetheless; the kind of wizardry without which much of today's world would simply cease to function.

These modern-day Wizards are masters of systems software for computer networks, switching systems, and operating systems such as UNIX and UTS on machines ranging from the largest mainframe to the smallest microcomputer. In many ways they hold the keys to the principles that control a society which is now dependent on this powerful software. At Lachman Associates, Inc., we understand the unique position of talented UNIX professionals because that is what we are. With over 100 full-time consultants, we advise on and direct sophisticated projects for some of the largest companies in the world. Our projects include multi-processor and high reliability operating system evaluation and development; networking with X.25 and Ethernet; tools such as compilers, interactive graphics, and device drivers; as well as training, product analysis, and documentation.

So be advised, Wizards do exist. In fact, perhaps you are one.

Equal Opportunity Employer
Resumes accepted in confidence

LACHMAN

Lachman Associates, Inc. *the UNIX people*™

Corporate Offices
645 Blackhawk Drive • Westmont, IL 60559
312 986 8840

Chicago Columbus
Denver New Jersey

EASY 3-D GRAPHICS

BY HENNING MITTELBACH

A BASIC *program for plotting* 3-D *surfaces*

AFTER READING "Budget 3-D Graphics" by Tom Clune (March 1985 BYTE, page 240), I decided to develop a low-cost program for three-dimensional graphics on small computers. [*Editor's note: Versions of the program for the IBM PC, Macintosh, and Apple II/IIe are available for downloading via BYTEnet Listings. The telephone number is (617) 861-9764. More information on downloading to your particular machine can be found at the end of the article.*]

The program is based upon the formulas for an axonometric projection in relation to the origin, as shown:

XB = X*COS(PHI) − Y*COS(PSI)
YB = X*SIN(PHI) − Y*SIN(PSI) + Z

Depending on the graphic window of the computer used, you may change these formulas to

XB = X0 + X*COS(PHI) − Y*COS(PSI)
YB = Y0 − X*SIN(PHI) − Y*SIN(PSI) − Z

where X0 and Y0 will represent the origin of the axes, as shown in figure 1. (I developed the program on an Apple II, with X0 = 110 and Y0 = 180.) Also in figure 1, (XB,YB) is the point to be plotted, and PHI and PSI are the angles referring to the horizon. The function Z = F(X,Y), in line 200 of the program, needs a scaling factor F (line 210) that the user has to introduce in the program.

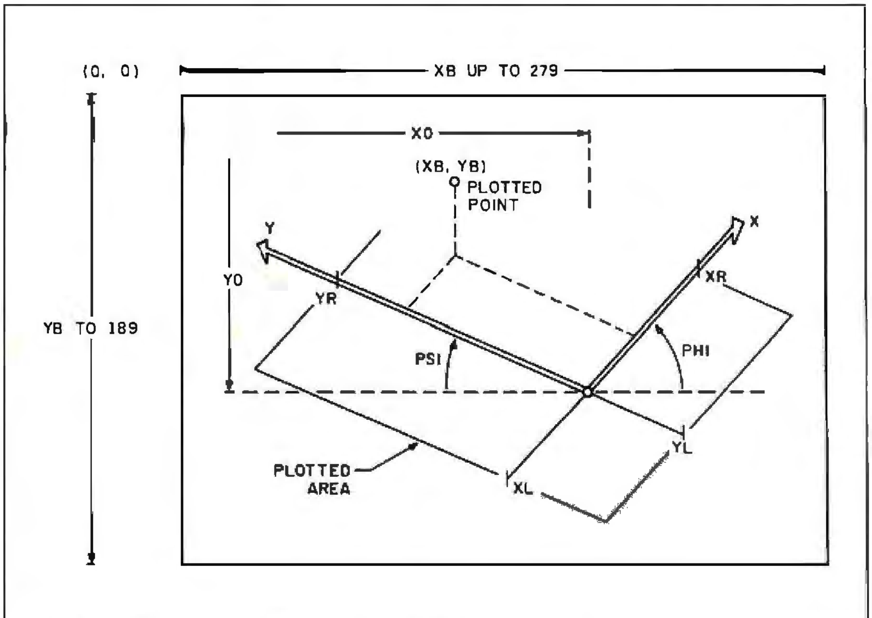


Figure 1: *The graphic window, shown here for the Apple II, on which the 3-D graphics program was developed.*

THE PROGRAM

The program starts at lines 100 to 180 where you set the parameters X0, Y0,

(continued)

Henning Mittelbach (FH München, Lothstrasse, D8000 München, West Germany) is professor of mathematics at Fachhochschule München.

PHI, PSI, XL, XR, YL, YR, and D. Changing parameters gives you variety. It is important that XL be less than XR and YL be less than YR, though these values may be either positive or negative.

The parameter D gives the distance between the coordinate lines to be plotted. The program sets D = 5, although you can make D smaller (for a more detailed graph) or larger (for a coarser graph that takes less time to plot). You should be sure, however, that the differences XR – XL and YR – YL are multiples of D, or the graphic will have no contour.

Line 200 contains the function to be plotted. Figure 2, for example, shows the plot of the program with the function

FN Y(X) = SIN (Y/F) * (X – Y) * (X – Y)/150

The parameter F, in line 210, stretches the X and Y directions in the argument of Y(X), as does the divisor 150 in line 200.

After fitting some abbreviations to accelerate the plotting (which can take several minutes), line 260 sets an upper limit for FN(X). Later, in lines 1040 and 2040, the program cuts those values of F(X) that would fall above the top of the window.

Line 270 asks whether you want to see the graph with two sets of coordinate lines, as in figure 2, or with one set of coordinate lines (which takes less time). Depending on your response, the program goes to subroutines at line 1000 or 2000.

Lines 300 to 330 ask if you wish to see the axes or not, and will draw them if you do, while line 350 draws a frame for the graph.

Next, an array H is set to the lower border of the window. Later, a part of this array will be plotted to get the hidden lines.

The program continues with line 1000. First the mask (array H) is raised to the front line of X. Later, the Y-coordinate lines can only be plotted if they are above this border. Thus, in line 1060

IF YB < H(XB) THEN H(XB) = YB

a small value for XB will be corrected up.

Line 1120 starts the first Y-coordinate line with the smallest Y value, Y = YL. The inner loop Y com-

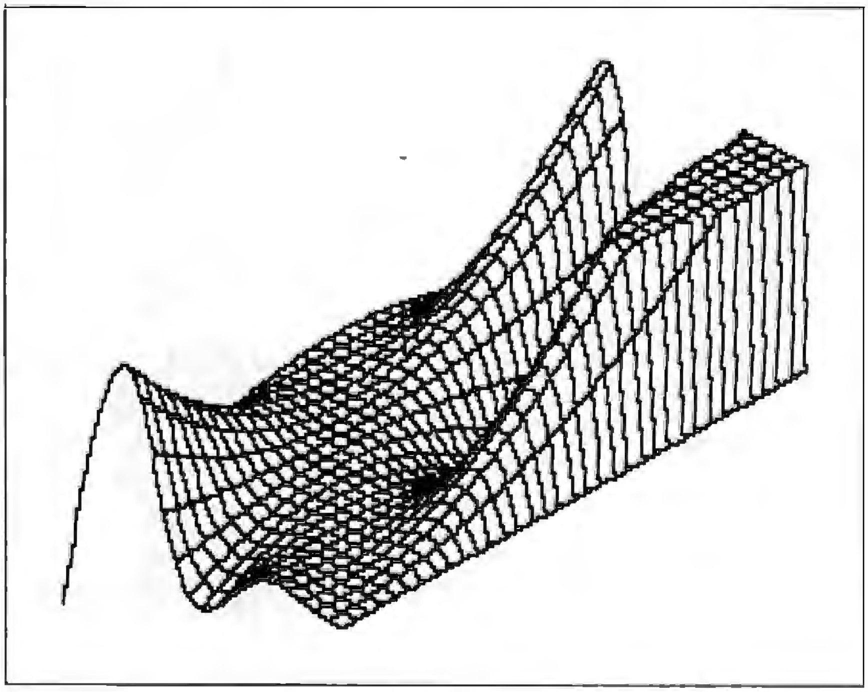


Figure 2: *The 3-D plot of the function* FN Y(X) = SIN(Y/F)*(X – Y)*(X – Y)/150.

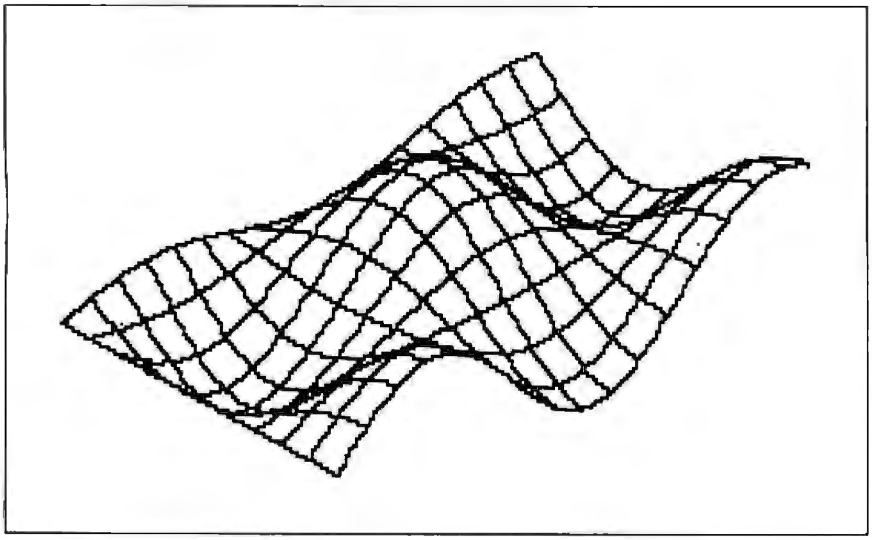


Figure 3: *The 3-D plot of the function* FN Y(X) = 20*SIN(X/F)*COS(Y/F).

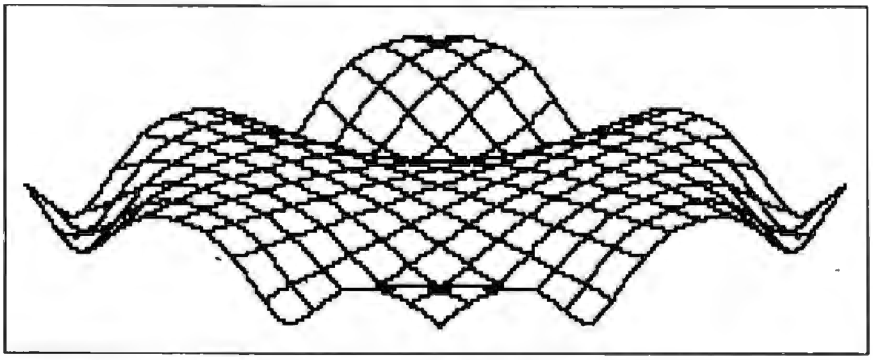


Figure 4: *The 3-D plot of the function* FN Y(X) = −8*EXP(SIN(X*Y/F/F)).

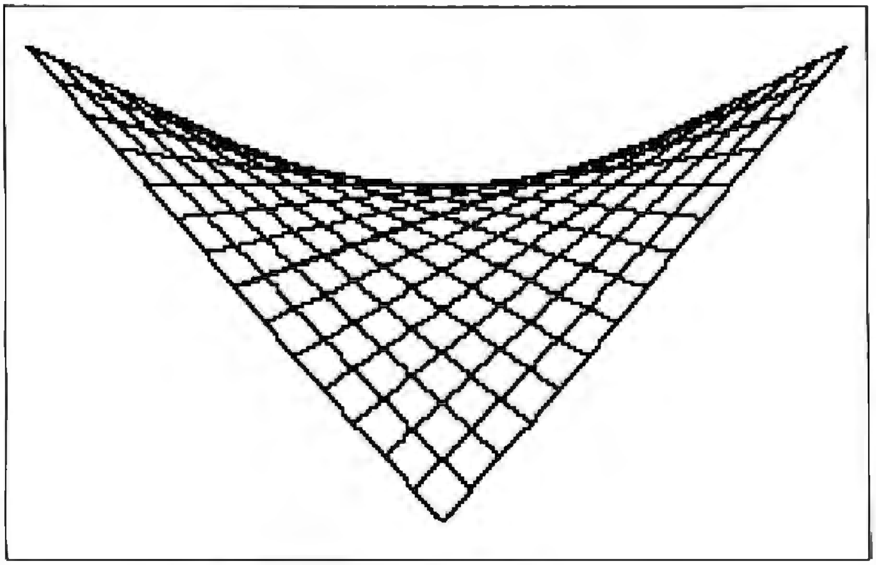


Figure 5: *The 3-D plot of the function* FN Y(X) = −X*Y/F/F.

putes all points with fixed X (first X=XL) and then, after setting the mask on this line, plots the line (lines 1200 to 1220 of the program).

Lines 2000 to 2240 are an exact copy of lines 1000 to 1240 and are called if you choose the cross-hatching option at the beginning of the program run.

A number of examples follow. Figure 2, the 3-D graphic that comes with the program, uses the parameters

XO = 110
YO = 180
PHI = 0.5
PSI = 0.4
XL = 0
YL = 0
XR = 170
YR = 100
D = 5
FN Y(X) = SIN (Y/F) * (X−Y) * (X−Y)/150
F = 10

Figure 3 uses similar parameters, except that D=10, F=20 and the function

FN Y(X) = 20 * SIN(X/F) * COS (Y/F)

was substituted on line 200. The parameters

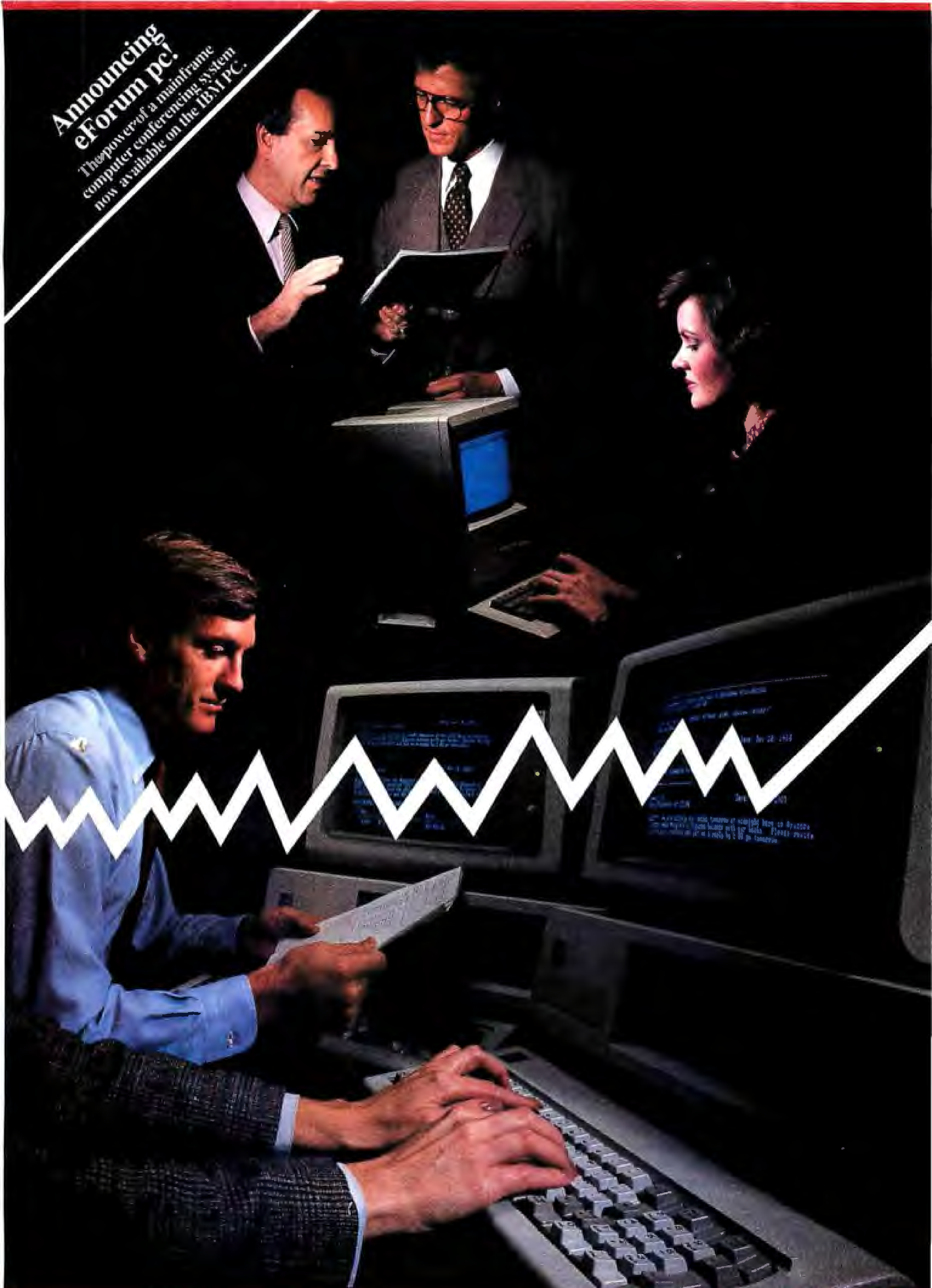
XO = 140
YO = 100
PHI = 0.3
PSI = 0.3
XL = −70
YL = −70
XR = 70
YR = 70
D = 10
FN Y(X) = −8 * EXP (SIN(X*Y/F/F))
F = 28

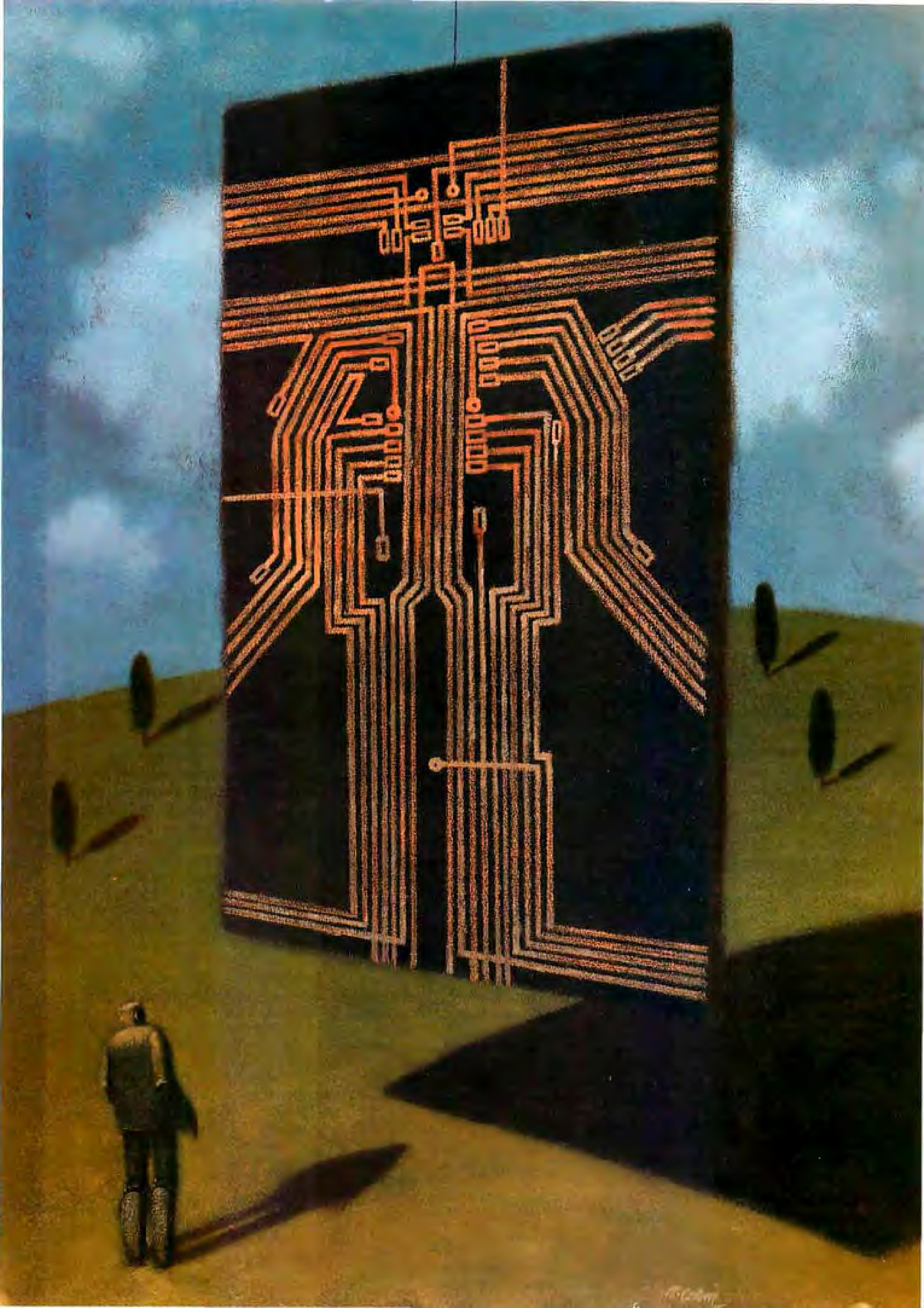
produce figure 4. Changing the function on line 200 to

FN Y(X) = −X*Y/F/F

and setting F=10 produces the plot shown in figure 5. ■

The program for easy 3-D graphics is available as PCGRAF.BAS *for the* IBM *Personal Computer,* MACGRAF.BAS *for the Apple Macintosh, and* APPLGRAF.BAS *for the Apple* II *family* (DOS 3.3). *You will need* BASIC *for whichever system you choose.*


Announcing
eForum pc!
The power of a mainframe
computer conferencing system
now available on the IBM PC.



Robotics

I TEND TO THINK of servo- and stepper-motor control, data acquisition with sensors, and the like as mature technologies. So when I began to research this theme, the foremost questions in my mind were, What makes robotics so hard? Why is it taking so long to develop this technology? This month's theme authors provide clear explanations of what some of the major problems are and indicate some of the new research developments that are finally bringing robotics to maturity.

One set of robotics problems involves sensors. We begin our theme with two pieces on this topic, one on vision and the other on touch. It is generally agreed that these two are necessary (and possibly sufficient) for most autonomous robotic functions.

First, Phil Dunbar presents a discussion of the problems of current camera systems for robotic vision. He includes an overview of some of the more interesting cameras available for machine vision.

Next, Kirk Pennywitt looks at directions in research on touch sensors. Those who think of mechanical touch as synonymous with pressure transducers will be surprised to learn how complex this subject really is.

Motion is central to the idea of robotics. We have two pieces that discuss some of the issues associated with machine motion. J. Scott Hawker, R. N. Nagel, Richard Roberts, and Nicholas G. Odrey discuss coordination of two arms in performing a task. Research on this topic is just beginning, so the focus of the piece is more on problems to be addressed than answers that have been devised. Charles Jorgensen, William Hamel, and Charles Weisbin consider the levels of complexity of robotic navigation. They use a delightful analogy to Magellan, Columbus, and Ulysses to clarify the issues involved in machine exploration.

The problems of robotic navigation are primarily concerned with artificial intelligence, as is our next piece. Clara and John Cuadrado discuss artificial intelligence in machine vision. Their article explains such AI concepts as frames, inheritance, and demons so clearly that I finally understand what these terms mean.

Finally, Gary W. Kramer and Philip L. Fuchs discuss how they used a robotic arm to automate their organic chemistry laboratory. I find two aspects of their piece especially interesting. First is how they solved the universal problem in robotics of interfacing disparate equipment. Second, the arm that they employ is perhaps the lowest-tech piece of equipment in their lab, but it has allowed them to unlock the power of the intelligent instruments with which they work.

It is impossible to cover all the major topics of robotics in a single theme. For example, both Phil Dunbar and the Cuadrados acknowledge that the hardest part of machine vision is the intermediate level, where camera data is analyzed to identify, for example, two overlapping objects in a field of vision. This is a hot topic in current vision research but is not included in our theme. However, we found the articles that are here exciting and informative. We hope you have as much fun reading them as we did.

—Tom Clune, Technical Editor

AI: The Future is at Gold Hill Today.

You know artificial intelligence is the wave of the future. Programs based on the ideas of artificial intelligence are being written today in COMMON LISP—the new LISP standard developed by researchers from universities and corporations such as Carnegie Mellon, DEC, MIT, Stanford, Symbolics and TI. LISP allows the development of programs that are intelligent, flexible, and even human-like. The problem has been that hardware needed to run LISP is expensive.

No longer. GOLDEN COMMON LISP (GC LISP) makes it possible for you to learn and use LISP on your *personal computer.* When you use GC LISP in combination with the AI examples provided, you will be able to develop such exciting applications as expert systems, natural language systems, and intelligent interfaces to complex software. The possibilities are endless. With GC LISP you can tackle problems that you could not solve before with ordinary number crunching programs. You will be able to write powerful programs that can accommodate casual computer users who want intelligible answers quickly.

GOLDEN COMMON LISP is the best selling AI language.

Easy to Learn

GC LISP makes it easy for you to learn the technology of AI at your own pace. Each package includes the *San Marco LISP Explorer*—an interactive software tutorial developed by Patrick H. Winston and his associates. This 800-frame instructional system guides you through the steps of LISP programming and makes the full range of LISP's power accessible to both novice and experienced programmers. The second edition of the classic *LISP* textbook by Winston and Horn is also included.

More Power

GC LISP comes complete with the intelligent GMACS editor (based on EMACS), full on-line documentation of all GC LISP and GMACS functions, the *Common LISP Reference Manual* by Steele, and a comprehensive user manual. In short, GOLDEN COMMON LISP comes with everything you need to program in LISP. GC LISP is the most powerful LISP available today on PCs; some of its advanced features include lexical and dynamic scoping, defstructs, closures, stream I/O, and multiple-value returning functions.

The Complete Solution

In addition to GC LISP, Gold Hill offers an entire line of development and delivery tools designed to increase your organization's productivity in artificial intelligence. These include the GC LISP Compiler, PC-to-Symbolics™ network, HALO™ Graphics, and training and consulting services. Gold Hill is also proud to introduce GC LISP LM (Large Memory)—the first PC-DOS language to take advantage of the 15-megabyte memory capacity of the latest generation of PCs (such as the IBM PC AT). For multiple-user sites, Gold Hill offers a Corporate License Package which features quantity discounts and service and support.

Order Today

For order information on Gold Hill products please call today.

800-2GC-LISP

GC LISP requires an IBM PC, PC XT, PC AT, or IBM-compatible with a minimum 512K and PC-DOS 2.0.

Gold Hill Computers Setting the AI Standard for Personal Computers.

GOLD HILL COMPUTERS

163 Harvard Street, Cambridge, Massachusetts 02139

Inquiry 145

MACHINE VISION

BY PHIL DUNBAR

An examination of what's new in vision hardware

THE POTENTIAL APPLICATIONS of machine vision are many and obvious. Everything from quality assurance to robotic navigation could benefit from the availability of reliable vision systems for computers. Perhaps less obvious, though, is the variety of problems that hamper development of the technology. These problems appear on all levels of machine vision—hardware, low-level analysis, and high-level AI (artificial intelligence) manipulation of low-level data. This article will discuss problems that plague the development of vision-system hardware and indicate some of the technology that has emerged to address these problems.

You might think that the most difficult hardware problem in vision systems is digitizing the high-frequency analog stream of camera data. In fact, that is not so. Currently, machine vision algorithms use gray-scale (i.e., monochrome intensity) video information almost exclusively. Such information can be adequately extracted from an analog signal by a 6-bit or 8-bit A/D (analog to digital) converter. Real-time conversion requires approximately a 10-MHz conversion rate to digitize a 512- by 512-pixel image. These rates can be achieved with flash converters, pioneered by the TRW company when it introduced the TDC 1007 in 1977. Flash converters employ (2^N)- 1 comparators to perform N-bit conversions. That is, an 8-bit flash comparator requires 255 comparators to operate. Since all possible digitized values can be compared to the signal at once, the throughput is much greater than with successive approximation methods. Of course, the complexity of the converter rises exponentially with linear increases in resolution. Notable among the commercially available flash converters is TRW's 8-bit monolithic chip flash converter (TDC 1048) that can operate at speeds necessary for real-time machine vision applications and costs about $140 per unit.

The real problems with vision hardware revolve around the cameras. The problems fall into two basic categories: video signal standards and limitations of particular camera hardware technologies.

TELEVISION STANDARDS

Much of robotics suffers from a lack of standards. Machine vision, on the other hand, suffers from the existence of video signal standards that are not appropriate for our needs. Those standards were created by and for the television industry. Since the entertainment industry is still a far more lucrative market for camera manufacturers than machine vision, few image sensors and cameras deviate from television standards.

The monochrome video signal standard used in the United States, Japan, and most of the Western Hemisphere is RS-170, a subset of the NTSC (National Television Systems Committee) standard. Europe uses the international CCIR (Consultative Committee, International Radio) standard, which is similar to, but not compatible with, RS-170. Since both standards present essentially the same problems to machine vision applications, I will limit my remarks to the RS-170 standard.

The RS-170 standard defines the composite video and synchronizing signal that your television uses (see figure 1). The image is transmitted one line at a time from top to bottom of

(continued)

Phil Dunbar is Manager of Software Engineering, Industrial Automation Division, Analog Devices Inc. (POB 280, *Norwood*, MA 02062).

the television screen. The full image frame consists of 525 lines, repeated at 30 Hz. Each frame consists of two interleaved fields of 262.5 lines. Forty lines are blank to allow for vertical retrace of the raster scan. Sync signals precede each line of video signal. The synchronization may originate from either the camera or the display apparatus.

Unfortunately for robotics and other machine vision tasks, the RS-170 standard specifies a 4:3 horizontal-to-vertical aspect ratio for video signals. This means that the video-signal representation of a square will be longer in the *x* direction than in the *y* direction. Your television has a complementary distortion of a 3:4 aspect ratio, so the image of the square ends up appearing visually correct. However, this system poses a problem to algorithm design, since vision algorithms measure distances and tolerances by counting pixels from edge to edge. When viewed through a 4:3 aspect ratio, there is a geometric distortion. At the digital level, circles become ellipses and squares become rectangles. Thus, distance measurement is tedious for objects of random orientation. For example, to determine the length of a straight edge, you must project the edge onto the *x* and *y* axes, normalize the distance on one axis to the opposite (reference) axis, and then calculate the true length as the hypotenuse. It would help to have machine vision cameras with a symmetric aspect ratio. Some do exist, but there is no public standard for the composite output signal.

LIGHTS, CAMERA, ACTION

There are other problems associated with the entertainment-industry bias of camera technology besides inappropriate standards. Primary among these is simply that the technology has been developed for consumption by human eyes and brains. Biological vision tends to be insensitive to absolute light intensity, slow variation in intensity, and spatial accuracy. While the human eye is well adapted to detection of local intensity gradients, global gradients cannot be perceived without high contrast. Since overengineering any product does not make economic sense, video cameras tend to suffer the same biases as humans do. I will discuss some of these biases in detail later in the article.

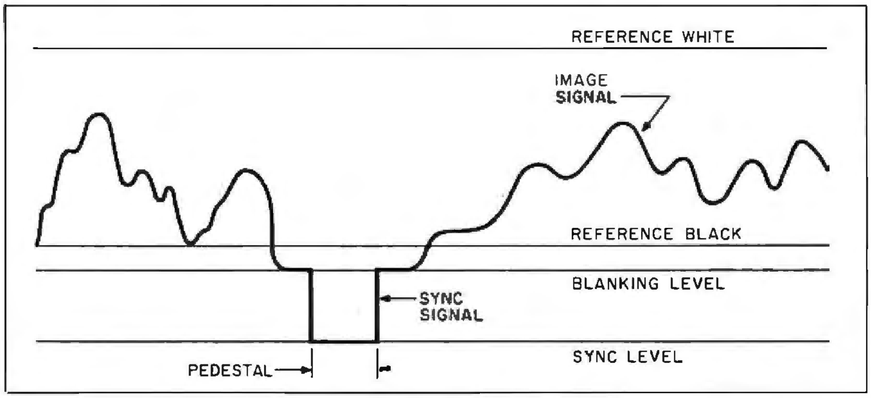


Figure 1: A *composite video signal as it might appear on an oscilloscope.*

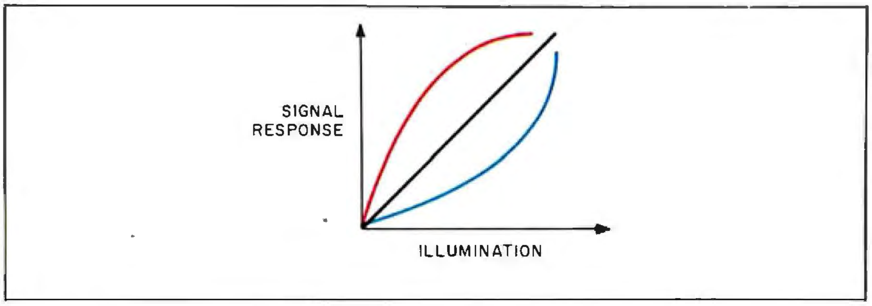


Figure 2: A *graph of response curves for* $\gamma < 1$ *(red),* $\gamma > 1$ *(blue), and* $\gamma = 1$ *(black).*

Another problem that can be traced to the entertainment industry is that most video cameras exhibit a nonlinear response to light intensity to compensate for nonlinearity in CRT (cathode-ray tube) monitors. What linearity means when you are talking about light intensity is not intuitively obvious, so I will pause to clarify this concept.

Camera dynamic range is determined by the ratio between video output amplitude at saturation and RMS (root mean square) noise in darkness. It is essentially limited by noise in the low end and maximum charge capacity in the high end. Some cameras have automatic gain control (AGC), which adjusts the absolute gray-scale response of the sensor to total brightness of the scene. Most often, however, you will control the illumination in machine vision applications. Thus, you may need to use reference gray values when you switch from scene to scene, or important information may be compressed in dark regions of the scene by AGC adjustment to bright regions.

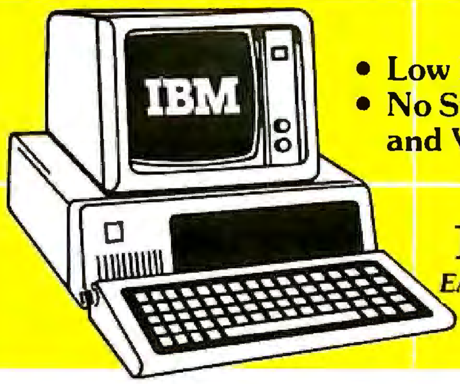
Gray-scale response linearity is specified by the term gamma (γ), which is the exponent in the function $A = K * I^{\gamma}$, where I is light intensity, K is a constant, and A is the output amplitude. A gamma of 1 yields a linear response, whereas less than 1 compresses the bright end of the response curve and greater than 1 compresses the dark end (see figure 2). Many video cameras have a gamma of less than 1 to compensate for video monitors that exhibit the opposite effect.

SENSOR TECHNOLOGIES

There are essentially two types of video cameras available—one is

(continued)

Save



- Low Low Prices
- No Surcharge for MasterCard and VISA

1-800-231-9842
WESTERN REGIONAL ORDERS

1-800-237-4048
EASTERN REGIONAL ORDERS

These Fine Corporations, Universities and Companies Put Their Trust In ***"COMPUTER MART"***

ATT	American Savings	University of:
3M	Landmark Mortgage	California
Magnavox	American Nurse Assoc.	Illinois
Eaton	Dun & Bradstreet	New York
Merrill Lynch	U.S. Navy - Army	Colorado State

Put Your Trust In COMPUTER MART

• COMPUTERS •

IBM ENHANCED AT	4928
IBM ENTRY LEVEL AT	3241
IBM PC, 1 DSDD DR, 256K	1702
IBM PC, 2 DSDD DR, 256K	1826
IBM PC, NO DRIVES, 64K	1316
IBM PC, 2 HALF/HYTE 256K	1702
IBM XT, 1DSDD DR/10MB, 256K	3355
IBM XT, 1DSDD DR/TA HD, 256K	2491
COMPAQ, 2 DSDD, 256K	2173
COMPAQ PORTABLE 2 MODEL 2	5292
COMPAQ DESK PRO MODEL 3	3304
COMPAQ DESKPRO MODEL 2	2156

• MONITORS •

AMDEK 300G	119
AMDEK 300A	133
AMDEK 310A	149
AMDEK 600 RGB COLOR	409
AMDEK 710 SUPER HI RES COLOR	447
IBM COLOR	616
IBM MONOCHROME	235
PRINCETON MAX-12 E	160
PRINCETON HX-12 RG COLOR	446
PRINCETON SR-12	575
PRINCETON HX-12E COLOR	510
QUADRAM AMBER-CHROME	171
QUADRAM QUADCHROME II	426
AMDEK 722	510

• DISPLAY CARDS •

STB SUPER HI RES 400	402
HERCULES COLOR	151
IBM MONOCHROME	218
IBM COLOR	226
EVEREX GRAPHICS EDGE	297
EVEREX THE EDGE	243
GENOA SPECTRUM	289
TECMAR GRAPHICS MASTER	459
PARADISE MODULAR GRAPHICS	274

• BOARDS •

AST SIX PACK PLUS, 64K	223
AST MEGAPLUS, 64K	205
AST MP-2, 64K	228
AST ADVANTAGE, 128K	384
AST I/O PLUS	122
JRAM-2	156
QUADRAM QUADBOARD ØK	186
QUADSPRINT	423
TECMAR CAPTAIN, ØK	162
TECMAR FIRST MATE, ØK	200
TECMAR WAVE XT, 64K	187
TECMAR JR CAPTAIN, 128K	295

• MODEMS •

HAYES 2400	627
HAYES 300	138
HAYES 300/1200	407
HAYES 1200B w/SOFTWARE	346
HAYES 1200B	351
VEN-TEL HALF CARD	374
VEN-TEL 300/1200 INTERNAL	341

AST REACH HALF CARD 1200	363

• PRINTERS •

OKIDATA 83A, WIDE CARRIAGE	545
OKIDATA 84P, WIDE CARRIAGE	660
OKIDATA 92P	392
OKIDATA 93P, WIDE CARRIAGE	597
OKIDATA 2410P	1782
OKIDATA 182	215
OKIDATA 192	376
OKIDATA 182S	259
OKIDATA 184	660
EPSON FX-80 TRACTOR	371
EPSON LX-80	255
EPSON FX-185, WIDE CARRIAGE	515
EPSON FX-100, WIDE CARRIAGE	531
EPSON JX-80 COLOR PRINTER	531
EPSON LQ-1500 PARALLEL	1002
NEC 2050	694
NEC 3550	1058
NEC 8850	1478
JUKI 6300	698
JUKI 6200	503

• ACCESSORIES •

NEC BI-DIRECTIONAL TRACTOR	151
NEC CUT SHEET GUIDE	63
JUKI 6100 BI-DIRECTION TRACTOR	105
JUKI 6300 BI-DIRECTION TRACTOR	122
MEMORY, 65K CHIPS	8
MEMORY, 256K CHIPS	39
PRINTER CABLE	10
MICROFAZER BUFFER, 8K	131
BERNOULLI, 2 DRIVE	2615
BERNOULLI, 1 DRIVE	1790

Save

COMPUTER MART

1901 S. TAMIAMI TRAIL, VENICE, FL 33595
2820 W. CHARLESTON, LAS VEGAS, NV 89102

Call for non-advertised and lower current prices. IBM is a registered Trademark of International Business Machines. Prices subject to change. We accept all major credit cards, money orders, and personal checks. 2% surcharge for shipping, handling and COD shipments, and purchase orders $100 minimum. Returns are subject to a 15% restocking fee. All sales final.

IN FLORIDA CALL 813-493-2736
IN NEVADA CALL 702-877-3988

based on vacuum-tube technology, and the other is based on semiconductor technology. While tube cameras have been around for a long time, solid-state cameras date back only to the early 1970s.

VIDICONS

Since vacuum tubes have been around the longest, we will consider vacuum-tube cameras first. Various types of photoemissive devices are used for imaging in specialized applications that require low light or infrared vision. For normal video applications, the most popular and cost-effective of the tube sensors is the vidicon tube (see figure 3), a photoconductive device. It employs a photoconductive layer that develops an electric charge in response to impinging photons. An electron beam scans the photo layer in a raster format, reducing the charge along a line of the picture. This discharge produces a continuous analog signal proportional to the light intensity of the focused image. The camera electronics insert sync pulses to indicate scan lines, fields, and frame ends. Vidicons can image a wide spectral band from the ultraviolet, through the visible, to the near-infrared. As you can see in figure 4, the vidicon tube has a spectral response similar to, but broader than, the human eye.

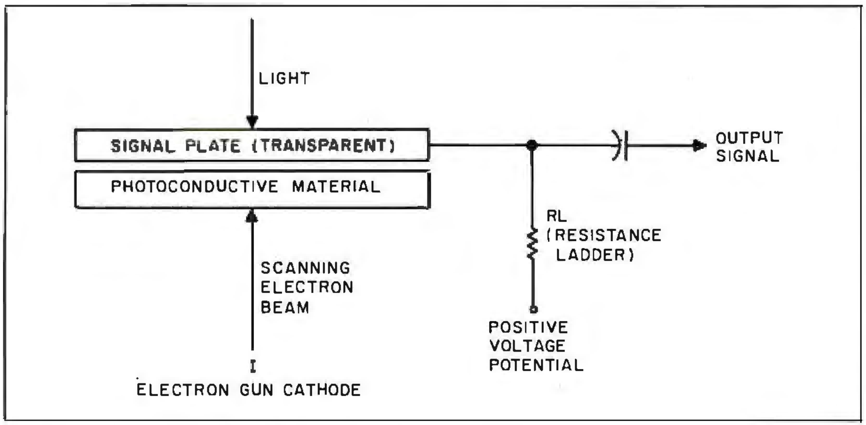


Figure 3: A *diagram of a vidicon tube sensor.*

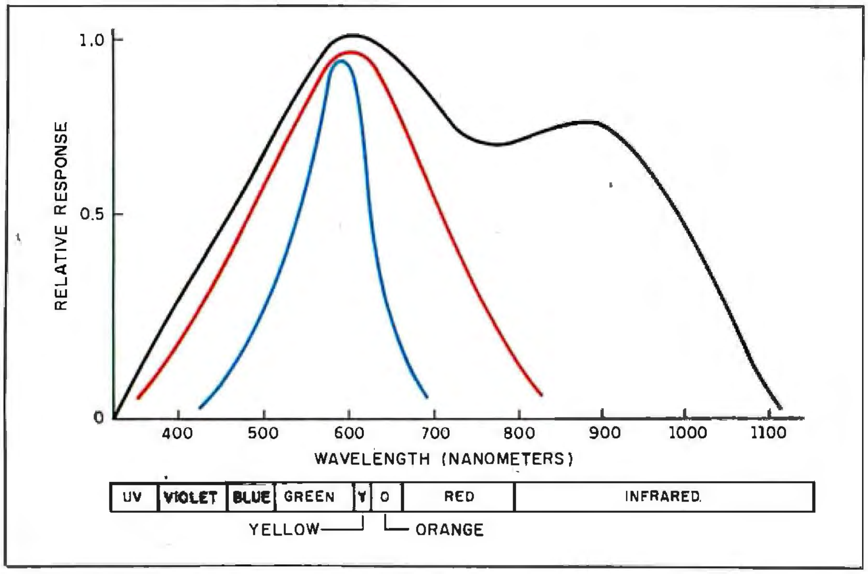


Figure 4: T*he spectral response of the human eye (blue), vidicon (red), and* CCD *image sensors (black).*

The drawbacks to vidicon tubes are analogous to the drawbacks to tubes generally. They require more power, are less rugged, weigh more, and are larger than solid-state devices. In addition, they have one drawback that is unique to camera technology: They exhibit significant image lag. What this means is that the electric charge that was induced in the photo layer for one frame tends to persist over subsequent frames. Thus, a quickly moving bright object will appear to leave a tail in its wake, rather like a comet. A newer kind of tube sensor, called the newvicon tube, has lower image lag than the vidicon. However, the newvicon has a spectral response biased toward the far-red region.

SOLID-STATE CAMERAS

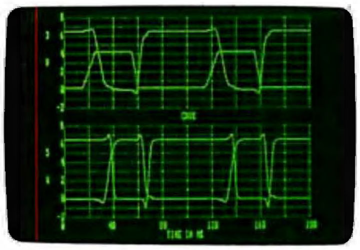
Most solid-state cameras are based on charge-coupled device (CCD) technology, which is now closing in on the performance of existing camera tubes. Silicon, with energy sensitivity in the range of 400 to 1100 nanometers (see figure 4), is a good choice for detection in the visible spectrum. However, one of the problems of solid-state image sensors is that they have a peak sensitivity in the near-infrared, although most have a bimodal spectral response with a second peak in the green. Because of broad near-infrared sensitivity between 800 and 1100 nm, you should use an infrared cut filter with solid-state cameras, particularly if they will be used under incandescent lighting. Ambient infrared light has a "wash-out" effect on response in the visible spectrum. In fact, most solid-state camera manufacturers specify sensitivity only with an infrared filter.

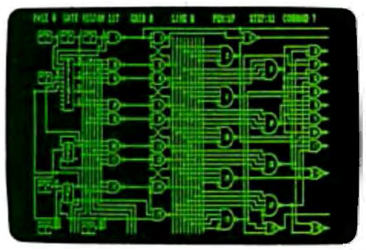
Solid-state sensors can be either metal-oxide semiconductor or photodiode. The basic structure of the CCD is that of an analog shift register consisting of a series of closely spaced capacitors. Charge integration by the capacitors provides the analog representation of light intensity.

CCD sensors most commonly use

(continued)

MICRO CAP and MICRO LOGIC put your engineers on line... not in line.


"Typical MICROCAP Transient Analysis"


"Typical MICROLOGIC Diagram"

How many long unproductive hours have you spent "in line" for your simulation? Well, no more. MICROCAP and MICROLOGIC can put you on line by turning your PC into a productive and cost-effective engineering workstation.

Both of these sophisticated engineering tools provide you with quick and efficient solutions to your simulation problems. And here's how.

MICROCAP: Your Analog Solution

MICROCAP is an interactive analog circuit drawing and simulation system. It allows you to sketch a circuit diagram right on the CRT screen, then run an AC, DC, or Transient analysis. While providing you with libraries for defined models of bipolar and MOS devices, Opamps, transformers, diodes, and much more, MICROCAP also includes features not even found in SPICE.

MICROCAP II lets you be even more productive. As an advanced version, it employs sparse matrix techniques for faster simulation speed and larger networks. In addition, you get even more advanced device models, worst case capabilities, temperature stepping, Fourier analysis, and macro capability.

MICROLOGIC: Your Digital Solution

MICROLOGIC provides you with a similar interactive drawing and analysis environment for digital work. Using standard PC hardware, you can create logic diagrams of up to 9 pages with each containing up to 200 gates. The system automatically creates the netlist required for a timing simulation and will handle networks of up to 1800 gates. It provides you with libraries for 36 user-defined basic gate types, 36 data channels of 256 bits each, 10 user-defined clock waveforms, and up to 50 macros in each network. MICROLOGIC produces high-resolution timing diagrams showing selected waveforms and associated delays, glitches, and spikes—just like the real thing.

Reviewers Love These Solutions

Regarding MICROCAP . . . "A highly recommended analog design program" (PC Tech Journal 3/84). "A valuable tool for circuit designers" (Personal Software Magazine 11/83).

Regarding MICROLOGIC . . . "An efficient design system that does what it is supposed to do at a reasonable price" (Byte 4/84).

MICROCAP and MICROLOGIC are available for the Apple II (64k), IBM PC (128k), and HP-150 computers and priced at $475 and $450 respectively. Demo versions are available for $75.

MICROCAP II is available for the Macintosh, IBM PC (256k), and HP-150 systems and is priced at $895. Demo versions are available for $100.

Demo prices are credited to the purchase price of the actual system.

Now, to get on line, call or write today!

Spectrum Software
1021 S. Wolfe Road, Dept. B
Sunnyvale, CA 94087
(408) 738-4387

Inquiry 335

one of three addressing strategies: interline transfer, frame transfer, or column-row transfer.

INTERLINE TRANSFER

The interline transfer CCD is organized into column pairs of devices. An imaging column of photosensors is adjacent to an opaque vertical shift register (see figure 5). Charge accumulates in the imaging column until the end of the integration period, when it is transferred to the opaque column. The signal then shifts vertically into a horizontal shift register that represents the picture sequentially, line by line. Since the photosensor area is interspersed with image-insensitive shift registers, there is a grate pattern that can create undesirable interference called aliasing and moiré effects (see the glossary on page 168).

The advantage of the interline transfer is that the transfer time (to opaque storage) is short compared to the integration period. This is desirable because when transfer time approaches the integration time, solid-state sensors tend to exhibit a locally contained spreading of image response. Such spreading is called, appropriately enough, *smear*. Interline transfer minimizes smear.

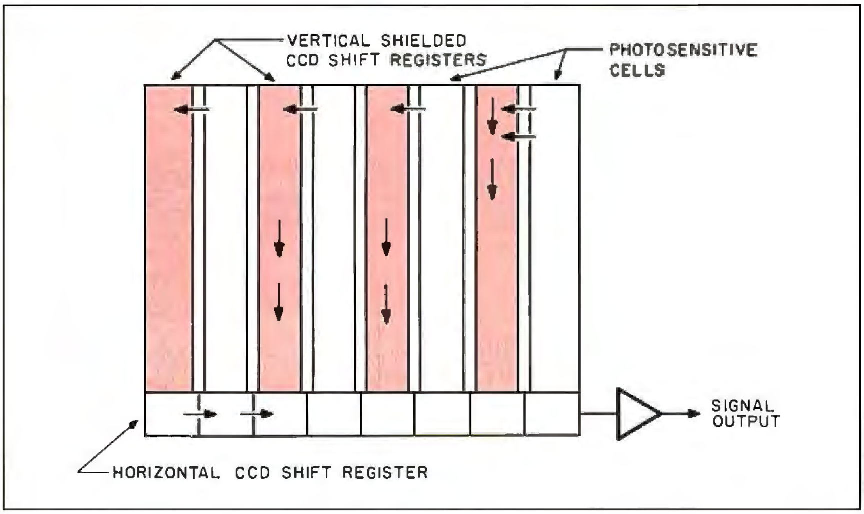


Figure 5: A *diagram of an interline transfer* CCD.

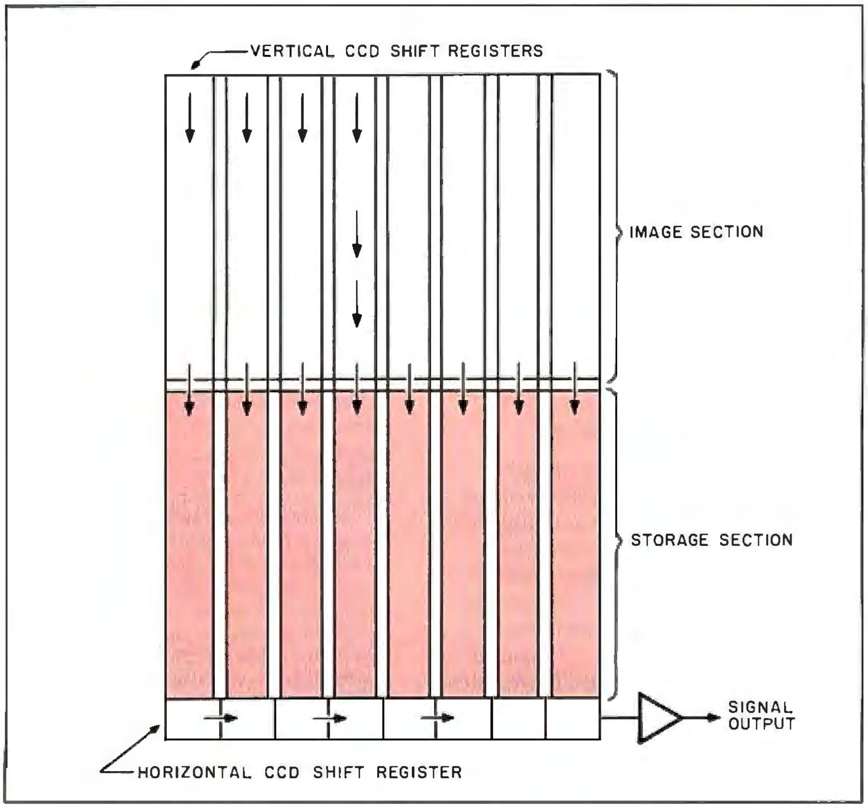


Figure 6: A *diagram of a frame transfer* CCD.

FRAME TRANSFER

In the frame transfer organization (see figure 6), the sensor consists of vertical columns of CCD shift registers divided into two zones. One zone, where charge accumulates during integration time, is photosensitive. When integration is complete, the whole array is transferred in parallel to the opaque storage area of the second zone. Since the whole image zone is photosensitive, the frame transfer organization minimizes problems with moiré effects. Another advantage of the frame transfer CCD is that it can transmit one image while acquiring another. This gives you the flexibility to vary the integration period without changing the readout time.

COLUMN-ROW TRANSFER

A third type of solid-state sensor employs *x-y*, or column-row, addressing (figure 7) to transfer charge from the photosite to the output signal amplifier. The sensor elements are addressed by selecting individual column and row electrodes. Charge collected under the column electrode is transferred to the row electrode and amplified for output.

BLOOMING

One general difficulty with solid-state sensors is that they tend to exhibit "blooming," which is the cascading of

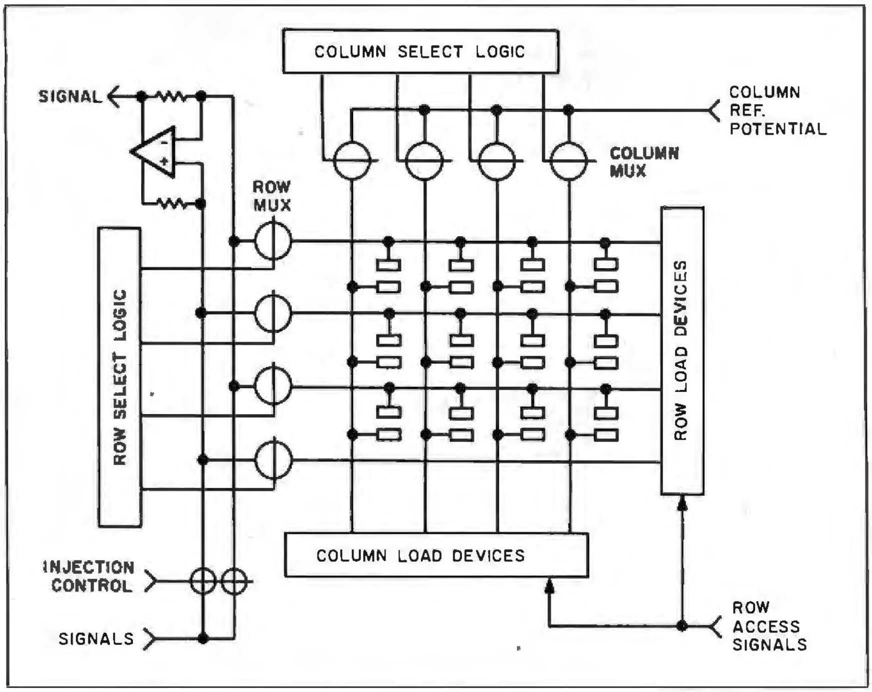


Figure 7: A *diagram of a* 4 *by* 4 CID *matrix with column-row addressing. Based on a drawing from General* Electric *Technical Information* GET 6803. U*sed with permission of* GE.

charge saturation from a few photo elements along paths of least resistance in the sensor array. The effect is bright streaks along a single axis or both axes, extending the full height of the sensor. Scenes containing objects with specular reflections at random orientations, where light saturation is difficult to control, are especially problematic.

To effectively contain blooming, newer devices employ charge drains adjacent to the sensor cell to absorb the excess charge before it spreads to neighboring image elements.

SPATIAL RESOLUTION

Whatever camera technology you use, you must concern yourself with the spatial resolution of the camera. There is considerable confusion among camera users as to what camera resolution means. It is often defined in terms of "TV lines." These units should not be confused with raster lines or the number of lines electronically scanned in the image. Lines of resolution correspond to the maximum number of alternating white and black lines per frame height or width that can be resolved by visual inspection. Often people will test resolution in both the horizontal and vertical axes by imaging a test pattern of converging black and white bars.

It is desirable to have equal resolution in both horizontal and vertical axes, but not all cameras do. In situations common to robotics, where objects may appear in the field of view at random orientations, you must assume that the camera resolution is the lower resolution of the two axes. Line resolution may also vary from region to region on the sensor surface, particularly on the peripheral areas of tube cameras.

A less subjective measure of resolution is the modulation transfer function (MTF), which relates output signal amplitude to the light image created by a bar pattern of sinusoidal variation in gray level. The function is normalized to 100 percent, where it levels off to a maximum for low spatial frequencies.

(continued)

A similar measure of resolution is the contrast transfer function (CTF). For this measure, we use a simple black-and-white "square wave" pattern rather than the sine wave modulated pattern. Resolution is specified as a percentage of response for a given number of TV lines. For example, 20 percent response at 800 lines would be considered high resolution by today's standards.

In solid-state cameras, resolution is limited by the number of photosites on the sensor, by the array geometry, and by how much opaque material separates the photosites. Charge leakage adversely affects resolution, as does transfer inefficiency in the case of CCD cameras.

Tube camera resolution is a function of the electron-beam diameter relative to the area of the photoconductive layer. Tube camera resolution is generally higher than that of solid-state cameras and easily outstrips the limitations imposed by the RS-170

(continued)

A Video Glossary

Aliasing: The kind of misrepresentation that results from pixel density being too low to represent the spatial frequencies in an image.

Blooming: A phenomenon whereby streaks fan out in the image around an area of intense illumination. Blooming occurs when excess charge in the sensor cell overflows into neighboring CCD registers. This can be suppressed by introducing overflow drains under or adjacent to the photosensitive area.

Candela: Intensity of a point source that generates one lumen per steradian (unit solid angle). Also called candle power. Abbreviated cd.

CCD: Charge-coupled device. A monolithic silicon structure in which discrete packets of charge are transported from position to position by sequential clocking of an array of gates.

CCIR: Consultative Committee, International Radio. International standard for composite monochrome video signals.

Chrominance: Indicates the hue and saturation of a color or the color information without the brightness.

CID: Charge injection device.

CPD: Charge priming device.

CTF: Contrast transfer function. Similar to MTF but uses a black-and-white test pattern.

Definition: Number of sensor cells per line/column.

Dynamic range: Ratio of the output voltage at saturation and RMS noise in darkness.

Exposure: Result of illumination over a given integration time.

Gamma (γ): A numerical value representing the exponent in a function that relates illumination to response. A gamma of 1 yields a linear response. A gamma of more than 1 results in a greater slope for bright illumination, and a gamma of less than 1 results in a greater slope for low illumination.

Integration time: Time allowed for light impingement on a given sensor cell.

Lag: Persistence of image charge over subsequent frames.

Lumen: The amount of luminous flux on a 1-square-foot area of a 1-foot radius sphere cast by a 1-cd light source at the center.

Luminance: Indicates the light intensity without the color.

Luminous flux: Luminous power per unit area.

Marking: Regional degradation of an electron tube from excessive exposure.

Moiré effect: Interference between the spatial frequency of the sensor structure and spatial frequencies in the image.

MTF: Modulation transfer function. The signal output of the sensor in response to a standard test pattern consisting of sinusoidal variations in gray-level density over a range of frequencies.

NTSC: National Television Systems Committee. A standard observed by the U.S.A., Canada, Japan, and most countries in the Western Hemisphere.

Nyquist limit: Upper limit of spatial resolution based on the spatial frequency of the placement of sensor elements.

PAL: Phase Alternation Line. A system in which the subcarrier phase is inverted from one raster line to the next. A standard observed by most European countries.

Pixel: Picture element or sensor element or photosite.

Pixel blemish: A pixel is blemished if it has a response not within an acceptable percentage of the average.

Resolution: Number of image lines per frame height with a contrast above or equal to 50 percent.

Response: Amplitude of output voltage per unit of light exposure.

Response nonuniformity: Difference in response between the most and least sensitive regions of the sensor under uniform illumination, expressed as a percentage of the average.

Saturation: Maximum amount of charge stored by a given sensor cell.

Saturation voltage: Maximum output voltage for sensor saturation.

SECAM: Système Électronique Couleur Avec Memoire. A standard observed by France and most Eastern bloc countries.

Sensitivity: Minimum illumination required to generate a usable signal.

Spectral range: Portion of the light spectrum over which the sensor has a response above 10 percent of the peak-to-peak voltage.

Table 1: *Commercially available cameras and their features.*

Vendor	Camera	Sensor	Resolution	MTF	Minimum Illumination	Signal/ Noise	Pixel Size	Gamma
Circon 749 Ward Dr. Santa Barbara, CA 93111 (805) 967-0404	MV. 9015-H	MOS array 648 (H) x 485 (V)	480 lines (H), 330 lines (V)		20 lux with f1.6 lens	42 dB		1.0 or 0.45 selectable
Cohu Inc. Electronics Division 5755 Kearny Villa Rd. POB 85623 San Diego, CA 92138-5623 (619) 277-6700	Model 4600	Interline transfer CCD 384 (H) x 490 (V)	285 lines (H), 480 lines (V)			50 dB		0.45 or 1.0 selectable
Cohu Inc. Electronics Division 5755 Kearny Villa Rd. POB 85623 San Diego, CA 92138-5623 (619) 277-6700	Model 5402	Vidicon E5405 (Chalnicon E5415 option)	Center 900 lines (H), corner 600 (H)		1 lux	54 dB	NA	0.5 to 1.0 adjustable
EG&G Reticon 345 Potrero Ave. Sunnyvale, CA 94086-9930 (408) 738-4266	MC9256	MOS photodiode array 256 x 256				60 dB		
Fairchild CCD Imaging 3440 Hillview Ave. Palo Alto, CA 94304 (415) 493-8001	CCD3000	Interline transfer CCD 380 (H) x 488 (V)	285 lines (H), 488 lines (V)	50% (CTF) at 488 lines (V)	20 lux with f1.4 lens	50 dB		1.0
Fairchild CCD Imaging CCD 3440 Hillview Ave. Palo Alto, CA 94304 (415) 493-8001	CCD 4001	Interline transfer CCD 256 (H) x 256 (V)						
General Electric 890 7th North St. Liverpool, NY 13088 (315) 456-2832	TN 2509	CID 260 (H) x 253 (V)		80% at limiting resolution		50 dB at saturation	28 x 28 μm	1.0
Hitachi Denshi America Ltd. 175 Crossways Park West Woodbury, NY 11797 (516) 921-7200	KP-120	MOS array 320 (H) x 244 (V)	240 lines (H), 190 lines (V)		5 lux with f1.4 lens	49 dB		
Imagerie, Industrie, Systeme (I2S) 239 rue du Jardin-Public 33300 Bordeaux, France (56) 29-10-03	IS 400	Frame transfer CCD 384 (H) x 576 (V)			3 lux	68 dB	23 x 23 μm	1.0

Response Uniformity	Geometric Distortion	Output Signal	Weight	Power Consumption
		RS-170	170 g (camera head)	10 W
		RS-170	511 g	5.5 W
	0.5%	RS-170, CCIR	450 g (camera head)	24 W
± 10% at saturation		Clock rate 525 kHz to 8 MHz at ± 1V or RS-170 with MB9000 data formatter	340 g	5 W
		RS-170	1 kg	
		RS-170	1 kg	
		RS-170	383 g	2.5 W
		RS-170	400 g	5 W
± 5%		RS-170, CCIR, 6-bit digital		

standard in the vertical axis.

One point that complicates evaluating resolution is that the host computer may digitize the output signal at a rate inconsistent with camera resolution.

NOTEWORTHY CAMERAS

Table 1 lists a selection of commercially available cameras. As anyone who has worked from manufacturers' specification sheets knows, however, the information provided by one manufacturer is not always readily comparable to the information provided by another manufacturer. Therefore, to help you evaluate the different cameras, I want to mention some aspects of particular cameras that we at Analog Devices have found particularly desirable for machine vision.

The GE cameras use a proprietary charge injection device (CID) sensor that contains an array of column-row addressed MOS sensor cells. The camera can be applied effectively with strobe lighting to capture transient events like moving objects. You can inhibit normal destructive readout of the camera's sensor until the event occurs, when light from the strobe generates the signal charge. Releasing the inhibit signal allows you to read out the signal. Another application of the inhibit feature is to extend the integration period of the sensor longer than the normal 50 or 60 Hz standard frame time. Extended integration allows you to accumulate more charge where scene lighting is low. With a format of 260 horizontal by 253 vertical pixels, the TN2509 camera has a symmetric aspect ratio and linear response.

For high resolution in a solid-state camera, VSP labs has the SC500 with 604 horizontal by 576 vertical photo elements. The sensor is a CCD array with high sensitivity in the blue region and a 1:1 aspect ratio.

ITM Corporation's Model 5000 Datavision has excellent response linearity and a typical spatial uniformity (response nonuniformity) of about 4 percent. The Model 5000 features

(continued)

Vendor	Camera	Sensor	Resolution	MTF	Minimum Illumination	Signal/ Noise	Pixel Size	Gamma
Image Technology Methods Corp. 103 Moody St. Waltham, MA 02154 (617) 894-1720	Model 5000 Datavision	CCD 384 (H) x 491 (V)	280 lines (H), 350 lines (V)		3 lux with f1.4 lens, without IR filter	45 dB	23 (H) x 13.4 (V) µm	1.0
Javelin Electronics 19831 Magellan Dr. Torrance, CA 90502 (213) 327-7440	JE-2062	MOS array 384 (H) x 485 (V)	500 lines (H)		30 lux with f1.4 lens	43 dB		0.45
Panasonic Industrial Co. One Panasonic Way Secaucus, NJ 07094 (201) 348-7000	WV-CD10	CPD 404 (H) x 256 (V)	280 lines (H), 190 lines (V)		10 lux with f1.4 lens, IR filter	46 dB		
Physitec Corp. 206 Main St. Norfolk, MA 02056 (617) 528-4100	43-0031	Frame transfer CCD 604 (H) x 575 (V)			0.1 lux		10 (H) x 15.6 (V) µm	
PULNiX America Inc. 453-F Ravendale Dr. Mountain View, CA 94043 (415) 964-0955	TM-34K	Interline transfer CCD 384 (H) x 491 (V)	280 lines (H), 350 lines (V)		3 lux with f1.4 lens	45 dB	23 (H) x 13.4 (V) µm	
RCA Closed Circuit Video Equipment New Holland Ave. Lancaster, PA 17604 (717) 397-7661	TC2900	CCD 403 (H) x 512 (V)		50% at 200 lines (H)	0.025 lux	52 dB		0.5 to 1.0 adjustable
Sanyo Industrial Video Division 1200 W. Artesia Blvd. Compton, CA 90220 (213) 537-5830	VDC3800	Frame transfer CCD 572 (H) x 485 (V)	420 lines (H), 400 lines (V)		2 lux with f1.4 lens	46 dB		
Sierra Scientific Corp. 2189 Leghorn St. Mountain View, CA 94043 (415) 969-9315	DAV-26	Plumbicon (other tubes available)	1000 lines (H), 700 lines (V)	20% at 1000 lines (H)	3 lux	36 dB typical	NA	
Sony Component Products Division 15 Essex Rd. Paramus, NJ 07652 (201) 368-5001	XC-38	Interline transfer CCD 384 (H) x 491 (V)			3 lux with f1.4 lens, without IR filter	46 dB	23 (H) x 28 (V) µm	
Video Logic Corp. 597 North Mathilda Ave. Sunnyvale, CA 94086 (408) 245-8622	CDR-460	Interline transfer CCD 384 (H) x 491 (V)	250 lines (H), 350 lines (V)		3 lux	46 dB	23 (H) x 13.4 (V) µm	
VSP Labs Inc. 670 Airport Blvd. Ann Arbor, MI 48104 (313) 769-5522	SC500	Frame transfer CCD 604 (H) x 576 (V)	400 lines (H), 400 lines (V)	70% at 400 lines	20 lux with f1.4 lens	30 dB	10 x 15.6 µm	1.0 or 0.6 option

Response Uniformity	Geometric Distortion	Output Signal	Weight	Power Consumption
4% typical		RS-170, 8-bit digital	1.36 kg	
		RS-170, CCIR	300 g	2 W
		RS-170	600 g	6.8 W
		CCIR		
		RS-170	122 g	
		RS-170	900 g	7.2 W
		RS-170		5 W
10% peak-to-peak	1.0%	RS-170	5.9 kg	100 W
		RS-170	115 g	2.3 W
		RS-170	545 g	
		RS-170	1 kg	

standard RS-170 output with an optional 8-bit digital output at 7 MHz.

Another notable camera for robot vision is the I2S IS400. The sensor is a 384 horizontal by 574 vertical frame transfer CCD array with symmetric photo elements. Output options include RS-170, CCIR, or 6-bit digitized data at TTL levels. The outstanding feature of the IS400 is the Monoshot, or image-gating, mode. Monoshot allows the host to trigger the start of charge integration and control the time period of charge integration. With integration periods possible from 3 to 100 milliseconds, you can use the camera to capture moving objects under good lighting conditions or to image static scenes under poor illumination.

EXPECTATIONS

We are reaching the performance limitations of RS-170 and CCIR standards as sensor resolution improves. With the price of flash converters coming down, it would make sense to design cameras for machine vision with the converter in the camera—as close to the sensor as possible—to minimize signal noise and degradation. A multidrop bus with camera select and handshake would enable the host computer to select one of several cameras on the bus and send commands. Data would be received as a serial byte stream. Useful commands might include window coordinates where only a subregion of the scene is of interest, programmable gain, subsampling rate, or variable integration time.

Feature and distance gauging requires that pixel cells be symmetrical in both horizontal and vertical axes, and most sensor manufacturers recognize this. Sensiti ity, dynamic range, and uniformity are improving as weight, power consumption, and package size decrease.

In the future, we hope to have the ability to perform pixel processing at the sensor level. Operations like edge nhancement or even object detection could be performed before the data is passed to the host, thus lowering traffic on the bus. ■

Our professionals

If you seriously shop around for the best priced computer hardware, software, and services, you've probably talked product and price with a PROGRESSIVE MICRO DISTRIBUTORS' professional. If you haven't, you've been depriving yourself and your company of a beautiful professional relationship. Here's why.

WE MEAN BUSINESS.

By focusing on details, PROGRESSIVE MICRO DISTRIBUTORS provides business buyer's with the criteria needed to make informed purchasing decisions. Our professionals give you expert advice on current computer and peripheral applications. Quote you prices that make good business sense. Inform you about specials on overstocked items. Make sure that each system is burned-in and fully tested overnight before being shipped. And follow your order from the moment it's processed until it reaches its final destination.

Furthermore, if a problem does occur, you won't be left dangling. Direct access to our customer service and technical support centers is available daily. Whether you need a product repaired or replaced, factory authorized technicians and customer service specialists are standing by to quickly resolve any problems you might experience.

HOW TO KEEP UP WITH PROGRESSIVE.

It's easy. With the Microgram, our monthly customer newsservice, you'll gain insights on new products and receive money saving incentives. And we'll keep you posted on specials and current prices with our monthly price lists. Lists are shipped automatically with all system orders and are available on disk. In addition, FREE UPS shipping is guaranteed on all prepaid orders with confirmation of current pricing.

To receive your current price list immediately, just call PROGRESSIVE MICRO DISTRIBUTORS today, TOLL FREE 1-800-446-7995. And remember . . . for professional service every time, call the professionals at PROGRESSIVE MICRO DISTRIBUTORS.

POLICIES

1. We accept VISA, MC, AMEX; No surcharge for VISA or MC.
2. COD requires cash or certified check; Company check when approved.
3. Allow 1 week for personal and company checks to clear.
4. Wiring information available upon request.
5. Corporate, Government and Institutional volume purchase agreements available.
6. Call for exact shipping charges; air shipments take priority.
7. If we must split shipment, you incur no additional shipping charges.
8. All orders shipped insured — No additional charge.
9. All products fully waranteed; Some up to 5 years.
10. All items subject to availability; Prices subject to change without notice.

FOR ORDERS
1-800-446-7995

ORDERING INFORMATION
1-404-446-7995

CUSTOMER SERVICE
1-404-446-7996

TECH ASSISTANCE
1-404-446-7997

HRS: 9AM-9PM EST. SAT. 12N-5PM EST.

make us Progressive.

PC SYSTEMS

AT&T PC 6300
640K, 2 d nonitor/adapter, DOS/BASIC $1995
640K, 2 drives, color monitor/adapter, DOS/B $2495
640K, 1 drive, 10MB hard disk, DOS/BASIC $2595

AT&T PC 6300 PLUS
25% faster than IBM's AT .... CALL FOR BEST PRICE.

IBM PC
256K, 2 drives, monochrome/printer adapter & monitor $2195
256K, 2 drives, color/graphics adapter & monitor $2495
256K, 2 drives, 10MB internal hard disk $2595

IBM PC XT
256K, 2 drives, monochrome/printer adapter & monitor $2295
256K, 2 drives, color/graphics adapter & $2595
256K, 2 drives, 10MB internal hard disk $2595
256K, 2 drives, 20MB internal hard disk $2695

IBM PC COMPATIBLE
256K, 2 drives, 8 slots, 135w power supply $995
256K, 1 drive, 10MB, 8 slots, 135w power supply $1595
These systems are brand new, shipped fully tested and burned in, fully warranteed for ninety days AND ARE ALWAYS IN STOCK! **All system orders include our PC Utilities Package at no extra charge!**

PRINTERS

EPSON
FX-85 (160 cps narrow carriage NLQ dot matrix) $389
FX-185 (160 cps wide carriage NLQ dot matrix) .. $509
LX-80 (100 cps narrow carriage NLQ dot matrix) $249
JX-80 (160 cps narrow carriage color dot matrix) $525
LQ-1500 (LQ dot matrix w/parallel interface) $995
DX-10, 20, 35 (new EPSON daisywheels) .. ON SPECIAL!

OKIDATA
ML 192 (160 cps narrow carriage dot matrix) $399
ML 193 (160 cps wide carriage dot matrix) $559
PACEMARK 2410 (350 cps wide carriage dotmatrix) $1995

CANON
LBP-8A1 (8 ppm, better than HP) $2195
PW-1080A (160 cps dot matrix) $329
PJ-1080A (32 cps color printer) $549

TOSHIBA
P-351 (192 cps wide carriage LQ dot matrix) $1095
P-1340 (120 cps narrow carriage LQ dot mat ... $595

TEXAS INSTRUMENTS
TI-855 (150 cps nar--- carriage LQ dot matrix) CALL

BROTHER
HR-15+ (17 cps narrow carriage letter quality) .. $395
HR-25 (23 cps wide carriage letter quality) $550
HR-35 (32 cps wide carriage letter quality) $795
M-1509 (180 cps, wide carriage NLQ, S&P Dot Matrix) .... CALL

C. ITOH
Starwriter (40 cps letter quality) $895
Printmaster (55 cps letter quality) $1195

NEC
Pinwriter P-2 & P-3 .... CALL
Spinwriter 2050, 3550, 8850 .... CALL
Ask about our full line of tractors and cut sheet feeders!

PLOTTERS

We carry all HOUSTON INSTRUMENTS and HEWLETT-PACKARD plotters

FLOPPY DISK DRIVES

HALF-HEIGHT 360K (PC/XT/AT compatible) $119
HALF-HEIGHT 1.2MB (PC/XT/AT compatible) $159

MISC. HARDWARE

POLAROID Palette (Makes color slides from your PC's screen) $1395
ORCHID PC Turbo (adds 8MHz processor, multitasking to PC) .... from $649
KEYTRONIC KB 5151 & 5153 keyb .... CALL
MOUSE SYSTEMS Optical PC MOUSE $155
MICROSOFT Serial or Bus mouse w/N $155
GIS Power Back-ups (SPS' and UPS') .... CALL
QUADRAM Microfazer Printer Buffer .... m $155
CURTIS System accessories .... CALL

HARD DISK DRIVES

Internal
PC/XT 10MB ... 'rom $429
AT 20MB $695
PC/XT 20N $645
AT 30MB $895
PC/XT 30N $995
AT 85MB $1995
AT 105MB $2995
AT 140MB $3395
AT 190MB $4395

External
PC/XT 10MB $695
PC/XT 20MB $945
380MB $6995

We proudly offer what we think are the best price/performance hard disk and streaming tape sub-systems available. We will gladly test and format any hard disk we sell at a nominal charge. Our line includes: ALLOY, BERNOULLI TECHNOLOGY, CIPHER DATA, DMA, EMERALD SYSTEMS, EPSON, GENOA, IRWIN, MAXTOR, PEACHTREE TECHNOLOGIES, PRIAM, QUADRAM, RODIME, SYSGEN, TALLGRASS, TULIN and WANGTEK

MULTIFUNCTION BOARDS

We carry the finest quality multifunction boards at prices too low to mention. We are factory authorized centers for the top names in the industry. Our volume buying allows us to set the most competitive prices anywhere. Call us for the lowest prices a *full service distributor* can give you.

CHIPS

64K (nine chips) ... $10
8087 (coprocessor ... $129
80287 (coprocessor) $199
128K (AT RAM) $38
256K (jr & AT boards) $35
CALL FOR QUANTITY DISCOUNTS

GRAPHICS CARDS

We carry a variety of display adapters. So, call us if you don't see the one you want or need help choosing.

GENOA
Spectrum (High res color & Mono) $299

AT&T
Enhanced Display Adapter (runs 640x400 w/ a palette of 16,000 colors on AT&T's Hi Res color monitor ... CALL

HERCULES
Graphics Card (Lotus compatible monochrome graphics) $29
Color Graphics Card (short-slot color card w/par) $179

PARADISE
Modular Graphics Card & Multi-Display Card from $299

TECMAR
Graphics Master (640x400 16 colors and monographics) $489

PERSYST
BoB Board (clear text on a color monitor) $489

TSENG LABS
UltraPAK (132 col. mono graphics, ser, par, C/C) ... $439

MONITORS

AMDEK
300G & 300A (Green or Amber composite video monitors) .... /$139
310A (Amber TTL input, non-glare tube) $169
COLOR 600 (13" 640x240 RGB w/text button, a $425
COLOR 700 (13" 720x480 RGB w/.31mm dot) $475
COLOR 710 (13" 720x480 RGB, non-glare/flicker) $575

PRINCETON GRAPHICS
PGS MAX-12 (Amber TTL input, non-glare ---- . $189
PGS HX-12 (690x480 RGB w/.31mm dot) $449
PGS SR-12 (690x480 non-interlaced RGB w/.31 dot) $595

QUADRAM
Amberchrome (Amber TTL monochrome) $149
Quadchrome (690x480, .31mm dot pitch) $489
Quadchrome II (same as IBM Color Monitor) $369

TAXAN
New 600 Series high res color monitor .... CALL
We carry WYSE and KIMTRON terminals, call for prices.

PROTOCOL CONVERSION

We carry all AST and DCA products, call for prices

MODEMS

HAYES
Hayes 1200 (external 300/1200, auto answer/dial) .. $419
Hayes 1200B (internal 300/1200, w/Smartcom ... $379
Hayes 2400 (New external 2400 baud modem) $675

DCA
New Fastlink 10KB modem .... from $1595

ANCHOR AUTOMATION
Signalman Mark XII (1200 baud at 300 baud price) $259
We also carry modems by AST RESEARCH, BIZCOMP, PENRIL, QUADRAM, RIXON, VENTEL — please call for current pricing.

NETWORKING

We carry all the best names including 3COM, AST RESEARCH, FOX, IBM, and ORCHID TECHNOLOGIES. Call our Networking Applications experts to design a cost-effective device-sharing networked layout for your office! Regional ON-SITE installation and training available.

C.A.D.

We sell and support the finest computer aided drafting/design packages available. Regional ON-SITE installation and training available.

DISKETTES

VERBATIM
Single sided/Single density .... 10/$24 100/$199
Double sided/Double density .... 10/$29 100/$249

DYSAN
Double sided/Double density .... 10/$29 100/$249
High density AT diskettes .... 10/$59 100/$549

MAXELL
High density AT diskettes .... 10/$59 100/$549

PMD
Double sided/Double density .... 10/$16 100/$129

SOFTWARE

LOTUS Symphony $449
MICROSOFT Excel .... CALL
ASHTON-TATE Frar $399
ENABLE by Software Group .... CALL
PFS Write, File, Graph, Report .... from $79
SSI WordPerfect 4.1 .... $259
MULTIMATE, Multimate ADVANTAGE, JUST Write .. CALL
MICROSOFT Word 4.0 .... $259
LIFETREE Volkswriter $169
LOTUS 1-2-3 .... $309
ASHTON-TATE dBase III $399
MICRORIM R-BASE 5000 .... $389
MICROSTUF Crosstalk XVI $109
PERSOFT SmarTerm 100, 125, 400 .... CALL
RELAY .... CALL
DOW JO! .... CALL
SORCIM/IUS Complete accou .... m $289
BPI ACCOUNTING Complete .... CALL
OPEN SYSTEMS Accounting .... CALL
SYSTEMS PLUS Books! accountir .... CALL
MECA/TOBIAS Managing Your M $129
MONOGRAM Dollars and Sense $119
DECISION RESOURCES Signmas .... /$249
ZSOFT PC Paint Brush $95
HARVARD Harvard Project Manager .... CALL
MICROSOFT Project .... CALL
CLIPPER dBase compiler by Nantucke .... CALL
BORLAND Turbo Pascal & Toolbox .... ea. $59
MICROSOFT All products .... CALL
DIGITAL RESEARCH All products .... CALL
BORLAND All products .... rom $39
SOFTSTYLE Printworks $36
NORTON Utilities 9
QUAID Copywrite, Disk Explor .... CALL
CENTRAL POINT Copy II PC $35
FASTBACK by 5th Generation $115
ATI Training $55

PROGRESSIVE
MICRO
DISTRIBUTORS
3039 Amwiler Road, Atlanta, Georgia 30360

ROBOTIC TACTILE SENSING

BY KIRK E. PENNYWITT

Coming to grips with tactile sensors

TODAY'S INDUSTRIAL ROBOTS perform a variety of tasks, and robotic applications are steadily increasing. Nevertheless, robots currently in use are quite primitive; at best, they possess only a rudimentary awareness of their surroundings. As a result, they are generally limited to performing precisely defined tasks in a highly structured environment.

The controlled environment of a factory floor is considerably different from the unstructured and complex world in which most humans live and work. The robots of the future should be able to adapt to any work environment because it is often not practical to adapt the environment to them. Robots of the future should also be able to work with the same tools and equipment—conventional wrenches, hammers, pliers, screwdrivers, and so on—that human workers use. For robots to achieve these goals and attain more widespread use, they must be equipped with more sophisticated sensory capabilities that resemble those of a human.

Of the five human senses, only vision and touch are really required for a successful and adaptable robot. (Although hearing could be useful for the reception of oral commands by a robot, it is not a truly necessary capability. The use of ultrasonic ranging techniques has been investigated for proximity sensing, but interference from the loud noises common in an industrial environment remains an obstacle.)

VISION AND TOUCH

The capabilities of vision and touch are generally seen as complementary for most future robotic applications. Vision is obviously important for object identification and obstacle avoidance. It is considered a prerequisite process for locating, positioning, and identifying objects and also as a proximity sensor for the robot hand or end effector. Touch, or tactile sensing, then takes over for subsequent manipulations in which force, pressure, and compliance are important factors.

For many applications, the sense of touch is often considered more important than vision during manipulation. A robot must be able to judge when contact is made with an object and know how much force is being exerted upon that object.

A robot should also be able to determine when slip is beginning to occur and when the object is positioned properly in its intended location. In the past, greater attention has been devoted to visual sensing, but robotic touch is now beginning to attract more attention.

In this article I will provide an overview of robotic touch sensing, some of its problems, and some of the more promising approaches.

TACTILE SENSING

In robotic applications, we are concerned with tactile sensing, or *taction*, rather than simple touch. The term taction was coined by the late Professor Leon D. Harmon of Case Western Reserve University, one of the pioneers of tactile-sensing research.

Tactile sensing is defined as the continuous sensing of variable contact forces, commonly by an array of sensors. This sensing should be capable

(continued)

Kirk E. Pennywitt is a research engineer at Georgia Tech Research Institute (Electronics and Computer Systems Lab, Command and Control Division, Atlanta, GA 30332). He works in the areas of computer-based decision support systems, videodisc and computer-graphic software, and robotic tactile sensing.

of being performed within an arbitrary three-dimensional space. This distinguishes taction from touch, or binary sensing, which is simple contact or force sensing at a single point. Tactile sensing generally refers to skinlike properties where areas of force-sensitive and displacement-sensitive surfaces are capable of reporting graded signals and parallel patterns of touching.

Tactile sensing may be viewed as a two-step process: (1) transduction and (2) data processing. Transduction occurs when the features of an object being examined are converted into signals of some form, as in the case of the translation of forces into electrical impulses. Data processing then interprets these signals to obtain useful information about the features of interest.

Since it is often stated that a robotic tactile sensor should have capabilities similar to that of human touch sensing, we should briefly examine human tactile perception.

KINESTHESIA VERSUS CUTANEOUS RESPONSES

Human tactile perception consists of two separate and distinct components: *cutaneous* and *kinesthetic* responses. The cutaneous response conveys touch, force, slip, and temperature information via the sensitive nerve arrays on the fingertips. This type of capability is what is usually thought of when considering robotic tactile sensing.

The kinesthetic response plays a very significant role in the sense of touch. Kinesthesia is the sensing of limb and joint position. It includes both *afferent* incoming signals developed at muscles and joints and *efferent* outgoing signals that are *motor* muscle action commands.

The combined cutaneous and kinesthetic senses are sometimes referred to as *haptic* perception. Together, cutaneous and kinesthetic stimulation allow a person to perceive objects of three dimensions and events in three-dimensional space.

Cutaneous sensations provide the perception of texture and details of shape. Kinesthesia allows the detection of larger contours and enables a person to control exploratory movements. Cutaneous stimulation and kinesthesia must work together for an organism (or robot) to be able to actively explore and perceive its tactile environment. Current research in robotic taction focuses almost exclusively on the cutaneous aspects of touch. Since a satisfactory approach to the development of a cutaneous-like sensor has yet to be achieved, it is perhaps premature to be overly concerned with the lack of attention devoted to the kinesthetic aspects of touch sensing. However, it is impor-

(continued)

COMPUTER WAREHOUSE

CALL TOLL FREE 1-800-528-1054

FREE FEDERAL EXPRESS Air Express Shipping
See Details Below

HARDWARE

SPECIAL Zenith Computer Products — SAVE Up to 50%

PRINTERS

Anadex All Models .... Call
Brother All Models .... Call
Cannon Laser Printer $2099
Citizen MSP-10 .... $255
MSP-15 .... $349
MSP-20 .... $319
MSP-25 .... $489
Datasouth All Printer Models .... Call
Diablo D-25 .... $549
635 .... $1079
Other Printer Models .... Call

EPSON
All Printer Models .... Call

Juki 6000 .... $169
6100 .... $349
6300 .... $679
NEC 2010, 2015, 2050 .... $629
3510, 3550 .... $989
3515 .... $1009
3530 .... $935
8810, 8830, 8850 .... $1379
P2, P3 .... Call
Elf 360 .... $399
Elf370 .... $389

OKIDATA
All Printer Models .... Call

Panasonic 1091 .... $235
1092 .... $349
1093 .... $429
KXP3151 .... $409

STAR MICRONICS
All Printer Models .... Call

Silver Reed
EXP400 Parallel $205
EXP500 Parallel or Serial $279
EXP550 Parallel or Serial $389
EXP770 Parallel or Serial $699

Toshiba P1340 Parallel or Serial $439
P351 Parallel $969

DISKETTES

Maxell MD-2 Plastic Box (Qty 100) .. $158
Sony MD/2 (Qty 100) $158

MONITORS

Amdex All Monitors .... Call
NEC All Monitors .... Call
Princeton Graphics .... Call
Taxan All Models .... Call
Zenith All Models .... Call

VIDEO TERMINALS

Altos Smart III $599
IBM 3161 & 3163 Series .... Call
Qume QVT Green 101 .... $299
QVT Amber 101 .... $314
Wyse 30 .... $299
50 .... $419
75 .... $559
Wyse 85 .... $579
Wyse 350 .... $859
Zenith Z-22 .... $455
Z-29 .... $599
Z-49 .... Call

MODEMS

AT&T
4000 External $309
Anchor Automation
Anchor Express $229

HAYES
All Modems .... Call

Novation Smart Cat Plus $279
Prometheus All Models .... Call
US Robotics Courier 2400 .... $389
Password 1200 .... $189
Microlink 2400 .... $389

COMPUTERS

ZENITH
Z-158 All Models .... Call
Z-138 All Models .... Call
Z-148 All Models .... Call
Z-171 .... Call
Z-200 .... Call

DISK DRIVES

Alpha Omega Turbo 10 .... $529
Turbo 20 .... $529
Turbo 30 .... $729
Everex All Hard Disks .... Call
Haba Macintosh 400K $279
Macintosh 800K $409
Iomega
Bernoulli Boxes for IBM .... Call
Bernoulli Boxes for Macintosh .... Call
Paradise Macintosh Hard Disk .... Call

BOARDS

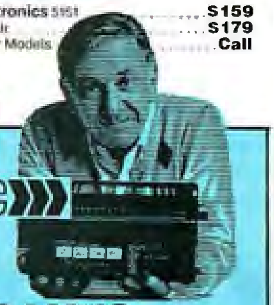
AST Advantage $389
Six Pack Plus $219
Everex Boards .... Call
Hercules Color Card $149
Graphic Card $299
Paradise Modular Graphic 06-1 .... $259
Five Pak $119
Quadram
Quadlink $325
Tec Mar Graphics Master $445
Captain No Memory $155

PLOTTERS

Enter Sweet-P600 .... $749
Epson Hi-80 .... Call

KEYBOARDS

Keytronics 5151 .... $159
5151 Jr $179
Other Models .... Call



COPIERS

Canon ((PC))
Canon PC-10 .... $509
Canon PC-14 .... $649
Canon PC-20 .... $719
Canon PC-25 .... $939

XEROX
1020 w/Toner $1099

SANYO
SFT 600 .... $609

SOFTWARE

IBM PC and 100% Compatibles

Gem Collection ... $115
Gem Desktop $29
GemDraw .... Call

LANGUAGES

C Compiler (Microsoft) $235
Fortran Compiler (Microsoft) $209
Macro Assembler $89
Pascal Compiler (Microsoft) $178
Turbo Pascal 3.0 .... $35
Lattice C Compiler .... Call
Run C Interpreter $85
Quick Basic $59
Turbo Tool Box $28

PROJECT MANAGEMENT

Harvard Total Project Manager $239
Microsoft Project .... Call
Super Project $182
Timeline 2.0 .... $249

COMMUNICATIONS

CompuServe Starter Kit $17
Crosstalk XVI $94
PFS Access $78
Remote $94

INTEGRATIVE SOFTWARE

Enable 1.1 .... $329
Framework .... Call
Smart Software System $459
Symphony .... Call

TRAINING

Flight Simulator $30
Typing Instructor $29
Typing Tutor III $29

GRAPHICS

Chartmaster $206
PC Paintbrush $62
Turbo Graphix Tool Box $28
Diagram Master 190
Dr. Halo $55
Energraphics $165
Energraphics w Plotter Option $214
Microsoft Chart $172
PC Draw $203
PC Draw Light Pen $104
PC Paint w Mouse $123
PC Mouse w Paintbrush $107
PFS Graph $78
Printmaster $30
Signmaster $135

WORD PROCESSORS

Leading Edge Word Processor $50
Leading Edge W/Pwith Spell & Mail .. $137
Microsoft Word .... Call
Multimate 3.3 .... $206
PFS:Write $78
Wordstar w/Tutor $169
Wordstar Pro Pack $239

Word Perfect (Ver.4.1) $199
Wordstar 2000 .... $239
Wordstar 2000 Plus .. $285

UTILITIES

1 DIR $48
Copy II PC $19
Norton Utilities 3.1 .... $49
Sidekick $28
Sidekick (Unprotected) $43
Sideways $31
Superkey $35
Printworks $36
Spotlight $43
Sidekick—Superkey (Bundle) $65

SPREADSHEETS

Lotus 1-2-3 .... Call
Multiplan $114
Spreadsheet Auditor 2.0 .... $83

Supercalc 3 (Ver.2.1) .. Call

MONEY MANAGEMENT

Dollars & Sense w/Forcast $95
Tobias Managing Your Money $95

DATA BASE MANAGEMENT

Cornerstone $255
dBase II .... Call
dBase III .... Call
Nutshell .... Call
PFS:File $78
PFS:Report $70
Quickcode $139
QuickReport $139
Extended Report Writer $80
Think Tank $93
Clipper $355
Knowledgeman II .... Call
Knowledgeman Upgrade Kit .... Call

R:Base 5000 ...... $335

Many other titles available.

We do not guarantee computer compatibility.

COMPUTER WAREHOUSE

Order Line: 1-800-528-1054
Order Processing: 602-224-9345

2222 E. Indian School Rd.
Phoenix, Arizona 85016
602-954-6109

Store Hours: Mon-Fri 10-5:30
Saturday 9-1
Order Line Hours: Mon-Fri 7-5:30
Saturday 9-1
Order Processing Hours: Mon-Fri 10-3

Prices reflect 3% to 5% cash discount. Product shipped in factory cartons with manufacturer's warranty. Please add $9.00 per order for UPS ground shipping. Orders 10 lbs. and under you pay for ground service, receive air service at no extra charge. Available on orders 11-30 lbs. $17 for air service. Prices & availability subject to change without notice. Send cashier's check or money order...all other checks will delay shipping two weeks.

VISA MasterCard AMERICAN EXPRESS CWF-1185

Inquiry 82 for MS-DOS Products. Inquiry 83 for all others.

tant to realize that both of these components should be integrated to develop a successful robotic tactile sensor.

Cutaneous sensations are conveyed by the skin. The skin's structure, sensitivity, and density of nerve-sensing sites vary considerably over the extent of the human body. Within the hand, the sensitivity may vary by an order of magnitude from the palm to the fingertip. The properties and sensory capabilities of fingertip skin most closely resemble those desired for robotic tactile sensors.

TACTILE RESOLUTION

Estimates of the spatial resolution of the fingertips vary from 0.8 to about 3 millimeters. The coarser estimates are based on two-point threshold tests, where two sharp points are pressed against the skin and the minimum separation distance required to determine that two points are being applied is measured. With this method, estimates of spatial resolution range from 2 to 3 mm.

Other methods of determining resolution include detecting gaps in a surface applied to the finger, determining the orientation of a fine grating, and identifying the forms of alphabetic characters. The last three methods yield resolution estimates closer to 0.8 mm. The higher resolutions obtained in these latter examples seems to indicate that when larger touch areas are involved, additional information is obtained that allows finer perceptions.

Tactile acuity is more than just a function of the sensory unit density. It also depends on the relative portion of the brain devoted to tactile representations and on the structure of the skin itself. It has been demonstrated that the brain region devoted to tactile processing can change and in turn alter tactile acuity.

Experiments on monkeys show that upon loss of a finger, the brain region devoted to the remaining fingers grows to include the region previously devoted to the amputated finger. The tactile acuity for the remaining fingers improves substantially. Moreover, the role of any individual nerve cell is believed unimportant; rather, networks of thousands of cells provide tactile response.

In addition, the structure of fingertip skin, particularly the papillary ridges (the raised ridges on the fingertips that produce fingerprints), may contribute to tactile perception. During fine movements of the fingers, the ridges create vibratory effects that propagate through the various skin layers, adding to tactile pattern recognition. These phenomena illustrate that the data-processing aspects of tactile sensing should be considered at least as important as the transduction concerns.

TACTILE SENSING VERSUS VISION

Tactile sensing is analogous to visual sensing in many respects. Both sample continuous signals over a two- or three-dimensional space and share a common model of the outside world. Both must employ pattern-recognition techniques to interpret the spatially sampled pattern representations of their environment. These similarities may allow tactile sensing to derive benefits from the considerably greater effort that has already been devoted to visual sensing.

However, taction has many advantages over vision for physical manipulation tasks, which, of course, include almost all commercial and industrial applications. With taction, the physical properties being directly measured are those we are most interested in—object position, shape, texture, surface detail, and so on. Vision can infer these properties only indirectly by deducing them from optical properties (shading, projection, reflectivity, etc.).

(continued)

The collection of tactile data is more readily controlled because the sensor is generally in actual physical contact with the object being examined. This eliminates potential problems involving uneven illumination, confusing background image information, or camera point-of-view constraints. There is also potentially less data to analyze in a tactile versus a visual representation. A tactile sensor is obviously ideal for pressure, slip, and incipient-slip detection as well.

On the other hand, tactile sensing involves several unique problems. With vision, the three-dimensional reconstruction of the object (based on the two-dimensional camera image) may be done by a powerful central processor that is remote from the sensor.

For taction to be useful, you must be able to actively manipulate and explore the object being examined. This requires not only the transduction to be performed at the object site but a large amount of real-time data processing to be performed there as well.

Because a visual sensor is remote from the subject at all times, it faces only moderate constraints on physical size and placement. However, a tactile sensor is normally an integral component of a robot end effector and thus must conform to strict size and shape constraints. In addition, the sensor itself must be capable of resisting abrasion, heat, and chemicals present in the industrial environment.

REQUIREMENTS OF A TACTILE SENSOR

The exact requirements of a particular tactile sensor depend on its specific application. However, there is a consensus among actual and potential robot users on the capabilities a general-purpose tactile sensor should possess.

The most commonly stated requirement is that the sensor be skinlike. It should exhibit high sensitivity, fast response time, continuously variable signal output, and low power consumption. It should also be cheap and durable.

The ideal end effector should be handlike. Touch, force, pattern, slip, and movement detection should all occur in one device. Forces transferred to the support structure should be used for analyzing larger signals (kinesthetic versus cutaneous sensing). Finally, the hand should be intrinsically "smart." That is, a significant amount of data preprocessing should be done at or near the sensor. Low-level data processing should take place at the sensor level, including detection of information regarding edges, holes, etc.

Most surveys of industrial robot

(continued)

Inquiry 103

"I Program In BetterBASIC And I Recommend It."

"Lifeboat Associates," has expanded its philosophy of endorsing structured programming languages to include a truly superior product—BetterBASIC. More than just a BASIC, BetterBASIC offers use of the full memory of the computer, true procedures and functions, modularity and more. BetterBASIC has the advantages of the C language on which Lifeboat built its reputation and appeals to the wide audience of programmers who already program in BASIC. I liked BetterBASIC so much, I decided "Lifeboat" should publish it. I program in BetterBASIC and I recommend it."

Dr. Edward Currie, President—Lifeboat Assoc.—New York, NY

640K Now you can use the full memory of your PC to develop large programs.
STRUCTURED Create well organized programs using procedures and functions that are easily identified and understood and completely reusable in future programs.
MODULAR Use procedures and functions grouped together to form "library modules" which are then available to you or anyone else for future use.
EXTENSIBLE Create your own BetterBASIC modules which contain BetterBASIC extensions. This feature coupled with the easy-to-use Assembly Language support, makes this an ideal OEM language.
INTERACTIVE BetterBASIC acts like an interpreter because it responds to the users' commands in an immediate mode. However each statement is actually compiled as it is entered.
COMPILED Each line of the program is compiled as it is entered into the computer's memory rather than interpreted at runtime.
RUNTIME SYSTEM The optional Runtime System generates stand alone EXE. files allowing for the distribution of products written in BetterBASIC with no royalties.
SUPPORTS Windows, Graphics, DOS and BIOS ROM calls, Chaining, Overlays, Local and Global Variables, Recursion ... and more.
BetterBASIC Runs on IBM PC, XT, AT and all IBM-compatibles. Ask your local dealer for BetterBASIC or call 1-800-225-5800 in Canada call 416-469-5244. Also available for the Tandy 1000, 1200, AND 2000 AT Tandy/Radio Shack stores.

Summit Software Technology, Inc.™
P.O. Box 99, Babson Park
Wellesley, MA 02157

PRICES:

BetterBASIC	$199
8087/80287 Math Module	$99
BTrieve™ Interface	$99
Runtime System	$250
Sample Disk with Tutorial	$10

Better BASIC.

Because It's The Best.

MasterCard, Visa, Checks, Money Order, C.O.D. accepted and P.O. on approval.

(If you're using BetterBASIC and would like to be featured in one of our ads, please write to the Director of Advertising at Summit.)

Inquiry 341

Prosthetic and orthotic needs for the handicapped are an important use for manipulators and tactile sensors.

users indicate that the spatial resolution required for a useful tactile sensor is approximately 1 mm. For a manipulator of the same approximate size as a human fingertip, this implies a sensor array of from 5 by 10 to 10 by 20 elements.

The sensor should have a sensitivity on the order of 1 gram and should have an upper-limit capability of approximately 1000 grams. (A logarithmic response would be satisfactory for most users.) Nonlinearity in the response of the sensor is generally tolerable because it can be compensated for in the data-processing software. Hysteresis in the sensing device, however, is absolutely intolerable. (Hysteresis is a characteristic of many materials whereby a physical parameter, such as electrical response, varies markedly depending on whether the phenomenon on which it depends is increasing or decreasing.)

A sensor's response should be stable and repeatable, and its response time should be short. The sensor transduction bandwidth requirements vary from 100 to 1000 hertz. That is, the data from the sensor should be updated at least every 10 milliseconds and preferably every 1 millisecond. (It is interesting to note that human touch is fairly hysteretic and that the transduction bandwidth ranges from 20 Hz for separate touches to several hundred Hz for vibration sensing.) The sensor must also be durable and capable of withstanding the rigors of an industrial environment.

Applications for tactile sensors include manipulation, teleoperation, and prosthetic and orthotic needs. Industrial uses include assembly, casting and molding, forging, grinding and polishing, heat treating, machining, painting, pouring, sorting, stacking, transporting, and welding. Many agencies, particularly the military, have uses requiring robots with tactile sensing capabilities. These include undersea exploration and salvage, prospecting, space-station operations, mining, and hazardous factory, power plant, and rescue operations.

Tactile sensing is ideally suited for use in obscured environments, such as murky water and smoky rooms. Teleoperated manipulators require accurate force feedback, stable grasping, position sensing, detection of slip, and light touch. This area of sensing has received surprisingly little significant attention.

Prosthetic and orthotic needs for the handicapped are another important use for manipulators and tactile sensors. These include artificial limbs for the amputee and sensing and assist devices for the paralyzed. The requirements for prosthetic and orthotic aids are primarily the same as for teleoperation: stable grasping, light touch, slip detection, and so on.

Half of the estimated 7,500,000 disabled persons in the U.S. could probably be helped to some degree with presently available robotics technology.

Despite the considerable list of needs for effective touch sensing, the present state of the art remains extremely primitive. Automated tactile sensing is at a very early stage of investigation, comprehension, and capability. Until very recently, touch feedback systems for robots and manipulators were quite simple and relatively crude.

Today's industrial systems still employ extremely simple devices; almost all of the more sophisticated, complex, and potentially useful tactile sensors are still in laboratory development, primarily in the academic or government environment (see table 1).

However, the transition from simple contact sensing to full robotic taction is under way. A great deal of research is currently being devoted to tactile sensing, and many promising approaches are being investigated.

Approaches

The design of a tactile sensor is influenced by its intended use. The major applications for tactile sensors can be divided into three general categories:

1. Simple pressure determination and slip sensing. These capabilities are necessary for the most common industrial applications of handling a workpiece without damage.
2. Determination of object orientation and position. This is required for more complex and unstructured applications, such as picking an object from a bin, orienting it into a new position, and assembling it with other objects.
3. Object identification or recognition. This feature is necessary for advanced applications in which a robot may be working in a totally unknown environment (such as undersea exploration) and may be required to classify or identify an object based solely on tactile sensations.

Each of these applications involves a different design approach and different computational requirements. The first application is technically the simplest to implement, and industry has found several workable approaches to it. The latter two applications are the most challenging, and it is on these applications that most of the current laboratory research is focused.

The mainstream of current tactile sensor research can be divided into three broad categories, distinguished by their fundamental principles of operation: sensors using electro-optical, piezoresistive, or piezoelectric properties.

Electro-Optic Tactile Sensors

Electro-optic sensors rely on the modulation of a light source by the

(continued)

Table 1: *A comparison of robotic tactile sensors and their characteristics.*

Sensor	Principle	Spatial Resolution	Bandwidth	Force Sensitivi	Load Range	Status	Advantages	Disadvantages
Ideal Sensor (Harmon Compilation)	—	1 mm	100-1000 Hz	1 gm	1-1000 gm	Hasn't been invented yet	General-purpose, no hysteresis, high resolution	None
Lord Tactile Sensor	Optic	1.8-7.6 mm	300 Hz	3 gm	0-681 gm	Commercial	Durable, little electromagnetic interference	Individual LED/ detector for each site limits ultimate resolution
MIT Sensor-Schneiter/ Sheridan	Optic	0.6 mm	30 Hz	N.A.	18:1 dynamic range	Experimental	Very high spatial resolution possible, little electromagnetic interference	Possibly high computational requirement, limited durability at present
Tactile Robotic Systems	Optic	2.5 mm	12 Hz	0.04 gm	256:1 dynamic range	Commercial	Low hysteresis, relatively inexpensive devices available for experimentation	Still relatively experimental
MIT Sensor-Purbrick	Conductive silicone rubber	2 mm	40 Hz	5 gm	5-100 gm	Experimental	Simple, inexpensive design	High hysteresis, nonlinearity
MIT Sensor-Hillis	Aniso-tropically conductive silicone rubber	0.6 mm	N.A.	5 gm	5-50 gm	Experimental	High resolution, inexpensive design	Hysteresis problems
Barry Wright Corporation Sensoflex Tactile Sensor	Conductive elastomer	1.3 mm	30 Hz	230 gm	200-50,000 gm	Commercial	Relatively low hysteresis, durable, wide load range, high repeatability	Relatively low sensitivity
Transensory Devices Inc.	Silicon strain gauge	2 mm	N.A.	10 gm	10-1000 gm	Commercial	Mature technology, low hysteresis, high repeatability	Fragile, brittle
University of Florida Induced Vibration Tactile Sensor	Piezoelectric	0.3 mm* (not yet real-time)	1 Hz	Not tested	Not tested	Experimental	Inexpensive, good for slip detection or exploration	No static response, highly experimental
University of Pisa Sensor	Piezoelectric	3 mm	100 Hz	20 gm	20-80,000 gm	Experimental	Multipurpose temperature, vibration, and pressure sensing	Static response requires increased complexity of design

* Single-element sensor, high-resolution capability based on vibrational design concept.
N.A.: Information not available.

mechanical deformation of a flexible material. An elastic membrane often forms the touch surface and is usually chosen to be tough and durable. This type of sensor is generally a completely sealed unit and is thus impervious to most industrial contaminants.

Electro-optic tactile sensors may also be highly sensitive, providing a direct readout of the degree of mechanical deformation of their touch surface and are usually less susceptible to electromagnetic interference than other types of tactile sensors. Two tactile sensors based on electro-optics are commercially available, and they represent the two most common optical approaches.

The Lord Corporation of Erie, Pennsylvania, presently markets a line of tactile sensors designated as the LTS-100, LTS-200, and LTS-300. All are based on the same principle and differ primarily in sensing area and resolution. The Lord Tactile Sensor is made up of three major components: a touch surface, a transduction array, and an electronic interface and control.

The touch surface is an elastomeric pad that contacts an object to be examined. The transduction medium consists of an array of LEDs (light-emitting diodes) and phototransistor pairs.

The light from the LED is projected across a small gap and is received and converted into an electrical current by the phototransistor. When the touch surface comes into contact with an object, a pinlike projection on the underside of the touch surface protrudes into the transduction area. This projection is forced downward into the gap between the light emitter and detector and progressively blocks the light from the LED emitter (see figure 1).

The current generated by the light detector is inversely proportional to the degree of deflection of the transduction medium. The amount of force applied at a site may be determined by the properties of the elastomeric touch surface.

The Lord LTS-100 sensor consists of an 8 by 8 array of LED/phototransistor pairs providing a total of 64 sensitive sites for pattern information. Each site is sensitive only to normal loads, and the electrical signal generated at each site is digitized to an 8-bit value to provide gray-scale information.

Photo 1 shows the LTS-100 and a sample output image. The site-to-site spacing of this sensor is 7.62 mm, and the deflection range at each site is from 0 to 1.52 mm, corresponding to 0 to 681 grams. The 7.62-mm resolution of this sensor is relatively coarse, although its sensitivity of 3.18 grams per deflection increment is fairly good.

Deflection information for the entire array is scanned and output approximately every 3 milliseconds. The LTS-200A sensor provides higher resolution by using an array of 10 by 16 sensitive sites on 1.80-mm centers. However, these sites are only digitized to 4-bit values, which reduces their sensitivity.

The Lord sensor is a durable and rugged unit. However, since the design requires that each sensitive site be equipped with its own light emitter/receiver pair, which must be individually scanned, the ultimate resolution of the sensor is limited by the physical size of the sites and the complexity of the electronics required to interpret the signals received.

(continued)

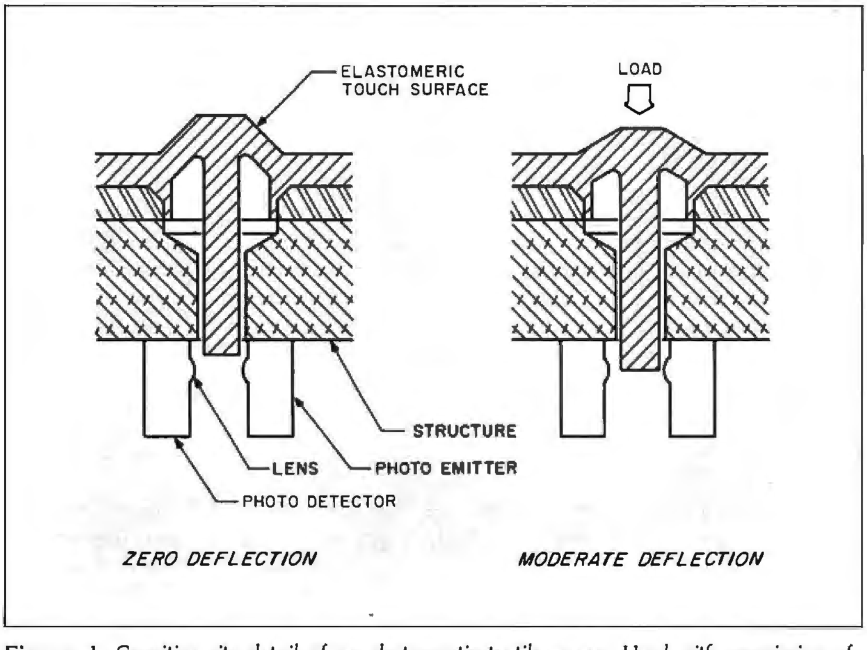


Figure 1: *Sensitive site detail of an electro-optic tactile sensor. Used with permission of Lord Corporation, Erie, Pennsylvania.*

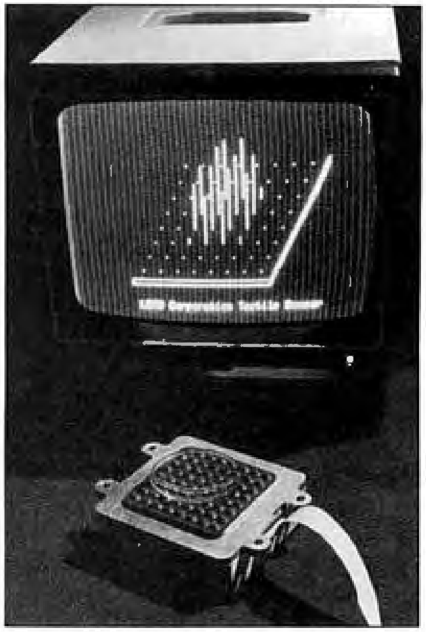


Photo 1: LTS-100 *sensor with display of tactile impression. Used with permission of Lord Corporation, Erie, Pennsylvania.*

Betcha our compiler can beat up your compiler.

Or your money back.

If you program in BASIC, Pascal, Fortran or C, you're using yesterday's technology. We know this statement will start a brawl, but it's true. So, before you start a fight you can't win, take a closer look at the Modula-2 language and the Modula-2 Software Development System (M2SDS) from Interface Technologies. Just compare the features and performance of M2SDS to your system. You'll find a new language and a programming environment that's more flexible, much faster and works on any IBM® PC or 100% compatible with 256 K memory or more.

	M2SDS
COMPILE SPEED (MIN:SEC)	
30 LINES	*0:15.58*
300 LINES	*0:25.48*
EXECUTION SPEED (MIN:SEC)	
SIEVE	*0:13.92*
FIBONACCI	*0:53.49*
30X30 MATRIX (8087)	*0:08.84*
FP OPERATIONS	*0:27.56*
FP OPERATIONS (8087)	*0:01.97*
SYNTAX CHECKING EDITOR	*YES*
MULTIPLE WINDOW EDITING	*YES*
EDITOR FILESIZE LIMIT	*MEMORY SIZE*
COMPILE ERROR CALLS EDITOR	*YES*
LINKER	*YES*
PRODUCES .EXE FILES	*YES*
EXECUTABLE CODE SIZE LIMIT	*DISK SPACE*
DOS ACCESS FROM EDITOR	*YES*
DOS ACCESS FROM PROGRAMS	*YES*
8087 SUPPORT STANDARD	*YES*
COPY-PROTECTED DISK	*NO*
COST WITH 8087 SUPPORT	*$50.88/$80.88*

Source: Software Resources, Inc.
Sieve program from BYTE, January 1983.
Fibonacci program from Dr. Dobb's Journal, February 1985.
Matrix program from BYTE, October, 1982.
FP Operations program from BYTE, May 1985.
M2SDS with or without 8087 uses 8-byte accuracy.
Programs compiled with all checking options on.
All tests conducted on a standard IBM-PC/XT with 512K of memory and an 8087 math coprocessor.

Trade In and Trade Up. Just to prove that we're not all brag... we'll send you M2SDS for just $50.88 if you mail us your present compiler or interpreter diskette.* That's $30.00 off the regular price. If within 30 days you're not programming faster than ever, just return the diskette and we'll send you your money back. So you've got a no risk way to experience the programming efficiency of the future.

Heavyweight Champion SDS-XP. If you're ready to move into light-speed, you need SDS-XP. It has everything M2SDS has with a little "punch" added. Like Extended Libraries, M2MAKE and a Foreign Object Module Importer. SDS-XP offers buyers a stout discount when compared with the cost of buying M2SDS and the additional components as add-ons. For a limited time only, SDS-XP is available for $99.00 with compiler trade-in. That's $150.00 off the advertised price of $249.00.

**Original or back-up diskette may be sent for trade-in. Diskette will be destroyed immediately upon receipt so that your current compiler license agreement is not violated.*

IBM is a registered trademark of International Business Machines Corporation.

Calling All Compilers. So now that you're wise to the limitations of your system, why not trade it in. You'll soon see that it was smarter to switch than fight. And a pretty safe bet.

INTERFACE TECHNOLOGIES

3336 Richmond Ave., Suite 200
Houston, Tx 77098

1-800-922-9049

(In Texas, call 713/523-8422) Telex: 322127
Modula-2 Bulletin Board: 713/523-7255

Here's my diskette. Rush me:

☐ M2SDS for $50.88 each, plus $7 shipping and handling.

☐ SDS-XP for $99.00 each, plus $7 shipping and handling.

Or, send me:

☐ M2SDS for $80.88 each, plus $7 shipping and handling.

☐ SDS-XP for $249.00 each, plus $7 shipping and handling.

☐ My check is enclosed.
☐ Apply charges to credit card indicated below:

VISA/MasterCard/American Express (circle one).

Credit Card # ____________

Expiration Date ____________

Signature ____________

Name ____________
(please print)

Shipping Address ____________

____

City ____________

State/Zip ____________

Day Phone ____________

Texas residents add 6.125% Sales Tax.
International orders add $30 for shipping/handling.
If paying by check, check or draft must be in U.S. dollars drawn on a U.S. bank.

INTERFACE TECHNOLOGIES CORPORATION
3336 Richmond, Suite 200, Houston, Texas 77098

A tactile sensor based on the use of fiber optics is illustrated by research performed at MIT by John L. Schneiter and Thomas B. Sheridan. In this approach, light is transmitted through a bundle of fiber optics to an elastic reflective surface. The light reflected back from this surface is transmitted through another bundle of fiber optics to a video camera. The camera's output is digitized and made available to a computer for processing.

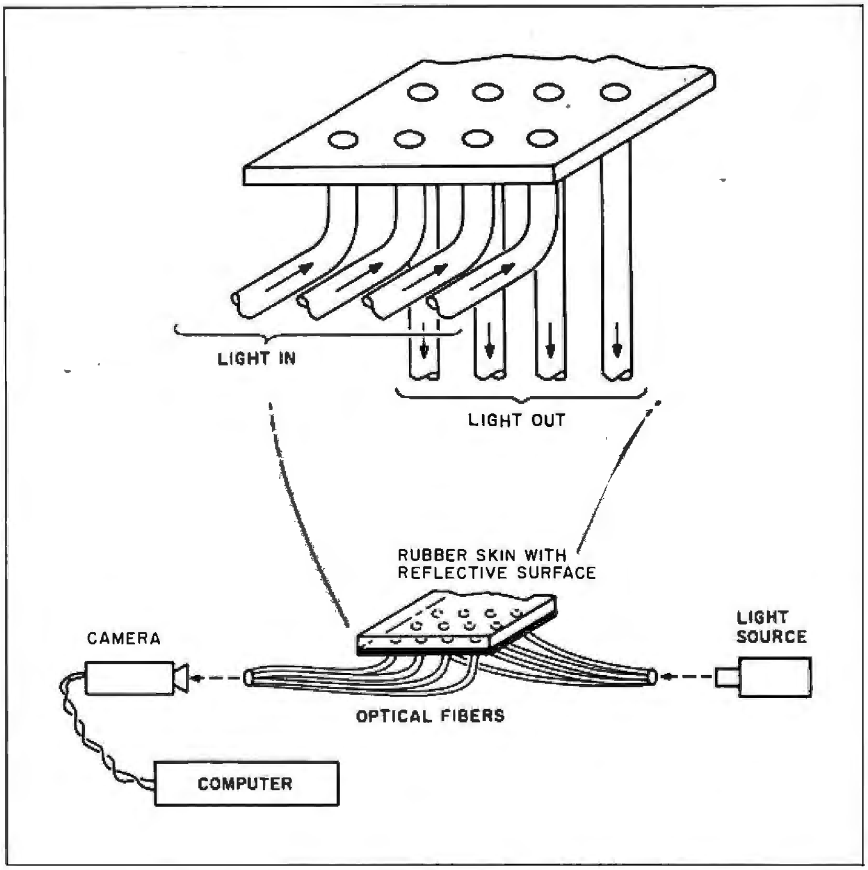


Figure 2: A *tactile sensor based on the use of fiber optics, designed by* John L. *Schneiter and Thomas* B. *Sheridan. Reprinted from* Robotics and Computer-Integrated Manufacturing. *Courtesy of Pergamon Press.*

When pressure is applied to the deformable reflector, the intensity of the light transmitted through the individual fibers changes. This information can be converted into a visual image by the computer. (The Jet Propulsion Laboratory in Pasadena, California, has developed a tactile sensor based on the same principle; however, the JPL sensor uses individual photodetectors for each of 16 fiber-optic sensors in a 4 by 4 array.)

The touch surface of the MIT sensor consists of a layer of white silicone rubber that acts as a deformable reflector. This layer is bonded to a layer of clear elastomer, to which the fiber-optic bundles are attached. Various methods of transmitting and receiving the light have been experimented with.

In one case, individual fibers were paired into emitting and receiving layers. This design, illustrated in figure 2, was somewhat difficult to fabricate because of the requirement that half the fibers be directed to the light source and the other half to the video camera.

A different design, shown in figure 3, uses each fiber for both emitting and receiving. In this implementation,

(continued)

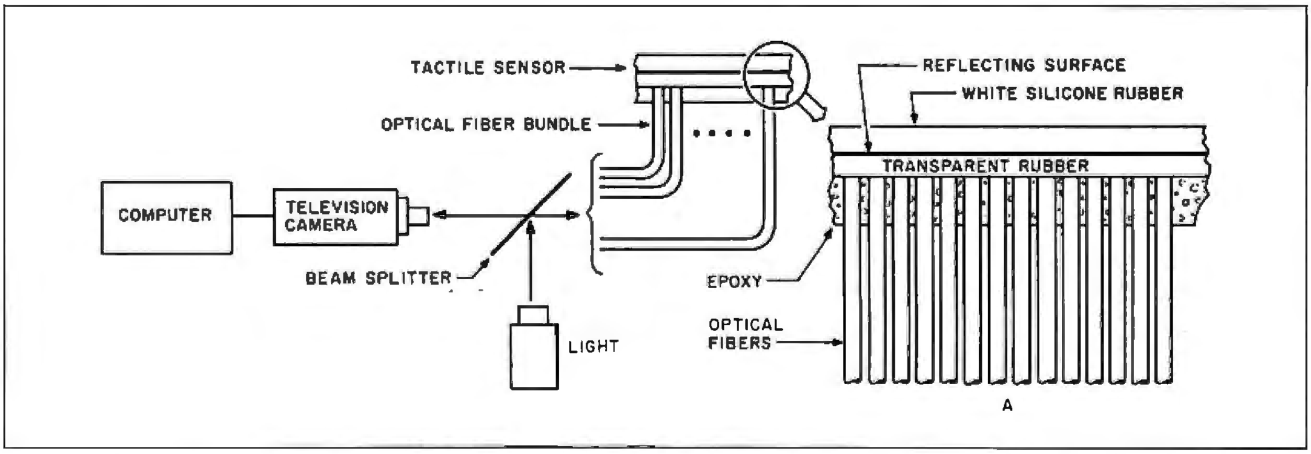


Figure 3: A *fiber-optic-based tactile sensor that uses each fiber as both emitter and receiver. Reprinted from* Robotics and Computer-Integrated Manufacturing. *Courtesy of Pergamon Press.*

TODAY IF YOU COME IN SECOND, YOU'VE LOST THE RACE.

It may have been good enough in a Soapbox Derby,® but these days there is no second place.

Fortunately there's a new way to get a jump on your competition. Introducing Amiga.™ The first personal computer that gives you a creative edge.

Amiga makes charts and graphs with more color and dimension than any other personal computer (and faster than most of them). But that's just a start. You can prepare presentations with stereo music and animation, slide shows, create package designs, instruction manuals, brochures.

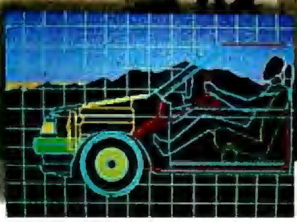
Amiga can not only do many more tasks, it can do more of them at once. And work on all of them simultaneously. While you're preparing the spreadsheet, Amiga will print the memo. And there's probably enough power left over to receive a phone message or a stock quote over a modem at the same time.

You won't find a computer that's easier to use, either. You point at symbols with the mouse or use keyboard commands if you prefer. Only Amiga is built to give you a choice.

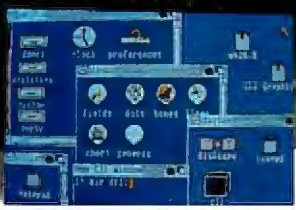
Amiga has twice the memory of an IBM® PC. But although it can run rings around IBM, it will also run IBM programs. You have instant access to the largest collection of business software in the industry, including old standbys like Wordstar® and Lotus® 1,2,3. Amiga is more powerful than Macintosh,™ too, and more expandable. With an optional expansion module you can add memory up to 8 megabytes. And while it can do much more than Macintosh or IBM, Amiga costs less than either of them.

See an Authorized Amiga Dealer near you. Now that Amiga is here, the question isn't whether you can afford a computer, it's whether you can afford to wait.

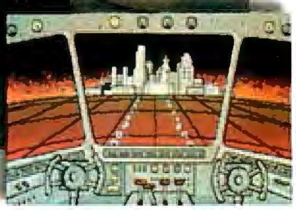
Amiga by Commodore



Amiga can help you design anything, from autos to atoms.



Like you, Amiga can do many things at once.



Amiga's color graphics leave the competition far behind.

AMIGA GIVES YOU A CREATIVE EDGE.

light is directed from the light source to a beam splitter. At the beam splitter, 75 percent of the light is transmitted straight through and is lost. The other 25 percent is directed into the fiber-optic bundle and transmitted to the reflector. This light is then reflected from the reflector back into the bundle, where it again passes through the beam splitter (with 75 percent transmission) to the video camera. In this way, each fiber acts a both an emitter and a receiver, and fabrication is greatly simplified.

Because this type of sensor uses tightly packed bundles of optical fibers, extremely high spatial resolution is possible. The ultimate resolution of this type of device is limited only by the diameter of the individual optical fibers.

Schneiter and Sheridan have reported usable spatial densities of over 2100 sensitive sites per square inch, which is roughly equal to a resolution of better than 0.6 mm. The device is also completely immune to electromagnetic interference and can be used in environments that would harm computers by simply routing the fibers from the sensor to a remote location.

The prototype device is currently limited by a reaction time of 33.33 milliseconds (based on the video camera refresh rate), a somewhat restricted dynamic range of 18 to 1, and a touch surface that wears out fairly rapidly (after a few hundred cycles). It is also important to note that very high spatial resolutions, like those attained in this design, often require increased computational requirements as well.

A commercial tactile sensor combining features of both the Lord and the MIT optical sensors is available from Tactile Robotic Systems of Sunnyvale, California. The company's highest-resolution sensor consists of a 16 by 16 array of sensitive sites spaced approximately 1.3 mm apart. Each sensing site is composed of a very small cantilever spring that protrudes through a metal plate. An optical fiber passes beneath each sensing site.

The fiber has a small gap cut in it so that the two cut ends look at each other across a small air space. Light is passed through the fibers from an array of LEDs along one side of the sensor and is received by phototransistors along the opposite side. When pressure is applied to a sensing site, the cantilever spring pushes one end of the optical fiber out of alignment with the other fiber, thus diminishing the amount of light received by the photodetector at the opposite end of the fiber.

This arrangement is similar to the Lord approach, but it can provide a potentially higher spatial resolution because the light emitters and detectors are located along the sides, rather than within the interior, of the sensor array. Also, whereas the Lord sensor relies on the properties of its elastomer surface to provide the force-versus-displacement calibration, the Tactile Robotic Systems device uses the metal cantilever spring to provide a more stable and predictable spring constant.

The sensor can be calibrated to determine loads ranging from 10 to 1000 grams per sensing site. Each sensing site can resolve approximately 256 discrete steps, so the sensitivity of an individual site can be as high as 10/256 grams, or approximately 0.04 grams. The data response time of the sensor is restricted by the hardware and software of the personal computer it is interfaced to and is currently limited to a scan rate of 3 kHz for each site, or approximately 12 Hz over the entire array.

Piezoresistive Tactile Sensors

The category of piezoresistive tactile sensors is quite broad and includes

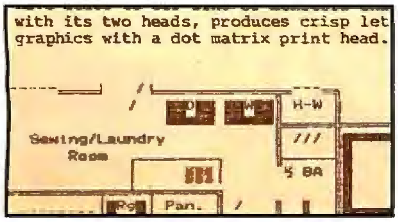
(continued)

THE DUAL HEAD PRINTER

THE FORTIS DH45, THE START OF A NEW BUSINESS GENERATION

DAISY OR DOTS... *Have it your way. Don't settle for one or the other... get both.*

The revolutionary **FORTIS DH45** *dual head printer combines the speed and bit image graphics of a dot matrix with a high quality daisy wheel for crisp letters. All this in one compact unit that saves desk space and at a price that is less than you would pay for one printer. It is also compatible with IBM* PC and most other personal computers.*



Imagine the advantage of having two heads in one printer. Need graphics or condensed print spreadsheets or a rough draft of a long letter, just touch the control panel. How about important correspondence to impress a potential client, again, just touch the control panel to switch to the letter quality daisy wheel. Indeed, the old saying **TWO HEADS ARE BETTER THAN ONE**, *really holds true in the* **DH45.**

*IBM is a registered trademark of IBM Corp

FORTIS Dynax, Inc.™

DYNAX, INC. OFFICES

- **HEADQUARTERS** 6070 Rickenbacker Rd., Commerce, CA 90040 • (213) 727-1227
- **NEW JERSEY** One Madison St., East Rutherford, NJ 07073 • (201) 471-0100
- **TEXAS** 6012 Campus Circle, Suite 250, Irving, TX 75062 • (214) 257-1700
- **ILLINOIS** 415 West Golf Rd., Suite 48, Arlington Heights, IL 60005 • (312) 228-0707
- **MASSACHUSETTS** 400 W. Cummings Park, Suite 5300, Woburn, MA 01801 • (617) 933-8162
- **N. CALIFORNIA** 683 West Maude Ave., Suite A, Sunnyvale, CA 94086 • (408) 730-1712

Inquiry 114

YES! Please send me more information on the FORTIS DH45 Dual Head Printer

Name ____________ Title ____________

Company ____________ Phone ____________

Address ____________ City ______ State ______ Zip ______

Mail to: **DYNAX, INC. Customer Service / FORTIS DH45**
6070 Rickenbacker Road, Commerce, CA 90040

Inquiry 243

a multitude of different device types and approaches. These range from simple strain gauges and solid-state silicon devices to conductive elastomers and foams. They are all included in this single category because all rely on materials whose electrical conductivity varies as pressure is applied.

The use of conductive elastomers as the basis for a tactile sensor has been studied for some time. A conductive elastomer is simply an elastic, rubberlike material that has electrically conductive properties. Many different conductive elastomer or conductive foam materials have been experimented with, but most sensor designs use an approach similar to that used by John Purbrick of the MIT Artificial Intelligence Laboratory.

Purbrick noted that if a flat, hard conductor is pressed against another that is rounded and compressible, the area of the electrical contact will vary according to how hard the first conductor is pushed. The greater the pressure, the larger the contact area formed and the lower the electrical resistance.

Strings of conductive silicone rubber with a semicircular cross-section were formed into two identical sets of 16 parallel lines. These were aligned perpendicular to each other and placed into contact to form a 16 by 16 array. This created 256 nodes where the convex surfaces of both sets of cords touched. An automatic scanning system passed a current into the array along a horizontal string and out across a vertical string, one combination at a time.

It was possible to measure the resistance of each of the 256 contact points in the grid approximately 40 times per second. Purbrick's device was able to distinguish at least 10 different amounts of pressure in a range from 5 to 100 grams.

William D. Hillis, also of the MIT Artificial Intelligence Laboratory, extended this approach by using sheets of a material known as anisotropically conductive silicone rubber (ACS). ACS has the useful property of being conductive along only one axis in the plane of the sheet.

A flexible printed-circuit board was etched into fine parallel lines so that it, too, was conductive in only one direction. The etched-circuit board and the ACS were placed into contact, with the lines on the printed-circuit board oriented perpendicular to the ACS axis of conduction. The contact points at each intersection of the perpendicular conductors form the pressure sensors. A springy nylon mesh (made from pantyhose material) was used to separate the contacts after pressure was released.

The array was scanned electronically to determine the applied pressure at each contact point. Hillis's device was a 16 by 16 array over a 1-square-centimeter area. It was able to reliably measure pressures ranging from 5 to 50 grams per square millimeter.

Barry Wright Corporation of Watertown, Massachusetts, markets a commercial tactile sensor based on the research of Purbrick and Hillis. However, the Barry Wright sensor uses a proprietary elastomer material, rather than silicone compounds.

The Sensoflex Tactile Sensor is currently available in two models, one made up of a 16 by 16 site array on 0.1-inch centers and the other an 8 by 16 array on 0.05-inch centers. The sensor is scanned on a row/column basis, and the output is digitized to an 8-bit value. The sensor can be scanned at rates up to 30 times per second and is designed for recommended loads ranging from 0 to 75 pounds per square inch. Barry Wright Corpora-

(continued)

For Further Information

Cholakis, Peter N. "Tactile Sensing for End Effectors." SME Seminar on Robotic End Effectors, March 1984.

Dario, Paola, and Danilo De Rossi. "Tactile Sensors and the Gripping Challenge." *IEEE Spectrum*, August 1985.

Fox, J. L. "The Brain's Dynamic Way of Keeping in Touch." *Science*, vol. 225, no. 4664, August 27, 1984, pages 820–821.

Hapgood, Fred. "Inside a Robotics Lab: The Quest for Automatic 'Touch.'" *Technology Illustrated*, April 1983, pages 18–22.

Harmon, Leon D. "Automated Tactile Sensing." *The International Journal of Robotics Research*, vol. 1, no. 2, Summer 1982.

Harmon, Leon D. "Touch Sensing Technology: A Review." Case Western Reserve University, SME Technical Report MSR80-03, 1980.

Hillis, William Daniel. "Active Touch Sensing." Massachusetts Institute of Technology Artificial Intelligence Laboratory, A.I. Memo 629, April 1981.

Kowalski, Carl. "Silicon Succeeds in Touch Sensing." *Robotics Today*, April 1985.

McMillan, William W. "The Robot's Sense of Touch: Some Lessons from Human Taction." *Proceedings of the* 1984 *Computer Science Conference*. New York: The Association for Computing Machinery, February 1984.

Nevill, G. E., Jr., E. F. Schildwachter, and K. L. Doty. "Alternative Skin Geometries and Materials for Induced Vibration Touch Sensors." Gainesville, FL: University of Florida, June 1985.

Patterson, Robert W. "Development of a Dynamic Touch Sensor." Ph.D. Dissertation. Gainesville, FL: University of Florida, 1985.

Purbrick, John A. "A Force Transducer Employing Conductive Silicone Rubber." First Robot Vision and Sensors Conference, 1981.

Rebman, J., and M. W. Tull. "A Robust Tactile Sensor for Robotic Applications." *Proceedings of the* 1983 *International Computers in Engineering Conference and Exhibit*, American Society of Mechanical Engineers, August 1983.

Schneiter, John L., and Thomas B. Sheridan. "An Optical Tactile Sensor for Manipulators." *Robotics and Computer-Integrated Manufacturing*, vol. 1, no. 1, 1984, pages 65–71.

"Tactile Robotic Systems Inc. Product Information Sheet" and personal communication. Sunnyvale, CA: Tactile Robotic Systems Inc., August 21, 1985.

A Printer For All Reasons

Search For The Best High Quality Graphic Printer

If you have been looking very long, you have probably discovered that there are just too many claims and counter claims in the printer market today. There are printers that have some of the features you want but do not have others. Some features you probably don't care about, others are vitally important to you. We understand. In fact, not long ago, we were in the same position. Deluged by claims and counter claims. Overburdened by rows and rows of specifications, we decided to separate all the facts — prove or disprove all the claims to our own satisfaction. So we bought printers. We bought samples of all the major brands and tested them.

Our Objective Was Simple

We wanted to find that printer which had all the features you could want and yet be sold directly to you at the lowest price. We didn't want a "close-out special" of an obsolete product that some manufacturer was dumping, so we limited our search to only those new printers that had the latest proven technology. We wanted to give our customers the best printer on the market today at a bargain price.

The Results Are In

The search is over. We have reduced the field to a single printer that meets all our goals (and more). The printer is the SP-1000 from Seikosha, a division of Seiko (one of the foremost manufacturers in the world). We ran this printer through our battery of tests and it came out shining. This printer *can* do it all. Standard draft printing at a respectable 100 characters per second, and with a very readable 12 (horizontal) by 9 (vertical) character matrix. This is a full bi-directional, logic seeking, true descender printer.

"NLQ" Mode

One of our highest concerns was about print quality and readability. The SP-1000 has a print mode termed Near Letter Quality printing (NLQ mode). This is where the SP-1000 outshines all the competition. Hands down! The character matrix in NLQ mode is a very dense 24 (horizontal) by 18 (vertical). This equates to 41,472 addressable dots per square inch. Now we're talking ***quality*** printing. It looks like it was done on a typewriter. You can even print graphics using the standard graphics symbols built into your computer. The results are the best we've ever seen. The only other printers currently available having resolution this high go for $500 and more *without* the interface or cable needed to hook up to your computer.

Features That Won't Quit

With the SP-1000 your computer can now print 40, 48, 68, 80, 96, or 136 characters per line. You can print in ANY of 35 character styles including 13 double width and 3 reversed (white on black) styles. You not only have the standard Pica, Elite, Condensed and Italics, but also true Superscripts and Subscripts. Never again will you have to worry about how to print H_2O or X^2. This fantastic machine will do it automatically, through easy commands right from your keyboard. Do you sometimes want to emphasize a word? It's easy, just use **bold** (double strike) or use *italics* to make the words stand out. Or, if you wish to be even more emphatic, underline the words. You can combine many of these modes and styles to make the variation almost endless. Do you want to express something that you can't do with words? Use graphics with your text — even on the same line. You have variable line spacing of 1 line per inch to infinity (no space at all) and 143 other software selectable settings in between. You can control line spacing on a dot-by-dot basis. If you've ever had a letter or other document that was just a few lines too long to fit a page, you can see how handy this feature is. Simply reduce the line spacing slightly and ... VOILA! The letter now fits on one page.

Forms? Yes!
Your Letterhead? Of Course!

Do you print forms? No problem. This unit will do them all. Any form up to 10 inches wide. The tractors are adjustable from 4 to 10 inches. Yes, you can also use single sheets. Plain typing paper, your letterhead, short memo forms, labels, anything you choose. Any size to 10" in width. In fact this unit is so advanced, it will load your paper automatically. Multiple copies? Absolutely! Use forms (up to 3 thick). Do you want to use spread sheets with many columns? Of course! Just go to condensed mode printing and print a full 136 columns wide. Forget expensive wide-carriage printers and changing to wide carriage paper. You can now do it all on a standard 8½" wide page, and you can do it quietly. The SP-1000 is rated at only 55 dB. This is quieter than any other impact dot matrix printer that we know of and is quieter than the average office background noise level.

Consistent Print Quality

Most printers have a ribbon cartridge or a single spool ribbon which gives nice dark printing when new, but quickly starts to fade. To keep the printers output looking consistently dark, the ribbons must be changed quite often. The SP-1000 solves this problem by using a wide (½") ribbon cartridge that will print thousands of pages before needing replacement. (When you finally do wear out your ribbon, replacement cost is only $11.00. Order *#2001.)*

The Best Part

When shopping for a printer with this quality and these features, you could expect to pay around $500 or more. *Not now!* We sell this fantastic printer for **only $259.95! You need absolutely nothing else to start printing — just add paper.**

No Risk Offer

We give you a 2-week satisfaction guarantee. If you are not completely satisfied for any reason we will promptly refund your purchase. A 1-year warranty is included with your printer. The warranty repair policy is to repair or replace and reship to the buyer within 72 hours of receipt.

The Bottom Line

Be sure to specify the order # for the correct version printer designed for your computer.

Commodore C-64 & C-128, Order #2200, cable included

IBM-PC and compatibles, Order #2100, plus 8' cable #1103, $26.00

Standard Parallel with 36 pin Centronics connector, Order #2400, no cable

We also have interfaces and cables for other computers not listed. Call Customer Service at 805/987-2454 for details.

Shipping and insurance is $10.00 — UPS within the continental USA. If you are in a hurry, UPS Blue (second day air), APO or FPO is $22.00. Canada, Alaska, Mexico are $30.00 (air). Other foreign is $70.00 (air). California residents add 6% tax. The above are cash prices — VISA and MC add 3% to total. We ship the next business day on money orders, cashiers' checks, and charge cards. A 14-day clearing period is required for checks.

For information call 805/987-2454

TO ORDER CALL TOLL FREE

1-(800) 962-5800 USA
1-(800) 962-3800 CALIF. **(8-6 PST)**

or send order to:

APROTEK

1071-A Avenida Acaso
Camarillo, CA 93010

Inquiry 22 for End-Users. Inquiry 23 for DEALERS ONLY.

tion, manufacturer of the Sensoflex Tactile Sensor, claims that its product exhibits the characteristics of low hysteresis, fast response time, and high repeatability.

STRAIN GAUGES AS TACTILE SENSORS

Although careful material selection can minimize hysteresis and long-term creep, these effects will always be present to some degree in an elastomer material. Some researchers prefer to avoid these potential pitfalls by basing their sensor design on the more mature and proven technology of strain gauges.

In its simplest form, a strain gauge is a circuit that is capable of measuring very minute changes in the resistance of one or more of its components. When a force is applied to the gauge or to an object to which the gauge is attached, some parts of the gauge are subjected to tension or compression. This results in a small change in the physical dimensions of the gauge and can be quantified by the resultant change in the electrical resistance of the strain-gauge circuit. Strain gauges are available in a variety of shapes and sizes and offer the dual advantages of low hysteresis and low fatigue.

Transensory Devices Inc. of Fremont, California, is developing a tactile sensor based on solid-state silicon strain gauges. These miniature strain gauges allow for the relatively dense arrays of sensing sites generally considered necessary for an effective tactile sensor.

Each individual sensing site of the Transensory Devices sensor consists of a small box-shaped silicon element (called the mesa) that protrudes out of a silicon diaphragm. The mesa is capped with a protective square of hard plastic, and the whole assembly is bonded to a glass substrate housing the electrical connections. A rugged elastomer material covers the entire assembly for protection (see figure 4).

The mesa, diaphragm, and interface circuitry are all machined from a single piece of silicon wafer. In use, a 5-volt power supply provides a reference signal for the sensor, as well as power for the on-board logic circuitry. The sensor's output is an analog voltage that changes proportionally with the force applied to the sensitive area.

Two sensors have been developed and tested by Transensory Devices. One is a single-element sensor; the other is a 3 by 3 array of sensor elements spaced on approximately 2-mm centers. The present devices provide good linearity in force sens-

(continued)

ing and are designed to measure from 0 to 2 pounds of force. This design approach of miniature solid-state transducers offers great promise for future high-resolution sensors. However, the current silicon and glass sensor is both fragile and stiff and will require further refinements before it is suitable for widespread application in an industrial environment.

PIEZOELECTRIC TACTILE SENSORS

Piezoresistive sensors measure a change in electrical resistivity as a result of an applied force. Piezoelectric sensors are based on materials that *generate* an electrical response to an applied force. Piezoelectricity is a common phenomenon of crystalline materials such as quartz, and piezoelectric ceramics are in widespread use. However, the brittle nature of most common piezoelectric materials tends to make them unsuitable for tactile sensor applications.

A class of materials known as piezoelectric polymers offers considerable promise for tactile sensing. Piezoelectric polymers are, as the name implies, polymers that exhibit piezoelectric properties. They are rugged, durable, inexpensive, and available in thin flexible sheets that allow them to conform to complex contours.

Piezoelectric polymers may be formed into patterns of high-resolution arrays by either metalizing the polymer film through a suitable mask or by selectively etching a metalization previously deposited on the film. They are flexible, rugged, high-resolution, and inexpensive. These are some of the key characteristics of the ideal tactile sensor discussed earlier.

In addition to their piezoelectric properties, the polymers also exhibit pyroelectric characteristics. That is, they show a change in electrical response based on temperature as well as pressure stimuli. This can be a problem or an asset, depending on how it is dealt with. One piezoelectric polymer that is widely used in tactile sensor research is polyvinylidene fluoride, or PVDF. This material exhibits the desirable property of a relatively large and linear electrical response to an applied external force.

One problem with the use of PVDF or other piezoelectric materials in general is that the electrical response is inherently dynamic. That is, the material generates an electrical response only while it is being deformed. If a continuous, nonvarying load is applied to a PVDF sensor, the electrical signal generated by the load will soon decay to zero.

THE DYNAMIC-MOTION PRINCIPLE

Researchers at the University of Florida dealt with that potential problem by developing a sensor based entirely on dynamic motion. The concept of a sensor based on the vibrations induced by sliding motion across a sample object was developed by Gale E. Nevill Jr. and Robert W. Patterson of the University of Florida.

This concept is based on the theory that the papillary ridges of the fingertips provide information that is useful in the identification of objects by touch. To investigate the theory, a tactile sensor was designed that would move across an object under examination.

The sensor is composed of two separate PVDF transducers. One transducer is oriented so that its direction of greatest electrical sensitivity is parallel to the direction of movement; the other is oriented transverse to that direction. The two transducers, oriented perpendicular to each other, are bonded together with nonconductive epoxy. The transducer assembly is then bonded to a silicone rubber pad.

The surface of the rubber pad is made up of a regular series of triangular ridges, meant to simulate the ridges on the human fingertip. Separate electrical leads from the parallel and transverse transducers are fed to a signal analyzer. The construction of the sensor allows for the separate analysis of the transverse and parallel vibrations induced by moving an object across the sensor.

In experimental use, objects are moved across the sensor at a constant speed via a rotating platform. When the sensor pad contacts an object, a measurement is made of the signal induced by both the transverse and parallel vibrations. This results in a signal spectrum of voltage versus frequency. Discrete values of the signal within certain bandwidths are used as parameters for a discriminate analysis pattern-recognition scheme.

During laboratory tests, sample objects are first moved across the sensor to establish a test template of parameters. Afterward, the sensor is able to recognize objects to which it has been previously exposed with almost 100 percent accuracy. It is capable of reading the Braille alphabet and can distinguish between different grades of sandpaper. It can tell

(continued)

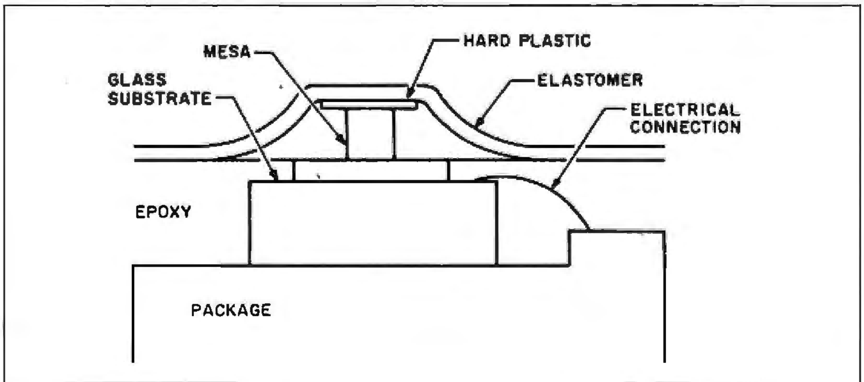


Figure 4: *The major components of a single-element tactile sensor that measures force normal to its surface. By permission of Transensory Devices Inc., Fremont, California.*

Look at what we're plugging now.

Plug-in Teacs.

We offer a full line of PC compatible components to increase your floppy storage, to add Winchester drives, or to include a streaming cassette

Our FD-55 Series, half-height, low power, 5¼-inch floppy disk the world-wide standard of excellence with over 3 million in serv... A quick and easy way to double your capacity.

Our MT-2st Kit is all you need to plug-in a streaming cassette back-up system. With 90 ips performance, you can store up to 20 megabytes of back-up incredibly quick.

Our PS-5250 subsystem is a completely self-contained, self-powered add-on that includes a 20 megabyte Winchester drive and a 20 megabyte streaming cassette back-up.

With Teac, adding on more storage capacity is an open and shut case.

Inquiry 348

Built To Fanatical Standards. TEAC.

INSTRUMENTATION AND COMPUTER PRODUCTS DIVISION, 7733 TELEGRAPH ROAD, MONTEBELLO, CA 90640
East (617) 475-7311 South/Midwest (312) 351-9124 Rocky Mountain (602) 242-4025 (303) 337-6329 (801) 532-2111
Northwest (408) 727-1427 Southern California (213) 726-0303

the difference between cylinders and spheres of varying sizes and can resolve differences between ball bearings spaced 0.25 inch versus 0.26 inch apart. It can also determine the features of an object under examination even if the speed with which it is scanned across the object is changed.

More recent experiments have identified materials for the surface pad that are more resistant to temperature and abrasion than the original silicone rubber pad. Further investigations are being performed to develop sensor arrays that offer increased spatial resolution. This type of sensor shows promise in applications that are primarily exploratory or object-identification-oriented. It also appears appropriate for use in slip detection.

However, since its output depends on dynamically induced vibrations, this type of sensor is unsuitable for conventional gripping applications unless wedded with another sensor design. Also, since the computer must know the sensor's relative speed of motion, there must be communication with another device capable of determining that speed. This is not necessarily a problem, since such information could be obtained from the movement of a robot arm attached to the sensor, but it is a consideration nevertheless.

P. Dario, D. De Rossi, P. C. Pinotti, R. Bardelli, and others at the University of Pisa in Italy have been involved for many years in developing an artificial, skinlike, tactile sensor capable of alleviating some of these problems.

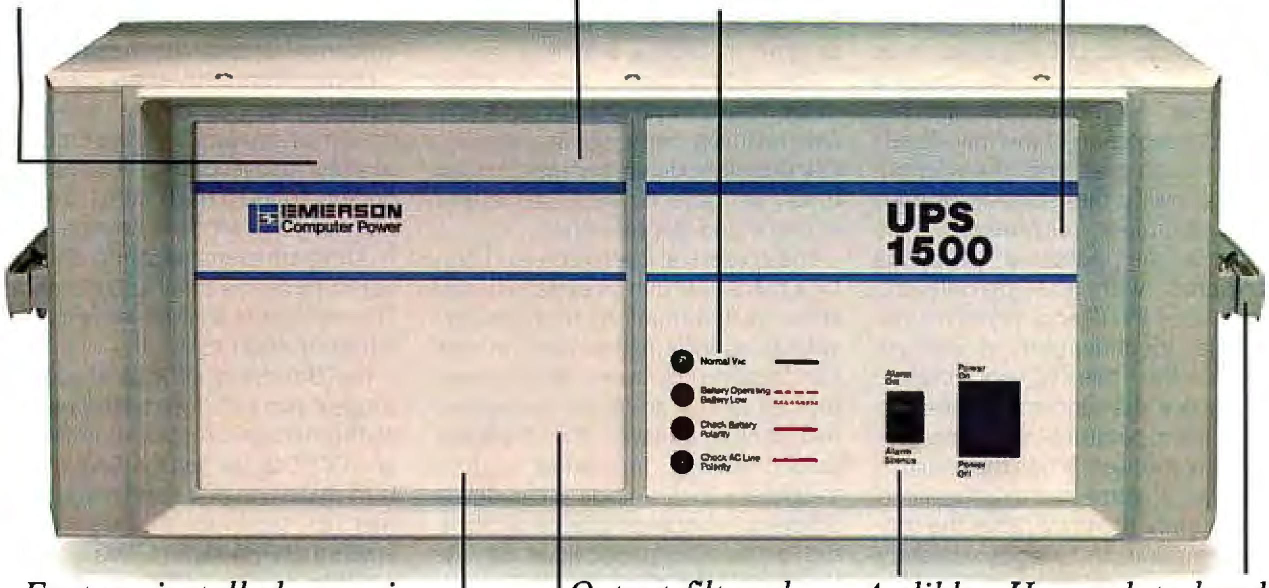
One of their designs attempts to reproduce the sensing properties of the human fingertip. The sensor consists of an outer *epidermal* layer and an inner *dermal* layer (see figure 5), each of which performs distinct sensing functions. The epidermal layer consists of a 40-micrometer-thick film of PVDF protected by a thin Mylar sheet.

Electrodes on the top and bottom of the epidermal PVDF film carry off any electrical charge to signal processing equipment. The underside of the PVDF layer is covered with a resistive paint and is backed by an elastomer layer. A 110-micrometer-thick PVDF film is attached to the underside of the elastomer layer. The lower PVDF layer serves as the dermal sensor and is bonded to a circuit board containing an 8 by 16 array of circular electrodes, spaced on 3-mm centers.

Any charge developed in the dermal PVDF layer is discretely measured by the closest electrode sites. The signals from the electrodes are consecutively scanned, fed into a charge amplification device, and measured. This design allows the sensor to measure gross pressure deformations in the epidermal layer and more highly resolved and localized defor-

(continued)

"Power Protection"



Announcing: AP1000 Series UPS
Full sine wave UPS for low power applications from Emerson, the Technology and Price Leader in Uninterruptible Power Systems

Your electronic equipment depends upon clean uninterrupted power. If that power is disturbed by "Black-outs", "Brown-outs", Spikes or Surges, your equipment could be damaged and memory lost. Your valuable system becomes worthless.

Do you have these?

P.C.'s, office computers, ATM's, PBX's, Point of Sale Terminals, Security Systems, or Test Equipment. They could be vulnerable to power-line disturbances.

Now they can be economically protected with the new Emerson AP1000 Series UPS with power ratings from 200-1500 watts and starting at $379. From 200VA to 4,000 KVA, Emerson has you covered.

For a free Technical Brochure and the Distributor/Dealer nearest you, call toll free 1-800-BACK-UPS. Emerson Computer Power, 3300 S. Standard St., Santa Ana, California 92702.

CALL
1-800-BACK-UPS
For Your Free Technical Brochure

EMERSON Computer Power

Inquiry 422 for End-Users. Inquiry 423 for DEALERS ONLY.

mations in the dermal layer.

The overall sensor dimension is approximately 1 by 2 inches. The elastomer layer between the two PVDF layers provides electrical insulation. In addition, the elastomer introduces a time delay of about 1 second between the detection of thermal signals in the epidermal and the dermal layers, allowing the isolation of thermally induced responses. This alleviates the potential problems associated with the pyroelectric response of PVDF and allows for the possible identification of objects based on their thermal conductance.

In practice, the sensor replicates the human's temperature- and pressure-sensing responses. When the resistive paint layer is connected to a regulated power supply, the paint raises the sensor's temperature to approximately 37° Celsius. When the tactile sensor touches an object, heat flows from the resistive layer through the PVDF epidermal sensor to the object. The rate of heat flow depends on the thermal properties of the object being touched. This allows metals, which have a high thermal conductivity, to be clearly distinguished from plastics or other insulating materials.

The dermal sensor array continuously measures varying contact forces over relatively dense sensing sites and can therefore detect geometrical features of objects such as edges, corners, and depressions.

The epidermal layer, protected only by a thin Mylar film, is extremely sensitive to deformations and can provide gross information only on contact location. However, when gently rubbed against an object, the epidermal sensor behaves like a phonograph needle, indicating surface roughness. In this mode, it can detect differences between grades of fabric, similar to the capabilities of the University of Florida sensor.

When pressed against an object and then released, the combined signals detected by the epidermal and dermal layers provide information on object hardness. When installed in a mechanical gripper, the sensor can determine object slippage based on microvibrations generated in the epidermal layer by the slipping object.

During laboratory tests, the sensor detected slips as small as a few hundred micrometers over the time span of a few milliseconds. The sensor has demonstrated a maximum load capability of 40 newtons (a newton equals 1 kilogram/meter/second) and can detect forces as small as 0.01 newton. This represents an impressive dynamic range of 4000 to 1.

The University of Pisa researchers suggest two solutions to the problem of the dynamic response limitations of a PVDF tactile sensor. One solution is to make use of a conductive elastomer to separate the dermal and epidermal PVDF layers. This elastomer can then measure continuous pressure in the same way as the conductive elastomer sensors described earlier.

Another solution is to send sound pulses from the lower to the upper PVDF layers. By measuring any differences in the travel time of the waves from the lower to the upper layer, the amount of compression can be determined and the pressure indirectly inferred. The University of Pisa sensor appears to offer great promise as a general-purpose tactile sensor combining many functions into a single device.

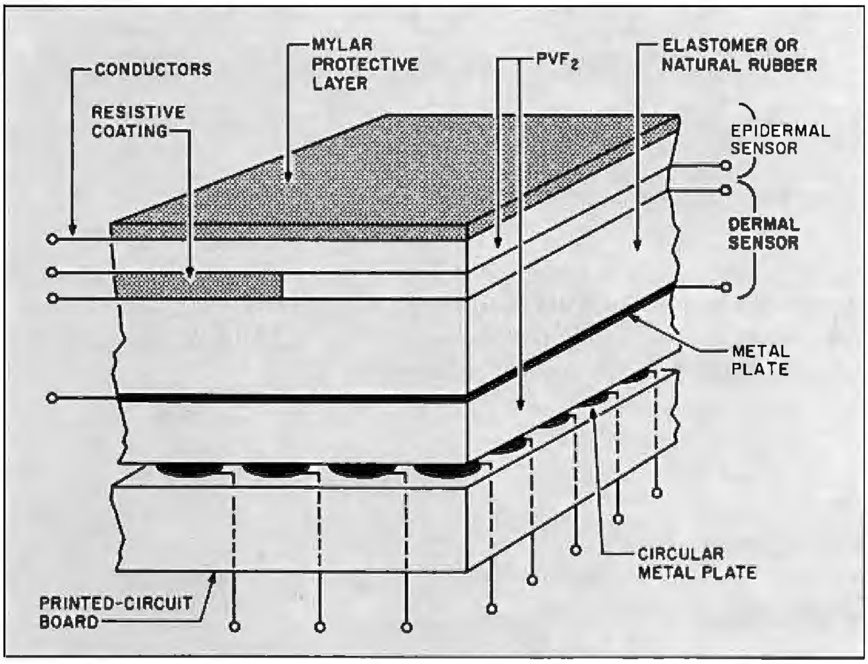
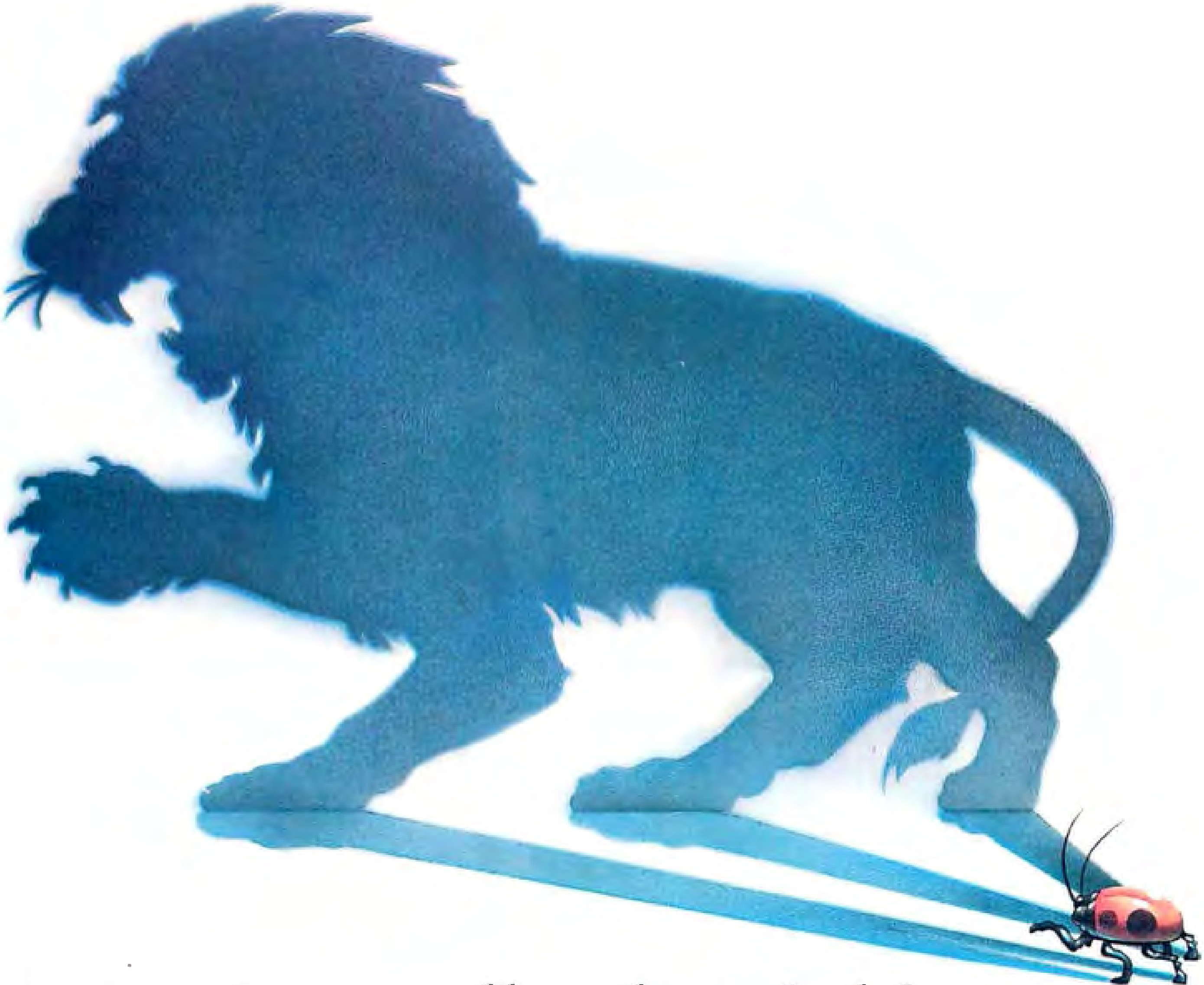


Figure 5: A *skinlike tactile sensor with an outer (epidermal) layer and an inner (dermal) layer. The sensor was developed at the E. Piaggio Center of the University of Pisa and at the Institute of Clinical Physiology of the Italian National Research Council. This figure is reprinted with permission of the IEEE and appeared in "Tactile Sensors and the Gripping Challenge" by Dr. Paolo Dario and Dr. Danilo De Rossi* (IEEE Spectrum, *August* 1985).

CONCLUSION

There are many approaches to tactile sensing that I have not covered. These include the use of ultrasound, magnetic induction, electrotopography, and other intriguing techniques. I have tried to identify many of the major concepts and stimulate ideas for future approaches.

The robotics designer should be aware of the trade-offs involved between the spatial density of a sensor array and its resultant computational requirements. Higher resolutions often require much greater data-processing capability. Also, it is important to remember that the intended use of the sensor plays a major role in its design. ■



Even the smallest bug is big game.

There are no insignificant bugs. They're often ferocious... and elusive!

That's why we built the better "bug hunter." The UDL (Universal Development Laboratory). It's actually an:

- Advanced 48-channel bus state analyzer
- 8/16 bit in-circuit emulator
- EPROM programmer
- Input stimulus generator

All packed into one, compact box for only *$2995.*

UDL turns almost any PC/MS-DOS and CP/M™ computer into a powerful, integrated workstation for hardware/software debugging. UDL's unique, real-time emulation lets you track bugs of 46 different target microprocessor "species," without buying expensive hardware adapters.

Access all four instruments through the same control program. Handle single-step debugging with the emulator. And quickly define a complex trigger spec, so the built-in logic analyzer can find those nasty, subtle bugs.

When your tested program is bug-free, plug a PROM into the socket. And with one command, simply write your program from emulation memory directly into the PROM.

Let our UDL simplify the hunt, and keep you quick on the trigger. If you're serious about bug hunting, find out how to qualify for a no-obligation, 10-day "safari" with UDL. Call: **800/245-8500** (or 415/361-8883 in California). Or write: 702 Marshall Street, 6th Floor, Redwood City, CA 94063.

ORION Instruments

Become a Professional Bug Hunter.

CP/M is a trademark of Digital Research.

MULTIPLE ROBOTIC MANIPULATORS

BY J. SCOTT HAWKER, R. N. NAGEL, RICHARD ROBERTS, AND NICHOLAS G. ODREY

Designing a task-oriented control system for multiple manipulators

WHEN CONFRONTED WITH issues related to robots, the average person generally envisions a device or system that is humanlike in form and possesses some human attributes. Robotic reality is quite different from this perception. Robots are generally not human in form and rarely possess human qualities or attributes. Robots in the industrial environment are, for the most part, very simple devices performing simple tasks. To date, few robots have been integrated to work together on the same task or even in the same workspace.

It appears on the surface that coordinating two robots is not a difficult assignment. This is not the case. To more fully appreciate the potential difficulties with coordinated performance, consider the requirements for holding a pencil or cylindrical object between the tips of two index fingers. This action requires that the two fingers exert a force on each end of the pencil or cylinder. These forces must support the weight of the pencil (see figure 1a). At the same time, the forces must be limited so they don't damage either the pencil or, from the human standpoint, the fingertips. This type of behavior clearly requires force sensors and coordinated control between the two fingertips.

Now let's add more complexity to the assignment. Consider the problem of holding one fingertip poised in space (fixing one end of the pencil) while moving the other fingertip in a circular path, causing the other end of the pencil to follow (figure 1b). A slightly more ambitious assignment would be moving both ends in circular paths simultaneously (figure 1c). Then, while rotating both pencil tips in circular paths, move or translate the pencil through space (figure 1d).

The three motions described require that the forces between the fingers and the positions of the fingertips be carefully controlled. We recommend that you attempt these motions (as shown in figures 1a through 1d) to appreciate the subtleties involved in moving the pencil through its paces.

It becomes apparent that a means of monitoring and controlling the applied force is needed. In addition, a means for setting, monitoring, and controlling the paths of the pencil's end points is required. Communica-

(continued)

J. Scott Hawker, who holds B.S.E.E. and M.S.E.E. degrees from Texas Tech University, is a graduate research assistant at the Institute for Robotics, Lehigh University, Bethlehem, Pennsylvania. He is now on leave from AT&T Bell Laboratories, studying robotics and manufacturing systems.

R. N. Nagel holds B.S. and M.S. degrees in mathematics from Stevens Institute of Technology and a Ph.D. in computer science from the University of Maryland. Dr. Nagel is the director of the Institute for Robotics at Lehigh University.

Richard Roberts holds a Ph.D. in mechanical engineering from Lehigh University. Professor Roberts is an expert in the areas of machine design and failure analysis.

Nicholas G. Odrey holds B.S. and M.S. degrees in aerospace engineering and a Ph.D. in industrial engineering. Dr. Odrey is the director of the Robotics Laboratory of the Institute for Robotics at Lehigh University.

All of the above authors may be contacted at the Institute for Robotics, Lehigh University, 200 West Packer Ave., Bethlehem, PA 18015.

tion channels and a minimum level of intelligence are required so that the proverbial left hand knows what the right hand is doing.

In addition to these requirements, the benefits of practice should have become obvious. As the tasks are repeated and the fingertips become more skilled, the coordinated motion becomes easier. This last feature, the ability to improve performance through trial, is especially important if a robot is to be a truly flexible, adaptable element in a factory environment.

DUAL-ARM STRUCTURE

Researchers at the Institute for Robotics at Lehigh University are now studying the philosophy and implementation of high-level, task-oriented control of dual-arm robots, as well as the design and low-level control of robotic arms. The dual-arm robot being described was designed as a research system capable of providing a variety of issues related to coordinated control of two or more robotic arms.

As we made individual design decisions, we always biased them to provide as challenging a set of problems as possible for the researcher. The dual-arm robot currently being constructed at Lehigh University consists of two movable robot arms attached to a rigid base. Each arm possesses seven degrees of freedom: three translational and four rotational. Figure 2 shows the structure and the various degrees of freedom of one of these arms.

Each arm is attached to the rigid base in a way that allows the attachment points to move with two degrees of freedom in a fixed vertical plane. The range of travel for coordinate axes is as follows: Translational axis 1 is 7 feet, translational axis 2 is 3 feet, and translational axis 3 is approximately 1½ feet. When fully extended, the robot hand can reach 55 inches from the vertical plane represented by coordinate translational axes 1 and 2.

The precise limitations of the angular travel of rotational coordinates 1, 2, and 3 are not known but are believed to be in the range of plus or minus 90 degrees. Rotational axis 4 can provide a full 360 degrees of rotation. With the ranges of travel noted for the translational and rotational axes of the two arms, a large work envelope can be addressed. This should provide ample space to confront the two arms with tasks that require coordinated motion.

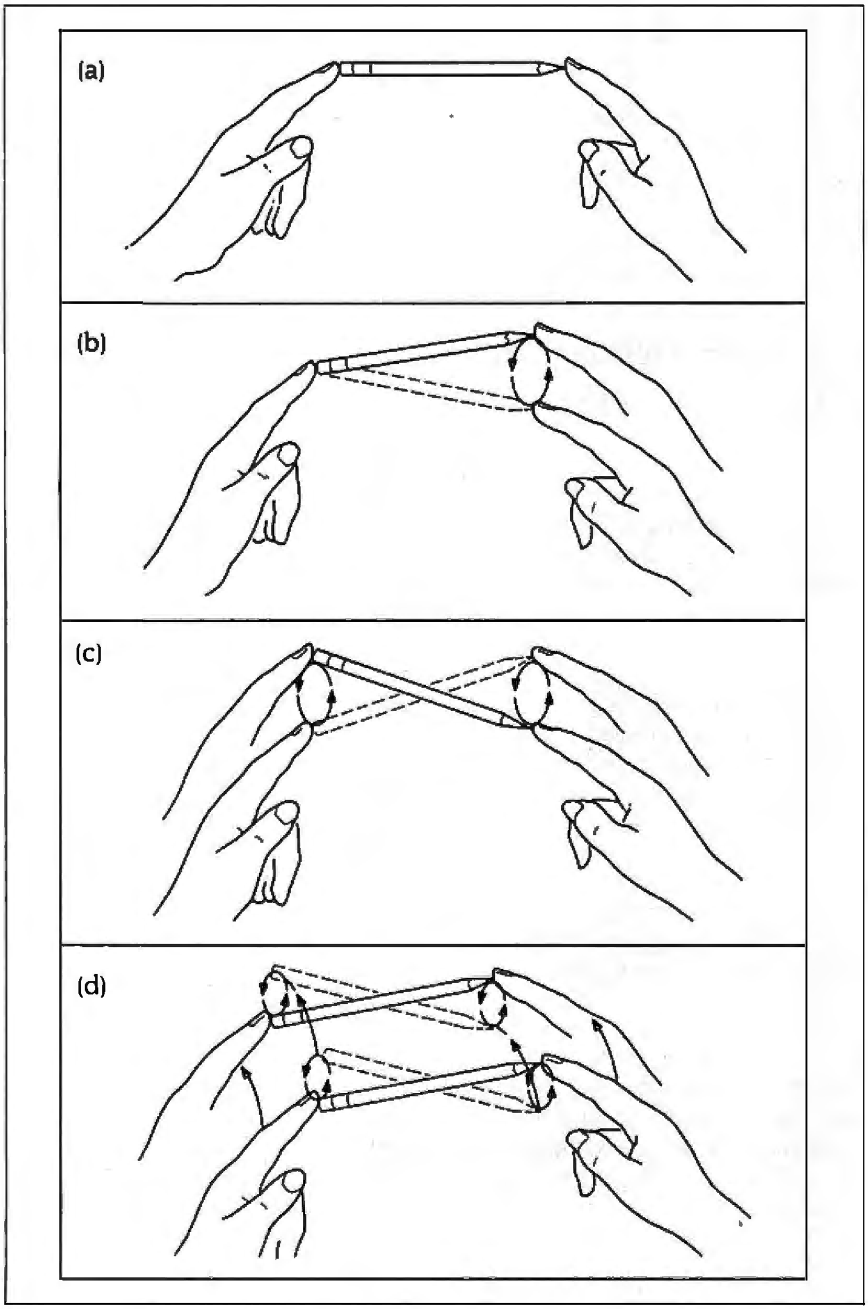


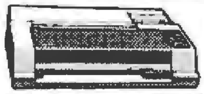
Figure 1: *The actions of two hands rotating a pencil and moving it through space.*

IMPLEMENTATION

We chose aluminum as the material for construction of the robot arms in order to minimize the weight of the arms and reduce the requirements of the driving actuator motors for the system (we designed each arm to han-

(continued)

Lyco Computer Marketing & Consultants



1091..........$233

SAVE ON THESE IN STOCK PRINTERS

SG-10.........$208

AXIOM SEIKOSHA
- GP550AT (Atari) 222
- GP550CD (C-64) 222
- GP700AT (Atari) 439
- GP700AP (Apple) 439
- ELITE5CD (C-64) 229

C. ITOH
- ProWriter 8510Sp+ 349
- 1550Sp+ 489
- StarWriter 769
- PrintMaster 929

TOSHIBA
- P1340 469
- P351+ 1149
- P341P 969
- P341S 999
- 351 Sheet Feeder 529

CARDCO
- 32K BUFFER..(C-64) 59

CORONA
- LP300 Laser Printer 2686
- 200361 Toner Cartridge 89

EPSON
- FX85 (New) 333
- LX80 212
- FX185 (New) 464
- LX90 (New) 226
- SQ2000 (New) 1555
- JX80 467
- Homewriter 10 193
- CR-20-Atari 153
- CR-220-C-64 153
- DX-10 (New) 207
- DX-20 (New) 297
- HS-80 (New) 288
- LQ1500P 975
- LQ1500S 1039
- RX-100 356
- FX-100+ ...... CALL

CITIZEN
- MSP-10 269
- MSP-15 358
- MSP-20 337
- MSP-25 495
- Sheetfdr (10/20) 189
- Sheetfdr (15/25) 199

OKIDATA
- Okimate 10 179
- Okimate 20 ...... CALL
- 182 214
- 192 348
- 193 563
- 92P 349
- 93P 565
- 84P 645
- 92 Imagewriter 349

*IBM versions also

BROTHER
- HR-15XL-P 359
- HR-15XL-S 359
- HR-35P 839
- HR-35S 839
- 2024L-P 949
- M1009-P 189

JUKI
- Juki 6100 347
- RS232 Serial Board 55
- 6100 Tractor 119
- 6100 Sheet Feeder 209
- Juki 6300 757

LEGEND
- 880 188
- 1080 222
- 1380 262
- 1385 296
- LEGEND 808 159

DIGITAL DEVICES
- 16K BUFFER 75
- 32K BUFFER 89
- 64K BUFFER 125

DIABLO
- D25 549
- 630 API 1599
- 630 ECS 1759
- D 80 1F 2395
- P 32 CO1 699
- P 38 1749
- C 150 999
- DX-35 (NEW) ...... CALL
- AP-80 ...... CALL

PANASONIC
- 1091 233
- 3131 (NEW) 269
- 1092 373
- 1093 426
- 3151 Letter 426
- 4K Buffer 65

SILVER REED
- EXP400 249
- EXP500 295
- EXP550 399
- EXP770 749

STAR MICRONICS
- SG-10 208
- SG-15 373
- SD-10 336
- SD-15 442
- SR-10 483
- SR-15 583
- SB 10 595
- Power Type 303
- SG-10 C-64 (NEW) ...... CALL

MONITORS

TAXAN
- 115 12" Greeen Composite ...... CALL
- 116 12" Amber Composite ...... CALL
- 121 12" Green TTL 135
- 122 12" Amber TTL 145
- 220 14" Color Composite 259
- 410 12" RGB Hi Res IBM 329
- 420 12" RGB Super Hi IBM 409
- 440 12" RGB Ultra Hi Res 555
- Tilt Stand 35

ZENITH
- ZVM 122A Amber 75
- ZVM 123G Green 75
- ZVM 124 Amber IBM 129
- ZVM 131 Color 275
- ZVM 133 RGB 389
- ZVM 135 Composite 449
- ZVM 136 Hi Res Color 589
- ZVM 1220 95
- ZVM 1230 95
- ZVM 1240 149

TEKNIKA
- MJ-10 Composite 179
- MJ-22 RGB 255

AMDEK
- 300 Green 118
- 300 Amber 128
- 310 Amber IBM 155
- Color 300 Audio 234
- Color 500 Composite 369
- Color 600 397
- Color 700 495
- Color 710 569

PANASONIC
- DT1300D 13" RGB/Composite 247
- DTM140 14" RGB/Composite 329
- DTH103 10" RGB Hi Res 395
- DTS101 10" Composite 175
- DT1000G 10" RGB 166
- TX12H3P 12" Color 419
- TR120M1PA 12" Green 109
- TR120MBPA 12" Amber 109
- TR122M9P 12" Green IBM 148
- TR122MYP 12" Amber IBM 148

SAKATA
- SG 1000 12" Green 99
- SA 1000 12" Amber 109
- SG 1500 12" Green TTL 119
- SA 1500 12" Amber TTL 129
- SC 100 13" Color Comp 209
- SC 200 13" RGB 389
- STS1 Tilt Stand 29

NEC
- JB-1260 Green 95
- JB-1201 Green 135
- JC 1215 Color 235
- JC 1216 RGB 375
- JC 1460 Color 265

X-TRON
- Comcolor 1 Composite Green 177

PRINCETON GRAPHICS
- MAX-12 Amber 185
- HX-12 RGB 465
- SR-12 RGB 595

MODEMS

HAYES
- Smartmodem 300 133
- Smartmodem 1200 377
- Smartmodem 1200B 347
- Smartmodem 2400 598
- Micromodem IIE 135

MICROBITS
- 1064Modem 57

TELE LEARNING
- Total Telecommunications (C-64) 29.95
- AP-250 (300 Baud Apple) 69.95
- IB-250 (300 Baud IBM) 69.95

US ROBOTICS
- Password 1200M 229
- Password 1200F 229
- Password 300M 139
- Password 300F 139
- Autodial 212A 359
- PCM5 319
- PCM64 519
- PCM256 769
- S-100 379
- Courier 469
- Microlink 469
- Telpac Ms-DOS 79

NOVATION
- IBM 300/1200 MS-DOS ext 319
- IBM 300/1200 CPM-86 ext 319
- IBM 300/1200/2400 ext 529
- IBM 300/1200/2400 MS-DOS 579
- IBM MS-DOS int 325
- IBM CPM-86 int 325
- Macmodem 300/1200 315
- Upgrade Apple Cat II 225
- Cat 300 Acoustic 139
- J-Cat RS232 89

ANCHOR
- Volksmodem 55
- Volksmodem 12 188

DRIVES

INDUS
- GT ATARI 215
- GT COMMODORE 235

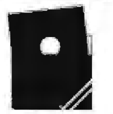
MSD
- SD1 Drive (C-64) 229
- SD2 Drive (C-64) 469

COMTEL
- Enhancer 2000 (c-64) 179

TANDON
- 320K 5¼" Drive 115

DISKETTES

DENNISON
- ELEPHANT 5¼" SSSD 11.99
- ELEPHANT 5¼" SSDD 12.99
- ELEPHANT 5¼" DSDD 14.99
- PREMIUM 5¼" SSDD 13.99
- PREMIUM 5¼" DSDD 15.99



VERBATIM
- 5¼" SSDD 13.99
- 5¼" DSDD 19.99

BONUS
- 5¼" SSDD 9.99
- 5¼" DSDD 12.99

IBM-PC COMPATIBLE

*LOTUS
- Lotus 1-2-3 ...... 309.00
- Symphony 439.00

ITT XTRA XP Personal Computer!
- *256K 2 Drive System ...... CALL
- *256K 10 Meg Hard System ...... Call

BRODERBUND (IBM)
- Bank St. Writer 48.95
- The Print Shop 34.95
- Graphics Library I 22.95
- Lode Runner 22.95
- Ancient Art of War 27.95
- Champ Lode Runner 22.95

MICROPROSE (IBM)
- F-15 Strike Eagle 20.75
- Solo Flight 20.75
- Hellcat Ace 20.75
- Spitfire Ace 18.75

*LEADING EDGE
- Nutshell 69.95
- LEWP Basic 65.00
- LEWP Merge Print 99.00
- LE Spell Correction 169.00

TOLL FREE 1-800-233-8760

MasterCard

TO ORDER

CALL TOLL FREE
800-233-8760
Customer Service 1-717-327-1825

VISA

or send order to
Lyco Computer
P.O. Box 5088
Jersey Shore, PA
17740

RISK FREE POLICY

In-stock items shipped within 24 hours of order. No deposit on C.O.D. orders. Free shipping on prepaid cash orders within the continental U.S. Volume discounts available. PA residents add sales tax. APO, FPO, and international orders add $5.00 plus 3% for priority mail service. Advertised prices show 4% discount for cash, add 4% for MasterCard or Visa. Personal checks require 4 weeks' clearance before shipping. Ask about UPS Blue and Red label shipping. All merchandise carried under manufacturer's warranty. Free catalog with order. All items subject to change without notice.

dle a total load of 5 pounds).

Both stepper motors and servo motors are used for driving the robot arms. The three translational axes and the first rotational degree of freedom are powered by stepper motors. The drivers for the remaining three rotational degrees of freedom and the motor that actuates the hand are servo motors.

We based the decision to mix the types of motors on size and power requirements, delivery schedules, and cost. In addition to these factors (and probably just as important) was the desire to provide the designers of the low-level controls with the different challenges presented by each motor type. All of the stepper and servo motors are equipped with position sensors so that the motions of the arms can be measured. In addition to the positional sensors, each hand will be equipped with a force sensor so that the forces exerted by the hand can also be measured.

Controlling two arms to cooperate in accomplishing one task is more complex than controlling two arms to accomplish two independent tasks. Nevertheless, it is very important that adequate, independent, single-arm control mechanisms be in place for each of the two arms so that their motions and applied forces can be controlled within the motion constraints specified. These single-arm controllers can then be extended and coupled to form an integrated dual-arm controller.

Since dual-arm control is an extension of single-arm control, we will first describe the common approaches to and requirements of single-arm control. We will highlight the single-arm control problems that are not adequately solved and will assume that answers to these problems will be applicable to dual-arm control.

Single-Arm Control

In order to provide a clear understanding of the goals of single-arm control, our discussion will consider a robotic arm to be very much like a human arm: a series of connected mechanical links or "bones" that allow the end of the last link (the end effector or "hand") to be placed at some position and orientation in space. The energy that causes the motion of the arm comes from actuators or "muscles" that drive the motion of each mechanical "joint" to achieve the desired pose, motion, or force of the end effector.

A control computer is normally used to generate the particular ac-

(continued)

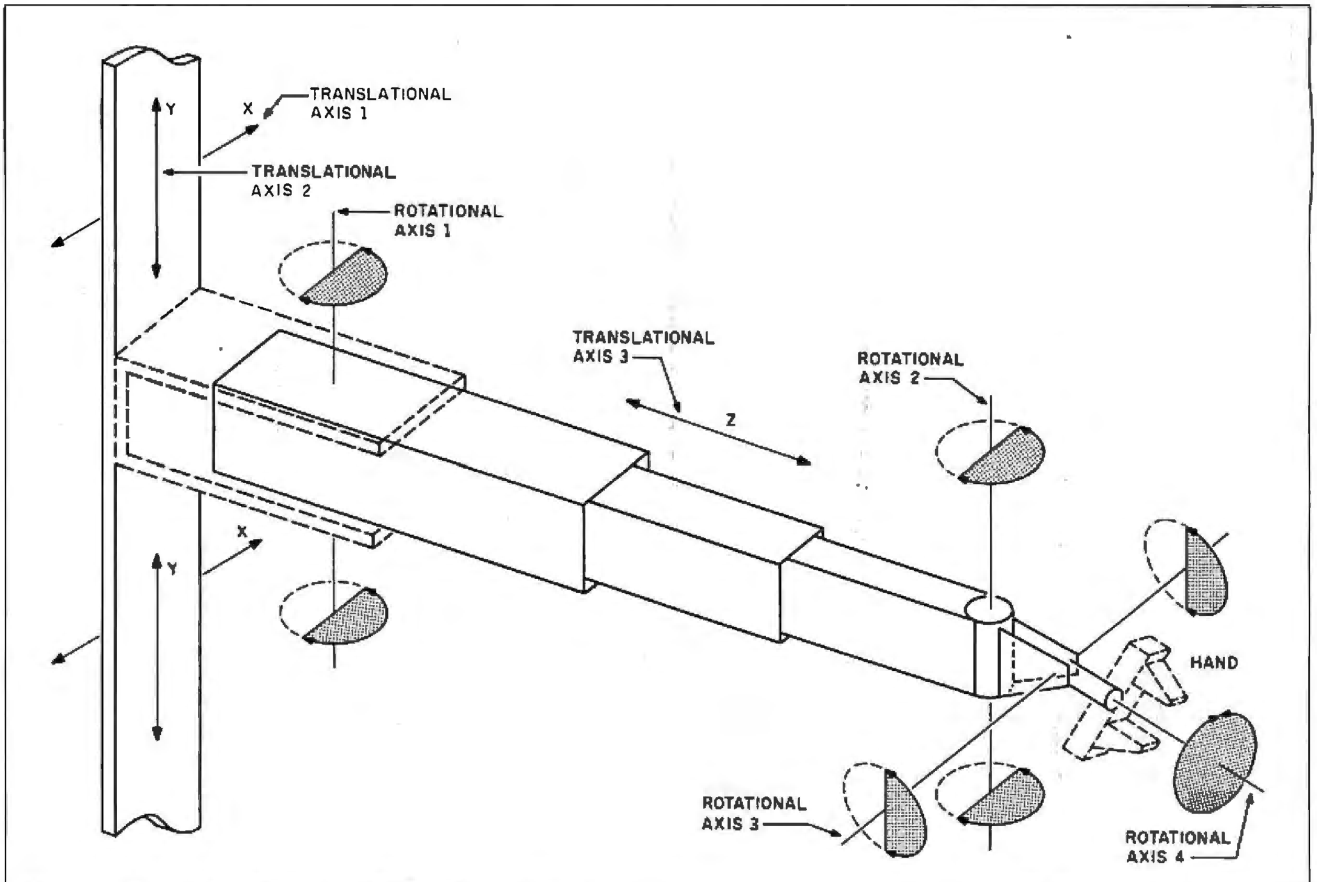


Figure 2: *A schematic representation of Lehigh University's robot arm showing the three translational axes of movement and the four rotational axes of movement.*

tuator drive signals that coordinate the motion of the joints and linkages of a single-arm manipulator. For example, raising the end effector may be achieved by "shoulder" motion, "elbow" motion, or both. This kind of control, which corresponds loosely to the basic motor skills of the human brain, is called "low-level" control in that it is automatic. (Most people don't concentrate on which muscles they have to move to lift a pencil.) Much more effort is expended on planning and executing the overall task (the high-level control), while the low-level control operation is assumed to be available and is essentially ignored.

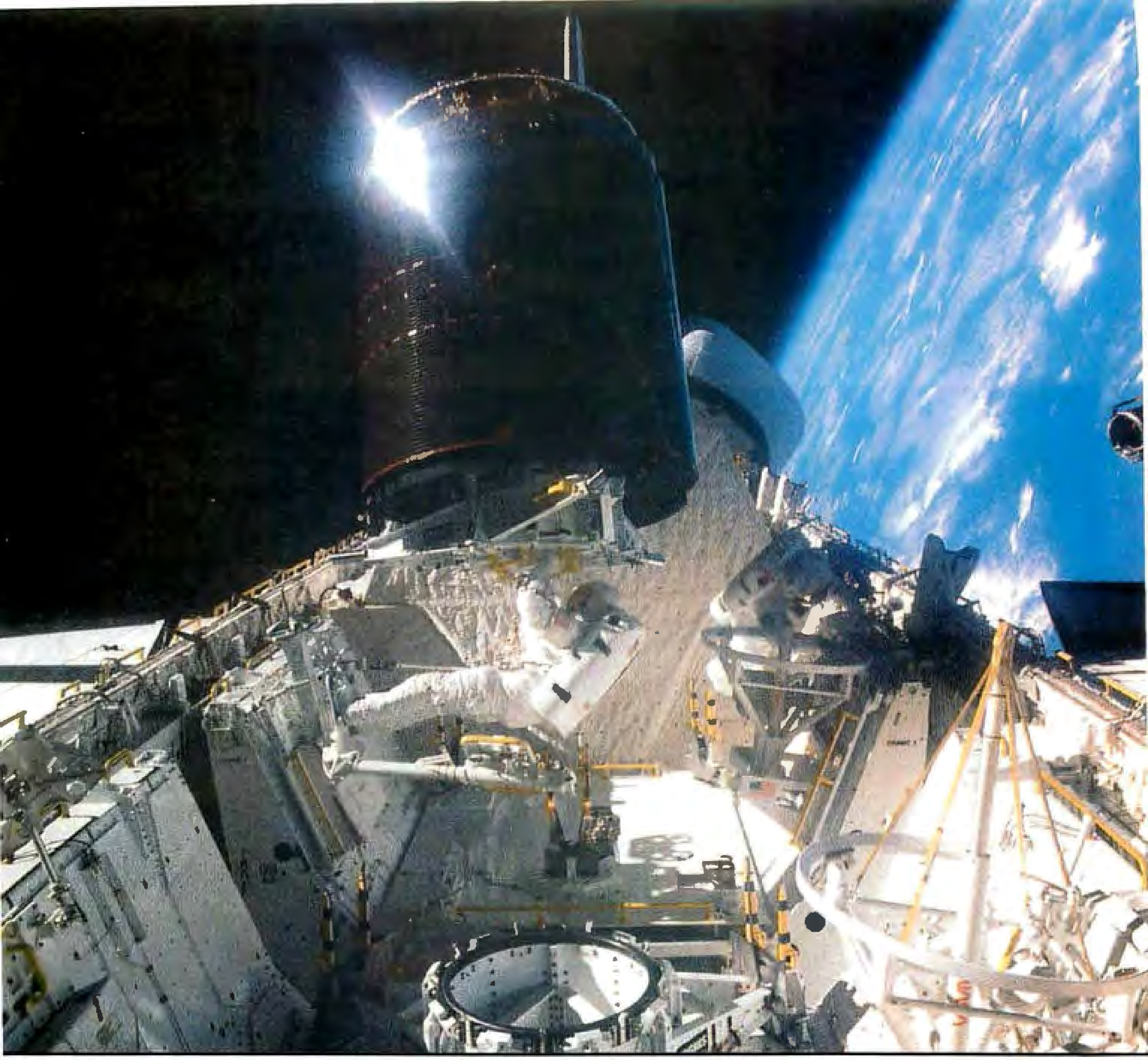
All the planning, execution monitoring, and low-level control suggests that there is far more to a single robotic arm than a collection of linkages, actuators, and basic motor control that mimics the human arm. This is indeed true. For example, the end-effector "hand" is usually designed for specific tasks. A welding tool is used on a welding arm, a viselike gripper or humanlike hand on an assembly arm, and a paint sprayer on a painting arm. The operation of the end-effector devices must also be controlled in coordination with the motions of the end effector, as determined by the low-level controlled motion of the link actuators.

It is obvious then that the high-level control that dictates to the low-level control the pose of the arm end effector must also tell the end effector what to do once it is there. The goal of the high-level computer is to determine the particular sequence of link motions and end-effector operations that accomplish a given task and then drive the low-level control that generates the arm and end-effector actuator drive signals to achieve the task motions and operations.

Throughout the performance of the task, the task execution must be monitored through sensors not only to assure that the motions and operations are as expected but also to adjust the actuator drive to correct any sensed errors. Such closed-loop or feedback control is used at both the low and high levels of control.

In order to achieve real-time closed-loop control for a system as complex as an autonomous robot, data must be gathered (through sensing transducers), processed, and monitored to update the parameters of the control and decision algorithms before they are executed. The real-time aspect is required so that error feedback can provide input corrections quickly enough to reduce errors before they become too large. The more variable the working environment, the more data must be gathered, and the more quickly unexpected changes might occur, the more quickly this data must

(continued)



OEM & OWN BRAND
COMPOSITE & TTL COMPATIBLE COLOR & MONO MONITOR TERMINAL

SAMSUNG
Electron Devices

SEOUL OFFICE
6~8TH FL, THE JOONG-ANG DAILY NEWS BLDG., 7 SOONHWA-DONG, CHUNG-KU, SEOUL, KOREA
TEL: 7516-955/7, 7516-959/961
TLX: STARNEC K22596
CABLE: "STARNEC" SEOUL

LONDON OFFICE
6TH FLOOR, VICTORIA HOUSE SOUTHAMPTON ROW W.C.
1 LONDON, ENGLAND
TEL: (01) 831-6951/5
TLX: 264606 STARS LG
FAX: (01) 430-0096

SANTA CLARA OFFICE
3003 BUNKER HILL LANE, SUITE 201 SANTA CLARA, CAL. 95050, U.S.A.
TEL: (986)8473
TLX: 171685 SAMSUNG SNTA

TOKYO OFFICE
KASUMIGASEKI BLDG., 2522 KASUMIGASEKI 3-2-5 CHIYOTA-KU, TOKYO, JAPAN
TEL: (03) 581-5804, (03) 581-9521~4
TLX: 228009 SANSEI

Inquiry 317

be processed and fed back to the control input.

STABILITY

Complex coupled systems such as single- or dual-arm robots have the potential for unbounded or uncontrolled behavior (instability) in certain ranges of operation. These regions are usually characterized by constraints on allowed velocities and accelerations or by regions of the workspace that are less precisely controlled than other regions. The control system must be designed to locate and avoid, or otherwise accommodate, these regions of operation without adversely affecting the flexibility in the range of operation.

Most commercial control systems simplify the control issues by placing limits on the overall velocities and accelerations and therefore do not allow the robot to perform to its maximum capabilities throughout the workspace.

As the above discussion indicates, the more flexibility required in a robotic application, the greater the number of variables that must be controlled simultaneously. State-of-the-art systems are typified by the extensive use of fixtures to reduce the number of variables to a manageable level. Unfortunately, such structures also reduce the flexibility of a system in accommodating new tasks or unexpected difficulties.

This use of rigid structures is often attributable to the lack of availability of a broad range of sensors and low-cost control computers, and the difficulty and cost of overall integration into a sensory feedback, real-time control system. The development of the more complex dual-arm robotic systems must address these issues more directly, without imposing rigid structures by "engineering away" problems.

CONTROL LEVELS

Researchers at the National Bureau of Standards (NBS) have developed a philosophy for designing and implementing real-time, hierarchically distributed, sensory-control systems incorporating robotic arms, machine tools, and other manufacturing devices.

This philosophy has been successfully demonstrated repeatedly and has recently been applied to a form of dual-arm control. Because of this demonstrated success, the dual-arm research at Lehigh is based on the NBS philosophy of distributed hierarchical control.

We have chosen to describe the portion of the control that *achieves* the desired motions as "low-level control" and the portion that *determines* the motions desired for a task as "high-level control." This dictates the following interpretation of the present state of research in robotic arm control.

Closed-loop sensing and control algorithms now exist that allow precise and stable control of the position and orientation of the end effector of an arm, and techniques for more general velocity and force control are well under development at many research laboratories. Low-level control mechanisms now or will soon exist that, when given the desired trajectory (position versus time) of the end effector, will provide the desired motion.

The end effector itself is typically a very simple special-purpose tool for which low-level control is also readily available. However, more general-purpose end effectors, such as humanlike hands that can grasp a wide variety of objects or hand tools, are slow in development due to many of the same problems of dual-arm control.

Much of the research on high-level, task-oriented control is focused on the planning aspects associated with various tasks. The planning aspects are concerned with how to automati-

(continued)

cally generate the trajectory path of an arm carrying an object so that it does not collide with other objects in the workspace, or how to determine the best grasp location and force for a particular object based on data represented in a computer-aided design (CAD) model of the object.

Perhaps more important, artificial intelligence researchers are searching for algorithms and heuristics for the automatic decomposition of the steps of a task into a sequence of simpler subtasks that are already implemented. Artificial intelligence researchers and others are searching for robust techniques for executing the task steps in the presence of uncertainties and unexpected changes in the work environment.

Visible results of research on high-level control systems include a number of human-oriented graphical programming and simulation systems for robot motion programming and the development of high-level robot programming languages. These languages have, in some cases, been modeled after popular structured programming languages (e.g., Pascal, APL, and FORTH).

Other available results include the development and application of a number of techniques for visual image processing and image understanding. Methods for integrating these and other sensory-perception techniques into an autonomous, intelligent control system are under intense, although slow, study. Our plan is that the dual-arm research project will provide a flexible and powerful test bed for accelerating the development of robust, generic solutions to high-level control problems.

DUAL-ARM CONTROL

There are research challenges in dual-arm control at both the low level (how to achieve the desired motions in real time) and the high level (how to determine the desired motions to achieve a task). The challenges at the low level derive from the need for coordinated control of two arms in real time, as well as a data-communications technique that supports the distribution of commands and data among the distributed control elements of the two arms.

Many single-arm systems can bypass these requirements because the control and sensing algorithms are simple enough to allow a single computer to perform all tasks in real time. With dual-arm systems, the number of control and sensing procedures is more than double that of single-arm systems, so the sensing and control functions must be distributed among a number of physically distinct and heterogeneous computers.

At the high level, the problems associated with single-arm task planning and execution are magnified by the fact that the job tasks must be partitioned among two arms, but the task partitioning must be coordinated in such a way that the high-level task is accomplished correctly. Algorithms for planning and monitoring must be modified from the domain of the single arm to the more general dual-arm arena.

Just as general techniques for the distribution of function and data have proved elusive in the world of distributed and parallel computing, so too have general techniques for distributed control of robots.

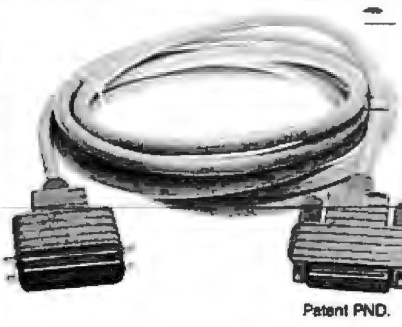
The NBS approach is to partition the sensory processing, world modeling (expectations), and control functions. The control functions are decomposed into hierarchically structured, limited-scope modules. This same approach has proved useful in the preliminary study and research of dual-arm systems at Lehigh University.

It seems natural to think of a dual-arm robot as two independent, low-level, single-arm controllers directed by a third (higher-level) controller that coordinates and synchronizes the arms (see figure 3). This approach, however, does not allow the arms to work together in a tightly coupled operation such as manipulating the pencil.

The role of the high-level coordinating controller is needed, but the low-level single-arm controllers must also be integrated, for example, to

(continued)

THE ULTIMATE CABLE ASSEMBLY



Patent PND.

No More Fumbling with Screwdrivers! Just a twist of the thumb wheel screw heads and the cable is securely screwed into position.! No cable looks or works quite like this. DATA SPEC® cable assemblies not only visually enhance your computer equipment, but provide superior quality inside and out.

FEATURES:
- Gold Plated Pins
- Positive Strain Relief
- Full Shielding (Exceeds F.C.C. EMI/RFI Emission Requirements)
- Large Convenient Thumbscrews (No More Screwdrivers Needed!)
- Exclusive P.D.T. Underhood for Maximum Integrity
- Lifetime Warranty

DATA SPEC® makes cable assemblies to fit any of your interface needs: RS232, Parallel (Centronics), Printers, Modems, Disk Drives, and monitors. For your IBM, Apple, AT&T and other popular PC's. Ask for DATA SPEC® cables at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

USE INQUIRY NUMBERS BELOW

PRINTER JACK™

Apple IIc Serial to Parallel Printer Interface

The Printer Jack™ is a device that will enable you to use the Apple IIc, which is not equipped with a parallel port, with any standard parallel printer. The Printer Jack can also be used with other computers with an optional cable.
The Printer Jack set, Model A1250 includes: a CPU unit (the big box), a 9V power supply and a 5 pin to a 5 pin cable.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

USE INQUIRY NUMBERS BELOW

SURGE PROTECTOR

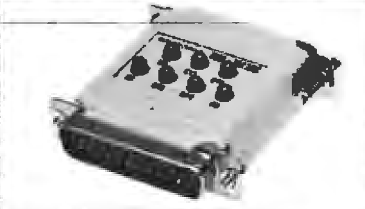
Power Spikes can occur anywhere! Even in RS232 lines! Stop power spikes with the NEW RS232 Surge Protector from DATA SPEC®

The RS232 Surge Protector will eliminate power spikes and surges generated by static discharges from damaging computers and peripherals. Comes with a Female DB25 on one end and a DB Male on the other end with gold plated pins. All 25 pins are wired through. Ask for the RS232 Surge Protector at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

USE INQUIRY NUMBERS BELOW

RS232 MINI-TESTER



This miniature RS232 tester is designed to monitor RS232 lines. This tester is very useful in diagnosing RS232 communication problems.

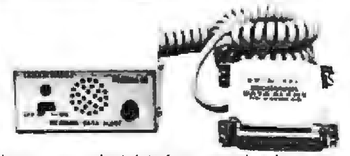
There are 7 different colored LED indicator lights to monitor the following functions: Receive Data (RD), Clear To Send (CTS), Data Terminal Ready (DTR), Request To Transmit Data (TD), Request To Send Data (RTS), Data Set Ready (DSR), and Carrier Detect (CD). Ask for the RS232 Mini Tester at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

USE INQUIRY NUMBERS BELOW

NO LOST DATA!

Even Computer Owners Need Beepers



Have you ever lost data from a modem because you forgot to turn a switch? Now you can be "beeped" and visually alerted with the Incoming Data Alert from DATAS SPEC®.

This device will sound an audible "beep" (for about 15 seconds) and light a red L.E.D. (which stays lit until reset) whenever data is being transmitted through an RS232 line. The Incoming Data Alert monitors pin 3 and can used betweens modems and computers and terminals.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

USE INQUIRY NUMBERS BELOW

25 PIN DATA SWITCH

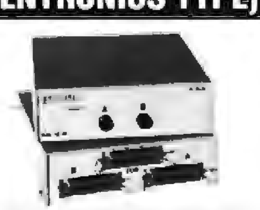
$59.95

All RS232 25 pin switch boxes are available in these configurations: AB-25, ABC-25 and ABX-25 (Cross Matrix, allows the use of 2 computers and 2 peripherals). Can be switched with IBM PC paralell port, compatibles too!
It's about time you benefit from high performance at affordable prices? Ask for the 25 Pin Data Switches at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

36 PIN PARALLEL DATA SWITCH

(CENTRONICS TYPE)



These switch boxes also have gold plated pins and have all 36 pins switched. The 36 pin boxes are available in these configurations: AB-36 and ABC-36.

Quality features, outstanding durability and affordable prices! Ask for the 36 Pin Data Switches at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

L.E.D. 25 PIN DATA SWITCH BOX

Get all the outstanding features of DATA SPEC's RS232 25 Pin Data Switch Boxes and more with the ABL-25LE. This luxury edition data switch box features 7 L.E.D. indicators (TD, RD, RTS, CTS, DSR, DTR & CD) and gold plated pins.

Ask for the 25 Pin L.E.D. Data Switch Box at your nearest authorized DATA SPEC® dealer.

DATA SPEC®
FROM ALLIANCE RESEARCH CORPORATION
20120 Plummer Street
Chatsworth, CA 91311 • 1-818-993-1202

IBM, Apple and AT&T are registered trademarks respectively of International Business Machines Corp., Apple Computer Inc. and AT&T Information Systems.

Inquiry 418 for End-Users. Inquiry 419 for DEALERS ONLY.

allow the forces felt by one arm to directly modify the forces applied by the other arm. This results in the conceptual control architecture shown in figure 3, integrated into the overall system architecture shown in figure 4. Note in figure 4 that the low levels are coupled directly in the control portion and also indirectly through the model.

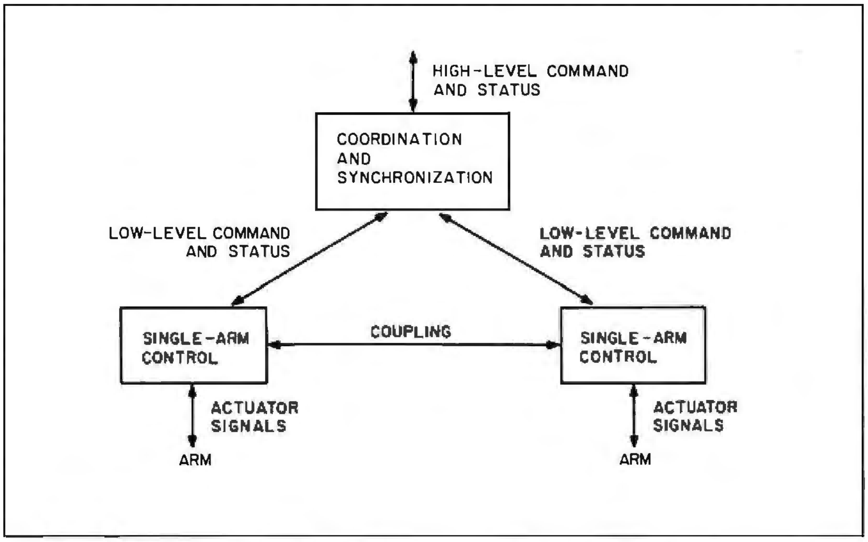


Figure 3: *Simplified dual-arm control hierarchy showing low-level and high-level functions.*

Distribution of Function

Physical implementation of the conceptual system models shown in figures 3 and 4 requires more explicit definition of the distribution of function and data between low- and high-level control and between the individual low-level controls. For example, consider which element is responsible for avoiding collisions (i.e., the individual arm controllers or the high-level coordinating controller).

It seems that the collision-avoidance function itself should be split and the subfunctions distributed. Similarly, how does the grasp planning of one arm consider the fact that an object is to be handed to another arm whose grasp requirements must also be accommodated? The laboratory system

(continued)

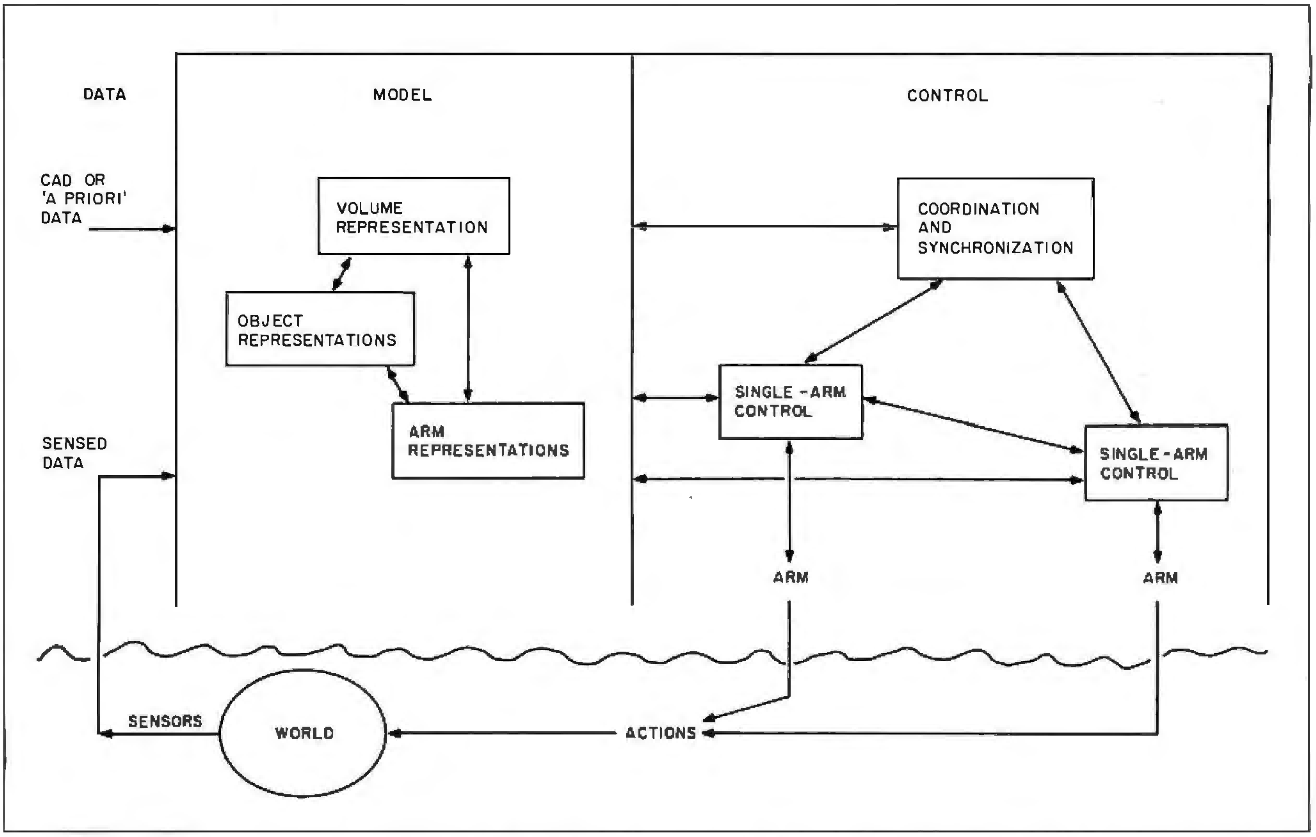


Figure 4: *Overall system control hierarchy of a dual-arm robot, showing the relationship between the external world, the actual control, and the intrinsic model used by the system.*

In 1876 Alexander Graham Bell gave people an easier way to stay in touch. Today, we're doing the same for computers.

The 1876 liquid telephone.
With it Bell made the world's first phone call:
"Mr. Watson, come here. I want you."

At Kyocera, we think it's about time computers had an easier way of staying in touch. That's why we're introducing a telecommunications package featuring our 1200 bps modem and Microsoft's Access software for IBM-PC, XT, AT and all compatibles.

It's the most advanced bundled system on the market. But you don't need an advanced degree in computer science to use it.

We designed our 1200 bps modem with a mind of its own. It can answer automatically, distinguish busy and dial-tones, even handle voice and data communications on the same line. And you won't have to work overtime memorizing mind boggling command sequences, because we've also given our modem built-in help menus.

For software we teamed up with the most advanced telecommunications program available, Microsoft's new Access. Only Access features X.PC protocol which lets you simultaneously monitor up to 15 live connections through separate "windows" on your screen.

Kyocera's intelligent stand alone modem with Microsoft Access software.

For instance, as one window displays stock market returns, another can provide market analysis. Through a third window, you can book an airline flight via OAG (Official Airline Guide). All the while, X.PC checks data transmissions for errors.

Access also lets you compose, send and receive letters through electronic mail services.

The Kyocera 1200 bps modem with Microsoft Access is available in stand alone or direct card and includes all necessary accessories. And because it's bundled, you'll save a bundle.

If Alexander Graham Bell were around today, he'd wish it was his idea.

KYOCERA Modems
A tradition of innovation.

Inquiry 196 for End-Users. Inquiry 197 for DEALERS ONLY.

For the Kyocera dealer nearest you, call toll-free (800) 235-1222 or (408) 257-8000.

currently under development will allow various alternatives to such issues to be quickly and easily explored.

Lehigh University researchers have designed a control structure for complex dual-arm operations, and initial research has progressed in two areas: pick-and-place operations with two arms that have overlapping workspaces and the design of task-planning algorithms to allow the interchange of objects between arms (i.e., end effectors) in free space.

The existence of overlapping workspaces has led to the development of algorithms for collision avoidance that consider two moving arms. The planning of free-space object interchange takes into consideration the relative locations of the arms, objects to be manipulated, and object destinations, and assigns arm subtasks based on these considerations within the confines of workspace areas accessible to the arms.

Coordinated-Control Research

Lehigh University researchers believe that a distributed control and communications system must be implemented and that high-level control algorithms must be developed to accommodate the increased number of variables and capabilities of dual-arm robots. They have also noted that single-arm low- and high-level control techniques may not be directly applicable due to the increased complexity of dual-arm implementations.

Lehigh's research team has developed a plan that will begin to uncover the requirements and implementations of dual-arm and more general-purpose multidevice manufacturing systems. The first step in the study of multidevice systems is to obtain a clear understanding of how complex tasks are decomposed into simpler subtask "primitives." This understanding of task decomposition must be accompanied by an in-depth knowledge of how manufacturing systems are combined to achieve a particular task. We must understand the system composition that supports the task decomposition.

We are approaching this problem in two ways. First, we are identifying and developing mathematical system analysis (decomposition) and synthesis (composition) tools that allow theoretical modeling and study of manufacturing systems. Second, we are developing a flexible system-implementation strategy that follows the structure of the mathematical tools.

This strategy includes modular design with rules for integrating the modules into a system. Clearly defined, functionally bounded modules with clearly defined data and control interfaces must be developed.

The dual-arm laboratory system under development is the first step toward this system-building understanding. It will allow us to study such questions as "How can two arms be controlled to cooperate in lifting a load heavier than one arm can handle alone?" or "How can two arms be controlled to manipulate the ends of a pencil without dropping or breaking the pencil?"

More fundamental to an autonomous flexible operation, perhaps, is obtaining answers to such questions as "What general task-decomposition techniques are needed to consider the increased capability of two arms, rather than simply considering two independent arms?" That is, "What does parallelism provide that distinguishes it from overlapping sequential control?" We believe the answer lies in the term "coordination," which could be interpreted as "dependent" overlapped sequential control.

Our research is aimed at understanding and controlling this dependency to achieve coordination. Our short-term goal is to develop a

(continued)

Get the Picture with PHOTOBASE

PHOTOBASE is a software package that works with data base management systems such as: dbase II, R:Base 4000* and the IBM Filing Assistant*.*

PC-EYE™

PC-EYE is a high speed, high resolution video digitizer board that lets you capture anything you can see.

Now you can open up a whole new dimension in data base applications by merging real-life pictures with popular data base management systems. Pictures of people, products, diagrams, maps, company logos — whatever you want to photograph — can be integrated with your data base. Consider these typical applications:

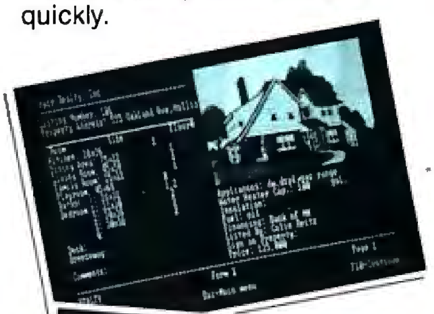
Security — verify those employees who have authorized clearance to limited access areas. A data base containing employee pictures and personnel records can be searched and displayed for visual verification.

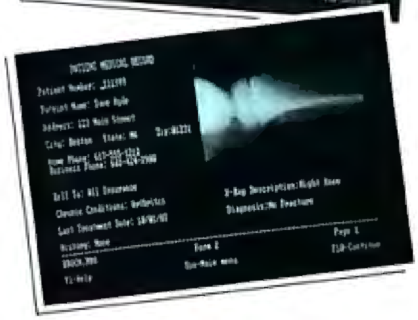
Signature Verification — increase the efficiency of credit checks by adding pictures of customer signatures to your financial data base records.

Real Estate — add pictures of houses to on-line real estate listings for faster property identification and improved sales presentations.

Electronic Cataloging — pictures of products can be combined with a data base system containing product specifications, pricing, availability and much more.

Customers, distributors and sales personnel can quickly search data and view the resulting product/picture information on one screen. Files can be updated easily, quickly.





It's Easy

With a simple keystroke, pop-out of your data base system and into the PHOTOBASE menu. Capture images of text, photos, artwork and 3-dimensional objects with an ordinary video camera and our high resolution PC-EYE™ video digitizer. Pop back into your data base system and add the picture name to your data base like you would any other piece of information. The full functionality of the data base system is preserved, but the resulting display is text and picture information on one screen.

Pictures are displayed in the upper right quadrant of the screen at a resolution of 320 x 200 with 16 colors or levels of gray. Text information from data base records fills the rest of the screen. Pictures can also be exploded to full screen.

Call or write and we will send you information on PHOTOBASE, PC-EYE, compatible cameras and other imaging equipment in the Chorus Family of products.

(603) 424-2900 or 1-800-OCHORUS.

TM PHOTOBASE and PC-EYE are trademarks of CHORUS Data Systems.
*dBase II is a trademark of Ashton-Tate; R-Base 4000 is a trademark of Microrim, Inc.; IBM Filing Assistant is a trademark of International Business Machines Corporation.

CHORUS

Inquiry 59

CHORUS Data Systems, Inc., 6 Continental Blvd., P.O. Box 370, Merrimack, New Hampshire 03054

IBM COMPATIBILITY

. . . at a not so IBM price

TECH TURBO PC/AT
$2399

PRICE INCLUDES:
- *6 TO 8 MHZ 80286 CPU*
- *512K*
- *ONE, 1.2 MB FLOPPY DRIVE*
- *8 EXPANSION SLOTS*
- *195 WATT POWER SUPPLY*
- *COMPLETE MS DOS, PC DOS, XENIX COMPATIBILITY*
- *RUNS LOTUS 123, DBASE III FRAMEWORK AND ALL OTHER POPULAR AT SOFTWARE*
- *ONE YEAR WARRANTY!!*

OPTIONS:

TECH TURBO PC/AT WITH 20MB HARD DISK **$2825**

TECH TURBO PC/AT WITH 20MB HARD DISK, MONOCHROME MONITOR, HERCULES® COMPATIBLE MONOGRAPHICS CARD **$2999**

ALSO AVAILABLE WITH TAPE BACKUPS, MODEMS, LARGER HARD DISKS, AND NETWORKING SYSTEMS.

TECH PC/AT
$1999

PRICE INCLUDES:
- *6MHZ 80286 CPU*
- *512K*
- *ONE, 1.2 MB FLOPPY DRIVE*
- *8 EXPANSION SLOTS*
- *195 WATT POWER SUPPLY*
- *COMPLETE MS DOS, PC DOS, XENIX COMPATIBILITY*
- *RUNS LOTUS 123, DBASE III FRAMEWORK AND ALL OTHER POPULAR AT SOFTWARE.*
- *ONE YEAR WARRANTY!!*

OPTIONS:

TECH PC/AT WITH 20 MB HARD DISK **$2499**

TECH PC/AT WITH 20MB HARD DISK, MONOCHROME MONITOR, HERCULES® COMPATIBLE MONO/GRAPHICS CARD **$2699**

ALSO AVAILABLE WITH TAPE BACKUPS, MODEMS, LARGER HARD DISKS, AND NETWORKING SYSTEMS.

TECH TURBO PC/XT
$1099

PRICE INCLUDES:
- *4 TO 7 MHZ SOFTWARE SWITCHABLE CPU*
- *640K*
- *TWO 360K DS/DD FLOPPY DISK DRIVES*
- *8 EXPANSION SLOTS*
- *135 WATT POWER SUPPLY*
- *ONE YEAR WARRANTY!!*

OPTIONS:

TECH TURBO PC/XT WITH 20MB HARD DISK **$1699**

TECH TURBO PC/XT WITH 20MB HARD DISK, MONOCHROME MONITOR AND HERCULES COMPATIBLE MONO/GRAPHICS CARD **$1950**

ALSO AVAILABLE WITH TAPE BACKUPS, MODEMS, LARGER HARD DISKS, AND NETWORKING SYSTEMS.

TECH PC/XT
$799

PRICE INCLUDES:
- *4.77 MHZ CPU*
- *256K*
- *TWO, 360K DS/DD FLOPPY DRIVES*
- *8 EXPANSION SLOTS*
- *135 WATT POWER SUPPLY*
- *ONE YEAR WARRANTY!!*

OPTIONS:

TECH PC/XT WITH 20MB HARD DISK **$1449**

TECH PC/XT WITH 20MB HARD DISK, MONOCRHOME MONITOR, HERCULES COMPATIBLE MONO/GRAPHICS CARD **$1649**

ALSO AVAILABLE WITH TAPE BACKUPS, MODEMS, LARGER HARD DISKS, AND NETWORKING SYSTEMS.

HI-TEK PGS AVT TAXAN IBM AMDEK HERCULES GENOA PARADISE TEAC TOSHIBA HARDWARE/SOFTWARE NETWORKING HAYS AST JRAM HI-TEK PGS AVT TAXAN AMDEK HERCULES GENOA PARADISE TEAC TOSHIBA

PLEASE ALLOW ONE WEEK FOR SHIPPING **VISA, MASTERCHARGE** **TELEX: 272006 Answer Back-TECH** **FAX: 714/556-8325**

TECH PC

TECH PERSONAL COMPUTERS
2131 South Hathaway, Santa Ana, California 92705

714/754-1170

Inquiry 349 for End-Users. Inquiry 350 for DEALERS ONLY.

The Lehigh arm has seven degrees of freedom.

mathematical theory of manufacturing-system building and to develop implementations that realize these theoretical systems. The long-term goal is to develop a general approach to classification of the capabilities of manufacturing devices and then extend the dual-arm analysis and synthesis philosophies to allow synthesis of multiclass machine work-cell tasks.

The ultimate goal of this and related research is to develop the mathematical tools and system-implementation techniques needed to automatically synthesize an entire facility's production schedule in direct response to customer demand, even when (especially when) the customer demands only one custom part. This implies that, with only a customer's description of the part, the facility resources are automatically allocated and control programs are generated (synthesized) and executed, resulting in the economical production of that one custom part.

CONCLUSIONS

In order to implement a manufacturing system with the flexibility required for future production, we must first develop a fundamental understanding of manufacturing-device coordination in conjunction with the necessary system analysis and synthesis tools to achieve this device coordination.

The direct results of dual-arm robotic research will be readily applicable to many manufacturing tasks. More important, the overall knowledge obtained by studying the dual-arm system will be applied toward developing a general theory of structural analysis and synthesis for flexible, modular manufacturing systems.

We have begun the ambitious undertaking of developing such a general theory. To date, Lehigh has implemented a sensory-control and modeling system based on the NBS philosophy of hierarchical real-time system control. In addition, we have implemented a data-communications network and distributed the low-level and high-level control of a dual-arm cooperating pick-and-place robot, and we are in the process of duplicating this control for the pair of Lehigh-designed, dual seven-degrees-of-freedom arms described above.

Many of the high-level control strategies are in the feasibility phase of development and thus offer only rudimentary capabilities. They were developed to demonstrate the cooperation of two arms in an overlapping workspace for the "simple" tasks involved in pick-and-place operations. The implementations allow more general study of the sophistication required of the high-level coordination mechanisms needed for flexible, autonomous, multidevice manufacturing systems. ■

BIBLIOGRAPHY

Albus, J. S., A. J. Barbera, and R. N. Nagel. "Theory and Practice of Hierarchical Control." *Proceedings of the 23rd IEEE Computer Society International Conference*, September 1981.

Barbera, A. J., J. S. Albus, M. L. Fitzgerald, and L. S. Haynes. "RCS: The NBS Real-Time Control System." Detroit, MI: Robots 8 Conference and Exposition, June 1984.

Jones, A. T., and C. R. McLean. "A Cell Control for the AMRF." ASME Conference, August 1984.

Nagel, R. N. "Robots: Not Yet Smart Enough." *IEEE Spectrum*, May 1983, pages 78–83.

Nagel, R. N. "State of the Art and Predictions for Artificial Intelligence and Robotics," in *Robotics and Artificial Intelligence*, M. Brady, L. A. Gerhardt, and H. F. Davidson, eds. Berlin: Springer-Verlag NATO ASI Series, 1984.

Nagel, R. N., and S. R. Garrigan. "An Analysis of Robot Software and Plans for Its Enhancement." #85-001 Joint Report Series, Manufacturing Systems Engineering Program, CDMI, & NET Ben Franklin Technology Center, Lehigh University, June 1985.

Scott, H., and K. Strouse. "Workstation Control in a Computer Integrated Manufacturing System," *Proceedings of Autofact 6*, October 1984.

COMPUTER MAIL ORDER

MONITORS

AMDEK
- Video 300 Green....................$129.00
- Video 300A Amber....................$139.00
- Video 310A Amber TTL....................$169.00
- Color 300 Composite....................$179.00
- Color 500 Composite/RGB....................$289.00
- Color 600 Hi-Res. RGB....................$399.00
- Color 710 Ultra Hi-Res....................$489.00
- Color 722 Dual Mode....................$549.00

NEC
- JB 1260 Green....................$59.99
- JB 1201/1205 ....(ea.) $99.99
- JB 1270 Green/1275....................$119.00
- JB 1275 Amber....................$119.00
- JB 1280 G TTL/1285 A TTL....................$149.00
- JC 1410 RGB....................$669.00
- JC 1225 Composite....................$179.00

PRINCETON
- MAX-12E Amber....................$179.00
- HX-9 9" RGB....................$469.00
- HX-9E Enhanced....................$519.00
- HX-12 12" RGB....................$469.00
- HX-12E Enhanced....................$559.00
- SR-12 Hi-Res....................$599.00

TAXAN
- 115 12" Green....................$119.00
- 116 12" Amber....................$129.00
- 121 TTL Green....................$139.00
- 122 TTL Amber....................$149.00
- 610 510x200 RGB....................$NEW
- 620 640x200 RGB....................$NEW
- 630 640x200 RGB....................$NEW
- 640 720x400 RGB....................$NEW

QUADRAM
- 8400 Quadchrome I....................$499.00
- 8410 Quadchrome II....................$339.00
- 8420 Amberchrome....................$179.00
- 8500 Quad Screen....................$149.00

ZENITH
- ZVM 1220/1230....................(ea.) $99.99
- ZVM 1240 IBM Amber....................$149.00
- ZVM 130 Color....................$269.00
- ZVM 131 Color....................$249.00
- ZVM 133 RGB $429.00
- ZVM 135 RGB/Color....................$459.00
- ZVM 136 RGB/Color....................$599.00

INTERFACES

AST
- Multi I/O (Apple II)....................$159.00

PRACTICAL PERIPHERALS
- Graphcard....................$79.99
- Seriall Card....................$99.99
- Microbuffer II+....................$169.00
- Microbuffer 32K....................$189.00

QUADRAM
- Microfazer....................from $139.00
- Efazer (Epson)....................from $79.99

Orange Micro
- Grappler CD (C64)....................$89.99
- Grappler + (Apple)....................$89.99
- Grappler 16K+ (Apple)....................$159.00

DIGITAL DEVICES
- Ape Face (Atari)....................$49.99
- U-Print A (Atari)....................$54.99
- U-A16/Buffer (Atari)....................$74.99
- U-Call Interface (Atari)....................$39.99
- U-Print C (C64)....................$49.99
- P-16 Print Buffer....................$74.99
- U-Print 16 apple IIc....................$89.99

PRINTERS

Canon
- A40....................CALL
- LBP-8A1 Laser....................CALL

CITIZEN
- MSP-10 (80 col.)....................$279.00
- MSP-15 (132 col.)....................$389.00
- MSP-20 (80 col.)....................$349.00
- MSP-25 (132 col.)....................$509.00

C.ITOH
- Prowriter 7500....................$219.00
- Prowriter 8510 NLQ....................$329.00
- Prowriter 1550P....................$449.00
- Starwriter 10-30....................$459.00

corona
- Lazer LP-300....................$2799.00

DIABLO
- D25 Daisywheel....................$549.00
- 630-109 Daisywheel....................$1749.00
- D80IF Daisywheel....................CALL

daisywriter
- 2000....................$749.00

EPSON
- Homewriter 10, LX-80, LX-90....................CALL
- FX-85, FX-185, RX-100, JX-80....................CALL
- DX-10, DX-20, DX-35, LQ-1500....................CALL
- SQ-2000, Hi-80, HS-80, AP-80....................CALL
- Epson/Comrex 220-Atari....................$89.99

JUKI
- 6000 Letter Quality....................CALL
- 6100 Letter Quality....................CALL
- 6200 Letter Quality....................CALL
- 6300 Letter Quality....................CALL
- 5510....................CALL

LEGEND
- 808 Dot Matrix 100 cps....................$179.00
- 1080 Dot Matrix 100 cps....................$259.00
- 1380 Dot Matrix 130 cps....................$289.00
- 1385 Dot Matrix 165 cps....................$339.00

NEC
- 8027 Transportable....................$229.00
- 3000 Series....................$1099.00
- 8000 Series....................$1449.00
- ELF 360....................$449.00
- Pinwriter 560....................$999.00

OKIDATA
- 182, 183, 192, 193, 2410, 84....................CALL
- Okimate 10 (Specify C64/Atari)$189.00
- Okimate 20 (IBM)....................CALL

Panasonic
- KX1080....................$NEW
- KX1091....................$259.00
- KX1092....................$389.00
- KX1093....................$479.00

QUADRAM
- Quadjet....................$399.00
- Quad Laser....................CALL

SILVER-REED
- 500 Letter Quality....................$279.00
- 550 Letter Quality....................$419.00
- 770 Letter Quality....................$759.00

star
- SG-10C (C64 Interface)....................CALL
- SB/SD/SG/SR Series....................CALL
- Powertype Letter Quality....................CALL

Texas Instruments
- TI850....................$529.00
- TI855....................$639.00
- TI865....................$799.00

TOSHIBA
- 1340 (80 column)....................$589.00
- P341 (132 column)....................$989.00
- P351 (132 column)....................$1149.00

PC COMPATIBLES

IBM PC SYSTEMS
Configured to your specification. Call for Best Price!

IBM-PC, IBM-PC II, IBM-XT, IBM-AT

KAYPRO
- KP-2000 Portable....................CALL

SOFTWARE FOR IBM

ASHTON-TATE
- Framework II....................CALL
- dBase III....................$369.00

BORLAND
- Turbo Pascal 3.0....................$49.99
- Sidekick (unprotected)....................$59.99
- Reflex....................$79.99

CENTRAL POINT
- Copy II PC-Backup....................$29.99

DECISION RESOURCES
- Chartmaster....................$229.00
- Signmaster....................$169.00
- Diagram Master....................$219.00

ENERTRONICS
- Energraphics/Plot....................$289.00

FOX & GELLER
- Quickcode III....................$169.00

FUNK SOFTWARE
- Sideways....................$39.99

HARVARD SOFTWARE
- Total Project Manager....................$269.00

INFOCOM
- Cornerstone....................$279.00

LIFETREE
- Volkswriter Deluxe....................$159.00

LIVING VIDEOTEXT
- Think Tank $109.00
- Ready....................$64.99

LOTUS
- Symphony....................CALL
- 1-2-3....................CALL

MECA SOFTWARE
- Managing Your Money 2.0....................$109.00

MICROSTUF SOFTWARE
- Crosstalk XVI....................$89.99
- Crosstalk Mark IV....................$149.00
- Remote....................$89.99

MICRORIM SOFTWARE
- R:Base 4000....................$249.00
- R:Base 5000....................$389.00
- Clout 2.0....................$129.00

MICROPRO
- WordStar 2000....................$249.00
- WordStar 2000 +....................$299.00
- WordStar Professional....................$299.00
- Easy....................$99.99

MICROSOFT
- Word....................$229.00
- Mouse....................$139.00
- Flight Simulator....................$39.99
- MultiPlan....................$129.00

MULTIMATE
- Advantage....................$299.00
- Multi Mate Word Proc....................$249.00
- On File....................$94.99
- Just Write....................$94.99

NOUEMENON
- Intuit....................$69.99

NORTON
- Norton Utilities 3.0....................$59.99

ONE STEP
- Golf's Best....................$39.99

PEACHTREE SOFTWARE
- Peachtext 5000....................$179.00

PFS:IBM
- First Success....................$218.00
- File/Graph....................(ea.) $79.99
- Report....................$74.99
- Write/Proof Combo....................$79.99

PROFESSIONAL SOFTWARE
- Wordplus-PC w/Boss....................$249.00

THE SOFTWARE GROUP
- Enable....................$259.00

SATELLITE SYSTEMS
- Word Perfect 4.1....................$219.00

SORCIM/IUS
- Accounting AP/AR/GL/INV/OE....................(ea.) $295.00
- SuperCalc III....................$195.00
- EasyWriter II System....................$195.00
- Super Project....................$195.00

SPI SOFTWARE
- Open Access....................$379.00

SUBLOGIC
- Jet....................$39.99

6th GENERATION
- Fast Back....................$119.00

ZENITH
- PC-138 Series....................CALL
- PC-148 Series....................CALL
- PC-158 Series....................CALL
- PC-160 Series....................CALL
- PC-171 Series....................CALL
- AT-200 Series....................CALL

SANYO
- MBC 550-2 Single Drive....................$669.00
- MBC 555-2 Dual Drive....................$969.00
- MBC 675 Portable....................CALL
- MBC775....................CALL
- MBC 880 Desktop....................CALL

AT&T
- Safari (7300)....................CALL
- 6300....................CALL

corona
- PPC400 Dual Portable....................$1289.00
- PPCXT 10 meg Portable....................$1989.00
- PC40022 Dual Desktop....................$1389.00
- PC400-HD2 10 meg....................$1989.00

ITT
ITT X-TRA
- 256K, 2 Drive System....................CALL
- 256K,10 meg Hard Drive System CALL
- XP5, 20 meg....................CALL

SPERRY
- Sperry-AT....................as low as $1749.00
- Sperry-IT....................as low as $2699.00

Call for Specific Configuration!

- All Models....................CALL

MULTIFUNCTION CARDS

AST
- Six Pack Plus....................$229.00
- Mega Plus II....................$269.00
- I/O Plus II....................$139.00
- Advantage-AT....................$399.00
- Graph Pak/64K....................$599.00
- MonoGraph Plus....................$399.00
- Preview Mono....................$299.00
- PC Net Cards....................$379.00
- 5251/11 On-line....................$669.00
- 5251/12 Remote....................$579.00

dca
- IRMA 3270....................$879.00
- IRMA Print....................$999.00
- IRMA Smart Alec....................$779.00

EVEREX
- Edge Card....................$269.00
- Color Card (Graphics Edge)....................$289.00
- Magic Card II....................$169.00

HERCULES
- Graphics....................$299.00
- Color....................$159.00

IDEAssociates
- IDEA 5251....................$569.00

MYLEX
- The Chairman....................$469.00

PARADISE
- Color/Mono Card....................$159.00
- Modular Graphics Card....................$279.00
- Multi Display Card....................$219.00
- Five Pack C, S....................$139.00

PERSYST
- Bob Board....................$359.00

TECMAR
- Captain - 64....................$199.00
- Captain Jr. 128K....................$199.00
- Graphics Master....................$469.00

QUADRAM
- Quadport-AT....................$119.00
- Liberty-AT (128K)....................$349.00
- The Gold Quadboard....................$449.00
- The Silver Quadboard....................$239.00
- Expanded Quadboard....................$209.00
- Quad 512+....................$229.00
- Liberty....................$309.00
- QuadSprint....................$499.00
- QuadLink....................$399.00
- QuadColor....................$199.00
- QuadJr. Expansion Chassis....................$469.00
- Expansion Chassis Memory....................$199.00
- Chronograph....................$79.99
- Parallel Interface Board....................$64.99

INTEL
- PCNC8087 5MHz
- PCNC8087-2 8 MHz
- PCNC80287 6 MHz
- 1010 PC-Above Board
- 2010 AT-Above Board

CALL FOR YOUR PC

1-800-233-8950

AUTONOMOUS ROBOT NAVIGATION

BY CHARLES JORGENSEN, WILLIAM HAMEL, AND CHARLES WEISBIN

Teaching robots to look before they leap

MOST COMMERCIAL robotic systems depend heavily on the fact that their job environments are well known and change only in prescribed ways. Generally, when navigation is required, the environment rather than the robot is designed to accommodate movement. We can keep paths of movement open, preposition assembly lines, preplace parts, and reduce variations and unknown factors.

When we relax such restrictions, however, we must increase the robot's capabilities to compensate for unpredictability in the environment. Thus, the first step toward generalized mobility is to add sensors to provide data so that the environment and the internal state of the robot can be determined prior to any decisions. In this instance, because the spatial relationships between the robot and the world are no longer predetermined, two questions immediately arise. First, what does the world map look like? This requires some form of sensor mapping. Second, where is the robot at any given moment relative to that world? This is called self-location.

Because both robot position and environment may change in real-world problems, an advanced autonomous robot must be capable of answering both questions. Until recently, experiments in autonomous navigation have focused primarily on robot environment mapmaking rather than on the self-location problem. As a result, even though the experimental environment could change in minor ways, it usually contained a fixed reference point that the robot sensors could detect and use to calculate self-location. For example, self-location has been calculated by homing on a single point such as a radio source, following a path like a magnetic floor tape, using triangulation on infrared emitters (reference 1), or sighting specially constructed optical landmarks.

Commercial applications such as in-plant mail delivery have used such systems to a limited extent, but they are not practical for unplanned situations like military land-vehicle operation or emergency repair of nuclear power plant components. For these situations, a robot needs to construct temporary references instead of relying on known references. An example of a temporary reference is using a landmark such as a tall building to orient streets and buildings.

THE FIND-PATH PROBLEM

Once a robot has determined a reference point and used its sensors to generate a map of the external environment, it must select control algorithms associated with movement. That is, it must find a path to its goal.

The so-called find-path problem, which has been carefully studied in robotics, can be stated as follows: Given an object with an initial location and a set of obstacles whose spatial location is known, find a continuous path from the initial position to the goal that avoids collision with obstacles along the way. Researchers

(continued)

Drs. Charles Jorgensen, William Hamel, and Charles Weisbin are involved in research and development of robots and artificial intelligence at the Center for Engineering Systems Advanced Research of the Oak Ridge National Laboratory (POB X, Oak Ridge, TN 37831).

have proposed a variety of approaches to solving this problem.

One approach, called the configuration-space method by Lozano-Perez (reference 2), divides a navigation space into zones that the reference point of a robot can occupy without the robot colliding with any obstacles. Paths are then defined for the reference point that makes maximum use of the open area between the reference point and a specified goal. For example, to define the configuration space, Moravec's Rover (reference 3) bounded all obstacles with circles that were enlarged to assure clearances for the robot edges. Paths were then calculated as tangents to these circles. In the context of robot manipulators, Udupa (reference 4) chose to bound the obstacles with complex polyhedra.

Other approaches involve either local or global navigation strategies. Local navigation deals with immediate problems of obstacle avoidance, whereas global navigation considers larger regional information like the plan of a building or long-term goals. For example, Crowley (reference 5) described global path planning in terms of previously stored networks of places. He defined global navigation as traversals along "legal highways" in known areas, with local movement based primarily on avoidance procedures using sensors.

Recently, there has been an interest in merging exploration and learning. Learning has been considered in other aspects of robotics, such as manipulator movement (reference 6), but has only recently been applied to navigation control (reference 7). The many factors involved in exploratory robot navigation make it useful to have a conceptual framework to discuss the points. We will now consider one such framework, based on some well-known human explorers.

EXPLORATION

Navigation in unknown territory implies that a robot is going to encounter unexpected situations. The robot will have to surmount problems such as how to avoid obstacles. There will also be serendipitous discoveries that can be exploited. Such situations are common for all explorers, whether mortals or machines. To clarify the issues involved, let us consider three well-known explorers and their labors and how they relate to autonomous robot navigation.

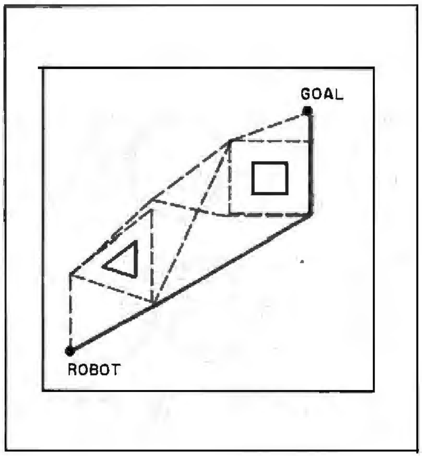


Figure 1: *A simple robotic obstacle-course floor map. The red lines represent the bloomed obstacle diameters, blue indicates projected path lines, and green identifies the shortest path.*

We will begin by comparing a mobile robot to Ferdinand Magellan, the British cartographer whose mapmaking consolidated a disordered 16th century world into sets of well-ordered countries and coasts. Next, we will consider the less structured world of Christopher Columbus navigating toward unknown territory. Finally, we will examine the mythical hero Ulysses as he contends with the whims of the gods who change his world and throw dangers in his path.

Our explorer will be HERMIES II, a small mobile robot at Oak Ridge National Laboratory, as he navigates around the laboratory at the Center for Engineering Systems Advanced Research (CESAR).

MAGELLAN

Magellan was interested primarily in the accurate circumnavigation of the world in which he traveled. He therefore prepared detailed maps from bits and pieces of geographic information gathered from many sources. He synthesized this information into a spatial map that reduced the three-dimensional real world into scaled distances between objects characterized in two-dimensional Cartesian projections.

When used by an experienced navigator, the maps of Magellan permitted the accurate selection of proper headings and destination points and minimized travel distances. In the same way that Magellan organized the world into maps and used that information for path planning, a robot must be able to use spatial maps of the environment to select destinations and minimize the expenditure of resources when seeking goals.

At the Magellan level, we assume that information about the spatial characteristics of the environment is suitably stored in computer memory and accessible to the robot-control algorithms. Given known obstacle locations that make straight-line traversal impossible, the robot's task becomes one of finding the best path to a goal destination. If necessary, the robot may need to turn and maneuver in tight spaces, dead-end corridors, or mazes. Such situations often occur in real-world environments such as large industrial plants or buildings.

Figure 1 shows a sample room with two obstacles placed between a robot and a goal point. The dark borders of the obstacles represent a two-dimensional projection of the three-dimensional object shapes. Because the exact locations of obstacles are known, navigation could be performed as follows: A line is projected from the robot to the goal. If the path is clear, the robot uses the line to calculate an angle of turn and travel distance using the Pythagorean theorem.

However, such a simple algorithm could result in problems. For one thing, we have made no allowance for the width of the robot, and it may collide with edges of obstacles. Consequently, a robust algorithm must take into account required clearances due to all sources of potential imprecision. Second, if a straight line is not reasonable, the robot requires a procedure

(continued)

HALF PRICE

Introductory Subscription Offer

If you're a technically-inclined micro user, subscribe to BYTE and cut your cost right in half. At 50% of the newsstand price, every BYTE issue will bring you stimulating, timely articles on new technology, innovative pc-applications, previews, reviews, and appraisals of major new hardware and software products. If your first trial issue of BYTE isn't everything you expected, just write "cancel" on the invoice and return it. Your first issue is FREE to keep with our thanks for trying. . . .

BYTE

THE SMALL SYSTEMS JOURNAL

4716

☐ Bill me (North America only)
☐ Charge Visa
☐ Charge Master Card
☐ Check enclosed (U.S. only)

☐ US 1 yr. $21.00 (12 issues)
☐ Canada or Mexico 1 yr. $23.00 U.S. (12 issues)
☐ Europe 1 yr. (air) $69.00 U.S.
☐ Foreign Surface Delivery (1 yr.) $37.00 U.S.

Name

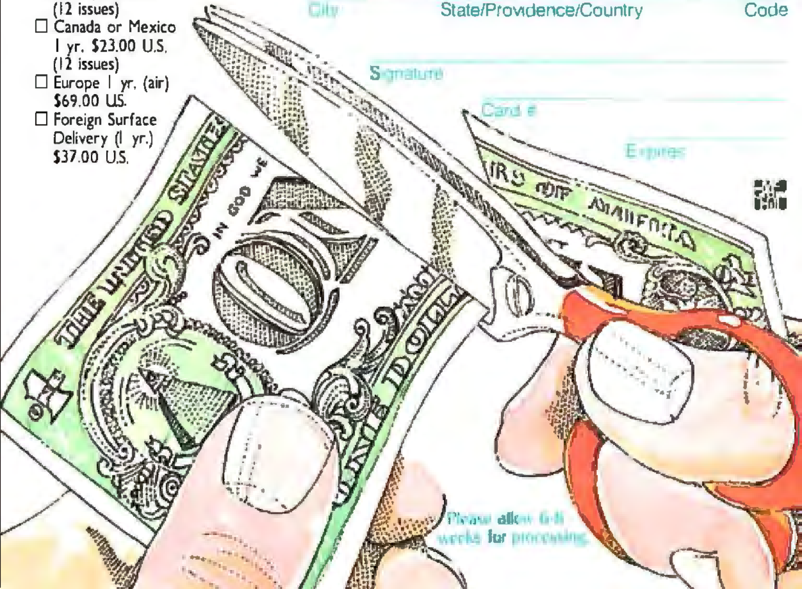
Address

City State/Providence/Country Code

Signature

Card #

Expires



Please allow 6-8 weeks for processing.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 39 MARTINSVILLE, NJ

POSTAGE WILL PAID BY ADDRESSEE

BYTE
THE SMALL SYSTEMS JOURNAL

Subscription Dept.
P.O. Box 597
Martinsville, NJ 08836-9956

Today, there are lots of BASICs. All but one are a forced fit.

BASIC is so popular it was worth chopping and squeezing it to fit the earliest micros. Stretching it again as memory expanded. And twisting it to do things like graphics. Now, its creators think it's worth reinventing.

Every first draft deserves a second chance.

John Kemeny and Tom Kurtz think the language they created deserves a fresh approach. One that offers structured programming, making line numbers optional but unnecessary. A language that understands external libraries, matrix algebra, and parameter type checking. Graphics syntax that's ready for new hardware when you are. An editor and compiler that are easy for beginners but ready for professional developers.

Sometimes, it's the small details.

Like support for the 8087 and up to 640K of memory on the IBM-PC®. Access to QuickDraw routines on the Macintosh™. Long strings, fast floating-point and an editor that includes block copy and global replace.

That's why we call it True BASIC™.

Because it's still the easiest place to learn programming. Because you and your programs won't have to start from scratch with a new language. All you have to do is visit your local dealer and ask for True BASIC™. Talk to Addison-Wesley Publishing about site licensing. Or call us directly at (603) 643-3882.

Because your computer and programming language should be a perfect fit.

True BASIC inc.

39 South Main Street
Hanover, NH 03755
Inquiry 363

The piano-mover problem considers both rotation and translation.

for obtaining other paths and selecting one from among the intermediate choices, much as a traveler would select intermediate stops on the way to a destination. This kind of situation is an instance of the find-path problem.

One way to implement a find-path algorithm is shown in figure 1. Here, the known boundaries of the obstacles are enlarged ("bloomed") by an amount equal to one-half the diameter of the robot plus an extra amount for uncertainty associated with the robot's actual position. At the same time, the robot is mathematically shrunk to a single point. If some object obstructs a straight-line path to the goal, hypothetical lines are drawn from that point to each of the vertices (edges) of the expanded obstacles in direct line of sight of the robot. From each of those points, new lines are drawn to each vertex of the obstacles in their line of sight, and so on, until a line of sight from some vertex to the goal has been obtained.

All paths from the robot's current position to the goal are converted into a graph of nodes and edges where each edge is a path segment. Finding the best path consists of examining path lengths from the start node to the finish and selecting the shortest sequence. Optimal solutions for such find-path problems have been developed that permit the answer to be obtained very efficiently, such as the A* algorithm used in the artificial intelligence community for the search of decision graphs. Moravec used the approach of projecting three-dimensional shapes onto two-dimensional surfaces and calculating tangential paths as a method of navigation planning for the Mars Rover.

When the available movement corridors are very narrow, the robot needs more complex algorithms to calculate its rotations. This class of path planning has been called the "piano-mover problem" (reference 8).

In the simple find-path problem above, we treated the robot as a point rather than a polygonal body with unequal dimensions and appendages into the navigation space. Such an approach will work if there is plenty of maneuvering room. In the case of the piano-mover problem, the corridors the robot will traverse may narrow so that the robot must rotate to squeeze through clearances the way a piano mover must make turns and rotations to climb stairs, go through doors, or go around corners.

The complexity comes from the fact that, in addition to finding a continuous motion that will take a robot from a given initial position to a final position, the robot is subject to geometric constraints during the motion. The constraints do not permit any part of the irregular robot body to come into contact with obstacle edges or walls.

You can simplify the task by imposing restrictions on the range of allowed robot motions, such as insisting that the robot move in a fixed orientation or that the change of orientation can occur not more than once during a path traversal, but in general the problem is approached as follows.

Each corner of the robot chassis outline is labeled and treated as an axis around which the robot can rotate. The map of the navigation area is divided into regions of open space formed by the intersections of the lines connecting the objects, room walls, and corners. Each region is separated from the other in terms of "critical curves" that are created by the set of points generated when each vertex of the robot outline is placed at an intersection point of two regions, and the robot is rotated around that axis until an intersection occurs with region boundaries.

The set of intersecting curves formed for all the robot vertices composes a finite connectivity graph that contains all possible boundary-crossing rotations of the robot. Algorithms are then applied to this connectivity graph to select a "path" consisting of axis rotations that permit the robot to cross from one region to another. In figure 2, the robot is represented by a triangle and the corridor to be navigated is bent at an angle. To traverse the boundary, the robot must turn right at the first boundary area and move backward down the corridor to fit through.

With the current state of robot sophistication, other factors can overshadow such tight maneuvers in real-life situations. These factors lead us

(continued)

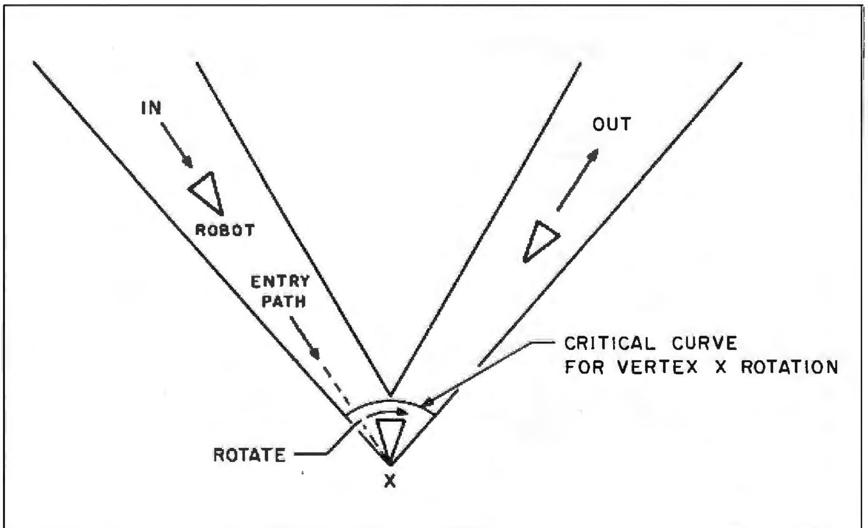


Figure 2: *The piano-mover problem.*

We have over 1000 Software and hardware items in stock. Shipments on almost all items within 24 hours!

Call for programs not listed

WAREHOUSE DATA PRODUCTS

FREE SOFTWARE! With over $100 purchase you will receive a free diskette for your IBM PC with label maker, checker game and banner programs.

Technical & Other Info. (602) 246-2222

TOLL-FREE ORDER LINE 1-800-421-3135

SOFTWARE

—DATA BASE MANAGERS—

Clipper	$345
Clout 2	129
Condor III	299
Fox and Geller Quickcode	145
Fox and Geller Quickreport	145
Knowledgeman	225
Knowledgeman II	309
K Paint	60
K Graph	135
K Text	105
K Report	135
Nutshell	55
PFS: File	78
Power Base 2.1	199
RBase 5000	Call
Think Tank	98
Tim IV	169

—WORD-PROCESSING—

Easy (Micro Pro)	89
Leading Edge w/Merge	85
Microsoft Word	225
Multimate 3.31	205
Multimate Advantage	255
Oasis Word Plus	85
Peachtext 5000	145
PFS: Write	78
Random House Spell Checker	36
Samna III 3.0	265
Volkswriter Deluxe	139
Word Perfect 4.1	195
Wordstar	170
Wordstar Propac	238
Wordstar 2000	238
Wordstar 2000+	285

—SPREADSHEETS—

Microsoft Multiplan	115
PFS: Plan	78
Supercalc II	145
Supercalc III 2.1	169

—ACCOUNTING—

BPI Accounts Payable	299
BPI Account Receivable	299
BPI General Accounting	299
BPI Payroll	299
Cyma	Call
Dollars and $ense	95
MBSI	Call
Tobias Managing Your Money	94

TCS. Big Four equivalent of Peachtree Series 4 - Specially augmented and customized for your IBM PC Terminal and Printer - GL, AR, PA, AP, CP/M-80, CP/M-86 for PC XT, DOS 1.1, 2.0.
Each Module **$65** For All Four **$249**

—INTEGRATED—

Enable	Call
Smart Software	Call

—TRANSFER PROGRAMS—

Crosstalk XVI	89
Hayes Smartcom II	88
Microsoft Access	149
Move-It	79
Remote	99

—GRAPHICS—

Chartmaster	215
Dr. Halo II	99
Energraphics w/o Plotter	170
Energraphics w/Plotter	220
Fontrix	99
Graphwriter/Combo	310
Microsoft Flight Simulator	30
PC Paint Brush	69
PFS Graph	78
Signmaster	135

INCREDIBLE VALUE!

Nationally advertised boards for IBM PC and compatibles at giveaway prices.

1 year warranty

5151 Equivalent Keyboards	$89
Hercules Graphic Board Equivalent with Parallel Port	$99
Expansion Board 0 to 576 K	$59
AST Six Pack Equivalent with game port	$99
Four Drive Floppy Controller	$45
Color Card without printer port	$79
Color Card with printer port	$95

IBM PC CLONE
256K Expandable to 640K on the motherboard, 2 drives 7 expansion slots **$650**

—LANGUAGES—

Concurrent PC/Dos	Call
Fortran 77	208
Lattice C Compiler	249
Run C Interpreter	89
Microsoft C Compiler	239
Microsoft Fortran	209
Microsoft Macro Assembler	89
Microsoft Pascal Compiler	178
Microsoft Quick Basic	65
Multi Halo	140

—UTILITIES—

Copy II PC	19
Copy II PC Board	79
Copywright	45
Norton Utilities 3.1	52
PC Tools	22
Prokey 4.0	75
Superkey	35

HARDWARE

BUYS OF THE YEAR

Expansion Board 0 to 576K	$59
KB5151 Keyboard Equivalent	89
Hercules Graphic Board w/Par Port Equivalent	115
AST Six Pack Equivalent	115

1 Year Warranty

—HARD DRIVES—

Bernoulli 20 MB ½ ht.	2439
Seagate 20 MB Internal w/Controller	499
Turbo 10 internal	529

—MODEMS—

Anchor Express	235
Hayes 1200	Call
Hayes 1200B w/Software	Call
Hayes 2400	599
Promodem 1200B w/Software	265
Promodem 1200	309

—RAM—

64K 150NS Chips (Set of 9)	9.50
256K Ram Chips (Set of 9)	27

—BOARDS—

AST Advantage	385
AST Sixpack (384K)	249

HARDWARE

Hercules Color Card	145
Hercules Graphics Card	289
J RAM III	Call
Paradise Five Pak	119
Paradise Modular Graphics Card	249
Quadram Board with Par/Ser and Game Port	199
Quadcolor I	185
Sigma Maximizer Multifunction	149
Sperry 512K Expansion w/128K	145
STB Chauffeur Board	249
STB Mono Board	155
AB Parallel Print Switch w/cables	75
Mini Micro Parallel Print Buffer	69

—COMPUTERS—

Corona PC	Call

Sperry PC Mono 256K Dual Drive Serial Port, Clock, MS/DOS 2.11 ...... **$1650**

IBM PC-AT	Call
ITT Computers PC Compatible 256k Dual Drive, Mono, MS/DOS	1395

ITT XP 80286 IBM/PC Compatible, 512K, 10 MB Winchester, 3 times faster than an XT. 30% faster than an AT **$2650**

Kaypro 2000 768K	$1695
Kaypro 16² w/external color monitor	1995
Zenith 171	Call

—PRINTERS—

FREE! PRINTER SET SOFTWARE
Purchase an Okidata, Epson, Gemini, Citizen or Toshiba printer and receive at no charge a menu driven program to set print characteristics or to make your computer function as a correcting typewriter. Retail value $35. Available for most disk formats.

CITIZEN

MSP-10	255
MSP-15	355
MSP-20	329
Citizen 120D	169
Premiere 35 Daisywheel	415

EPSON - Call on all models

JUKI

Juki 6100	349
Juki 6300	685

NEC

3550	989
8850	1349
P5 Parallel	995
Elf 360	398

OKIDATA - Call on all models

PANASONIC

1091	239
1092	349
1093	429
KXP3151	410

STAR MICRONICS - Call for prices

TOSHIBA

1340	499
P351	1049
P341	875

—MONITORS—

AMDEK	Call for price
Taxan 610	319
Taxan 121 Green	125
Taxan 122 Amber	134
Princeton Max 12	170

TERMS: Prices include 3% cash discount. Add 3% for charge and C.O.D. orders. Shipping on most software is $5.00. AZ orders +6% sales tax. Personal check- allow ten (10) days to clear. Prices are subject to change. We accept purchase orders.

TOLL-FREE ORDER LINE 1-800-421-3135
WAREHOUSE DATA PRODUCTS
2701 West Glendale Ave. • Phoenix, AZ 85021

Inquiry 378

to the next level of navigational complexity, the exploration of Columbus.

COLUMBUS

In the navigation of Magellan, the world map existed. Travel involved finding the best path to a goal. Columbus faced a different problem. He knew roughly where he wanted to go, but he had little or no information as to what he would encounter along the way.

Since others felt he might sail off the edge of the world, it was important that he create a detailed record of his journey as he went. The voyage was filled with both perils and great discoveries to record. For an autonomous robot, such situations occur with obstacle avoidance and world mapping through sensors.

Robotic sensors come in many types and include monoscopic and stereoscopic vision systems, fixed and mobile sonar range finders, laser range finders, touch sensors, stress and torque sensors, and collision detectors. For navigation, the most often sought sensor data is used for edge detection.

Vision systems usually encode pictures as matrices of gray-scale pixels that are connected through gradient-seeking algorithms that consider reflectivity, texture, and shading to produce skeletal representations of the scene objects. The skeletal edges are then used to direct turn angles or grasping orientations of end effectors. Using multiple cameras simultaneously permits the estimation of distances through optical parallax.

Lasar range finders allow precise location of edges and can be used in conjuction with other sensors such as those for vision. Touch sensors permit obstacle avoidance through edge following and work well if the objects are not highly irregular. Sonar sensors are widely used in robotics navigation. For a discussion of the nature and limitations of this kind of sensor, see the text box "Sonar Sensors" on page 230.

When the approximate locations of obstacles have been determined, the navigation algorithms use the sensor-

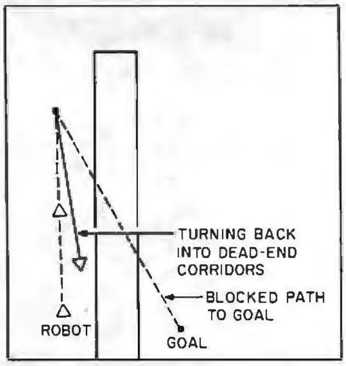


Figure 3: A *simple maze that demonstrates the need for memory in Columbus-level navigation.*

generated map to determine admissible paths much like the Magellan example. The situation is more complicated, though, because of the uncertainty that is introduced by sensor errors, fuzzy object shapes, and imprecise destination areas. Depending upon what the robot finds on the way, it may not be possible to reach a goal, and numerous unplanned changes in course may be required. It is also no longer possible to guarantee that the robot is taking the most efficient path to a goal any more than Columbus could guarantee that he had selected the best route to an unexplored continent.

When the environment is only partially known, new issues must be considered that would not occur with a complete world map. Just as Columbus could sail into closed lagoons, a robot can encounter dead-end corridors and mazes when exploring. A maze might be generated by rows of boxes, outdoor canyons, or tangled equipment and can result in a teleoperated robot getting choked by its own power cord. In contrast to Columbus, it is not always easy for a robot to determine that it is in a dead-end situation.

Figure 3 shows a maze problem. Suppose the robot were given a control algorithm like the following:

> When in a new area, first turn toward the location of the goal you wish to reach. Take a sonar reading to see if the path is clear. If the path is clear, then move. If it is not, take the first open path on either side of the line you would have taken if the path had been clear. Go one-half the distance to the goal. When you arrive at that location, turn back toward the goal and repeat the process.

At first glance, such a procedure appears very sensible. The first clear path closest to an ideal straight line is always the one taken. The half-distance criterion assures that if the robot is far from the goal it will move rapidly to it, but it will take smaller, more careful moves the closer it gets.

What, then, is wrong? The problem is that we have not given the robot an ability we take for granted. The robot has no memory. Look again at figure 3. The robot's goal is directly on the other side of a wall. If the robot follows our initial algorithm, it will scan the corridor it is in and select the first open move halfway to the goal after about a 90-degree left turn. The robot will begin to move up the corridor, away from the goal. After a short distance, the robot will be far enough from the goal so that it can travel half the distance by making a turn back toward the goal.

What happens? The robot again moves into the dead-end corridor. Thus, without external memory, our explorer bounces around and never reaches the goal. With a memory, previously explored blocked areas can be set off limits for a goal traversal so the robot is gradually squeezed out of dead-end situations.

Of course, there are many ways we could deal with this problem. The real difficulty is assuring that a general-purpose navigation algorithm considers all the possible traps that can be generated by deficiencies in the robot. Subtle complexities can hide in seemingly simple situations, such as a need to consider multistep memory to avoid recursive loops, a need to explicitly consider trading off distance traveled versus angle turned, and

(continued)

SONAR SENSORS

Sonar sensors have proved particularly useful in navigation research, largely because they are relatively inexpensive and able to grossly cover large areas more rapidly than detailed processing with visual systems. Nonetheless, their use in autonomous navigation does pose some problems. Figure A illustrates some of the properties that make "sonars" challenging for use in navigation.

Most low-cost sonar devices function by sending a multifrequency or "chirped" sound pulse from a transducer outward in a cone-shaped wavefront. The difference between the time of emission and return is then used to determine estimated distance calculated on the basis of how far the wave could travel in one-half the period.

Real-world factors intervene when a robot uses that information to construct spatial distance maps from different scanning positions. First, although not of great concern indoors, sonar is sensitive to temperature changes. Specifically, the speed of sound in air is proportional to the square root of the absolute temperature in degrees Rankine (degrees Fahrenheit plus 460). If a sonar range detector is calibrated at a standard temperature *S* and the actual room temperature is *A*, then the actual distance traveled by the sound in the air is the square root of (460 + *A*) / (460 + *S*) times the estimated distance. Thus, if a sonar were calibrated at 80° F and the actual room temperature was 60° F, a measured range of 35 feet would be overestimated by 7.8 inches (see table A). If that 7.8 inches overlapped with the position of a solid object, the difference could provide a shocking experience for a moving robot.

Another property of sound waves is that they exhibit specular reflection and interact with the texture of materials. This interaction was illustrated one day in our laboratory when we were going to demonstrate a small mobile robot for some visitors and decided to give the obstacles colorful coats of shiny new paint. The high gloss was attractive to the human eye but also extremely reflective to sonar, so that if the obstacles were not hit almost head-on by a sonar beam they vanished from the sonar navigation maps. The result was that the robot often rammed into the objects instead of going around them. After trying cardboard, metal, and other coverings, we found that the highest specular reflection was provided by simple plastic bubble wrap. Visitors now see

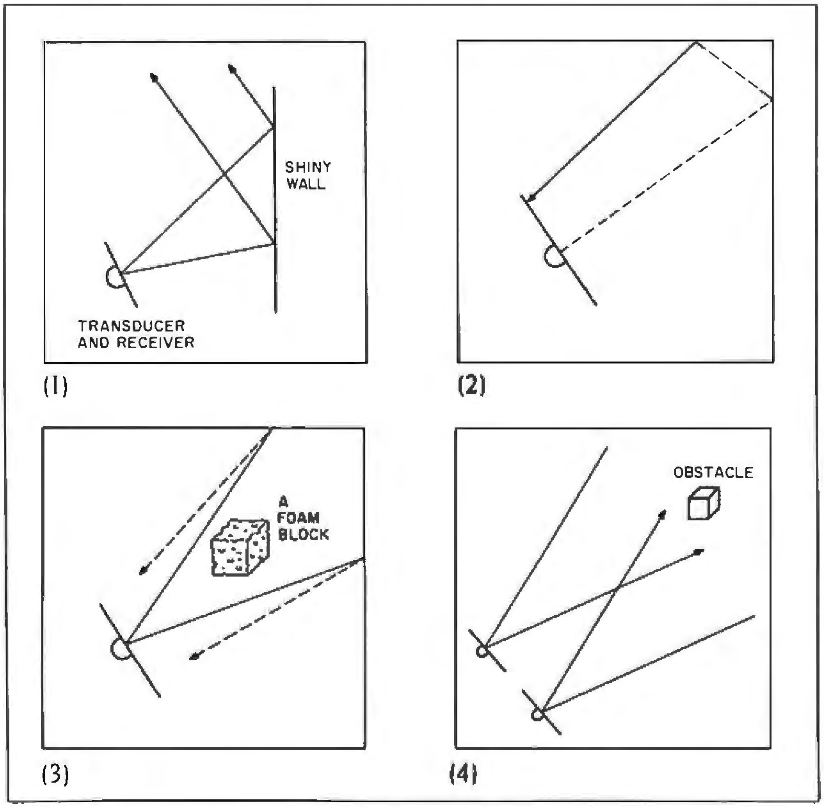


Figure A: *Sonar problems. (1) Specular reflection, (2) false distance readings caused by reflection, (3) absorbancy, and (4) beam focusing.*

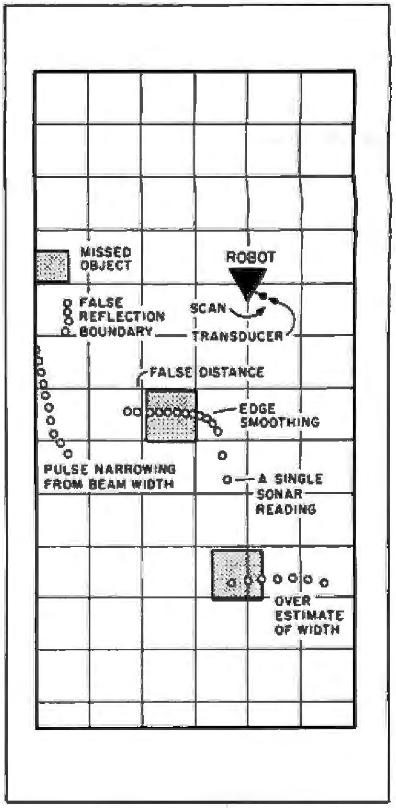


Figure B: A *sonar map of a room. Each grid is two feet square.*

Table A: *The equations of sonar in air.*

SPEED OF SOUND IN AIR $S = \sqrt{K_g HRT}$

Where

S = speed of sound
K_g = gravitational constant
H = ratio of specific heats of air at constant pressure to constant volume
R = gas law constant for air
T = absolute temperature

ACTUAL DISTANCE $D_s = \sqrt{A_t / S_t}$

Where

D_s = sonar-measured distance using the above formula
A_t = actual outside temperature
S_t = standard temperature

SONAR-CALCULATED DISTANCE $\frac{1}{2} tS$

Where

t = time between sending and receiving sonar pulse
S = speed of sound in air

colorful boxes through a fat layer of bubble packing. Since robot designers can't bubble-pack the world, it is obvious that other sensor types must be used in conjunction with sonar for navigation.

The characteristics of reflected sound also depend on signal energy and frequency. Frequencies that are useful in medical imaging, such as ultrasound, are not really practical for robotics because they take advantage of the density of the propagation medium, which is usually a fluid or tissue. Most sonar systems for air rely on a carefully selected subset of frequencies designed to minimize absorption by typical materials. Under some circumstances the frequency will be inappropriate even for head-on readings. An actual example occurred in some initial experiments using robot manipulators that attempted to grasp polyurethane foam blocks, which have extremely high sonar absorbency. For all intents and purposes, these blocks were invisible to sonar.

Other sonar problems occur because of the beam shape. The output of a sonar transducer is actually a cone, like the beam of a flashlight. Without a focusing horn, a typical sonar cone is about 35 degrees wide. Therefore, sonar maps have to take into account that the leading edge of the cone will contact a barrier well before the center axis of the transducer. If the false angular reading is not corrected, the map of an area a robot uses to navigate is distorted. Figure B shows a sonar map made by a robot in the CESAR laboratory that illustrates some of these effects. Specular reflection caused the map to show artificially smoothed edges to boxes, vanishing walls, and falsely closed movement corridors. Beam spread made obstacles that are farther away from the robot appear larger than they really were. Failure to correct for the width of the beam and plotting the distance returns as though they were at the center axis of the sonar resulted in a false inward wall curvature.

Many of these characteristics can be compensated for based on known properties of the sonar beam, but not all. The reason is that, in an unknown room, there is no way to assure that a sonar return is the result of a specular reflection effect instead of an actual return from a new object. Without further verification from different robot positions or alternate sensors such as vision, extraneous information must remain in the sonar map. The correction, or "unfolding," of sensor data thus becomes of major concern the more rapidly navigation decisions must be made.

checking sonar maps to handle changing reflections.

In addition to changing reflections, errors in robot position occur due to the cumulative buildup of mechanical and electronic innaccuracies in the robot propulsion system. Columbus-level navigations must be able to correct a position by keeping track of changing external references. There is also a need to keep track of higher-level global relationships. One problem is identifying and selecting a good reference point. A robot can use such a point to correct cumulative mismatches between what the internal map records as the robot's location and what sensor data indicate are actual object distances and orientations. How to best select and relate such references as well as how to update the internal map are topics still being researched.

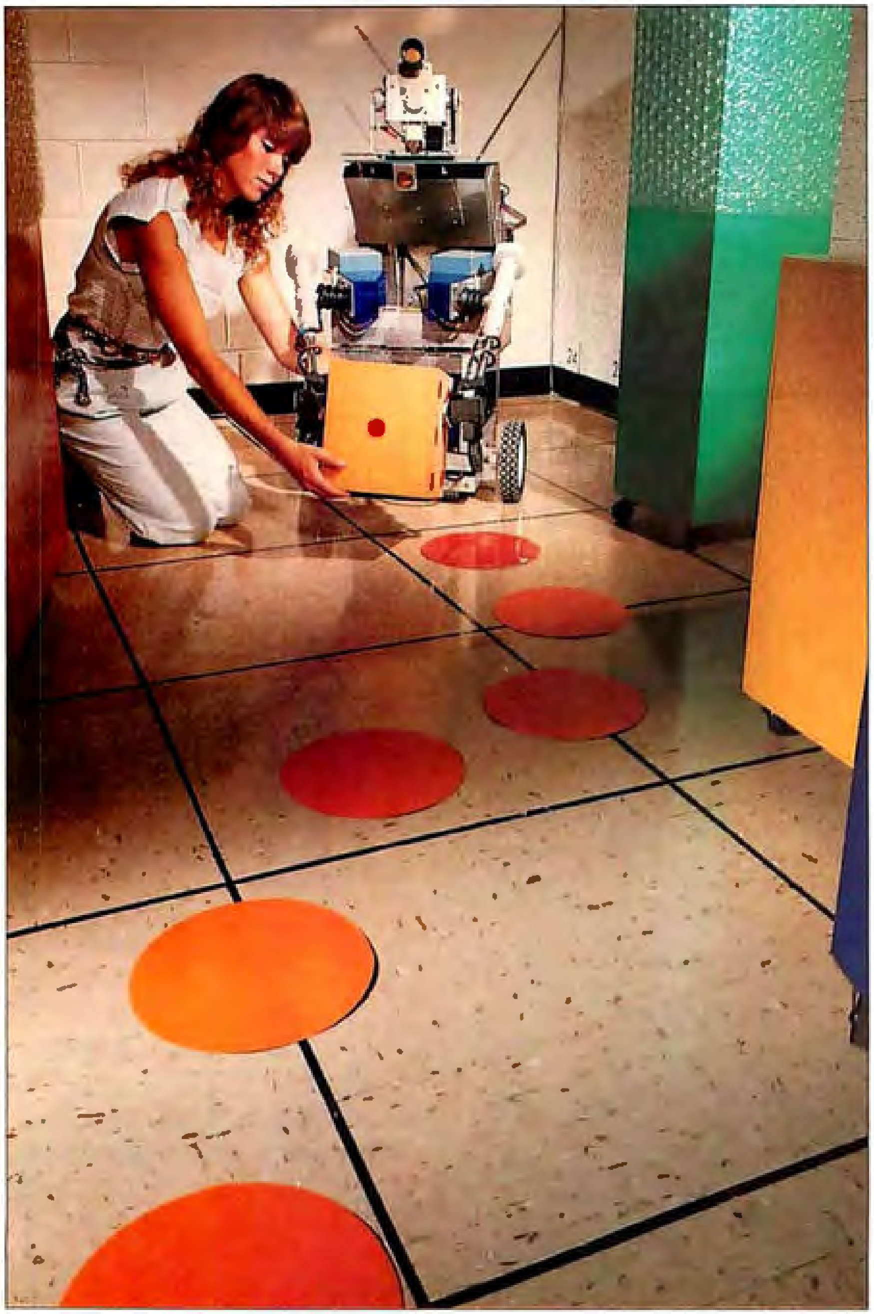


Photo 1: HERMIES *(right) and friend.* Notice *the bubble wrap on the obstacles and the two-feet-square floor grids.*

ULYSSES

Other types of problems occur when navigation in real time is considered. Ulysses had to contend with a multitude of perils on his explorations, but he also faced gods who kept changing his environment by adding threats or removing them.

For an autonomous robot, a similar situation occurs with traversal in an environment where objects move and requires creation of a stack of intermediate goals as changes invalidate global plans. The robot must generate new plans, remove invalid goals from the stack, and break world maps into static and dynamic areas.

Consider a woman walking down a crowded hall who is preoccupied with a schedule and takes only occasional glances to determine if something is in her way. A glance may work as long as the unexpected does not occur. The greater the amount of change in the environment, however, the faster and more frequently she must glance up and the more often she will have to modify a plan to walk straight ahead in order to avoid bumping into people.

A robot in a dynamic environment is in the same situation. Sensor processing speed must be sufficient to recognize changes in the environment before a preplanned action results in a catastrophe. Consider the implications for a Mars Rover that could only process the image of a cliff after rolling over the edge. Although current computer vision systems provide detailed two-dimensional information about the environment, they can be very slow and computation-intensive. The technology is changing, but vision may not be able to effectively handle the full navigation problem. Single-sensor limitations make us want to simultaneously use different kinds of sensors to provide more data. Higher-order logic may then be able to use the increased information to anticipate serious events before they occur.

Ulysses navigation often creates the need for multiple sources of information to supplement local sensor readings. Sensor speed is important because the total array of sensors must be fast enough to monitor world changes effectively. In addition, multiple sensors increase the importance of future research on databases that combine information into a composite data structure. One such area is robotic learning. An ideal autonomous vehicle would acquire information about its environment on a local basis and at the same time build or modify a global world model that can be used for more complex plans (reference 7).

A Visit with HERMIES

To illustrate how some of these techniques appear in a working system, consider HERMIES (see photo 1). A small mobile robot at Oak Ridge National Laboratory, HERMIES is the prototype of a robot series that contains many of the features needed for autonomous operation in hazardous environments.

HERMIES has a self-powered mobile platform with a wheel-driven chassis, dual manipulator arms, onboard distributed processors, and a directionally controlled sensor suite. He is propelled by two independent DC-motor-driven wheels with a common axle alignment. Common motor direction provides forward and reverse motion, while counter driving provides bidirectional pivoting for heading changes. On-board computers consisting of an IBM Personal Computer and a Z8 microprocessor are located in an enclosure mounted above the drive chassis. The PC controls all functions except the arms, which are controlled by the Z8. The dual arm manipulator torso is located above the computers with two five-degrees-of-freedom Hero I arms with added shoulder-pitch motion and a base rotation. At present, the sensory platform at the top of HERMIES has one four-element phased array and a binary vision system positioned by a pan-and-tilt mechanism. The sensor platform is controlled by an open-loop commercial multiaxis stepper controller. HERMIES does not do all planning on board but rather communicates sensor data to a remote LISP machine via a radio frequency link. Thus, all the navigation planning, map construction, and decision making occur in the LISP machine, and decisions are transmitted back to HERMIES as primitive FORTH commands recognized by the robot operating system.

The boxes shown in photo 1 are movable obstacles from which various maze and barrier problems can be constructed. The box mobility also permits experimenters to change the positions of the obstacles as HERMIES navigates. The circular disks on the floor are goal markers so the staff can assess how much cumulative error has been introduced between the internal sonar map of the robot location (displayed in real time on the LISP machine) and the actual location of HERMIES in the laboratory.

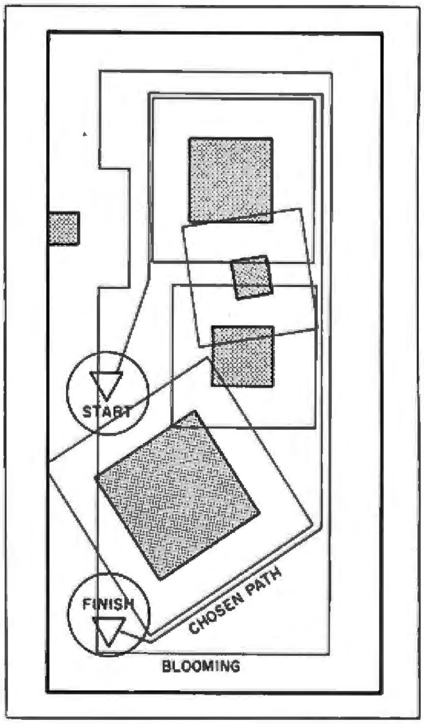


Figure 4: *A Magellan-level navigation by HERMIES, showing the original spatial map, the blooming of obstacle diameters by HERMIES (red), and the selected path (blue).*

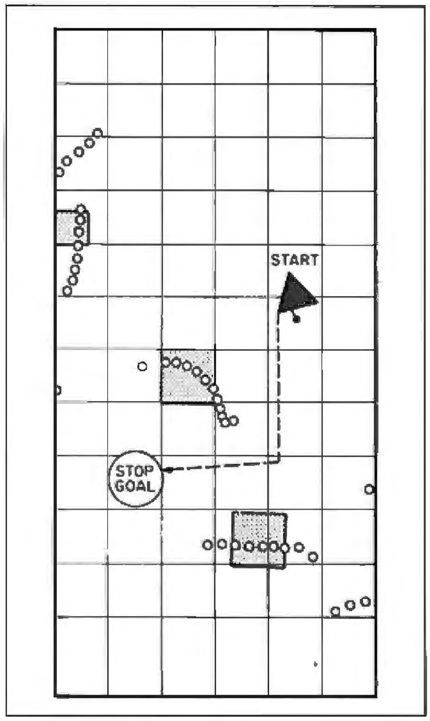


Figure 5: *A Columbus-level navigation by HERMIES. Obstacles are drawn into the figure but were not available to the robot. The small circles represent the obstacle locations as they appeared on sonar.*

Consider first a simple find-path problem. Figure 4 is an example of a spatial map that HERMIES constructed when given a Magellan problem involving four blocks. Notice how the edge of the room and the boxes were "bloomed" (red lines) to allow movement clearances. The blue line shows the computed path to be traveled, which corresponds to the selected vertices of the bloomed boxes. Notice that a shorter path looked possible but the robot did not select it because the clearances of the obstacles were insufficient after the obstacles were bloomed.

Figure 5 shows part of a Columbus problem navigation map generated by sweeping the HERMIES sonar through 180 degrees and recording the returned distances as small circles. The dashed line corresponds to the

(continued)

path selected by HERMIES to avoid the obstacles. The actual shapes of the obstacles are drawn in to illustrate the error introduced by the sonar returns (see "Sonar Sensors" on page 230) and were not available to HERMIES at the time of navigation.

Figure 6 shows part of a Ulysses-level global map that was built in four steps. This information is used to combine the history of multiple journeys for future navigation planning.

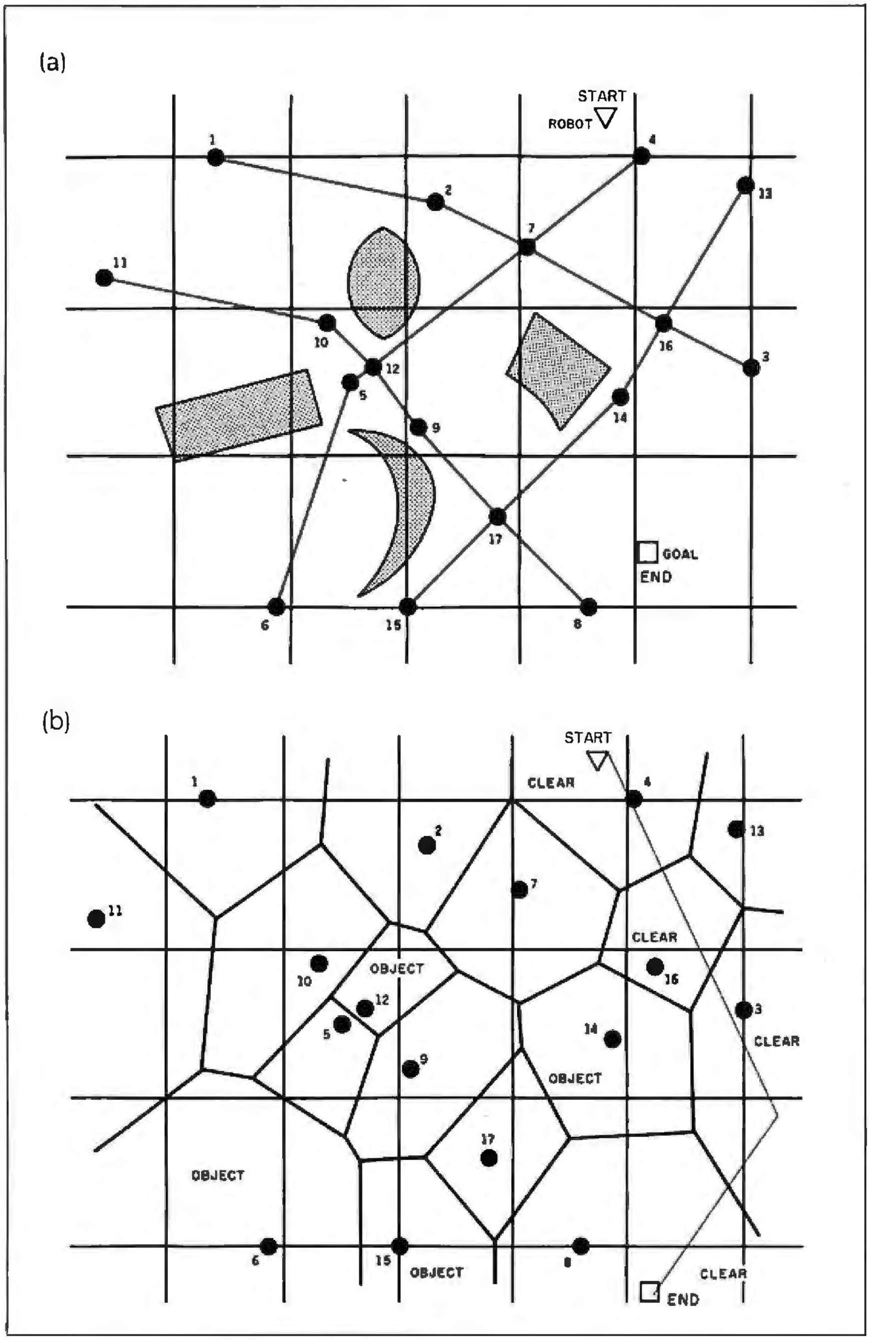


Figure 6: A *Ulysses-level map constructed by* HERMIES. *(a) The obstacle positions before exploration and four paths (blue) from previous traversals around the objects; (b) Voronoi regions are created and labeled from previous path points. The optimal path calculated is shown in blue.*

Figure 6a shows a spatial graph of current obstacle locations and paths from four earlier Columbus-level journeys. Figure 6b is a special type of graphic representation called a Voronoi diagram. Both are used to apply graph theory to the multipath history and calculate a new optimal path from previously learned information. This path would minimize additional sensor use. Learning occurs as new paths are added to the Voronoi diagram and spatial graphs so that, with time, the robot navigation control switches from sensor-driven obstacle avoidance to global graph-based decisions.

FUTURE DIRECTIONS

Advances in robot navigation are occurring very rapidly, so accurate projections about the future are speculative at best. Some trends appear evident, however. Robot navigation planning will move increasingly toward Ulysses-level problems. There will be more concern with the computational and algorithmic requirements of real-time sensor processing and decision making using parallel computer architectures, larger knowledge bases and expert systems, and effective characterization of uncertainty. Sensors will increase in speed and number with improvements being made in integrated functions, such as the use of multiple phased arrays to improve sonar focusing, laser range finders for precise distance and edge detection, touch sensing, and stereoscopic vision.

Future descendants of current mobile robots such as Carnegie-Mellon's Terregator, HERMIES, the University of Tolouse's Hilare, and the Department of Defense's Autonomous Land Vehicle will most likely be faster, smarter, and more aware of their environments than today's prototypes. The mobile robots of the future may well be a new class of explorers that journey to places or planets where people can never go. ■

REFERENCES

1. Juliere, M., L. Marce, and H. Place. A *Guidance System for a Mobile Robot.* 13th In-

ternational Symposium on Industrial Robots, ROBOT 7, vol. 2, April 1983.
2. Lozano-Perez, T. "Automatic Planning of Manipulator Transfer Movements." *IEEE Transactions on Systems, Man, and Cybernetics*. SMC-11, 1981, pages 681–689.
3. Moravec, Hans P. "Obstacle Avoidance and Navigation in the Real World by a Seeing Robot Rover." Stanford AIT-340, September 1980.
4. Udupa, Shriram M. "Collision Detection and Avoidance in Computer Controlled Manipulators." *Proceedings of IJCAI-5*. Cambridge, MA: MIT Press, 1977, pages 737–748.
5. Crowley, J. L. "Navigation for an Intelligent Mobile Robot." *IEEE Journal of Robotics and Automation.*, vol. RA-1, no. 1, March 1985.
6. Dufay. "Apprentissage par Induction en Robotique—Application à la Synthèse de Programmes de Montage." Thèse de Troisième Cyde, INPG Genoble, June 1983.
7. Iyengar, S. S., C. C. Jorgensen, S. V. N. Rao, and C. R. Weisbin. "Robot Navigation Algorithms Using Learned Spatial Graphs." ORNL technical report ORNL-TM-9782, August 8, 1985.
8. Schwartz, J. T., and Micha Sharir, "On the Piano Movers Problem, the Case of a Two Dimensional Rigid Polygonal Body Moving Amidst Polygonal Barriers." *Communications on Pure and Applied Mathematics*, vol. xxxvi, 1983, pages 345–398.
9. Everett, H. R. "A Multielement Ultrasonic Ranging Array." *Robotics Age*, July 1985, pages 13–20.

The research that is the subject of this article was sponsored by the Office of Basic Energy Sciences of the U.S. Department of Energy under contract No. DE-AC05-840r21400 with Martin Marietta Energy Systems Inc.

FOR FURTHER INFORMATION

For more detail on vision systems, see *Digital Image Processing* by Rafael C. Gonzalez and Paul Wintz (Reading, MA: Addison-Wesley, 1977).

For an interesting study of the Mars Rover, see *Robot Rover Visual Navigation* by Hans P. Moravec (Ann Arbor, MI: UMI Research Press, 1981).

For more detail on robotic arms, see *Teleoperation and Robotics: Evolution and Development*, Robot Technology Series vol. 3A, by Jean Vertut and Philippe Coiffet (London: Kogan Page, 1985).

For information on planning, see *A Structure for Plans and Behavior* by Earl D. Sacerdoti (New York: Elsevier, 1977).

AI IN COMPUTER VISION

BY JOHN L. CUADRADO AND CLARA Y. CUADRADO

Framing doors and windows

COMPUTER VISION INVOLVES a two-stage process: An early processing (sometimes called low-level processing) stage extracts intrinsic information of images, e.g., the gray level at various points on an image plane. This early processing is done very efficiently, albeit unconsciously, in the human visual system. We do not yet understand very well the way it works. In contrast, the late processing (or high-level processing) stage in computer vision uses general assumptions about how the physical world fits together to guide vision. This high-level processing is more easily understood in terms of the human visual system: We constantly utilize domain knowledge to guide our interpretation of images. Here vision becomes inseparable from general cognitive processing. This is the stage where artificial intelligence and vision meet; knowledge representation, inferences, goals, and plans all play an important role in this stage of vision.

In this article we will attempt to illustrate how artificial intelligence techniques can be used to aid computer vision. Because of the complexity and diversity of issues involved in these two fields, we feel it is futile to try to cover current state-of-the-art research. Interested readers should consult references 1, 2, 3, and 4. Instead, we will present a simple computer-vision system that we have constructed for the explicit purpose of demonstrating the role AI may play in a vision system. We will concentrate on the high-level end of the vision hierarchy but we will also point out the interplay between the low-level processes and the knowledge-intensive processes whenever appropriate.

FRAME-BASED KNOWLEDGE REPRESENTATION

Our computer-vision system uses a frame-based knowledge representation to handle all the components in the high-level processing of the vision hierarchy. (Probably the best introduction to the idea of frames and frame-based systems is reference 5. An excellent succinct presentation is also available in reference 6.) The frames structure we use is based on a combination of features from KRL (Knowledge Representation Language), SRL (Schema Representation Language), and FRL (Frame Representation Language). Our frame-based system is implemented in Prolog and includes such features as inheritance and demons.

The basic structure of an abstract frame is shown in figure 1. A frame consists of a name followed by an arbitrary number of slots, each of which can support an arbitrary number of facets. Each facet has an associated value. The data corresponding to these values is not typed data in general, although it is a simple matter to provide mechanisms for the enforcement of strongly typed facets. The value associated with a given facet can be an integer, string, list, or an even more complex object. The most common facet is the value facet.

(continued)

Clara Y. Cuadrado and John L. Cuadrado (Octy Inc., 10920 Oxford Court, Fairfax Station, VA 22039) both earned Ph.Ds from the University of Illinois at Urbana–Champaign. They taught at the University of Maryland and Dartmouth College, respectively, and now run their own company developing AI systems.

This facet refers to the actual value taken by the corresponding slot. Other commonly occuring facets include the default and if__needed facets. A simple example should help to clarify all this terminology.

Consider a simple personal computer consisting of a microprocessor, some memory, a disk drive, a video monitor, and a keyboard. This might be represented as shown in figure 2.

Now, a specific instance of this type of computer could be my computer, as shown in figure 3a. The ako acronym stands for "a kind of" and indicates that my__computer is one of the class of computers having all the characteristics of computer__brandX. In particular, my__computer "inherits" an 8088 processor from the computer__brandX. Similarly, if we want to know what kind of monitor my__computer has, we know that since we did not specify a monitor, my__computer will inherit the black-and-white monitor specified as the default monitor in computer__brandX.

From this simple example we see that we are going to need a number of procedures to retrieve values from frames, to install values in frames, etc. We must also agree on some specific representation for frames using the data-structuring facilities that our implementation language provides.

The implementation we have chosen is to let each slot-facet-value triple be represented as a predicate whose head is the frame name. For example, my__computer in figure 3a would be represented as shown in figure 3b. We have chosen not to implement frames as list structures in Prolog primarily because Prolog does not provide adequate list-surgery operations. This is not an oversight by the designers of Prolog. To perform such list surgery it becomes necessary to do certain manipulations that are against the applicative nature of Prolog. There is a way around it via difference lists, but we will not go into that here.

FRAMES IN PROLOG

In the next few paragraphs, we present a guided tour through the various functions that provide the retrieval and maintenance facilities for this particular representation of frames in Prolog. Each of the sets of functions presented below is organized as a main predicate that provides a general facility, including the ability to handle inheritance and the invocation of suitable demons.

First, we need a function that will retrieve information from the slots in a frame. The predicate frame__get performs such a function. It uses ffget as an auxiliary predicate to handle traversals up the frame hierarchy. The actual code for this function is presented in listing 1. [*Editor's note: The Prolog source code is available for downloading from* BYTE*net Listings at* (617) 861-9764. *The code can be run on* PDPROLOG, *which is also available from* BYTE*net Listings.*]

The next set of predicates provides the facilities to install values in a given slot of a frame. The code for frame__put in listing 1 does this.

Next, we provide a predicate for removing information from a frame, frame__remove (listing 1).

Occasionally, we not only need to install and remove values from some slot in a frame but also need to replace whatever value is in a slot with a new value. In listing 1, frame__replace does this.

Finally, there are times when we need to deal with lists as the values of some slots. Often in these cases we build the lists incrementally. For this reason, we provide the frame__append predicate that appends values to a list in a slot (listing 1).

To further illustrate the use of the frame-retrieval and maintenance

(continued)

```
<frame-name>
      <slot-name>
            <facet-name> : value
            .
            .
            .
            <facet-name> : value
      .
      .
      .
      <slot-name>
            <facet-name> : value
            .
            .
            .
            <facet-name> : value
```

Figure 1: *An abstract representation in pseudocode of a frame.*

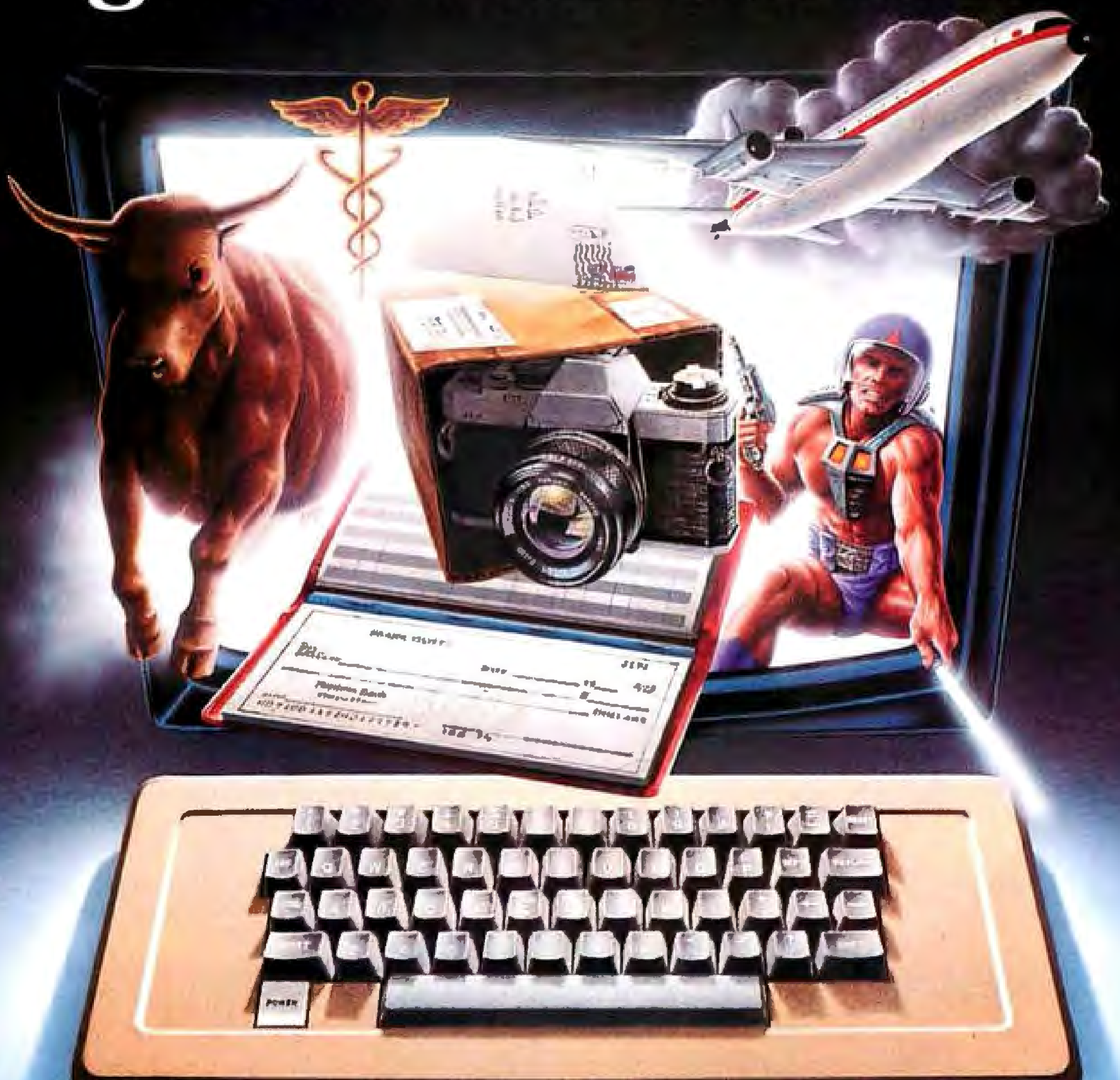
```
computer__brandX
      cpu
            value : 8088
      memory
            default : 256k
      keyboard
            default : 80__keys
      monitor
            default : black__white
      disk__drive
            default : ss__floppy
```

Figure 2: *A pseudocode representation of a frame defining a kind of microcomputer.*

```
(a)
my__computer
      ako
            value : computer__brandX
      memory
            value : 512k
(b)
my__computer(ako,value,computer__brandX).
my__computer(memory,value,512k).
```

Figure 3: *An instance of a figure 2–type computer in pseudocode (a) and as implemented in Prolog (b).*

We don't care which computer you own. We'll help you get the most out of it.



CompuServe puts a world of information, communications, and entertainment at your fingertips.

CompuServe is the world's largest information service designed for the personal computer user and managed by the communications professionals who provide business information services to over one quarter of the FORTUNE 500 companies.

Subscribers get a wealth of useful, profitable or just plain interesting information like national news wires, home shopping and banking, travel and sophisticated financial data. Plus electronic mail, national bulletin boards, forums (special interest groups), and a multichannel CB simulator.

You get games and entertainment, too. Board, parlor, sports, space and educational games. Trivia and the first online TV-style game show played for real prizes.

To buy a CompuServe Subscription Kit, see your nearest computer dealer. To receive our informative brochure or to order direct call or write:

CompuServe®

Consumer Information Service, P. O. Box 20212
5000 Arlington Centre Blvd., Columbus, OH 43220
800-848-8199 In Ohio Call 614-457-0802

An H&R Block Company

Inquiry 71

A NEW SOLUTION from
MicroComputer Accessories, Inc.

THE FEED & FOLD SOLUTION

Solved at last, Watson!

THE MICROFOLD™ PRINTER STAND

What's that, Holmes?

The proliferating paper problem. Now we can feed and refold paper in a space hardly larger than our printer's footprint.

Footprint, you say?

Look under the printer, Watson. The paper tracks from that lower tray, feeds up through the bottom or rear of the printer, and refolds back underneath, into the upper tray.

Tracks? Footprints? Holmes, I'm baffled.

Very observant, Watson. These cunningly designed baffles are the secret of its precise, smooth operation.

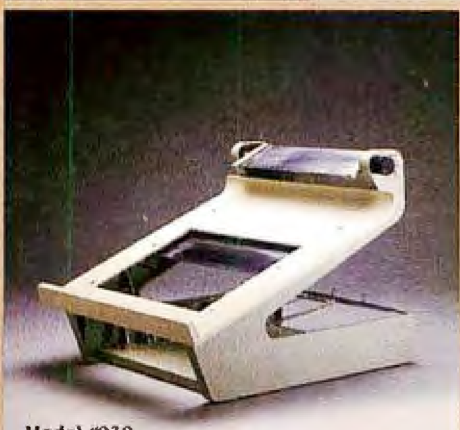
A smooth operator?

Even with its back to the wall, Watson!

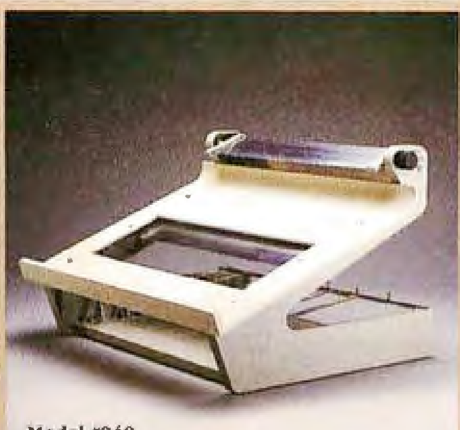
Are we tracking the footprints of a smooth operator? Holmes, I haven't a clue...

It's no secret, Watson—all other printer stands are now obsolete. Meet the MicroFold

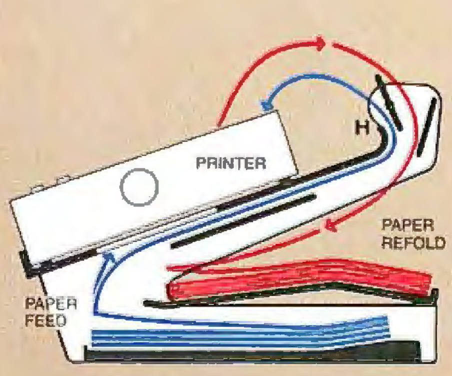
MicroComputer Accessories, Inc.™



Model #930
80 column printer stand



Model #940
132 column printer stand



USA: P.O. Box 3725, Culver City, CA 90231. Telephone 213/641-1800. EUROPE: Rue de Florence 37, 1050 Bruxelles, Belgique. Telephone 02/538.61.73.

Inquiry 239 for End-Users. Inquiry 240 for DEALERS ONLY.

Listing 1: *The Prolog frame-manipulation routines with an example routine for calculating cylinder attributes.*

```
/* Get the Value of Slot in a given Frame */
frame__get(Frame,Slot,Value) :—
        ffget(Frame,Frame,Slot,Value).

ffget(Parameter__Frame,Frame,Slot,Value) :- /* Check for a value Facet.
*/
        fget(Frame,Slot,value,Value).
ffget(Parameter__Frame,Frame,Slot,Value) :- /* Does it have a default?
*/
        fget(Frame,Slot,default,Value).
ffget(Parameter__Frame,Frame,Slot,Value) :- /* How about a demon?
*/
        fget(Frame,Slot,if__needed,Rule),
        F =.. [Rule,Parameter__Frame,Value],
        F.
ffget(Parameter__Frame,Frame,Slot,Value) :   /* None of the above. */
        fget(Frame,ako,value,Parent),   /* So, move up the hierarchy.
*/
        ffget(Parameter__Frame,Parent,Slot,Value).
fget(Frame,Slot,Facet,Value) :- /* Just grab the given Facet or
fail. */
        F =.. [Frame,Slot,Facet,Value],
        F.

/* Put Value in Slot of a given Frame. If this Slot has an associated
   if__added demon, then grab it and execute it after installing the
   given Value.
*/
frame__put(Frame,Slot,Value) :—
        get__rule(Frame,Slot,if__added,Rule), /* Must we do something
extra? */
        fput(Frame,Slot,value,Value),
        F =.. [Rule,Frame,Value],
        F.
frame__put(Frame,Slot,Value) :-
        fput(Frame,Slot,value,Value).          /* Just a simple fput will
do. */

fput(Frame,Slot,Facet,Value) :—
        F =.. [Frame,Slot,Facet,Value],
        assertz(F).

/* Remove Slot from a given Frame. If the Slot has an associated
   if__removed demon, then grab the rule and execute it before
   removing the Slot.
*/
frame__remove(Frame,Slot) :—
        get__rule(Frame,Slot,if__removed,Rule), /* Something extra to
do. */
        F =.. [Rule,Frame],
        F,
        fremove(Frame,Slot).
frame__remove(Frame,Slot) :-
        fremove(Frame,Slot).          /* Just a simple fremove. */

fremove(Frame,Slot) :—
        F =.. [Frame,Slot,value,Value],
        retract(F).
fremove(__,__).          /* If Slot doesn't exist, then no harm done. */

/* Replace whatever is in Slot with Value. If the Slot has an associated
   if__replaced rule, then grab it and execute it after doing the
   replacement.
```

(continued)

THE PC'S LIMITED AT™—$1995.
THE PC'S LIMITED TURBO PC™—$795.

At these prices, it's no wonder we're burning up the marketplace.

Yes, you can believe it. Since we ran our first advertisement for the PC's Limited AT™ and Turbo PC™, the calls we've received mostly start with comments like "Is this for real?" And "How can that be?" But now that our machines are in the hands of influential buyers, the questions tend to concern quantity discounts for further purchases. (Which are available.) You see, the PC's Limited machines are assembled from components bought worldwide with our strong buying power. Then they are offered directly to you—with no middleman markups. So light a match to your old budgets. With the savings we're providing, you'll have money to burn.

PC'S LIMITED AT™

—80286-based System Unit (runs at 6MHZ, 8MHZ optional)
—1024K on Mother Board
—1.2 Meg Floppy Drive
—Combined Floppy/Hard Disk Controller Card
—AT Keyboard
—192W Power Supply
—2 Serials and 1 Parallel Port
—Clock/Calendar with Battery Backup

Runs all Major Software written for the IBM PC™, PC XT™, and PC AT™. Unit has 8 Expansion Slots, with 7 available in above configuration. Same Bus Configuration as IBM PC AT™.

PC'S LIMITED TURBO PC™

—16-bit 8088-2 System Unit (running at 4.77 or 6.66MHZ)
—640K on Mother Board
—360K Floppy Drive
—Keyboard
—135W Power Supply

Runs all Major Software written for the IBM PC™ and PC XT™, 40% faster, without modifications. Unit has 8 Expansion Slots, with 7 available in above configuration.

PC'S LIMITED™

SALES-RELATED CALLS OUTSIDE TEXAS, 1-800-426-5150
1611 Headway Circle, Building 3, Austin, Texas 78754
Sales Calls from anywhere in country, (512) 339-6962
Technical Support Calls, (512) 339-6963 Customer Service Calls, (512) 339-6964
Telex No. 9103808386 PC LTD

Ad number 401

```
*/
frame__replace(Frame,Slot,Value) :-
        get__rule(Frame,Slot,if__replaced,Rule), /* Something extra to
do. */
        freplace(Frame,Slot,Value),
        F =.. [Rule,Frame],
        F.
frame__replace(Frame,Slot,Value) :-
        freplace(Frame,Slot,Value).              /* Just a simple
replace. */

freplace(Frame,Slot,Value) :-
        fremove(Frame,Slot),
        frame__put(Frame,Slot,Value).

/* Append Value to the list in Slot. If Slot has an associated
   if__appended rule, then grab it and execute it after appending
   the Value.
*/
frame__append(Frame,Slot,Value) :-
        get__rule(Frame,Slot,if__appended,Rule),
        fappend(Frame,Slot,Value),
        F =.. [Rule,Frame],
        F.
frame__append(Frame,Slot,Value) :-
        fappend(Frame,Slot,Value).

/* Here we check to see if the slot already exists.

   If it does, then we just append the new Value to the old value
list.
   If the Slot does not exist, then we create it and give it a value
   consisting of the list whose single element is Value.
*/
fappend(Frame,Slot,Value) :-
        fget(Frame,Slot,value,Old),
        (member(Value,Old)
        ;
         fremove(Frame,Slot),
         fput(Frame,Slot,value,[Value4Old])
        ).
fappend(Frame,Slot,Value) :-
        fput(Frame,Slot,value,[Value]).

/* This is a simple utility predicate used to travel up the frame
   hierarchy looking for an appropriate rule to grab.
*/
get__rule(Frame,Slot,Type,Rule) :-
        fget(Frame,Slot,Type,Rule).
get__rule(Frame,Slot,Type,Rule) :-
        fget(Frame,ako,value,Parent),
        get__rule(Parent,Slot,Type,Rule).

/* Example

frame representation:

   cylinder
      ako
            value : thing
      height
            if__added : cylinder__height__add
            if__removed : cylinder__height__remove
      radius
            if__added : cylinder__radius__add
            If__removed : cylinder__radius__remove
```

(continued)

```
        cross__section
                if__needed : cylinder__cross__section
        volume
                if__needed : cylinder__volume

    cylinder1
        ako
                value : cylinder

comments: cylinder1 above is an instance of cylinder. When we use
frame__put(cylinder1,radius,2), say, the system will install the number "2" as the
value of cylinder1's radius and it will further compute cylinder1's cross sectional
area and install it under the cross__section slot. Similar actions take place when we
do a frame__put for cylinder1's height. Below is the Prolog code that implements
all this. NOTE: PDPROLOG only supports integer arithmetic.
*/

cylinder(ako,value,geometric__object).
cylinder(height,if__added,cylinder__height__add).
cylinder(height,if__removed,cylinder__height__remove).
cylinder(radius,if__added,cylinder__radius__add).
cylinder(radius,if__removed,cylinder__radius__remove).
cylinder(cross__section,if__needed,cylinder__cross__section).
cylinder(volume,if__needed,cylinder__volume).

/* If we get the height, then we try to compute the cylinder's
   volume.
*/
cylinder__height__add(Cylinder,__) :-
        cylinder__volume(Cylinder,__).
cylinder__height__add(__,__).      /* If we can't do it,
                                      e.g., the radius is unknown,
                                      then no harm done. */

/* If the height is removed, then the old volume is no
   longer valid.
*/
cylinder__height__remove(Cylinder) :-
        frame__remove(Cylinder,volume).

        /* If we get the radius, then we can compute the cylinder's
   cross sectional area.
*/
cylinder__radius__add(Cylinder,__) :-
        cylinder__cross__section(Cylinder,__).

/* If the radius is removed, then the old cross sectional area
   is no longer valid.
*/
cylinder__radius__remove(Cylinder) :-
        frame__remove(Cylinder,cross__section),
        frame__remove(cylinder,volume).

/* PDPROLOG does not support floating-point arithmetic, so if you are
   using that version, change pi to an integer value.
*/
cylinder__cross__section(Cylinder,Cross__Section) :-
        frame__get(Cylinder,radius,Radius),
        Cross__Section is 3.1416*Radius*Radius,
        freplace(Cylinder,cross__section,Cross__Section).

cylinder__volume(Cylinder,Volume) :-
        frame__get(Cylinder,cross__section,Cross__Section),
        frame__get(Cylinder,height,Height),
        Volume is Height*Cross__Section,
        freplace(Cylinder,volume,Volume).

cylinder1(ako,value,cylinder).
```

predicates, we present an example. It describes a frame for a general cylinder and provides demons for calculating the cross-sectional area and volume. The code in listing 1 from the "Example" remark to the end of the listing accomplishes this.

In the above, we have presented a brief review of the concept of frame-based representation and provided enough frame-building tools so that anyone wishing to embark on the design of a frame-based system can utilize this skeleton to get started. Next, we will describe the workings of a vision system that incorporates these ideas.

A Simple Vision System

Sometime last year an architectural firm (let's call it Palladio Associates) came to us with a request for the design and implementation of a system capable of interpreting house drawings. They needed a system to classify houses according to a fixed number of models. They also wanted the system to make recommendations on possible improvements that could be made to a set of sample houses to make them conform more closely to the models. It was also important that the system be capable of justifying (explaining) any recommendations that it would make.

After talking with representatives from Palladio Associates, we learned that the number of their model houses was very small. We also learned that the sample houses to be presented to the system fell into well-defined, narrow categories with only some fairly straightforward differences between the samples and the models. The folks at Palladio also revealed that they had purchased adequate digitizing equipment to convert the pictures of the houses into what were essentially sharply segmented line drawings.

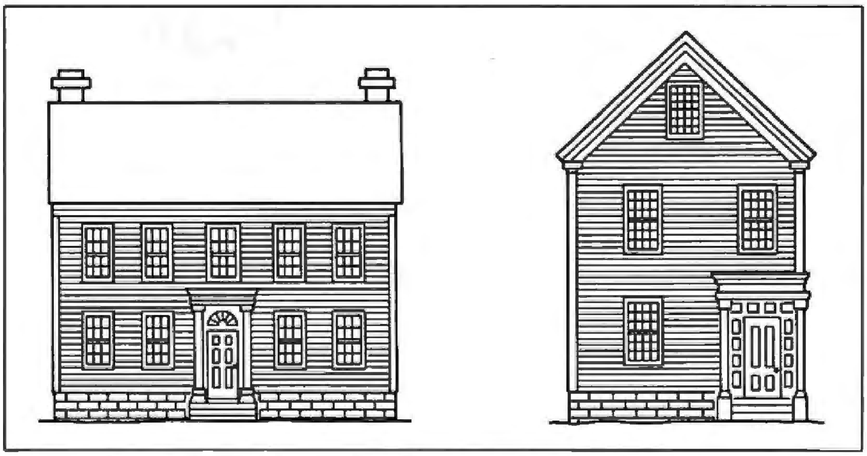


Figure 4: *Two house models used by "Palladio Associates."*

Figure 5: *Sample houses to be analyzed by the architectural program.*

Figure 4 shows line drawings of two of Palladio's house models. Figure 5 shows similar line drawings of two of the sample houses. We were also given a set of what the architects considered acceptable window, door, and siding styles to go with these traditional-style houses. Equally important was a set of window, door, and siding styles that the architects considered in poor taste, yet which would appear in the sample houses. They further made recommendations on which acceptable windows should replace which inadequate ones, etc. Confident that Palladio's requests for the sytem's features were manageable, we decided to undertake the project.

After agreeing to take on the job, we met with the architects from Palladio to come up with an initial set of system requirements. Since the digitizing equipment was already available, this presented no real problem. At this meeting the architects expressed an interest in having the capability to input sample houses to the system by using an icon-driven drawing system that they had just purchased for their computer. This did not present any additional problems. In fact, input from the icon-driven system would be simpler to deal with than input from the digitizer since, for example, the windows and doors would already be labeled according to their categories.

The Housing Project

We will now describe the overall system architecture that we used in the project and explain the flow of information through the system.

Figure 6 is a diagram of the structure of the system. As indicated by box 2 in figure 6, you interact with the system by specifying one or more sample houses that you wish to have

(continued)

the system analyze. You can have a picture digitized, or you may instead choose to input a line drawing using the icon-driven drawing system.

All system interactions are ultimately controlled by the inference engine (figure 6, box 1). It has a set of top-level routines that schedule when other processes in the system get to execute. Whenever some process in the system finishes executing, it passes control back to these top-level routines in the inference engine. The inference engine also provides a number of generic routines that are available to the rest of the system.

The core of the frame utilities component of the system (figure 6, box 0) has already been described in the previous section. The routines provided by this component are also generally available to the rest of the system and can be considered as providing another, higher-level language on top of Prolog.

After the image of a house has been suitably massaged by the low-level system components in boxes 3 and 4 in the diagram, the information then flows on to box 5. It is here that the system attempts to put together a higher-level description of the image. First, as depicted in figure 7, a set of processes partitions the image into "global house coordinates" and assigns sets of these coordinates to each of the major features of the house, for example, the windows and doors. The main goal here is to partition the house into a set of vertical and horizontal components, each of which contains some house feature that later system phases will find interesting. The general scheme here is basically a simple relaxation technique that first tries to partition the house into three vertical components and three horizontal components. By attempting to isolate significant features in each of the components, the process either increases or decreases the number of components. In the simple houses that the system deals with, the process usually converges very rapidly, and it takes only a couple of passes to settle down to a final partition. What we mean by "global house coordinates" is simply a left-to-right and bottom-to-top assignment of natural numbers to each of the partitions in the image, as illustrated in figure 7. During this phase the system also attempts to classify the windows and doors in the house and match them against the model windows and doors provided by the system. The frame representation of one of the system's models is shown in listing 2.

The processes in box 6 of figure 6 now take over and attempt to construct a frame representation of the entire house. This representation incorporates all the information from the intermediate processes in box 5, but it also discards the pixel-level information from boxes 3 and 4. The

(continued)

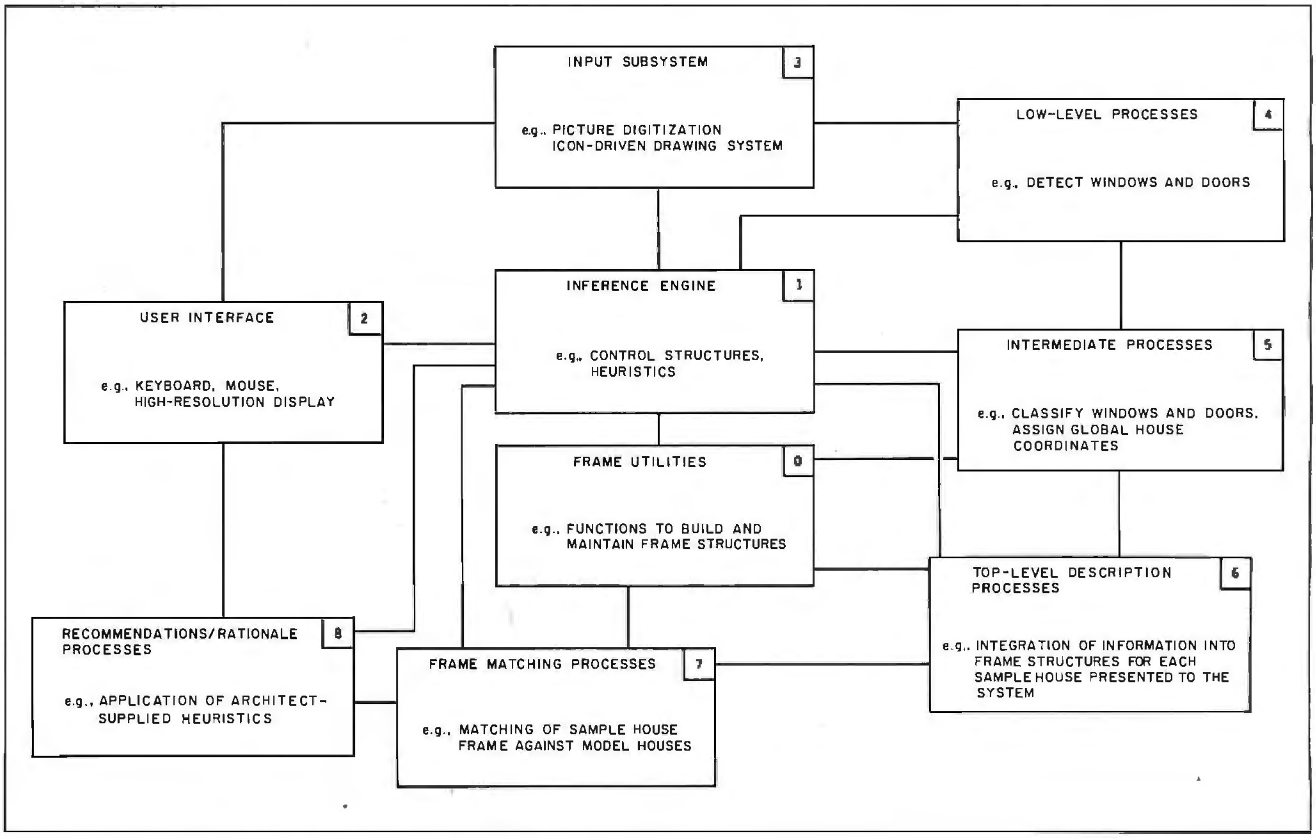


Figure 6: *Diagram of the structure of the architectural system.*

frame representation generated by the system for a typical sample house is shown in listing 3.

From here on, the system works with the frame representations exclusively. The processes in box 7 attempt to match the frame representation of the sample house against the model frames provided by the system. The matching process is very forgiving and utilizes a set of heuristics to include or ignore features that are considered relevant for a global match.

After the system has produced what it considers to be a suitable matching between the sample and one of the models, it passes control back to the top-level inferencing component. The system then invokes the final set of processes in box 8, which analyze the sample frame and the model and use a set of the heuristics supplied by the architects to make recommendations on how to modify the sample house to make it conform to the model more closely. The recommendations are coupled with various explanations based on the types of windows, doors, etc., and why the architects feel it would be more appealing to remodel according to some given plan.

EPILOG

The simple system presented in this article illustrates how techniques in artificial intelligence, such as frame-based knowledge representation, can be used in a vision system to provide a very high-level representation of the information contained in simple, well-specified images. The system works because the set of alternatives it has to consider is very small. The system only "knows" a very limited set of window, door, and siding types, some symmetries, and a few relatively simple heuristics relating to the interplay among these well-defined categories.

While we spare no effort in encouraging our readers to try their hands at applying AI techniques to their computer-vision problems, we hasten to add that the gap between our system and something like the ACRONYM system at Stanford (described in reference 7) is enormous. General-purpose systems like ACRONYM have to deal with issues that are not even addressed in the current system. It is important that our readers refrain from extrapolating the capabilities shown in the simple system described in this article into realms for which it was never intended.

Having said all that, we hope that our little system demonstrates that, given a narrow domain with relatively little noise, it is fairly straightforward to construct systems that have reason-

(continued)

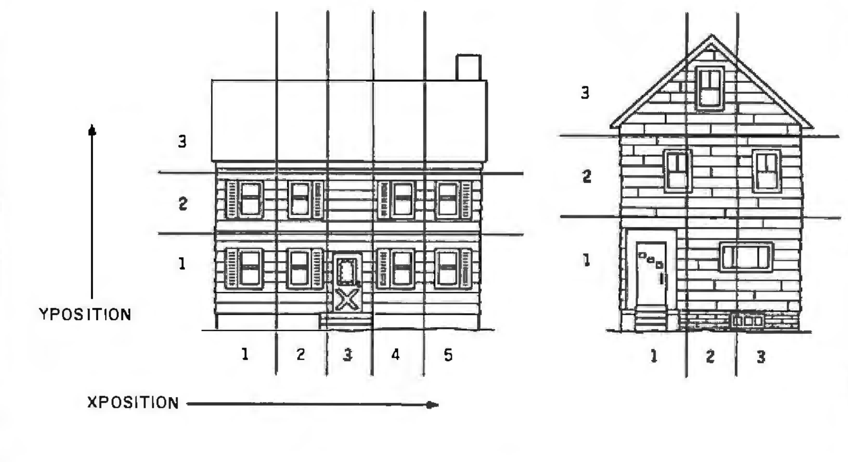


Figure 7: *Global house coordinates showing the partitioning of a sample house by the program.*

New from Logitech.

LOGIMOUSE® C7

The professionals' choice. Find out why AT&T, DEC, and Hewlett-Packard have chosen LOGITECH's mouse as part of their systems.
With LOGIMOUSE C7 there's no pad or tablet to clutter up your desk. There's no external power supply with extra wires and plugs. It's clean and simple. The professionals' choice for making all your software run faster and easier.

At a new $99 price.

Hardware Superiority

- HIGH resolution (twice as high as most other mice)
- NO external power supply required
- NO pad or grid required
- ENHANCED opto-mechanical design with CMOS technology

Software Superiority

- Logimouse C7 comes with its own software
- Universal Mouse Driver makes your mouse compatible with almost ALL applications. With an easy menu system for creating and saving mouse settings.
- TAG, the Text-And-Graphics editor, is ideal for memos containing maps, organization charts, simple schematics. With file editing capabilities.

Technical Support

- Fully documented package backed by complete engineering support.

To order LOGIMOUSE C7 for your application call our toll free number:

800-231-7717

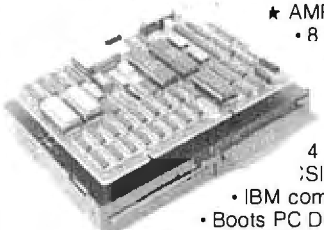
In California:

800-552-8885

LOGITECH

805 Veterans Blvd., Redwood City, CA 94063
Phone 415/365-9852

LOGIMOUSE is a registered trademark of LOGITECH.



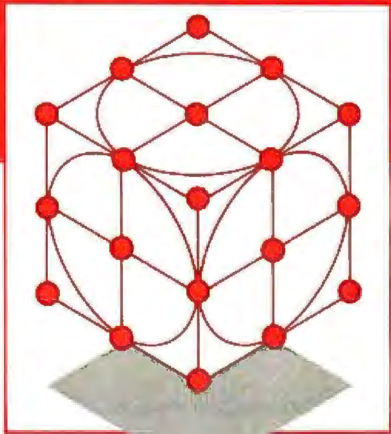
Listing 2: *The frame representation of one of the architectural system's house models.*

```
window_type1
      ako
            value : window
      panes
            value : 12
      style
            value : sash
window_type2
      ako
            value : window
      panes
            value : 24
      style
            value : sash
window_type3
      ako
            value : window
      panes
            value : 3
      style
            value : picture
window_type4
      ako
            value : window
      panes
            value : 3
      style
            value : sash
window_type5
      ako
            value : window
      panes
            value : 2
      style
            value : sash
window
      ako
            value : thing
      area
            if_needed : window_area
window_area(Window,Area) :-
      fget(Window,height,Height),
      fget(Window,width,Width),
      Area is Height * Width,
      freplace(Window,area,Area).
door_type1
      ako
            value : door
      panels
            value : 4
      symmetry
            value : yes
      doorway
            value : [columns,fan_light]
door_type2
      ako
            value : door
```

(continued)

New from Logitech.

MODULA-2/86 VERSION 2.0



Professional Modula-2 for $89.

Now the same powerful tools Micropro used to develop its latest word processing system is available to you at a new $89.00 price.

Building Blocks for Tomorrow's Technology

Universities are switching to LOGITECH MODULA-2. Innovative programmers now develop applications and products with LOGITECH MODULA-2. The most productive teams at major companies depend on LOGITECH MODULA-2.

Now you can create your professional software development system using the proven technical sophistication of LOGITECH MODULA-2/86.

Systems to Fit Your Needs.

Base Language System — $89
- Compiler and Linker
- Module Library

Base Language System/8087 — $129
- Inline 8087 code.

Base Language System/512K — $189
- Full 8087 support.
- Uses RAM to increase speed by 40 to 50 percent.
- 80186 and 80286 support.

Run-Time Debugger — $69
- Monitors the execution of a program with user-defined breakpoints or by stepping through the program.
- Symbolically displays the source code, data, procedure call chain, and raw memory.

MODULA-2 Editor — $59
- Fast on-line Modula-2 syntax check.
- Can run compiler and linker from the editor.
- User definable templates for Modula-2 syntax constructs.

Utilities Package — $49
- Decoders: Disassemble link and load files.
- Version: Administrate different versions of one program.
- Post-Mortem Debugger: Debugs a program after abnormal termination.
- Cross Reference: Produces a cross-reference listing of a Modula-2 program.

Sources — $179
- Sources to customize your system.
- Run-Time System sources.
- Some library module sources.

Not Copy Protected

INTRODUCTORY OFFER
Through the end of January you get the new MODULA-2 Editor for free with any purchase of the Base Language System.

To place an order call our special toll free number:
800-231-7717
In California:
800-552-8885

YES, I want to create my professional software development system. Please send me the following building blocks:

☐ BLS $89 ☐ BLS/8087 $129 ☐ BLS/512K $189
☐ RTD $69* ☐ EDITOR $59*
☐ UTILITIES $49* ☐ SOURCES $179*
*$10 less with the purchase of any Base Language System.
Please add $5 for shipping and handling.

☐ VISA ☐ MASTERCARD ☐ CHECK ENCLOSED

CARD NUMBER ________ EXPIRATION DATE ________
SIGNATURE ________
NAME ________
ADDRESS ________
CITY ________
STATE ________ ZIP ________ PHONE (___) ________

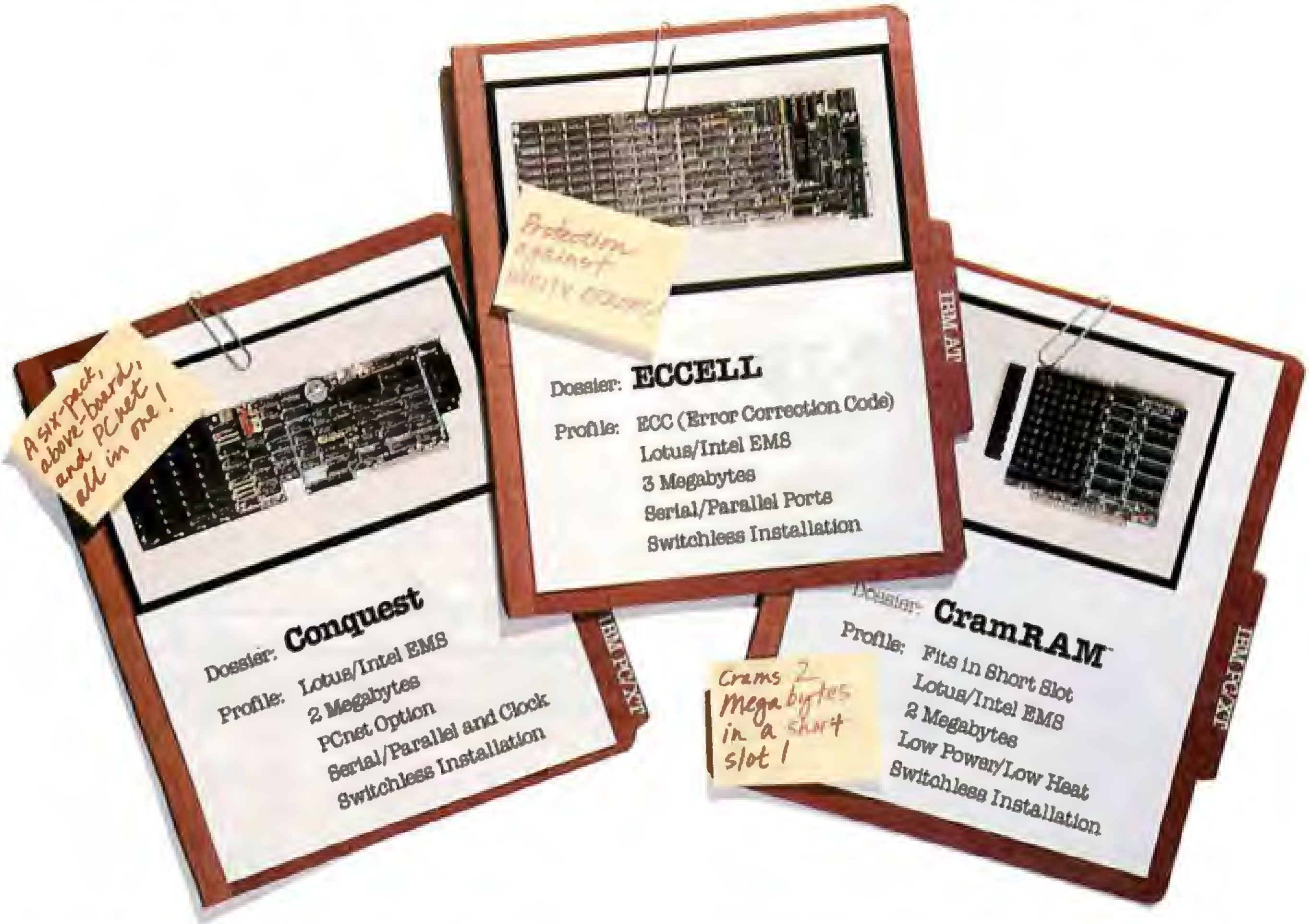
LOGITECH

LOGITECH, Inc.
805 Veterans Blvd., Redwood City, CA 94063, USA
Telephone: (415) 365-9852
LOGITECH SA
Box 32, CH-1143 Apples, Switzerland
Telephone: 41 (21) 774545

```
    panels
            value : 6
    symmetry
            value : yes
    doorway
            value : [columns, portico, side__windows]

door__type3
    ako
            value : door
    panels
            value : 0
    symmetry
            value : no
    doorway
            value : []

door
    ako
            value : thing
    area
            if__needed : door__area

door__area(Door,Area) :-
    fget(Door,height,Height),
    fget(Door,width,Width),
    Area is Height * Width,
    freplace(Door,area,Area).

siding__type1
    ako
            value : siding
    material
            value : clapboard
    width
            value : narrow
    cornerboard
            value : yes

siding__type2
    ako
            value : siding
    material
            value : aluminum
    width
            value : wide
    cornerboard
            value : no

siding
    ako
            value : thing

house__type1
    ako
            value : house
    stories
            value : 3
    siding
            value : siding__type1
    roof
            value : gable
    window1
            optional : yes
            xposition : 2
            yposition : 3
            type : window__type2
```

(continued)

INTRODUCING ORCHID'S S.W.A.T. TEAM



The Multifunction Force That's Superstuffed With Advanced Technology.

Every member of this team has the technology you need to get the job done: Lotus/Intel Expanded Memory Specification (EMS) breaks the 640K DOS limit. Powerful Productivity Software including Disk Caching, RAM Disk and Print Spooling.

Switchless design makes installation easy and fast. All these boards come with a Two Year Warranty to prove our team means business.

Finally, advanced technology in multifunction boards.

ORCHID

47790 Westinghouse Drive • Fremont, CA 94539
(415) 490-8586 • Telex 709289

ECCELL, Conquest and CramRAM are trademarks of Orchid Technology. Other products named in this document are trademarks of their manufacturers.

Inquiry 268

```
     window2
          xposition : 1
          yposition : 2
          type : window__type2
     window3
          xposition : 3
          yposition : 2
          type : window__type2
proto__house
     ako
          value : house__type1
     window4
          xposition : 1
          yposition : 1
          type : window__type2
     door
          xposition : 3
          yposition : 1
          type : door__type1
proto__house__mirror__image
     ako
          value : house__type1
     window4
          xposition : 3
          yposition : 1
          type : window__type2
     door
          xposition : 1
          yposition : 1
          type : door__type1
```

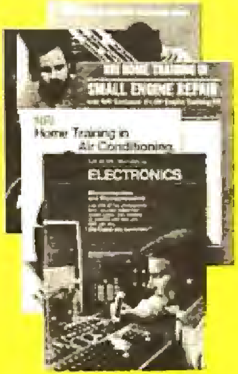
Listing 3: *The frame representation generated by the architectural system of a sample house.*

```
house17
     ako
          value : house
     stories
          value : 3
     siding
          value : siding__type2
     roof
          value : gable
     window1
          value : w7
     window2
          value : w12
     window3
          value : w17
     window4
          value : w23
     door
          value : door37
w7
     ako
          value : window__type4
     ipo                                 /* is__part__of */
          value : house17
     xposition
          value : 2
```

(continued)

RUSH POSTAGE-PAID CARD FOR YOUR FREE CATALOG

- **COMPUTER ELECTRONICS** training prepares you to service and repair all computers as you build your own 16-bit IBM PC compatible computer. Total system program includes disk drive, test equipment, bundled software, and NRI Discovery Lab.
- **TV/VIDEO/AUDIO SERVICING** includes training with 27" color TV with built-in stereo decoder, VCR, and actual instruction on videotape.
- **SATELLITE COMMUNICATIONS** training gives you the skills to service both commercial and consumer satellite earth station equipment as you assemble your own home satellite TV system.
- **ROBOTICS** training features remote-controlled mobile programmable robot you build, experiment with, and keep along with other test equipment.
- **INDUSTRIAL ELECTRONICS** training prepares you to service and maintain computer-controlled industrial systems. Training includes color computer, disk drive, exclusive NRI training software, and NRI Discovery Lab.



CHECK ☑ ONE

- ☐ Computer Electronics
- ☐ TV/Video/Audio Servicing
- ☐ Satellite Communications
- ☐ Robotics
- ☐ Data Communications
- ☐ Industrial Electronics
- ☐ Communications Electronics
- ☐ Electronic Design Technology
- ☐ Telephone Servicing
- ☐ Digital Electronics
- ☐ Basic Electronics
- ☐ Bookkeeping & Accounting
- ☐ Appliance Servicing
- ☐ Small Engine Servicing
- ☐ Air Conditioning, Heating, Refrigeration, & Solar Technology
- ☐ Locksmithing & Electronic Security
- ☐ Building Construction & Remodeling
- ☐ Automotive Servicing

Name (Please Print) Age

Street

City State Zip

For career courses approved under G.I. Bill ☐ Check for details.

Accredited by the National Home Study Council

170-016

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 10008 WASHINGTON, D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

NRI Schools
McGraw Hill Continuing
Education Center
3939 Wisconsin Avenue
Washington, D.C. 20016-9973

```
        yposition
                value : 3
w12
        ako
                value : window_type4
        ipo
                value : house17
        xposition
                value : 1
        yposition
                value : 2
w17
        ako
                value : window_type4
        ipo
                value : house17
        xposition
                value : 3
        yposition
                value : 2
w23
        ako
                value : window_type3
        ipo
                value : house17
        xposition
                value : 3
        yposition
                value : 1
door37
        ako
                value : door_type3
        ipo
                value : house17
        xposition
                value : 1
        yposition
                value : 1
```

able performance using a modest set of generally available and easily understood tools. ■

REFERENCES

1. Baird, H. S. *Model-Based Image Matching Using Location.* Cambridge, MA: MIT Press, 1984.
2. Ballard, D. H., and C. M. Brown. *Computer Vision.* Englewood Cliffs, NJ: Prentice-Hall, 1982.
3. Brady, J. M., ed. *Computer Vision.* New York: Elsevier, 1981.
4. Lowe, D. G. *Perceptual Organization and Visual Recognition.* Hingham, MA: Kluwer Academic Press, 1985.
5. Minsky, Marvin. "A Framework for Representing Knowledge." Cambridge, MA: MIT AI Memo #306 (1974).
6. Winston, P. H. *Artificial Intelligence,* 2nd ed. Reading, MA: Addison-Wesley, 1984.
7. Brooks, R. A. *Model-Based Computer Vision.* Ann Arbor, MI: UMI Research Press, 1984.

Actually, we give you two things free.

Our source code. And your freedom.

Just buy part or all of our excellent integrated business accounting system, the SBT Accounting Software Library.

We'll give you our source code absolutely free.

Which, in turn, gives you the freedom to customize our software to fit your business needs.

Say, for instance, you want to change the way a management report is formatted. Our free source code enables you to change it.

What's more, the change will be quick and simple because our software is written in easy-to-use dBASE.

In fact, the entire SBT Accounting Software Library runs with dBASE III or dBASE II,* so you get the power and flexibility of those best-selling programs. Plus the freedom to use any computer that runs dBASE.

The SBT Accounting Software Library. Great software and freedom. All in the same box.

Call today for our demo disk and brochure. (415) 331-9900.

THE SBT ACCOUNTING SOFTWARE LIBRARY.		
dProfessional	Time & Billing	$395
dOrder	Sales Order Processing	$195
dInvoice	Billing/Inventory Control	$195
dStatement	Accounts Receivable	$ 95
dPurchase	Purchase Order	$195
dPayable	Accounts Payable	$295
dPayroll	Payroll/Labor	$395
dLedger	General Ledger/Finance	$395
dAssets	Asset/Depreciation	$195
dProject	Project/Job Accounting	$395
dBackup	Menu/Backup	$ 65

sbt CORPORATION
Three Harbor Drive
Sausalito, CA 94965
(415) 331-9900

Call today for the name of the SBT consultant in your area.

Available for Multi-User

Free source code in every box.

*Compiled versions are also available. dBASE III and dBASE II are registered trademarks of Ashton-Tate, Inc.

Jameco ELECTRONICS — NEW LOW, LOW PRICES!!! — Jameco ELECTRONICS

CALL FOR QUANTITY DISCOUNTS

7400

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
SN7400N	14	.19	SN7474N	14	.35	SN74159N	24	1.49
SN7401N	14	.19	SN7475N	16	.35	SN74160N	16	.79
SN7402N	14	.19	SN7476N	16	.35	SN74161N	16	.59
SN7403N	14	.19	SN7479N	14	4.95	SN74162N	16	.85
SN7404N	14	.25	SN7480N	14	.59	SN74163N	16	.59
SN7405N	14	.29	SN7482N	14	.95	SN74164N	14	.69
SN7406N	14	.29	SN7483N	16	.49	SN74165N	16	.69
SN7407N	14	.29	SN7485N	16	.55	SN74166N	16	.69
SN7408N	14	.25	SN7486N	14	.29	SN74167N	16	2.95
SN7409N	14	.19	SN7489N	16	1.95	SN74170N	16	1.59
SN7410N	14	.19	SN7490N	14	.39	SN74172N	24	4.95
SN7411N	14	.25	SN7491N	14	.59	SN74173N	16	.75
SN7412N	14	.35	SN7492N	14	.49	SN74174N	16	.59
SN7413N	14	.35	SN7493N	14	.35	SN74175N	16	.59
SN7414N	14	.45	SN7494N	14	.89	SN74176N	14	.89
SN7416N	14	.35	SN7495N	14	.49	SN74177N	14	.89
SN7417N	14	.35	SN7496N	16	.65	SN74179N	16	1.49
SN7420N	14	.19	SN7497N	16	2.69	SN74180N	14	.75
SN7421N	14	.35	SN74100N	24	1.75	SN74181N	24	1.95
SN7422N	14	.49	SN74105N	14	.45	SN74182N	16	.75
SN7423N	16	.49	SN74107N	14	.19	SN74184N	16	1.95
SN7425N	14	.29	SN74109N	16	.39	SN74185N	16	1.95
SN7426N	14	.29	SN74116N	24	1.49	SN74189N	16	1.95
SN7427N	14	.25	SN74121N	14	.29	SN74190N	16	.89
SN7428N	14	.45	SN74122N	14	.45	SN74191N	16	.89
SN7430N	14	.19	SN74123N	16	.49	SN74192N	16	.69
SN7432N	14	.29	SN74125N	14	.45	SN74193N	16	.69
SN7433N	14	.45	SN74126N	14	.49	SN74194N	16	.69
SN7437N	14	.29	SN74132N	14	.49	SN74195N	16	.79
SN7438N	14	.29	SN74136N	14	.49	SN74196N	14	.79
SN7439N	14	.69	SN74141N	16	.65	SN74197N	14	.89
SN7440N	14	.15	SN74142N	16	2.95	SN74198N	24	1.35
SN7441N	16	.89	SN74143N	24	3.95	SN74199N	24	1.35
SN7442N	16	.45	SN74144N	24	2.95	SN74221N	16	.89
SN7443N	16	.79	SN74145N	16	.65	SN74251N	16	.79
SN7444N	16	.79	SN74147N	16	1.69	SN74273N	20	1.95
SN7445N	16	.69	SN74148N	16	1.29	SN74276N	20	2.49
SN7446N	16	.79	SN74150N	24	1.29	SN74279N	16	.79
SN7447N	16	.79	SN74151N	16	.59	SN74283N	16	1.39
SN7448N	16	.79	SN74152N	14	.49	SN74284N	16	2.95
SN7450N	14	.19	SN74153N	16	.49	SN74285N	16	2.95
SN7451N	14	.19	SN74154N	24	1.25	SN74365N	16	.59
SN7453N	14	.19	SN74155N	16	.49	SN74366N	16	.59
SN7454N	14	.19	SN74156N	16	.65	SN74367N	16	.59
SN7459N	14	.59	SN74157N	16	.49	SN74368N	16	.59
SN7460N	14	.25	SN74158N	16	1.39	SN74390N	16	1.49
SN7470N	14	.35				SN74393N	14	1.49
SN7472N	14	.39						
SN7473N	14	.35						

74LS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74LS00	14	.19	74LS133	16	.49	74LS253	16	.49
74LS01	14	.19	74LS136	14	.39	74LS257	16	.39
74LS02	14	.19	74LS137	16	.39	74LS258	16	.49
74LS03	14	.19	74LS138	16	.39	74LS259	16	1.19
74LS04	14	.25	74LS139	16	.39	74LS260	14	.49
74LS05	14	.25	74LS145	16	.99	74LS261	16	1.49
74LS06	14	.99	74LS147	16	.99	74LS266	14	.49
74LS07	14	.99	74LS148	16	.99	74LS273	20	.79
74LS08	14	.19	74LS151	16	.39	74LS279	16	.39
74LS09	14	.19	74LS153	16	.39	74LS280	14	1.19
74LS10	14	.19	74LS154	24	1.49	74LS283	16	.59
74LS11	14	.19	74LS155	16	.59	74LS289	16	3.95
74LS12	14	.19	74LS156	16	.49	74LS299	20	1.49
74LS14	14	.39	74LS157	16	.35	74LS322	20	2.95
74LS15	14	.29	74LS158	16	.35	74LS323	20	2.49
74LS20	14	.19	74LS160	16	.69	74LS347	16	.79
74LS21	14	.25	74LS161	16	.39	74LS353	16	1.19
74LS26	14	.25	74LS162	16	.69	74LS363	20	1.35
74LS27	14	.25	74LS163	16	.49	74LS365	16	.39
74LS28	14	.29	74LS164	14	.49	74LS366	16	.39
74LS30	14	.19	74LS165	16	.79	74LS367	16	.39
74LS32	14	.25	74LS166	16	.89	74LS368	16	.39
74LS33	14	.39	74LS168	16	.99	74LS373	20	.79
74LS37	14	.29	74LS169	16	.99	74LS374	20	.79
74LS38	14	.29	74LS170	16	1.49	74LS375	16	.69
74LS42	16	.39	74LS173	16	.49	74LS377	20	.79
74LS47	16	.89	74LS174	16	.39	74LS386	14	.45
74LS48	16	.89	74LS175	16	.39	74LS390	16	1.09
74LS51	14	.25	74LS181	24	1.49	74LS393	14	.79
74LS54	14	.25	74LS189	16	3.95	74LS399	16	1.49
74LS73	14	.35	74LS190	16	.49	74LS490	16	1.49
74LS74	14	.35	74LS191	16	.49	74LS533	20	1.95
74LS75	16	.29	74LS192	16	.69	74LS534	20	1.95
74LS76	16	.29	74LS193	16	.69	74LS540	20	1.09
74LS85	16	.49	74LS194	16	.69	74LS541	20	1.09
74LS86	14	.25	74LS195	16	.59	74LS590	16	5.95
74LS90	14	.39	74LS196	14	.89	74LS624	14	1.95
74LS92	14	.49	74LS197	14	.89	74LS629	16	2.49
74LS93	14	.39	74LS221	16	.59	74LS640	20	1.95
74LS96	16	.49	74LS240	20	.69	74LS641	20	1.29
74LS107	14	.35	74LS241	20	.69	74LS644	20	1.29
74LS109	16	.35	74LS242	14	.69	74LS645	20	1.29
74LS112	16	.35	74LS243	14	.69	74LS670	16	.99
74LS122	14	.45	74LS244	20	.69	74LS688	20	1.95
74LS123	16	.49	74LS245	20	.79	81LS95	20	1.49
74LS125	14	.39	74LS247	16	.99	81LS96	20	1.49
74LS126	14	.39	74LS251	16	.49	81LS97	20	1.49
74LS132	14	.39				81LS98	20	1.49

74S/PROMS*

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74S00	14	.29	74S112	16	.49	74S189	16	1.95
74S02	14	.29	74S124	16	2.75	74S194	16	1.49
74S04	14	.35	74S132	14	1.49	74S195	16	1.49
74S05	14	.35	74S133	16	.49	74S196	16	1.49
74S08	14	.35	74S135	16	[illegible]	74S240	20	1.49
74S09	14	.35	74S136	14	.79	74S241	20	1.49
74S10	14	.29	74S138	16	.79	74S242	14	2.69
74S11	14	.35	74S139	16	.79	74S244	20	1.49
74S15	14	.35	74S140	14	.55	74S251	16	.95
74S20	14	.29	74S151	16	.79	74S253	16	.79
74S22	14	.35	74S153	16	.79	74S257	16	.79
74S30	14	.29	74S157	16	.79	74S258	16	.79
74S32	14	.35	74S158	16	.95	74S273	20	2.39
74S37	14	.69	74S160	16	2.95	74S280	14	1.19
74S38	14	.69	74S161	16	1.95	74S287*	16	1.69
74S64	14	.35	74S163	16	1.95	74S288*	16	1.69
74S65	14	.35	74S168	16	3.95	74S299	20	2.95
74S74	14	.49	74S174	16	.99	74S373	20	1.69
74S85	16	1.49	74S175	16	.99	74S374	20	1.69
74S86	14	.35	74S188*	16	1.75	74S472*	20	3.49

74ALS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74ALS00	14	.35	74ALS32	14	.35	74ALS174	16	.89
74ALS02	14	.35	74ALS74	14	.49	74ALS175	16	.89
74ALS04	14	.39	74ALS109	16	.49	74ALS240	20	1.79
74ALS08	14	.35	74ALS112	16	.55	74ALS244	20	1.79
74ALS10	14	.35	74ALS138	16	.99	74ALS245	20	1.95
74ALS27	14	.35				74ALS373	20	1.95
74ALS30	14	.35				74ALS374	20	1.95
						74ALS573	20	1.95

74F

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74F00	14	.59	74F138	16	1.19	74F241	20	2.49
74F02	14	.59	74F139	16	1.29	74F244	20	2.49
74F04	14	.65	74F157	16	1.29	74F251	16	1.79
74F08	14	.59	74F158	16	1.29	74F253	16	1.79
74F10	14	.59	74F193	16	4.95	74F257	16	1.79
74F32	14	.59	74F240	20	2.95	74F280	14	1.79
74F74	14	.79				74F373	20	2.95
74F86	14	.79				74F374	20	2.95
74F109	16	.79				74F379	16	2.95

CD—CMOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
CD4000	14	.19	CD4043	16	.69	CD4093	14	.39
CD4001	14	.19	CD4044	16	.69	CD4094	16	2.95
CD4002	14	.19	CD4046	16	.69	CD4098	16	2.49
CD4006	14	.69	CD4047	14	.69	CD4099	16	1.95
CD4007	14	.25	CD4049	16	.29	CD4510	16	.79
CD4008	16	.79	CD4050	16	.29	CD4511	16	.69
CD4009	16	.29	CD4051	16	.69	CD4512	16	.79
CD4010	16	.29	CD4052	16	.69	CD4514	24	.99
CD4011	14	.19	CD4053	16	.69	CD4515	24	1.39
CD4012	14	.25	CD4060	16	.69	CD4516	16	.79
CD4013	14	.35	CD4066	14	.29	CD4518	16	.79
CD4014	16	.69	CD4068	14	.29	CD4520	16	.79
CD4015	16	.29	CD4069	14	.19	CD4522	16	.79
CD4016	14	.29	CD4070	14	.29	CD4526	16	.79
CD4017	16	.49	CD4071	14	.19	CD4527	16	1.49
CD4018	16	.69	CD4072	14	.19	CD4528	16	.79
CD4019	16	.29	CD4073	14	.25	CD4529	16	.79
CD4020	16	.59	CD4075	14	.29	CD4531	16	.69
CD4021	16	.69	CD4076	16	.69	CD4532	16	1.29
CD4022	16	.69	CD4077	14	.29	CD4538	16	.99
CD4023	14	.25	CD4078	14	.25	CD4541	14	.99
CD4024	14	.49	CD4081	14	.25	CD4543	16	1.19
CD4025	14	.25	CD4082	14	.25	CD4553	16	4.95
CD4026	16	1.29	CD4085	14	.69	CD4555	16	.79
CD4027	16	.39	CD4086	14	.69	CD4556	16	.79
CD4028	16	.59	CD4089	16	1.49	CD4566	16	3.95
CD4029	16	.69	CD4093	14	.35	CD4583	16	1.95
CD4030	14	.35	CD4094	16	.79	CD4584	14	.49
CD4034	24	1.39	CD4095	14	.99	CD4585	16	.79
CD4035	16	.69	CD4097	24	3.95	CD4723	16	1.19
CD4040	16	.69	CD4098	16	.89	CD4724	16	1.19
CD4041	14	.75	CD4099	16	1.49	MC14411	24	8.95
CD4042	16	.59	CD40109	16	1.39	MC14490P	16	4.49
						MC14572	16	1.39

SPECIAL!! SPECIAL!! SPECIAL!!

MOTOROLA — MC68701 — Microcomputer with EPROM

The MC68701 is an 8-bit single chip microcomputer unit (MCU) which significantly enhances the capabilities of the MC6800 family of parts. On-chip resources include 2048 bytes of EPROM, 128 bytes of RAM, Serial Communications Interface (SCI), parallel I/O, and a three function Programmable Timer.

MC68701. . . . . $24.95

CUSTOM COMMODORE CHIPS for VIC-20, C-64 and C-128 Personal Computers

Part No.	Description	Price	Part No.	Description	Price	Part No.	Description	Price
*6510	CPU	$19.95	*6526	CIA	$25.95	*6581	SID	$32.95
*6525	TPI	$20.95	*6560	VIC-I	$29.95	82S100PLA	PLA	$37.95
*SPECS AVAILABLE @ $1.50 EA.			*6567	VIC-II	$44.95	NOTE: 82S100 = U17 (C-64)		

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	Pins	Function	Price
1771AC	40	Floppy Disk Controller	4.95
CDP1802CE	40	CPU 3.2MHz	4.95
2651	28	Enhanced Prog. Comm. Interface	4.95
3242	28	Addr. Multiplexer & Refresh Counter	6.95

Z80, Z80A, Z80B, SERIES

Part No.	Pins	Function	Price
Z80	40	CPU (MK3880N)(780C)(2.5MHz)	1.75
Z80-CTC	28	Counter Timer Circuit	1.79
Z80-DART	40	Dual Asynchronous Rec./Trans.	4.95
Z80-DMA	40	Direct Memory Access Circuit	4.95
Z80-PIO	40	Parallel I/O Interface Controller	1.79
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	4.95
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	4.95
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	4.95
Z80-SIO/9	40	Serial I/O	4.95
Z80A	40	CPU (MK3880N-4)(780C-1)(4MHz)	1.85
Z80A-CTC	28	Counter Timer Circuit	1.89
Z80A-DART	40	Dual Asynchronous Rec./Trans.	5.25
Z80A-DMA	40	Direct Memory Access Circuit	5.95
Z80A-PIO	40	Parallel I/O Interface Controller	1.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	5.25
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	5.25
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	5.25
Z80A-SIO/9	40	Serial I/O	5.25
Z80B	40	CPU (MK3880N-6)(6MHz)	3.95
Z80B-CTC	28	Counter Timer Circuit	4.95
Z80B-DART	40	Dual Asynchronous Rec./Trans.	6.95
Z80B-PIO	40	Parallel I/O Interface Controller	4.95
Z80B-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)(MK3884-6)	12.95
Z80B-SIO/1	40	Serial I/O (Lacks DTRB)	12.85
Z80B-SIO/2	40	Serial I/O (Lacks SYNCB)	12.79

6500/6800/68000 SERIES

Part No.	Pins	Function	Price
6502	40	MPU with Clock (1MHz)	2.79
6502A	40	MPU with Clock (2MHz)	2.95
6502B	40	MPU with Clock (3MHz)	6.95
6520	40	Peripheral Inter. Adapter	2.95
6522	40	Versatile Interface Adapter	4.95
6532	40	RAM I/O, Timer Array	6.49
6545	40	CRT Controller (CRTC)	4.95
6551	28	Async. Comm. Interface Adapt.	6.95
6800	40	MPU	1.95
6802	40	MPU with Clock and RAM	4.95
6809	40	CPU – 8-Bit (On Chip Oscillator)	5.75
6809E	40	CPU – 8-Bit (External Clocking)	5.95
6810	24	128x8 Static RAM	1.95
68B10	24	128x8 Static RAM (2MHz)	3.49
6821	40	Peripheral Interface Adapt. (MC6820)	1.95
68B21	40	Peripheral Interface Adapter (2MHz)	3.95
6840	28	Programmable Timer	6.75
6843	40	Programmable Floppy Disk Controller	19.95
6845	40	CRT Controller (CRTC)	4.95
68B45	40	CRT Controller (CRTC)(2MHz)	10.95
6850	24	Asynchronous Comm. Adapter	1.95
6852	24	Synchronous Serial Data Adapter	4.75
6860	24	0-600bps Digital MODEM	7.95
68000L8	64	MPU 16-Bit (8MHz)	9.95
68488P	40	General Purpose Int. Adapter	14.95
68661	28	Enhanced Prog. Comm. Interface (2661)	8.95
68701	40	Microcomputer with EPROM	24.95

8000/80000 SERIES

Part No.	Pins	Function	Price
8031	40	Control Oriented CPU w/RAM & I/O	6.95
8035	40	MPU – 8-Bit	1.95
8039	40	CPU – Sgl Chip 8-Bit (128 Bits RAM)	2.75
8080	40	CPU – 8-Bit NMOS	2.75
8085A	40	CPU w/Basic Micro Interpreter	[illegible]
[illegible]	40	CPU	3.95
[illegible]	40	CPU	2.75
[illegible]	40	CPU – 8-Bit N-Channel (5MHz)	[illegible]
[illegible]	40	CPU 16-bit	[illegible]
8087	40	Arithmetic Processor (5MHz)	129.95
8087-2	40	Arithmetic Processor	179.95
8088	40	CPU 8/16-Bit	7.95
8116	18	Dual Baud Rate Generator	8.95
8155	40	HMOS RAM I/O Port-Timer	2.75
8156	40	RAM with I/O Port and Timer	2.75
8202	40	Dynamic RAM Controller	[illegible]
8203	40	64K Dynamic RAM Controller	29.95
8205	16	Hi Speed 1 out of 8 Binary Decoder	1.29
8212	24	8-Bit Input/Output (74S412)	1.95
[illegible]	[illegible]	Clock Generator/Driver	[illegible]
8228	28	Sys. Cont./Bus Driver (74S428)	3.49
8237	40	High Perf. Prog. DMA Contr. (5MHz)	14.95
8238	28	System Controller (74S438)	4.29
8243	24	I/O Expander for 48 Series	2.49
8250A	40	Async. Comm. Element	6.95
8250B	40	ACE (IBM PC or XT Software Compatible)	7.95
8251	28	Prog. Comm. I/O (USART)	1.95
8251A	28	Prog. Comm. Interface (USART)	2.75
8253	24	Programmable Interval Timer	2.75
8254	24	Programmable Interval Timer	[illegible]
8255	40	Prog. Peripheral I/O (PPI)	[illegible]
[illegible]	[illegible]	Prog. Peripheral I/O (PPI) (5MHz)	[illegible]
[illegible]	[illegible]	Prog. DMA Controller	[illegible]
[illegible]	[illegible]	Prog. Interrupt Controller	[illegible]
[illegible]	[illegible]	Sgle/Dbl. Density Floppy Disk Cont.	[illegible]
[illegible]	[illegible]	Floppy Disk Controller	[illegible]
[illegible]	[illegible]	Prog. CRT Controller	[illegible]
[illegible]	[illegible]	Prog. Keyboard/Display Interface	[illegible]
8282	20	Octal Latch	[illegible]
8284	18	Clock Generator/Driver	[illegible]
8286	20	Octal Bus Transceiver	[illegible]
8287	20	Octal Bus Transceiver (Inverted)	3.95
8288	20	Bus Controller	4.95
8289	20	Bus Arbiter	11.95
8741	40	8-Bit Univ. Peripheral Interface	4.95
8748	40	HMOS EPROM MPU	7.95
8749	40	MPU 8-Bit (EPROM Version of 8049)	9.95
8751	40	CPU w/4Kx8 EPROM & 128x8 RAM	21.95
8755	40	16K EPROM with I/O	14.95
80186	68	High Integration 16-Bit MPU	49.95
80188	68	High Integration 16-Bit MPU (8-Bit Data Bus)	49.95
80287	40	Numeric Processor Ext.	239.95

DYNAMIC RAMS

Part No.	Pins	Function		Price
1103	18	1024x1	(300ns)	.69
4027	16	4096x1	(250ns)	.69
4116N-15	16	16,384x1	(150ns)	.85
4116N-20	16	16,384x1	(200ns)	.79
4128	16	131,072x1	(200ns)	4.95
4164N-150	16	65,536x1	(150ns)	.89
4164N-200	16	65,536x1	(200ns)	.79
TMS4416-12	18	16,384x4	(120ns)	4.95
MM5261	16	1024x1	(300ns)	.75
MM5262	22	2048x1	(365ns)	.25
MM5270	18	4096x1	(250ns)	1.95
MM5280	22	4096x1	(200ns) 2107	1.95
MM5298-3	16	8192x1	(200ns)	.19
8118	16	16,384x1	(120ns)(+5V Only Req.)	1.95
41256-150	16	262,144x1	(150ns)	3.79
41256-200	16	262,144x1	(200ns)	3.19
50464-15	18	65,536x4	(150ns)(41254)(41464)	7.95

STATIC RAMS

Part No.	Pins	Function		Price
TMM2016-12	24	2048x8	(120ns)	1.69
2101	22	256x4	(450ns) 8101	1.95
2102	16	1024x1	(350ns)	.89
2102-2L	16	1024x1	(250ns) L.P. (91L02)	1.49
2111	18	256x4	(450ns) 8111	2.49
2112	16	256x4	(450ns) MOS	2.49
2114N	18	1024x4	(450ns)	.99
2114N-L	18	1024x4	(450ns) L.P.	1.09
2114N-2	18	1024x4	(200ns)	1.05
2114N-2L	18	1024x4	(200ns) L.P.	1.49
21C14	18	1024x4	(200ns) (CMOS)	.49
2116N-25L	24	2048x8	(250ns) L.P. NMOS	3.49
2125A	16	1024x1	(45ns) High Speed	2.95
2147HN	18	4096x1	(70ns)	3.95
2148HN	18	1024x4	(70ns)	4.29
2149	18	1024x4	(45ns)	4.95
27LS00	16	256x1	(80ns) L.P.	2.95
TMS4047-45	20	1024x4	(450ns)	.99
5101	22	256x4	(450ns) CMOS	3.95
MM5257	18	4096x1	(450ns) 4044	2.95
HM6116P-3	24	2048x8	(150ns) CMOS	1.79
HM6116LP-3	24	2048x8	(150ns) L.P. CMOS	1.85
HM6116P-4	24	2048x8	(200ns) CMOS	1.69
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	1.75
HM6264P-12	28	8192x8	(120ns) CMOS	4.69
HM6264LP-12	28	8192x8	(120ns) L.P. CMOS	4.75
HM6264P-15	28	8192x8	(150ns) CMOS	4.49
HM6264LP-15	28	8192x8	(150ns) L.P. CMOS	4.59
6514	18	1024x4	(450ns) (CMOS)(MM74C914)	4.49
74S189	16	16x4	(35ns)	1.95
74S289	16	16x4	(35ns) 3101	2.95

PROMS/EPROMS

Part No.	Pins	Function		Price
1702A	24	256x8	(1µs)	3.95
TMS2516	24	2048x8	(450ns)	3.49
TMS2532	24	4096x8	(450ns) NMC2532	3.95
TMS2564	28	8192x8	(450ns)	8.95
2708	24	1024x8	(450ns)	3.95
TMS2716	24	2048x8	(450ns) 3 voltage	6.49
2716	24	2048x8	(450ns)	2.49
27C16	24	2048x8	CMOS	9.95
2716-1	24	2048x8	(350ns)	2.95
2732	24	4096x8	(450ns)	2.49
2732A-20	24	4096x8	(200ns) 21V	3.95
2732A-25	24	4096x8	(250ns) 21V	2.95
2732A-45	24	4096x8	(450ns) 21V	2.75
27C32	24	4096x8	CMOS	10.95
2758	24	1024x8	(450ns) Single +5V	3.95
2764-20	28	8192x8	(200ns) 21V	3.95
2764-25	28	8192x8	(250ns) 21V	2.95
2764A-25	28	8192x8	(250ns) 12.5V	2.95
2764-45	28	8192x8	(450ns) 21V	2.19
27C64	28	8192x8	CMOS 21V	6.95
27128-25	28	16,384x8	(250ns) 128K 21V	2.95
27128A-25	28	16,384x8	(250ns) 128K 12.5V	4.95
27256-25	28	32,768x8	(250ns) 256K (12V)	7.95
27C256-25	28	32,768x8	(250ns) 256K (CMOS)	13.95
68764	24	8192x8	(450ns) 25V	15.95
68766	24	8192x8	(350ns) 25V	16.95
74S188	16	32x8	PROM O.C. (6330-1)	1.75
74S287	16	256x4	PROM T.S. (6301-1)	1.69
74S288	16	32x8	PROM T.S. (6331-1)	1.69
74S387	16	256x4	PROM O.C. (6300-1)	1.69
74S471	20	256x8	PROM T.S. (6309-1)	4.95
74S472	20	512x8	PROM T.S. (6349-1)	3.49
74S473	20	512x8	PROM O.C. (6348)	2.95
74S474	24	512x8	PROM T.S. (DM87S296N)	3.49
74S475	24	512x8	PROM O.C. (6340)	3.49
74S476	18	1024x4	PROM T.S.	4.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	3.49
74S573	18	1024x4	PROM T.S. (82S137)	2.95
825123	16	32x8	PROM O.C. (27S18)	2.49
825115	24	512x8	PROM T.S. (27S15)	9.95
825123	16	32x8	PROM T.S. (27S19)	2.95
825126	16	256x4	PROM O.C. (27S20)	2.95
825129	16	256x4	PROM T.S. (27S21)	2.95
825130	16	512x4	PROM O.C. (27S12)	3.95
825185	18	2048x4	PROM T.S. (TBP24S41)	9.95
825191	24	2048x8	(55ns)	14.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95

DATA ACQUISITION

Part No.	Pins	Function	Price
ADC0800	18	8-Bit A/D Converter (±1 LSB)	14.49
ADC0803	20	8-Bit A/D Converter (±1 LSB)	14.95
ADC0802	20	8-Bit A/D Converter (±1/2 LSB)	3.95
ADC0804	20	8-Bit A/D Converter (1LSB)	3.49
ADC0808	28	8-Bit A/D Conv. w/8-Channel Analog	[illegible]
ADC0809	28	8-Bit A/D Converter (8-Ch. Mult.)	[illegible]
ADC0816	40	8-Bit A/D Conv. w/16-Channel Analog	[illegible]
ADC0817	40	8-Bit A/D Converter (16-Ch. Mult.)	[illegible]
ADC0832	8	8-Bit Ser. I/O A/D Conv. (2-4- or 8-Ch. Mult.)	[illegible]
DAC0800	16	8-Bit D/A Converter (±1 LSB)	[illegible]
DAC0806	16	8-Bit D/A Converter (0.78% Lin.)	[illegible]
DAC0807	16	8-Bit D/A Converter (MC1408-7)	[illegible]
DAC0808	16	8-Bit D/A Converter (MC1408-8)	[illegible]
DAC0830	20	8-Bit µP D/A Conv. (.05% Lin.)	[illegible]
DAC0831	20	8-Bit µP D/A Conv. (.1% Lin.)	[illegible]
DAC1000	24	10-Bit D/A Conv. Micro Comp. (0.05% Lin.)	[illegible]
DAC1008	20	8-Bit D/A Conv. Micro Comp. (0.20% Lin.)	[illegible]
DAC1022	16	10-Bit D/A Conv. (0.20% Lin.)	[illegible]
DAC1222	18	12-Bit D/A Conv. (0.20% Lin.)	[illegible]
DAC1230	20	12-Bit µP D/A Conv. (.012% Lin.)	[illegible]
DAC1231	20	12-Bit µP D/A Conv. (.024% Lin.)	[illegible]
AY-3-1015D	40	30K Baud UART	[illegible]
AY-5-1013A	40	30K Baud UART (TR1602)	[illegible]

Low Profile (Tin) Sockets

Part No.	1-9	10-99	100-up
8 pin LP	.13	.12	.11
14 pin LP	.15	.13	.11
16 pin LP	.17	.15	.13
18 pin LP	.25	.23	.21
20 pin LP	.28	.26	.23
22 pin LP	.30	.28	.26
24 pin LP	.31	.30	.29
28 pin LP	.39	.37	.35
40 pin LP	.49	.46	.43

Soldertail (Gold) Standard

Part No.	1-9	10-99	100-up
8 pin SG	.39	.35	.29
14 pin SG	.49	.45	.39
16 pin SG	.55	.49	.45
18 pin SG	.65	.59	.54
20 pin SG	.75	.65	.59
22 pin SG	.79	.69	.65
24 pin SG	.79	.69	.65
28 pin SG	.95	.85	.75
36 pin SG	1.25	1.15	.99
40 pin SG	1.39	1.25	1.15

Wire Wrap Sockets (Gold) Level #3

Part No.	1-9	10-99	100-up
8 pin WW	.55	.49	.45
10 pin WW	.65	.59	.55
14 pin WW	.69	.65	.59
16 pin WW	.75	.69	.65
18 pin WW	.85	.79	.75
20 pin WW	.95	.89	.85
22 pin WW	.99	.95	.89
24 pin WW	1.19	1.09	.99
28 pin WW	1.39	1.29	1.19
36 pin WW	1.49	1.39	1.29
40 pin WW	1.79	1.69	1.59

Header Plugs (Gold)

Part No.	1-9	10-99	100-up
14 pin HP	.59	.49	.45
16 pin HP	.59	.55	.49
24 pin HP	.99	.89	.79

Header Covers

Part No.	1-9	10-99	100-up
14 pin HC	.15	.13	.12
16 pin HC	.19	.17	.15
24 pin HC	.29	.27	.25

$20 Minimum Order – U.S. Funds Only   CA Residents: Add 6% or 6½% Sales Tax   Spec Sheets – 30¢ each
Shipping: Add 5% plus $1.50 Insurance   Send $1 Postage for *FREE 1986 Jameco Catalog*   Prices Subject to Change
Send stamped, self-addressed envelope to receive a Quarterly Sales Flyer – FREE!

MasterCard — Mail Order Electronics · Worldwide — Jameco ELECTRONICS — VISA

1355 SHOREWAY ROAD, BELMONT, CA 94002

1/86   *PHONE ORDERS WELCOME – (415) 592-8097 – Telex: 176043*

EEPROM

Part No.	Pins	Function	Price
2816A	24	2048x8 16K E²PROM 350ns. . .	$8.95

Features: • On-board Address/Data Latches • Auto-Timed Byte Write (on chip timer) • 5V Erase/Write/Read • Optional High Voltage Erase/Program (9V-15V) • Power Up/Down Write Protection • Auto Erase before Write

The 2816A is an ideal nonvolatile memory providing in-system alterability with the same ease and with the same features as 2Kx8 Static RAMs.

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc. The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™. . . . . $24.95 ea.
MM54104 Processor Chip. . . . . $12.95 ea.

DT1057 – Expands the DT1050 vocabulary from 137 to over 250 words. Incl. 2 ROMs and specs.
Part No. DT1057. . . . . $11.95 ea.

INTERSIL

Part No.	Pins	Function	Price
FE0202D	40	[illegible]	12.95
FE0203D	40	[illegible]	12.95
7045IPI	28	CMOS Precision Timer	11.95
7045EV/Kit	28	Stopwatch Chip Kit (Evaluation Kit)	16.95
7106CPI	40	3½ Digit A/D (LCD Drive)	8.95
7106EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7107CPL	40	3½ Digit A/D (LED Drive)	8.95
7107EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7116CPI	40	3½ Digit A/D LCD Dis. HLD	8.95
7201IJS	[illegible]	Low Battery Volt. Indicator	2.29
7205IPG	24	CMOS LED Stopwatch/Timer	14.95
7205EV/Kit	24	Stopwatch Chip Kit (Evaluation Kit)	16.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit	16	Tone Generator Chip Kit (Evaluation Kit)	7.95
7207APD	14	Oscillator Controller	5.95
7207AEV/Kit	14	Freq. Counter Chip Kit (Evaluation Kit)	8.49
7211IPL	40	4 Digit LCD Display Decoder Driver (7 seg. compatible)	7.95
7211MIPL	40	4 Digit LCD Display Decoder Driver (Microprocessor compatible)	8.49
7215IPG	24	4 Func. CMOS Stopwatch Ckt	16.95
7215EV/Kit	24	4 Func. Stopwatch Chip Kit (Evaluation Kit)	19.49
7216AIJI	28	8 Digit Univ. Counter C.A.	31.49
7216DIPI	28	8 Digit Freq. Counter C.C.	21.49
7217IJI	28	4 Digit LED Up Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up Down Counter C.C.	8.95
7224IPL	40	LCD 4½ Digit Up Counter Drl	10.95
7226AEV/Kit	40	5 Function Counter Chip Kit (Evaluation Kit)	99.95

30009 1985 Intersil Data Book (1075 pgs.) **$9.95**

74HC HIGH SPEED CMOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74HC00	14	.35	74HC139	16	.79	74HC245	20	1.59
74HC02	14	.39	74HC147	16	.99	74HC251	16	.79
74HC03	14	.39	74HC151	16	.79	74HC253	16	.79
74HC04	14	.39	74HC153	16	.79	74HC257	16	.79
74HCU04	14	.39	74HC154	24	1.95	74HC259	16	1.19
74HC08	14	.39	74HC157	16	.79	74HC266	14	.69
74HC10	14	.39	74HC158	16	.79	74HC273	20	1.79
74HC11	14	.39	74HC160	16	.89	74HC280	14	2.95
74HC14	14	.59	74HC161	16	.89	74HC299	20	3.19
74HC20	14	.39	74HC162	16	.89	74HC366	16	1.49
74HC27	14	.39	74HC163	16	.89	74HC367	16	1.49
74HC30	14	.39	74HC164	14	.99	74HC373	20	1.49
74HC32	14	.45	74HC165	16	1.49	74HC374	20	1.49
74HC42	16	.75	74HC166	16	1.95	74HC390	16	1.19
74HC51	14	.39	74HC173	16	.89	74HC393	14	1.19
74HC58	14	.39	74HC174	16	.89	74HC533	20	1.95
74HC73	14	.45	74HC175	16	.89	74HC534	20	1.95
74HC74	14	.45	74HC190	16	1.19	74HC595	16	1.95
74HC75	16	.69	74HC191	16	1.19	74HC688	20	[illegible]
74HC76	16	.69	74HC192	16	.99	74HC4024	14	1.19
74HC85	16	1.19	74HC193	16	.99	74HC4040	16	1.19
74HC86	14	.59	74HC194	16	.89	74HC4049	16	.79
74HC107	14	.49	74HC195	16	.89	74HC4050	16	.79
74HC109	16	.49	74HC221	16	1.95	74HC4060	16	1.19
74HC112	16	.49	74HC237	16	1.19	74HC4075	14	.49
74HC123	16	1.19	74HC240	20	1.39	74HC4078	14	.49
74HC125	14	.99	74HC241	20	1.39	74HC4511	16	1.95
74HC132	14	.79	74HC242	14	1.39	74HC4514	24	2.95
74HC133	16	1.19	74HC243	14	1.39	74HC4538	16	1.95
74HC138	16	.79	74HC244	20	1.49	74HC4543	16	[illegible]

74C—C/MOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74C00	14	.29	74C151	16	1.95	74C373	20	1.95
74C02	14	.29	74C154	24	2.95	74C374	20	1.95
74C04	14	.25	74C157	16	1.75	74C901	14	.49
74C08	14	.35	74C160	16	[illegible]	74C902	14	.49
74C10	14	.29	74C161	16	[illegible]	74C903	14	.49
74C14	14	.59	74C162	16	[illegible]	74C906	14	.49
74C20	14	.29	74C163	16	[illegible]	74C907	14	.59
74C30	14	.29	74C164	14	[illegible]	74C911	28	7.95
74C32	14	.35	74C165	16	[illegible]	74C912	28	7.95
74C42	16	[illegible]	74C173	16	[illegible]	74C915	18	1.19
74C48	16	1.19	74C174	16	[illegible]	74C917	28	7.95
74C73	14	[illegible]	74C175	16	[illegible]	74C920	22	9.95
74C74	14	[illegible]	74C192	16	[illegible]	74C921	18	9.95
74C85	16	1.19	74C193	16	[illegible]	74C922	18	3.95
74C86	14	[illegible]	74C195	16	[illegible]	74C923	20	3.95
74C89	16	3.95	74C221	16	1.19	74C925	16	4.95
74C90	14	[illegible]	74C240	20	1.49	74C926	18	4.95
74C93	14	[illegible]	74C244	20	1.59	74C932	18	9.95
74C95	14	[illegible]				80C95	16	.69
74C107	14	[illegible]				80C97	16	.69

LINEAR

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
[illegible]	8	1.69	LM350K		3.95	LM748N	8	.59
TL064CN	14	1.95	LF351N	8	.49	UA760HC		1.29
TL071CP	8	.59	LF353N	8	.59	LM1456V	8	1.95
TL072CP	8	.79	LF355N	8	.89	LM1458CN	8	.49
TL074CN	14	.79	LF356N	8	.89	LM1488N	14	.69
TL081CP	8	.49	LM358N	8	.49	LM1489N	14	.69
TL082CP	8	.69	LM359N	14	1.59	LM1496N	14	.99
TL084CN	14	1.09	LM360N	8	2.19	LM1605CK		9.95
LM109K		[illegible]	LM361N	14	1.59	LM1871N	18	1.95
LM301CN	8	.35	LM370N	14	4.95	LM1872N	18	2.49
LM302H		.69	LM373N	14	4.95	LM1877N-9	14	2.49
LM304H		[illegible]	LM377N	14	1.95	LM1889N	18	1.59
LM305H		[illegible]	LM380CN	8	1.09	LM1896N	14	1.59
LM307CN	8	.45	LM380N	14	.89	LM2002T		1.95
LM308CN	8	.59	LM381N	14	1.29	ULN2003A	16	.99
LM309K		1.25	LM382N	14	1.29	XR2206	16	3.95
LM310CN	8	1.29	LM384N	14	1.69	XR2207	14	2.49
LM311CN	8	.45	LM386N-3	8	.69	XR2208	16	1.79
LM312H		1.49	LM387N	8	[illegible]	XR2211	14	2.95
LM317T		.99	LM389N	18	.99	LM2877P		1.95
LM317K		2.95	LM391N-80	16	1.29	LM2878P		2.19
LM318CN	8	1.19	LM392N	8	.59	LM2901N	14	[illegible]
LM319N	14	1.19	LM393N	8	.45	LM2902N	14	.59
LM320K-5		1.35	LF398N	8	2.39	LM2907N	14	1.95
LM320K-12		1.35	LM399H		3.95	LM2917N	8	1.55
LM320K-15		1.35	LF412CN	8	1.49	LM2935T		1.49
LM320K-24		1.35	TL494CN	16	1.95	LM3900N	14	.59
LM320T-5		.59	TL496CP	8	1.59	LM3905CN	8	1.19
LM320T-12		.59	TL497ACN	14	2.19	LM3909N	8	.89
LM320T-15		.59	NE531V	8	1.79	LM3911N	8	1.19
LM320T-24		.59	NE540H(CS40H)		2.95	LM3914N	18	1.95
LM322N	14	1.49	NE544N	14	1.49	LM3915N	18	1.95
LM323K		4.49	NE555V	8	.29	LM3916N	18	1.95
LM324N	14	.39	XR-L555	8	.69	RC4136N	14	.89
LM329DZ		.55	LM556N	14	.59	RC4151NB	8	.99
LM331M	8	3.49	NE558N	16	1.19	RC4193NB	8	2.95
LM334Z		1.19	NE564N	16	1.95	LM4250CN	8	1.19
LM335Z		1.29	LM565N	14	.99	NE5532	8	.99
LM336Z		1.09	LM566CN	8	1.39	NE5534	8	.89
LM337MP		1.15	LM567V	8	.89	78L05A		.35
LM337T		1.49	NE570N	16	2.49	78L12A		.35
LM338K		3.95	NE571N	16	1.95	79L05A		.59
LM339N	14	.49	NE592N	14	.89	79M05AH		[illegible]
LM340K-5		1.35	LM710N	14	.69	ICL8038	14	3.95
LM340K-12		1.35	LM711N	14	.69	LM13080N	8	1.19
LM340K-15		1.35	LM723N	14	.45	LM13600N	16	1.19
LM340K-24		1.35	LM733N	14	.69	75477	8	1.19
LM340T-5		.49	LM739N	14	2.95	76002	14	1.25
LM340T-12		.49	LM741CN	8	.29	76477	28	3.95
LM340T-15		.49	LM747N	14	.59			
LM340T-24		.49						
LF347N	14	[illegible]						
LM348N	14	[illegible]						

30003 1982 Nat. Linear Data Book (1952 pgs.) **. . $14.95**

AUTOMATION IN ORGANIC SYNTHESIS

BY GARY W. KRAMER AND PHILIP L. FUCHS

In search of the electronic chemist

THIS ARTICLE WILL cover aspects of how we are automating the research process for organic chemical synthesis. We use a robot arm to handle the mechanical aspects of the task (such as preparing samples) and a number of independent, microprocessor-based substations for support activities (such as cleaning the sample tubes and controlling the analysis equipment). We'll explain in detail how we are interfacing support equipment to one of the substations.

In the day-to-day life of the scientist there are occasional periods of great excitement, but more often the practice of experimental science is routine. Many times procedures are repeated with only small variations to determine the effect of variables or to gather enough data for sound statistical analyses. Organic chemistry is no exception.

Production of a target molecule, whether a drug, a natural product, or an industrial chemical, often requires carrying out a sequence of steps where the product from the current reaction becomes the starting material for the next step. Like all serial processes, synthesis schemes are adversely affected by weak links. Considerable effort is expended to improve the low-yielding steps of the process.

In the commercial production of chemicals, it is desirable to know the precise effects of variables on reaction rate and yield. This knowledge is important in compensating for unforeseen events that can affect production, safety, and economics. When the number of variables is large, the number of experiments needed to find the best set of conditions or to map out a reaction profile can be astronomical.

Automation is an answer to this problem. In other branches of chemistry, most notably clinical chemistry, automation of routine processes is common. In organic chemistry, where experimental procedures are more diverse, automation is not widespread. If automation is to come to the organic laboratory, it must be flexible enough to allow facile experimental reconfigurations.

The introduction of the Zymate Laboratory Robot in 1981 by the Zymark Corporation (see the "Products Mentioned" text box on page 268) greatly enhanced the practicality of automating organic synthesis. The Zymark robot consists of a nonmobile, nonarticulated arm that can rotate about its base, can be raised or lowered, and can move in and out to gain access to a cylindrical work area about 14 inches high and 54 inches in diameter. At the end of the arm is a wrist that can rotate 360 degrees. A unique feature of this robotic arm is its set of hands. Several different hand types (gripper, syringe, etc.) are available, and the robot can be programmed to change hands for different applications. A self-contained system controller and a variety of automated laboratory appliances (centrifuge, balance, shaker, vortexer,

(continued)

Gary W. Kramer holds a Ph.D. from Purdue University and is an instrumentation specialist with Purdue's Department of Chemistry. Philip L. Fuchs is a professor of chemistry at Purdue; he has a Ph.D. from the University of Wisconsin. They can both be reached at the Department of Chemistry, Purdue University, West Lafayette, IN 47901.

syringe pumps, etc.) complete a typical laboratory system.

THE FIRST-GENERATION SYSTEM

Although the Zymark system was created to do chemistry, it was designed with the sample preparation phase of analytical chemistry in mind. Accordingly, it was given the capabilities of weighing, mixing, diluting, pipetting, and extracting: tasks necessary to get a raw sample ready for final analyses by other instruments. Initially, we built our system around the robot, using it to do everything. However, as the system's capability has expanded, our philosophy has evolved to using the robot only to handle situations that would otherwise be difficult to automate.

The creation of new instrumentation often goes through several stages. First, a demonstration system is created, which performs some subset of the overall task. Its purpose is to answer key feasibility questions, highlight troublesome areas, and attract resources to the project. Our first-generation scheme consisted of a Zymark system, locally built automated room temperature reactors, and a semiautomated liquid chromatograph as the analyzer (see photo 1). The system was managed solely by the Zymark controller. The first chemical reaction tested was chosen not only because it fit the system capabilities but also because it was a step in a synthesis in need of yield improvement. The system was run open-loop; that is, the results from the reactions were printed out for later interpretation by the operator. This system ran 16 reactions and 240 analyses over a 50-hour period, producing a significant improvement in the yield of the desired material (see the article "Robotic Orchestration of Organic Reactions" by A. R. Frisbee, M. H. Nantz, G. W. Kramer, and P. L. Fuchs in the *Journal of the American Chemical Society*, volume 106, page 7143, 1984).

TOWARD THE SECOND GENERATION

Change is inevitable in creating open-ended systems such as ours, as to-

(continued)

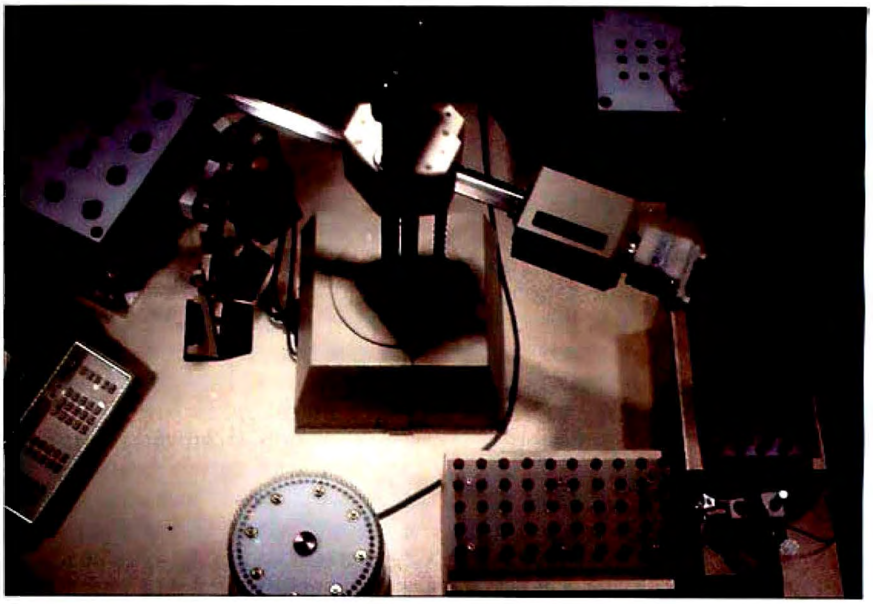
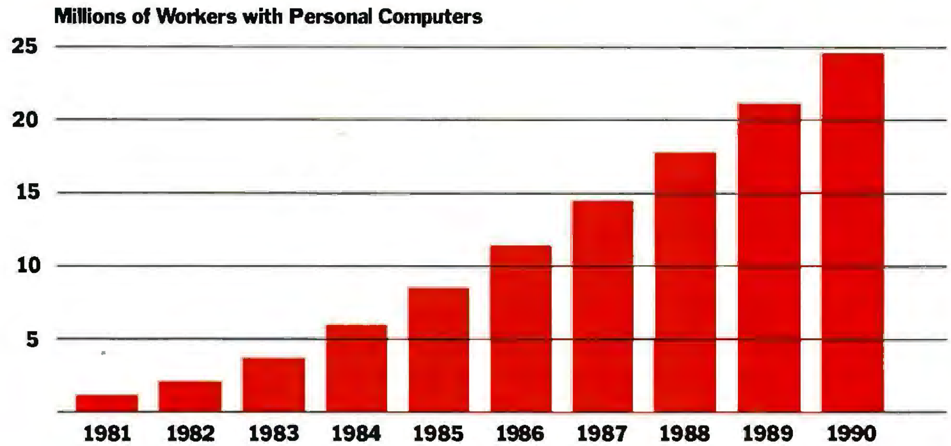


Photo 1: *The Purdue Automated Synthesis System, phase 1. The robot arm stands in the center of the laboratory setup. Arranged around the arm, starting from bottom left of the photo and continuing clockwise are:* HP3390A *reporting integrator, reagent station, reactor station, aliquot archive station, workup station, syringe and needle wash station, and sample turntable. In front of the reagent station are three hand parking stations.*

How will you manage the growth of PC technology in your organization?



Copyright © 1985 by Future Computing Incorporated, Dallas, Texas

Announcing *Future Directions*.™ The next generation of information services for PC managers.

Future Directions is different from any resource you've used before. It provides you with the information you need to make complex personal computer management decisions. It doesn't overwhelm you with lengthy product descriptions.

Designed specifically for busy personal computer and information center managers, *Future Directions* is a new loose-leaf service from the premier source of information in the personal computer industry, Future Computing Incorporated.

A new resource for personal computer managers.
Future Directions puts a team of experts behind every management decision you make, increasing your influencing power in the decision process and validating your selections.

It gives you more than our opinions on today's office automation trends. It also provides a clear picture of future trends in technology.

A time-saving decision tool for managers.
Future Directions is simple to use. In 250 pages of easy-to-read charts and text, it presents timely information on such product segments as personal computers, software, and peripherals.

For each product segment, we cover today's most important issues and trends, such as networking, site licensing, standards, compatibility, artificial intelligence, and more.

Future Directions leads you step-by-step through the important issues affecting product selections. First, it presents various product technologies. Concise charts match technologies to types of usage. Once you determine how your company will use a product, you can compare technologies based on price, performance, and other factors. And for each product segment, *Future Directions* explores future technology trends and industry standards.

Most of the information is presented in charts, so you can quickly find the data you need. It's also indexed for quick references. And you can extract our charts to support your decisions in management presentations.

And it's affordable.
Priced at $495,* *Future Directions* is a management tool you can't afford to work without. By helping you narrow down product alternatives quickly, it greatly reduces the number of products you need to evaluate before making quantity purchases. If *Future Directions* reduces your evaluation process by even one machine, it's more than paid for itself. It will also help you avoid mistakes in personal computer product selection.

Here's what you'll get:

- □ One loose-leaf binder packed with 250 pages of timely information on personal computer issues and technology trends
- □ Updates sent every other month
- □ 12 issues of a monthly newsletter
- □ Free telephone support

The personal computer information standard.
Future Computing has set the standards for personal computer vendors. Founded in 1980, Future Computing is recognized as the premier source of information on the personal computer industry. All of the information in *Future Directions* is based on our extensive research, including surveys of end users, distribution channel participants, and personal computer product vendors.

Money back guarantee.
Because we're confident that Future Directions is the most valuable resource on personal computer issues and trends, we're offering you a risk-free subscription. If you're not satisfied with *Future Directions* just return it within 15 days and receive a complete refund.

Order today.
To order, complete and mail the form below or call a Marketing Representative at 214 437-2400 today.

FUTURE COMPUTING INCORPORATED

McGraw-Hill

□ I want the information I need to make personal computer management decisions right at my fingertips. Enter my subscription for *Future Directions* for $495. ($600 international price.)
□ Please send me more information about *Future Directions*.

Sales Support
Future Computing Incorporated
8111 LBJ Freeway
Dallas, Texas 75251

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City/State/Zip ______________________

Phone (________) ______________________

*Price subject to change without notice.

day's wants become tomorrow's needs. Accommodating this change is a major design challenge. Flexibility, modularity, and portability in both software and hardware are essential.

The control-system architecture (figure 1) reflects these design criteria and allows orderly growth. The executive processor contains the user interface, application program, and the main control routines. It interacts with the rest of the system through 8-bit managerial processors. These managers are the key to the control system. They serve as buffers, translators, controllers, and isolators. Interprocessor communication is carried out in a block protocol over serial data lines. This architecture allows true concurrency while freeing the system from timing constraints. Its modularity permits replacement of system components with a minimum of problems. Isolation of the executive from the real-time, bit-flipping environment of the managers allows the application software to be written in a portable high-level language.

The analysis manager provides a good example of the managerial function. Most modern chemical analysis equipment is smart; that is, its internal control systems are processor-driven. Many of these instruments allow downloading of analytical methods, automatic sample injection, postprocessing of raw data into meaningful information, and transmission of results. In our work, a sample is loaded into the instrument's autoinjector by the robot, a command file detailing the processing is downloaded, and, following the analysis, the instrument returns the results.

Unfortunately, there is little standardization in the world of analytical instruments. Even within a given company's product line, the command to inject a sample on a high-pressure liquid chromatograph (HPLC) is not likely to be the same as that used on a gas chromatograph (GC). However, the managerial computer will know these details, so they can remain hidden from both the user and the application-level software.

Actual analytical parameters are specified by the user during system initialization and are stored as

(continued)

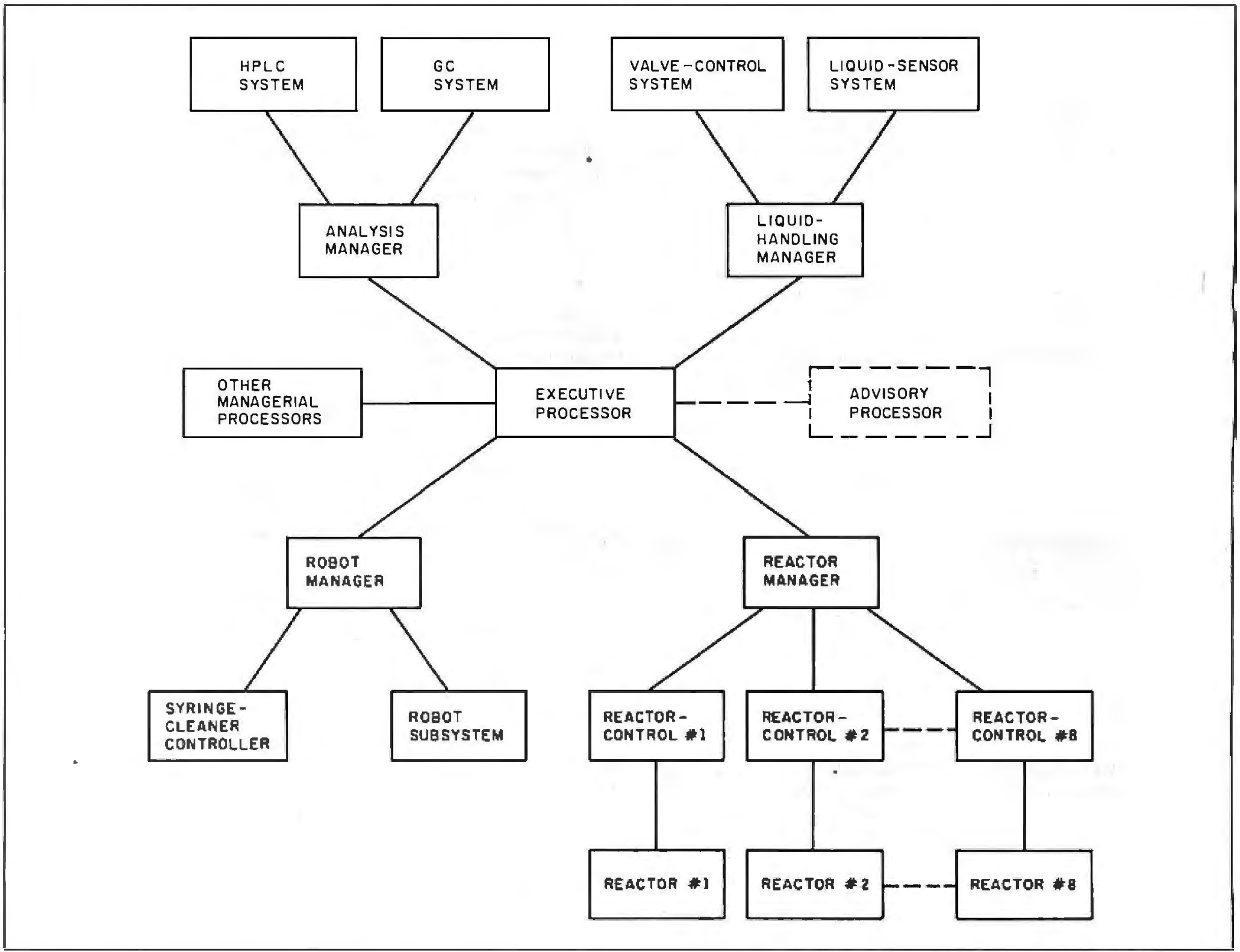


Figure 1: *Control-system architecture.*

methods files that are downloaded to the analytical manager at run time. During a run the executive can issue a task to the manager, such as "Take sample number three and run an HPLC analysis using method number two." Upon receiving this command, the manager checks to see if the task can be done (analytical instrument ready and sample three exists) and then returns a completion time estimate to the executive, which sets up a watchdog timer. The manager carries out this task by delivering the necessary directives to the analytical instrument.

When the results of the analysis are available and formatted for transmission to the managerial computer, it interrupts the executive. Uploading the results to the executive completes the task. If the executive watchdog times out, the executive will issue a status request to the manager and will initiate appropriate action based upon the returned status. Fault conditions in the analytical instruments are reported to the manager, which either corrects the problem or passes it up to the executive. In this way, a disparate collection of analyzers can be made to look relatively uniform to the application software.

Figure 1 shows an advisory processor in a dotted box to the right of the executive processor. In the future, we will probably use an expert system and other artificial intelligence (AI) methods to enhance the capabilities of our system. Since this technology usually requires special hardware and software environments, a separate computer seems appropriate.

Initially, the AI machine will function as a consultant to the executive, but in time the user interface and application programming functions may migrate to this processor.

CHOOSING THE COMPONENTS

Requirements for flexibility, modularity, and expansibility point to a multicard, bus-oriented system. Our choice of the IEEE-696 (S-100) bus over Multibus or STD-bus systems was

(continued)

PRODUCTS MENTIONED

Laboratory Robot
ZYMARK CORPORATION
Zymark Center
Hopkinton, MA 01748
(617) 435-9501

Chemically Inert Metering Pumps
FLUID METERING INC.
29 Orchard St.
Oyster Bay, NY 11771
(516) 922-6050

LQD Liqua Sense Liquid Level Sensor
HI-G COMPANY INC.
Electronics Division
580 Spring St.
Windsor Locks, CT 06096
(203) 623-2481

Liquid Level Quartz Sensor
NSG PRECISION CELLS INC.
560 South Broadway
Hicksville, NY 11801
(516) 938-7772

Optical Liquid Detector
IVEK CORPORATION
43 School St.
North Springfield, VT 05150

S19 Sight Glass Scanner
SKAN-A-MATIC CORPORATION
Route 5W
Elbridge, NY 13060
(315) 689-3961

Bantam-meter Optical Sensor
KONTES SCIENTIFIC GLASSWARE
Spruce St.
Vineland, NJ 08360
(609) 692-8500

Series 1, 2, and 18 Miniature Teflon Solenoid Valves
GENERAL VALVE CORPORATION
202 Fairfield Rd.
Fairfield, NJ 07006
(201) 575-4844

TAS™

the "Hard-nosed" Relational Database

$199.

the Database + Integrated Accounting

$349.

If You Liked DBase III, You'll Flip Over TAS™

Hard-nosed business owners have been asking for the power of DBase III™ and RBase 5000,™ but without the high price. That's why Business Tools, Inc. created TAS.™

Compare TAS with DBase III and RBase 5000. You'll see why we think TAS is the best "Hard-nosed" value around. TAS includes a data dictionary. TAS includes a true procedural language. TAS includes a run-time compiler. Plus TAS can be upgraded to multi-user for $100.

	TAS™	DBASE III	RBASE 5000
Multi-User	$100	No	$1400
Data Dictionary	Yes	No	Yes
Procedural Language	Yes	Yes	Yes
Compiler	Yes	No	Yes
Records Per File	Unlimited	Unlimited	Unlimited
Files Open	16	10	40
Fields Per File	Unlimited	128	400
File Size	Unlimited	Unlimited	Unlimited
Record Size	10,254	4,000	1,530
Field Size	254	254	1,530
Prices	$199	$696	$700

And TAS is no new comer. TAS was written by Phil Mickelson, the same "Hard-nosed" business person who created The Sensible Solution™ (relational database) in 1982.

TAS comes with a 30 day money back guarantee (less handling fee of $15 Level 1, $30 Level 2, $45 Level 3 and $10 Multi-User). TAS is available for the IBM PC/XT/AT,™ Compaq,™ AT&T 6300,™ Tandy 1000, 1200, 2000™ and most MS-DOS,™ CP/M™ and MP/M™ systems. Multi-user and LAN versions also available.

TAS lets you develop your own professional menu-driven business applications. And not just simple ones either. TAS applications can hold up to 17 million records. And because TAS compiles them, they run fast.

Get TAS Accounting Software for $349

But why stop with just a database? For just $349, you get TAS Relational Database/Language plus General Ledger, Accounts Receivable and Accounts Payable. And for $499 you get all the above plus Inventory, Sales Order Entry, Purchase Order Entry, and Payroll.

Source code is included FREE! So you can even modify the accounting to fit your business.

Call Today 1-800-648-6258
Ask for operator 11

Call our Toll-Free Hotline. Use your VISA or MasterCard to order today. Outside Washington call 1-800-648-6258. Washington residents call 1-206-644-2015.

Dealer Inquiries Welcome.

TAS™

NOT COPY-PROTECTED

"Affordable Software For Your Business Needs"

Describe your computer system:
☐ 8 bit
CP/M, MP/M
TurboDOS
☐ 16 bit
MS-DOS
PC-DOS
Disk size is:
☐ 5¼" ☐ 8"
Computer name/model is: ____
Name: ____
Street ____
City: ____
State: ____ Zip: ____
Phone: ____

Quantity:
____ TAS Database/Language–$199
____ Level 2 Accounting (TAS, GL, AR, AP)–$349
____ Level 3 Accounting (Level 2, SO, PO, INV, PAY)–$499
____ Multi-user upgrade–$100
Subtotal (WA add 7.8% tax) ____
Shipping (USA–$5.00 ea.) (Foreign–$20.00 ea.) ____
Total Enclosed: ____
Payment: ☐ VISA ☐ MC ☐ Cashier's Check
(All amounts are payable in U.S. funds only.)
Credit Card Expiration Date: ____
Card Number: ____
Name on card: ____
Signature: ____

4038-B 128th Ave. SE
Suite 266
Bellevue, WA 98006

BUSINESS TOOLS INC.

4038-B 128th Ave. SE
Suite 266
Bellevue, WA 98006

Inquiry 44

finally made on the basis of cost per board function and the authors' familiarity with S-100 systems. With the bus architecture decided, the choice of a CompuPro 8/16 was easy. At present, CP/M is the base-level operating system. However, only the terminals, printer, and disks are CP/M system devices. The special interrupt-driven, multitasking control software is implemented as a transient program. This run-time package takes control of the executive processor, relying on CP/M only for terminal and disk I/O (input/output) handling.

If the choice of the executive processor was easy, the converse was true of the managers. Many of the executives' requirements also apply to the managers. But the managers only need to be 8-bit ROM (read-only memory)-based machines; disks and operating systems are unnecessary. The choice came down to either an STD-bus approach or an in-house designed system. Over the years we have built up an extensive 8-bit system that has been used in several data acquisition and control projects. To aid in the development and maintenance of this system, we also created a variety of hardware and software tools. We have little experience with the STD bus; however, it is desirable to use commercially available equipment whenever possible. Ultimately, we chose the in-house design for our first synthesis system, feeling that we could get going quicker with it.

Each managerial computer contains the same set of core boards: an 8085 8-bit microprocessor with 19 interrupt channels, a status and start-up card containing bootstrap PROM (programmable read-only memory) used during initialization, a real-time clock card containing a day/date clock (MM58167) and six 16-bit timers (two 8253s), a triple serial interface card (three 2651s), and a 64K-byte PROM/RAM (random-access read/write memory) card. Other cards, such as buffered parallel interfaces, additional clock cards, analog-to-digital converter cards, digital-to-analog con-

(continued)

Someone new has just entered the world of programming.

Now, everyone can program their computer. Because now, there's *ALICE* to show you the way.

ALICE: The Personal Pascal . . . the first complete programming environment that lets you create your own sophisticated Pascal programs, while teaching you how.

Much More Than a Pascal Compiler

ALICE knows the syntax and the rules of Pascal . . . changing programming from what was once a slow, complex task to simply a matter of selecting the appropriate templates, and merely filling in the blanks. You can't make a frustrating syntax error. *ALICE* won't let you.

The Programming System With a Difference

ALICE has a unique Pascal interpreter that lets you run – *and debug* – your programs directly. You can actually see your program executing. And the programs that you develop with *ALICE* can be used with your Pascal compiler.

Help at Your Fingertips

All the information you'll ever need from *ALICE*. A tutorial, features of Pascal, and the meaning of error messages is now at hand . . . in over 500 screens of on-line HELP.

Let ALICE be the Teacher

ALICE is currently being used in hundreds of schools to teach Pascal programming. Why Pascal? Because it has emerged as the language of choice of colleges and universities and is now the language of choice of the SAT examinations.

ALICE Offers More!

- windows, menus, and function keys . . . easy.
- "undo" feature to take back mistakes . . . forgiving.
- screen control, color highlighting, and macros . . . powerful.

Now you'll program intelligently, accurately, almost intuitively . . . with *ALICE*.

To order by credit card, call 1-800-448-3400 ext. *ALICE* (in Canada 1-800-387-9018). Specify software or demonstration diskette. Or, fill in the order form and send to:

SOFTWARE CHANNELS INC. Inquiry 329

Software Channels Inc.
4 Kingwood Place, Kingwood,
Texas 77339 (713) 359-1024
Canada and International:
212 King Street West,
Toronto, Canada M5H 1K5 (416) 591-9131

ALICE
The Personal Pascal™

Name: ____________________
Address: ____________________
City: __________ State: __________ Zip Code: __________
Telephone: (____) __________ Machine Memory (K): __________
Number of Copies __________ @ $95.00 (Canada $129.00) = __________
☐ Demonstration Diskette: Shipping/handling $4.95 (Canada $5.95) = __________
Payment: VISA ☐ AMEX ☐ MC ☐ Check ☐ Money Order ☐ Bank Draft ☐
Credit Card Expiry Date: ______ / ______
Credit Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Signature: ____________________

ALICE: The Personal Pascal software prices include shipping and handling to the US and Canada. COD's will not be accepted. Texas residents add 4⅛% sales tax. Ontario residents add 7% sales tax.
For IBM PC, XT, AT and compatibles. Dealer and distributor inquiries welcome. Site licences available.

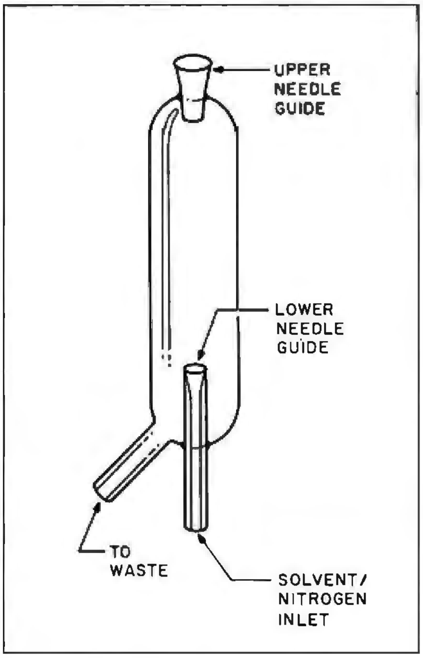


Figure 2: *Self-cleaning syringe washer.*

verter cards, and stepper-motor driver cards, are added as required by the specific application. The 44-pin bus is terminated actively on the backplane board. The front panel has LED (light-emitting diode) indicators for the system states (used during debugging), a reset button (warm start to location 0000H), and a restart button (cold start back to bootstrap PROM). A connector on the rear of the front panel allows a box with hexadecimal data/address displays, halt/run switch, and single-step switch to be attached for use during debugging. If needed, our DMA (direct memory access) card, disk-controller card, and disks can be added to create a CP/M-compatible development system.

Each managerial processor has at least one 8K-byte PROM, located at address E000H, which contains the system monitor, debugging routines similar to the CP/M DDT (dynamic debugging tool) functions, block-mode communication driver, and interrupt handlers. When the overall system is complete, there will be several managerial processors running simultaneously. It is impractical to provide a terminal for each computer, and the front-panel displays are quite limited. To debug and maintain the system, a spy feature is implemented in each manager. Periodically, the manager transmits a message from one of its serial channels describing its current activity and status. We connect the spy lines from each manager to a manual multiplexer switch connected to a single terminal. The system operator selects which manager is monitored. If this manual method proves too limited, the multiplexer and terminal can be replaced with a disk-based system that can log the activity of all the managers onto disk for postmortem analyses.

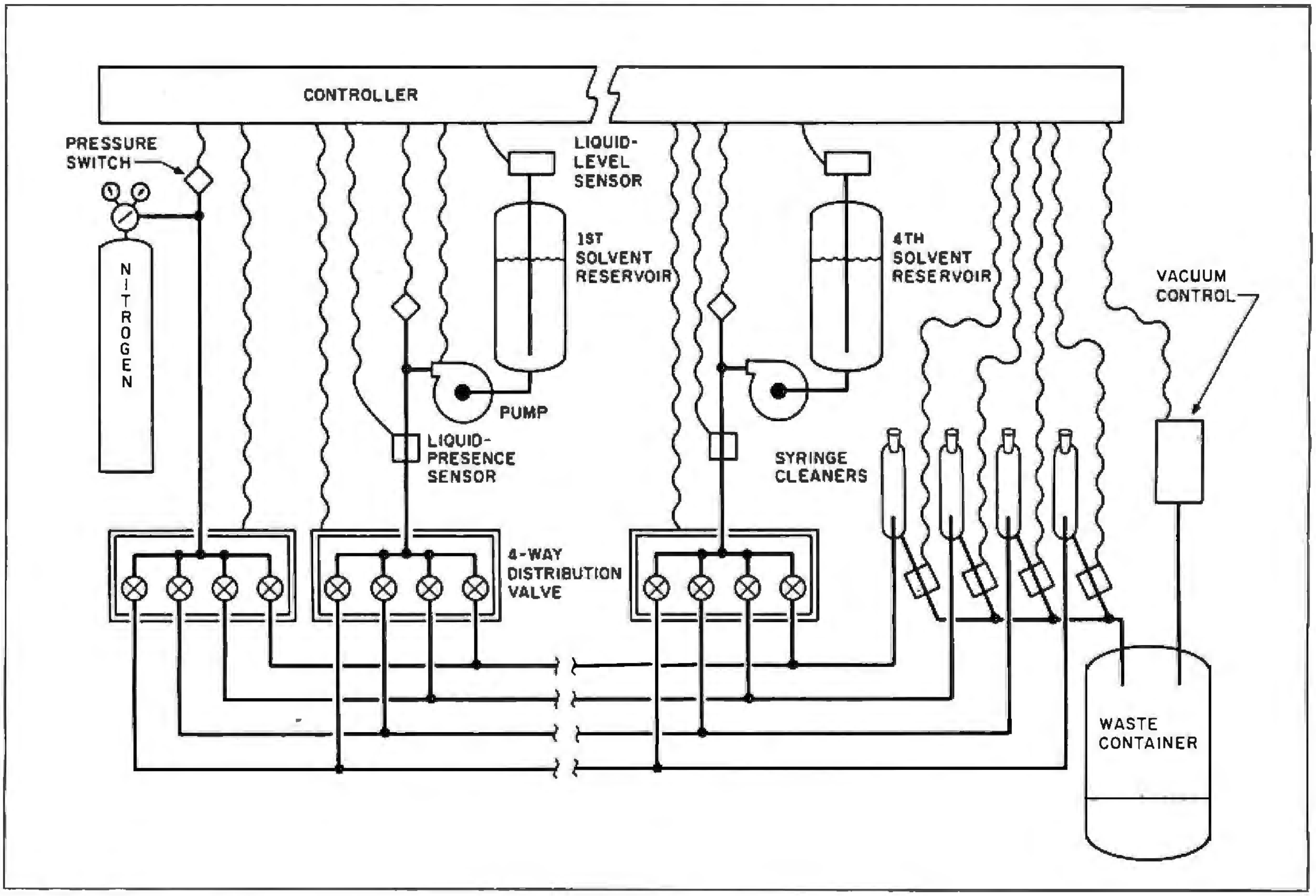


Figure 3: *Syringe-cleaner subsystem.*

Much software used by the managers will be PROM-based; only variables and special routines are downloaded after each master system reset.

ONE SUBSYSTEM IN DETAIL

Rather than give a condensed view of our entire system, it may be more illuminating to describe in some detail one subsystem, currently being built, that illustrates several techniques. First, a brief description of the robot's syringe hand is in order. The hand consists of a glass syringe whose plunger is driven by a small DC motor through rack-and-pinion gearing. A potentiometer, mechanically coupled to the drive assembly, provides position feedback. Normally, a syringe hand must be cleaned after each use. Figure 2 shows our self-cleaning syringe washer. The cleaning process involves inserting the syringe needle into the lower needle guide, drawing solvents into the syringe barrel one at a time, and then expelling them to waste, followed by pumping nitrogen in and out to dry the syringe. Sufficient solvent pressure is developed in the lower needle guide to provide efficient washing of both the syringe interior and the needle exterior. This process uses valuable robot time, since the hand must be attached to the arm for cleaning. Several other hands are available, so the robot could be doing useful work if a syringe could be cleaned while its hand is parked.

The robot could be doing useful work if a syringe could be cleaned while its hand is parked.

Figure 3 shows a system that alleviates the cleaning problem by allowing up to four syringe hands to be cleaned while parked. A syringe washer is placed below each parking station, and each hand is equipped with an auxiliary set of contacts that engage when the hand is parked. Parking a hand in its station initiates its cleaning cycle. The controller hardware for this subsystem is identical to that in the managerial processors previously described. In figure 1, this controller is shown reporting to the robot manager. However, it may end up serving the liquid-handling manager or even becoming a full manager itself.

The solvents are stored in large containers and directed to the cleaning stations by metering pumps driven by permanent magnet stepper motors.

(continued)

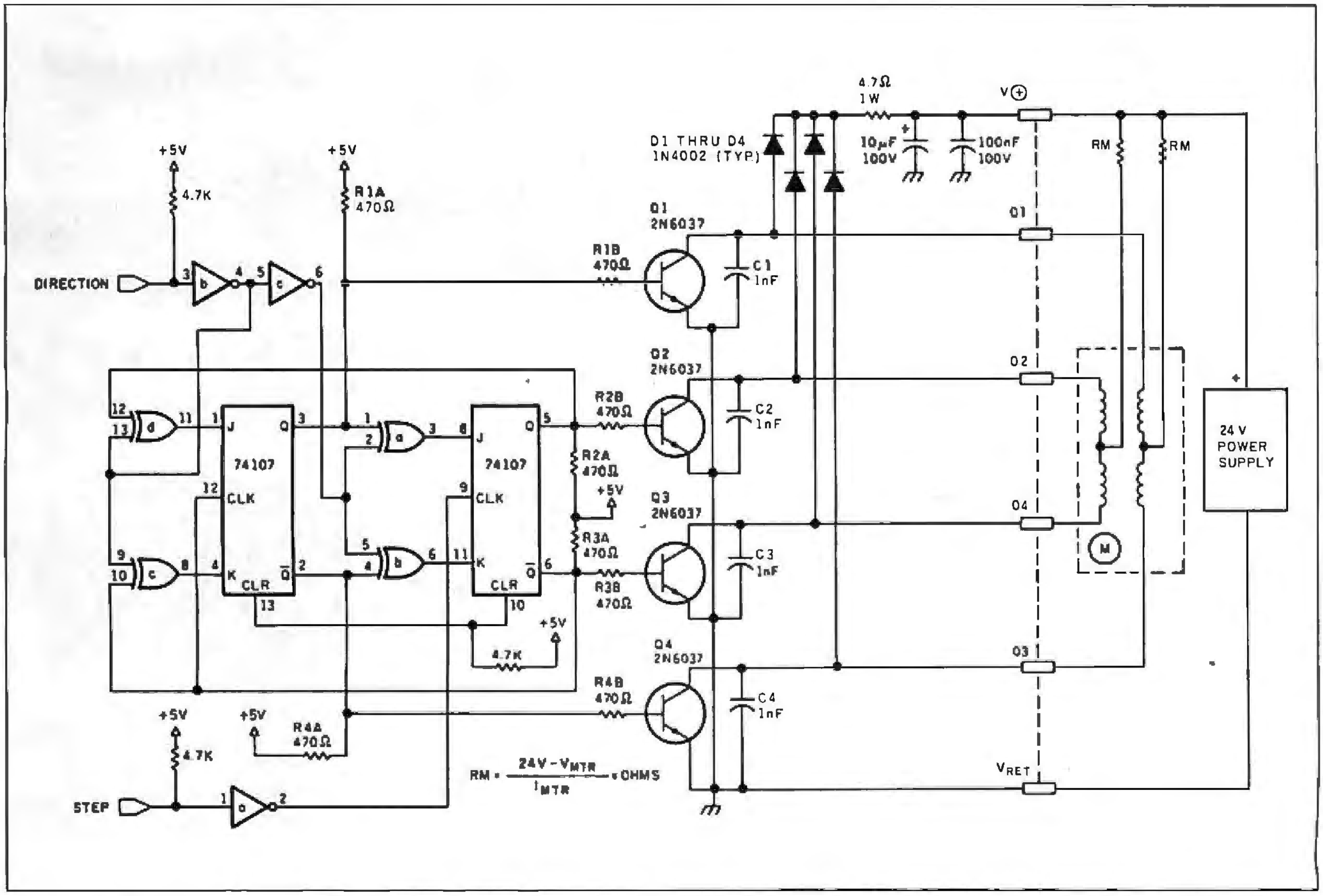


Figure 4: *Stepper-motor drive circuit.*

Solvent levels are monitored with sensors that make use of the reflectance of light passing through a glass rod.

Figure 4 shows the circuitry required for driving these four-phase motors. The direction line is left high, and the step line is driven from the buffered output of an 8253 or 8254 counter-timer controller (CTC). Our metering pumps (manufacured by Fluid Metering Inc.) deliver a fixed amount of liquid for each rotation of the motor. Solvent can be delivered at a programmable rate by using the CTC in the rate-generator mode. If a fixed amount of solvent is to be delivered, the rate-generator CTC can be gated with the complemented output from a second CTC channel that is used in the interrupt on terminal-count mode. Figure 5 shows one of the CTC circuits on our real-time clock card. Easy selection of true or complemented signals improves the flexibility of this card.

System reliability is improved by several sensors mounted near the pump. Solvent levels in the reservoirs are monitored using sensors that make use of the internal reflectance of light passing through a glass or quartz rod whose tip is cut to a 90-degree taper. According to Snell's law, when the tip is surrounded by a low-refractive-index medium such as air, light passing through the rod will be totally reflected. When the refrac-

(continued)

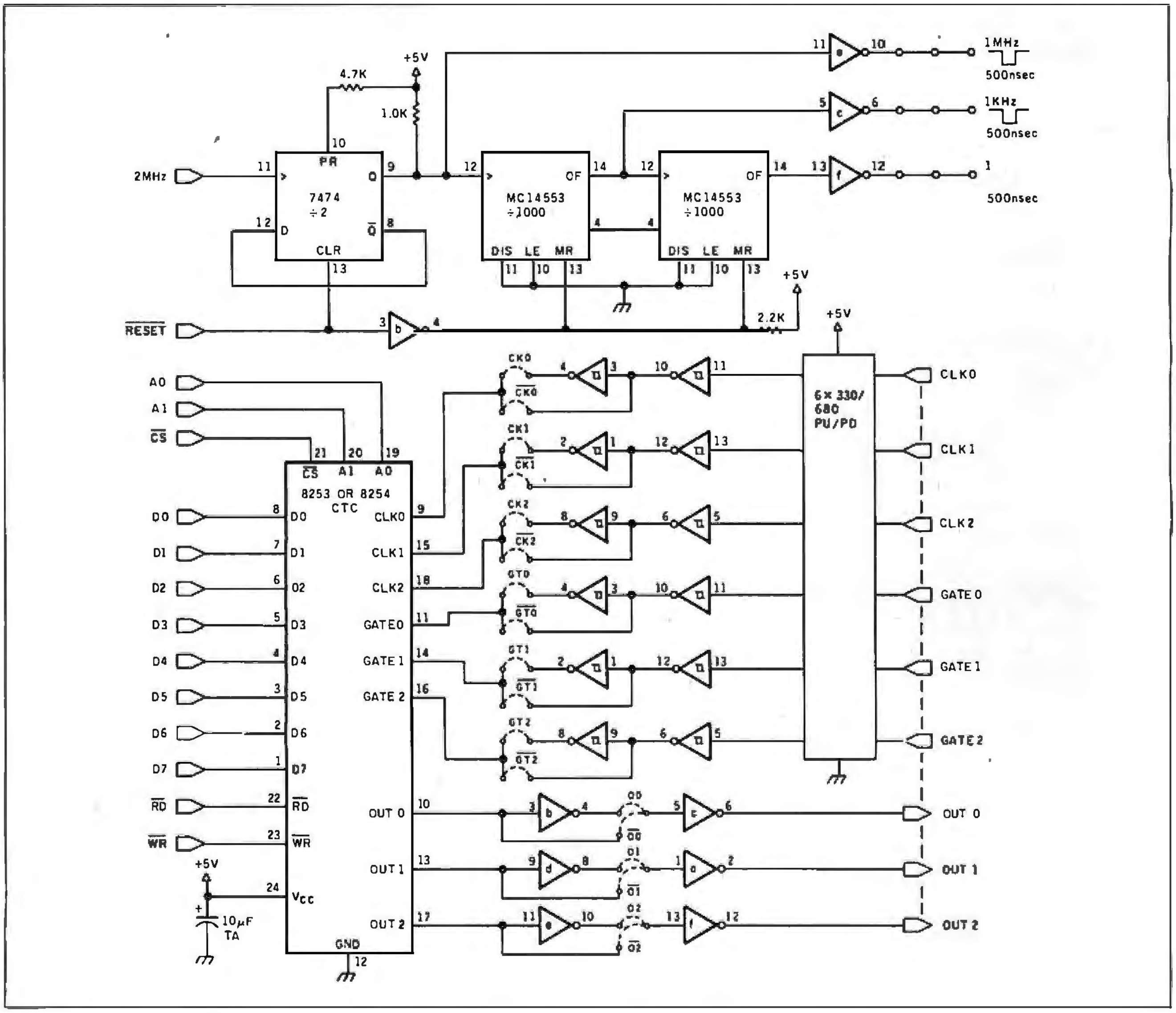


Figure 5: *Real-time clock (CTC) circuit.*

TOLL FREE 1-800-848-FAST **TOLL FREE 1-800-848-FAST**

MICRO EXPRESS SUPPLIES

THE TOP NAME DISKETTES ARE NOW AT THE LOWEST PRICES EVER.

	5.25" SSDD 48 TPI	5.25" DSDD 48 TPI	5.25" DSDD-HD PC/AT	3.5" SSDD	3.5" DSDD
	$1.48	$1.95	$4.05	$2.60	$3.50
	$1.38	$1.74	$3.65	$2.48	$4.00
3M	$1.25	$1.65	$3.75	$2.29	$3.40
maxell	$1.22	$1.66	$3.30	$2.20	$3.25
XIDEX	$ .80	$ .90		$2.45	

These are the highest quality and most reliable diskettes on the market. Now with one simple toll-free call you can buy them at the lowest prices around. Don't settle for a brand you never heard of when you can have the best for less.

TOLL FREE 1-800-848-FAST

TO ORDER

PAYMENT: *We accept MasterCard and Visa with no service charge • Bank checks, certified checks and money orders will insure fast delivery • COD — Add $3.00 - certified, bank check or money order only • Personal checks - we must wait 10 days to clear before shipping • Corporate accounts and purchase orders welcome, subject to credit approval • Prices subject to change without notice.* ***Shipping and Handling*** *— Standard case lot is 50 diskettes of the same type per case • Add 5% for less than case lot quantities • Minimum order size is $30.00 • Add 3% (minimum $3.00), per each 100 or fewer diskettes • Ohio residents add 5.5% for State Sales tax.*

EXPRESS MICRO SUPPLIES INC. • DEPT. L-557 • COLUMBUS, OH 43260

tive index of the surrounding medium is higher, such as with a liquid, a portion of the light passes from the rod into the liquid (figure 6). If a photodetector is placed at the flat end of the rod, its output will decrease when the conical tip of the rod is immersed in a liquid. A simple comparator circuit (figure 7) converts this change into a computer-readable signal. A version of this sensor, the LQD Liqua Sense Liquid Level Sensor, is commercially available. The simple design shown here must be shielded from external light; however, a more sophisticated synchronous detection scheme (such as the Liquid Level Quartz Sensor from NSG Precision Cells) can virtually eliminate this problem.

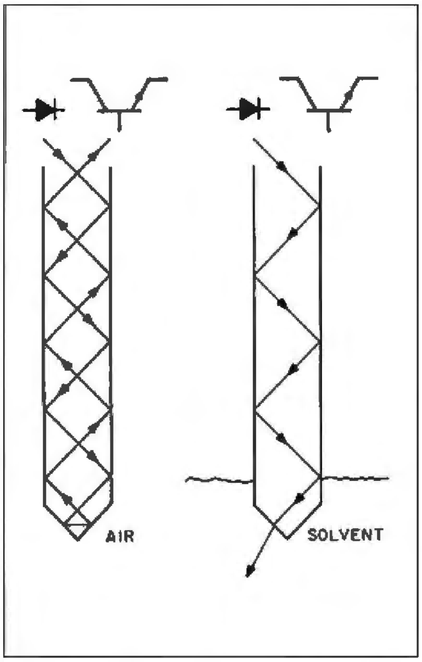


Figure 6: *Reflective liquid-level sensor.*

To ensure that the pump retains its prime, a flow-through sensor is mounted on the pump output to detect the presence of the liquid in the Teflon tubing leading to the distribution valve. This device uses an LED and a phototransistor on opposite sides of the translucent Teflon tubing to detect the presence of a liquid. Again, a comparator circuit (figure 7) provides a TTL (transistor-transistor logic) level signal. To shield this sensor from ambient light, the LED and phototransistor are mounted in an opaque plastic block (figure 8), and the entire circuit is housed in a small black plastic Pomona Box. We know of no commercial versions of this sensor that are as small as the one described, but models that work with larger tubing are readily available (the Optical Liquid Detector, the S19 Sight Glass Scanner, and the Bantammeter Optical Sensor).

A small bellows-type pressure sensor on the outlet of the pump is used to detect an overpressure condition due to a fully closed distribution valve or a clogged tube. The TTL outputs from these sensors are brought into the controller through a 16-bit buffered parallel I/O card. Figure 9 shows the input section of this circuit.

The effluent from each pump is brought to a four-way distribution valve whose exit ports lead to the individual washing stations. These distribution valves are typical of the miniature solenoid valves used in this project, which feature small internal volume (30 to 60 microliters), high-speed operation (8 milliseconds), low power drain (12 volts DC, 210 milliamperes), and all Teflon wetted parts (Series 1, 2, and 18 Miniature Teflon Solenoid Valves). Since the current required to drive these valves is greater than that provided by standard open-collector TTL drivers, additional buffering is provided as shown in figure 10. The diodes protect the switching transistor from the voltage spikes generated when the solenoid valve is

(continued)

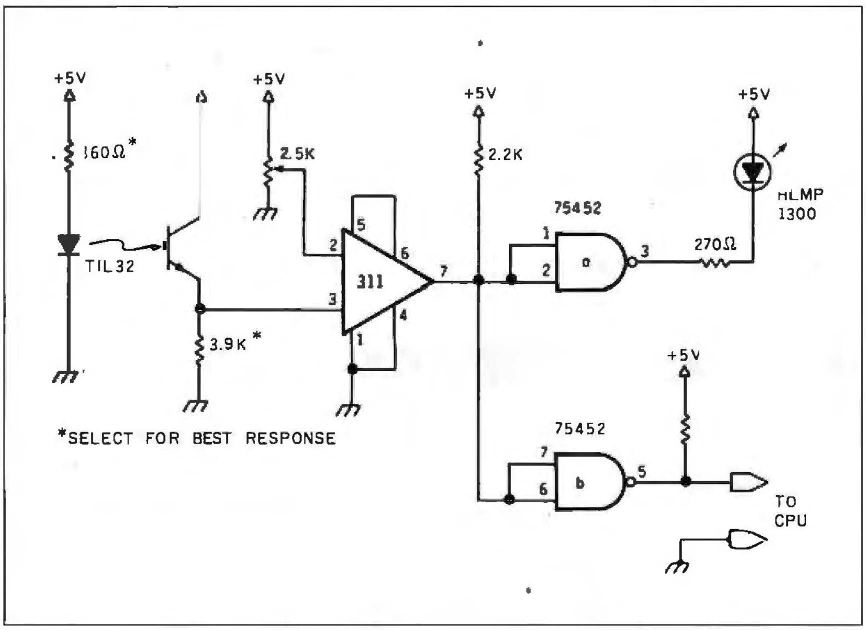


Figure 7: *Optical fluid detector circuit.*

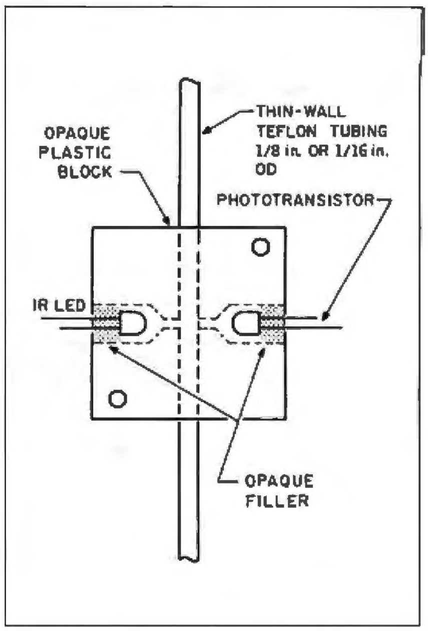


Figure 8: *Liquid-presence detector.*

NEW LANGUAGE BREAKS OLD RULES. GIVES PROGRAMMERS POWER, SPEED AND SIMPLICITY.

Try this remarkable language, PROMAL™, for 30 Days AT NO RISK and...

We think you'll be thrilled with this breakthrough system when you discover its power, ease of use, and dazzling performance on your IBM PC, Apple IIe/IIc, or Commodore 64. **But we don't expect you to accept our claims for PROMAL without proof,** so we invite you to explore the power of PROMAL on your own during our 30-day trial period.

Broken Rules

Now that PROMAL 2.0 has broken the rules, a structured language doesn't have to be slow, unwieldy and difficult to use. PROMAL is fast, elegant, and simple.

What Is PROMAL?

PROMAL stands for **PRO**grammer's **M**icro **A**pplication **L**anguage. But PROMAL is more than a high-level language, it's a total structured programming development system with a fast, one-pass compiler, a versatile full-screen editor, plus an integrated machine-language subroutine library. And for APPLE and Commodore systems it includes a DOS-like system "Executive."

Better By Design

PROMAL was designed from "scratch" for **optimum performance** and ease of use on microcomputers. It has a simplified syntax with no awkward terminators like ";" or "}" and **indentation is part of the syntax,** so structuring your code is natural and easy. Just compare PROMAL with BASIC in this example:

Equivalent Program Segments

```
;------ PROMAL --------
REPEAT
   PROMPT_AT 5.24, "Add Chg Quit?
   IF Reply = 'A'
      ADD item
      New_Items = New_Items + 1
   ELSE IF Reply = 'C'
      CHANGEItem
UNTIL Reply = 'Q'
```

```
11910REM -----BASIC ---------
11920CL = 5:LN = 24:PR$ = "Add Chg Quit?"
11925GOSUB 9490:REM GET REPLY
11930IF RP$<>"A" THEN 11950
11940 I9 = IT:GOSUB 10100:REM ADD
11945 NI = NI + 1:GOTO 11920
11950 IF RP$<>"C" THEN 11970
11960 I9 = IT:GOSUB 6050:REM CHG
11970 IF RP$<>"Q" THEN 11920
```

PROMAL is readable and understandable. You see the logic from the structure. And PROMAL lets you call procedures by name – so no more GOSUBs. But there's more.

Slick Editor

Editing your source is a snap with the specially-designed and integrated **full-screen Editor** – it not only helps you structure your program, it **even finds compilation errors** – automatically.

Quick Compiler

The compiler is a **lightning-fast,** one-pass, recursive descent design. On the IBM PC it crunches source to object at **2000 lines per minute,** and it's equally impressive on the Apple and C64. And your PROMAL source code is **portable from machine to machine.** That means your source can be used on all PROMAL target machines.

Run-Time Speed Demon

PROMAL blows away Apple II and C64 languages from BASIC and PASCAL to FORTH. (Send $3 for a copy of our full benchmark report.) It's **2000% faster** than BASIC. And on a normal IBM PC, the native 8088 code from **PROMAL beat Turbo Pascal 3.0** by 10% on the standard sieve benchmark!

DOS For Those Without

If you don't have a real "DOS," then PROMAL gives you a **true operating system** environment with the built-in operating system Executive. (See box.)

PROMAL 2.0 FEATURES

COMPILED LANGUAGE

- Structured indentation syntax
- No line numbers or terminators
- Long variable names (31 characters)
- Global, Local, & Argument variables
- Byte, Word, Integer & Real data types
- Decimal or Hex number types
- Functions & Procedures with passed arguments
- Predefined DATA of any type
- Multi-Dimensional Arrays (any type)
- Strings & pointers
- Control Statements: IF, IF-ELSE, WHILE, FOR, CHOOSE, REPEAT-UNTIL, BREAK, NEXT, INCLUDE, ESCAPE, REFUGE
- Bit-operators, shifts, type casts
- Variables at any memory location
- Simple Machine Language interface
- Recursion supported
- Program chaining and overlays (IMPORT/EXPORT)
- Separate compilation of modules
- Load and run relocatable M/L programs
- Compile errors trapped for Editor

EXECUTIVE (APPLE II & C64 Only)

- Command driven, with line editing
- Multiple user programs in memory at once
- Function key definitions
- Progam abort and pause
- Prior command recall
- I/O Re-direction & batch jobs
- "DOS"-like commands: COPY, RENAME, DELETE, display FILES, TYPE, HELP, etc.
- Memory MAP, SET, and display commands

EDITOR

- Full-screen, cursor driven
- Function key controlled
- Line insert, delete, search
- String search and replace
- Block copy, move, delete & file read/write operations
- Auto indent, undent support

LIBRARY

- 50 Resident Machine-language commands
- Call by name with arguments
- String handling (9 routines)
- Re-directable I/O (STDIN & STDOUT)
- Formatted numeric output
- Decimal & Hexadecimal I/O
- Block fill/move/read/write
- Cursor control & line editing
- Data type conversion
- Random number function
- Real function support (in PROMAL): ABS, ATAN, COS, EXP, LOG, LOG10, POWER, SIN, SQRT, TAN
- Modem device support & much more

Outside Opinion

Naturally we're enthusiastic about PROMAL, **but here's what other programmers are saying:**

"Excellent... an ideal development system.... Well done indeed!"
M. T. V.
Naperville, Ill.

"I am... so amazed by PROMAL... I cannot believe the high degree of excellence of this entire package."
C. P., Ph.D.
Ridgeway, New York

"I don't know that I've ever seen a [system] as thoughtfully designed and as skillfully executed as PROMAL. Its logic and ease of programming are truly remarkable. Its speed of execution is phenomenal... congratulations."
E. C. R.
Alexandria, VA

Safety In Numbers

SMA, Inc. has been satisfying customers (over 100,000) since 1982 with innovative microcomputer products. Now you can join our thousands of satisfied PROMAL users, by trying it today.

Try It For 30 Days On Us

Send us some bucks and we'll send you PROMAL on trial for 30 days. **If for any reason whatsoever you are not satisfied, just send it back** for a quick refund of your purchase price. No questions asked. No risk.

How To Order.

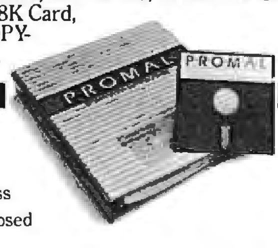
Call TOLL-FREE to order with your credit card or use the handy order form below to send in your check or money-order for your 30-day trial. Don't wait, you deserve the power of PROMAL today!

1-800-762-7874

In NC: 919-878-3600

Systems Management Associates, Inc.
3325 Executive Drive, Dept. PB-6
Raleigh, North Carolina 27609

PROMAL runs on IBM PC/PCjr with 192K, Commodore 64/128, APPLE IIc, or APPLE IIe with 80 Col. 128K Card, and is NOT COPY-PROTECTED.



Order Form for PROMAL 30-Day Trial!

My system is (check one)
☐ IBM PC/100% compatibles ☐ APPLE IIc/IIe
☐ COMMODORE 64/128

Please RUSH me:
☐ PROMAL Developer's System – Compiler, Editor, Library, Demo disk, 280-page manual, (Plus Executive for Apple and C-64) and stand-alone program generation (no royalties).
$99.95 + 5.00 Shipping & Handling
☐ End-User System for Apple IIc/IIe and Commodore 64/128 – all features of Developer's Version except stand-alone program generation (Executive needed for program execution)
$49.95 + 5.00 Shipping & Handling
☐ Graphics ToolBox (Apple/C64 only) – 20 routines for hi-res graphics: windows, clipping, text-on-graphics using scaled, rotated, user-defined fonts.
$29.95 + 2.50 Shipping & Handling

Please charge my
☐ Visa
☐ MasterCard
☐ American Express
☐ My check is enclosed

Card Number ________
Signature ________ Exp.Date ____
Name ________
Address ________
City ________
State ________ Zip ____

NC residents add 4½% sales tax.
Foreign orders add $20.00 additional shipping.

PROMAL is a trademark of Systems Management Associates, Inc. Turbo Pascal is a trademark of Borland International, Inc.

turned off. The capacitor connected from collector to emitter on the switching transistor slows its switching speed, preventing secondary breakdown from the turn-off transient of the inductive load. Drive for these current boosters is derived from a 16-bit buffered parallel I/O card. Figure 11 shows the output section of this circuit. The DP8311 octal peripheral driver is used as a medium-power (100 mA per line) open-collector inverting buffer. The SIP resistor pack on the outputs is optional and is not used when the power booster circuit is used.

The DC motor on the syringe hand that drives the syringe plunger is controlled by the circuitry shown in figure 12. The location of the plunger corresponding to the empty and full positions is discerned by a pair of comparators that monitor the voltage across the position feedback potentiometer in the hand. In this cleaning operation, we monitor only the open and closed positions of the plunger. When given an UP signal from the controller, the plunger is allowed to slew to the top position: a $\overline{\text{DN}}$ signal slews the plunger to the bottom. The controller can determine the position of the plunger by monitoring the $\overline{\text{TOP}}$ and $\overline{\text{BOTTOM}}$ signals. A third input signal, $\overline{\text{HAND PRESENT}}$, detects

(continued)

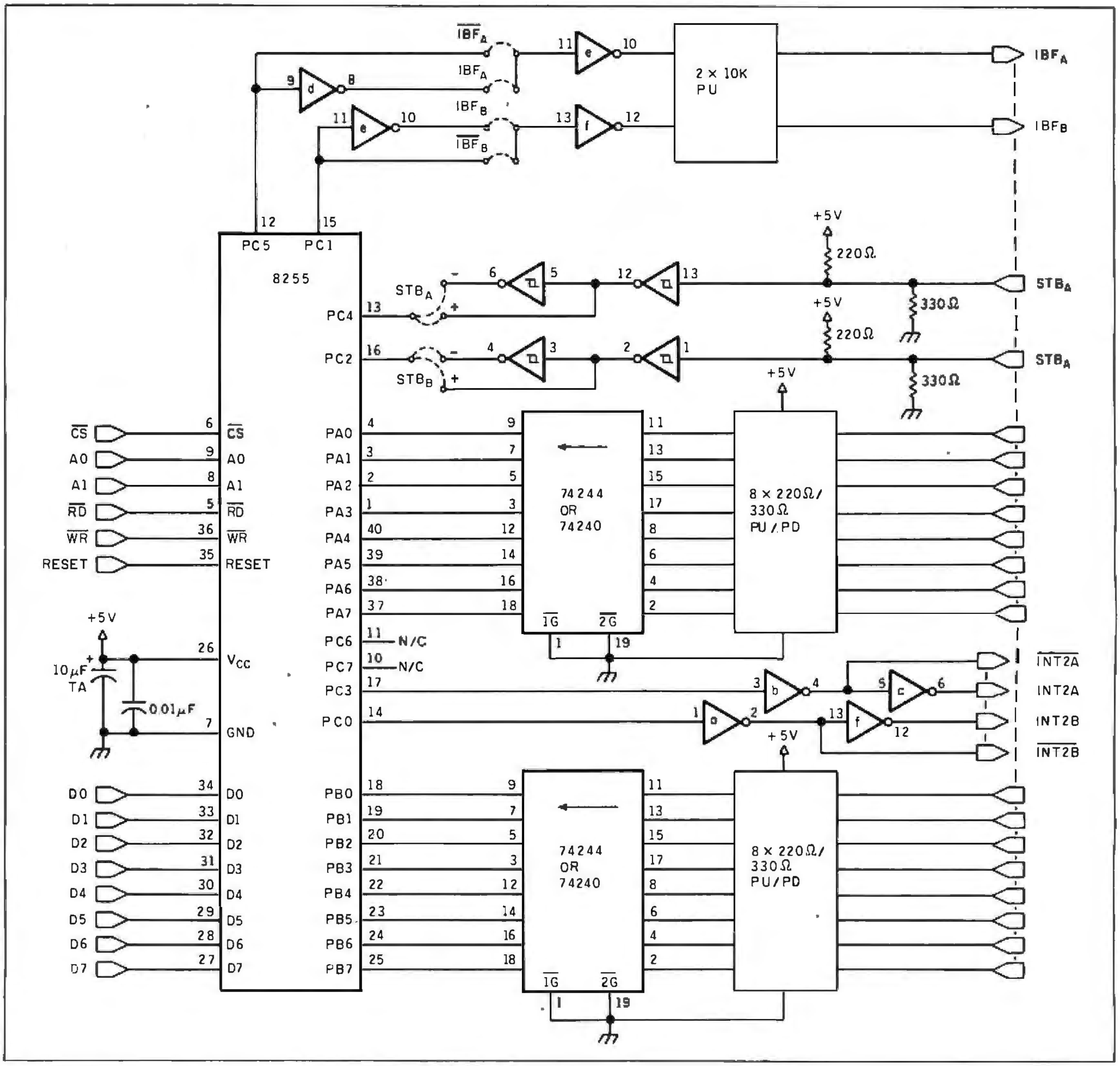


Figure 9: *16-bit buffered parallel input circuit.*

THE CMS POWER SERIES

**Expansion Subsystems for IBM®
and
Compatible Computers**

The Power Drive™	**The Power Twin™**	**The Power Tape™**
Hard Disk Subsystems	Hard Disk Plus Tape Backup	Tape Backup Subsystems
10 to 120 MB	10 to 30 MB	10 to 60 MB

Features:
- One master AC circuit
- Three independent AC circuits
- AC line filter
- AC surge suppressor
- Fan
- Triple output DC supply

The Power Center™

Stackable expansion subsystem

Accepts up to two half height
30 MB disk or 60 MB tape drives.

ENERGIZE YOUR PERSONAL COMPUTER

CMS

We Back You Up!

401 W. Dyer Rd. Santa Ana, CA 92707 (714) 549-9111

Inquiry 61

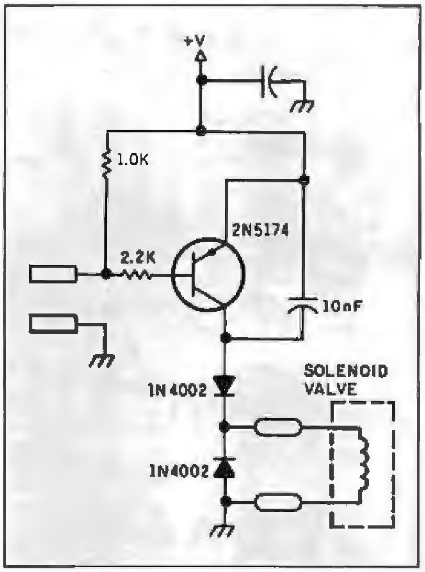


Figure 10: *Valve-driver power booster circuit.*

when the hand has been placed in its parking station. One subtle feature is the internal interlock signal. This signal is generated by a magnetically actuated reed switch on the parking station. The magnet is attached to the robot arm. The purpose of this circuit is to prevent power from the auxiliary contacts from being applied to the hand when it is still attached to, and powered by, the robot arm. To activate the syringe cleaner drive, the robot arm must physically back away from the hand.

The final device controlled in this application is a standard 120 V AC solenoid valve used to turn on and off the water to an aspirator that provides vacuum for removing the waste solvent. This valve is controlled by an optically coupled solid-state relay driven directly from a DP8311 output. Liquid-presence sensors on each waste line are used to help ensure that the washing operation actually occurred.

Having described the hardware, let us examine some of the software requirements. Since this is a subsystem, it must be able to communicate with a higher-level computer. The communication is done serially over an RS-232C link in a block protocol, with CRC-16 error checking and automatic

(continued)

The Transporter Night Shift

Long After Your Staff Goes Home, We Keep Your PC Making Calls, Sending and Receiving Files, and Keeping a Log

Your microcomputer doesn't go home at five. Why not keep it working?

TRANSPORTER keeps your PC communicating almost as well as your staff could do it. Just load it with a "task list" before you go home. It can automatically call other computers, log in, repeat calls if necessary, send and receive files, and more.

It can do it overnight, when phone rates are lowest.

The next morning, TRANSPORTER gives you a report of what it has accomplished during its night shift.

So you can start the day ahead of the game.

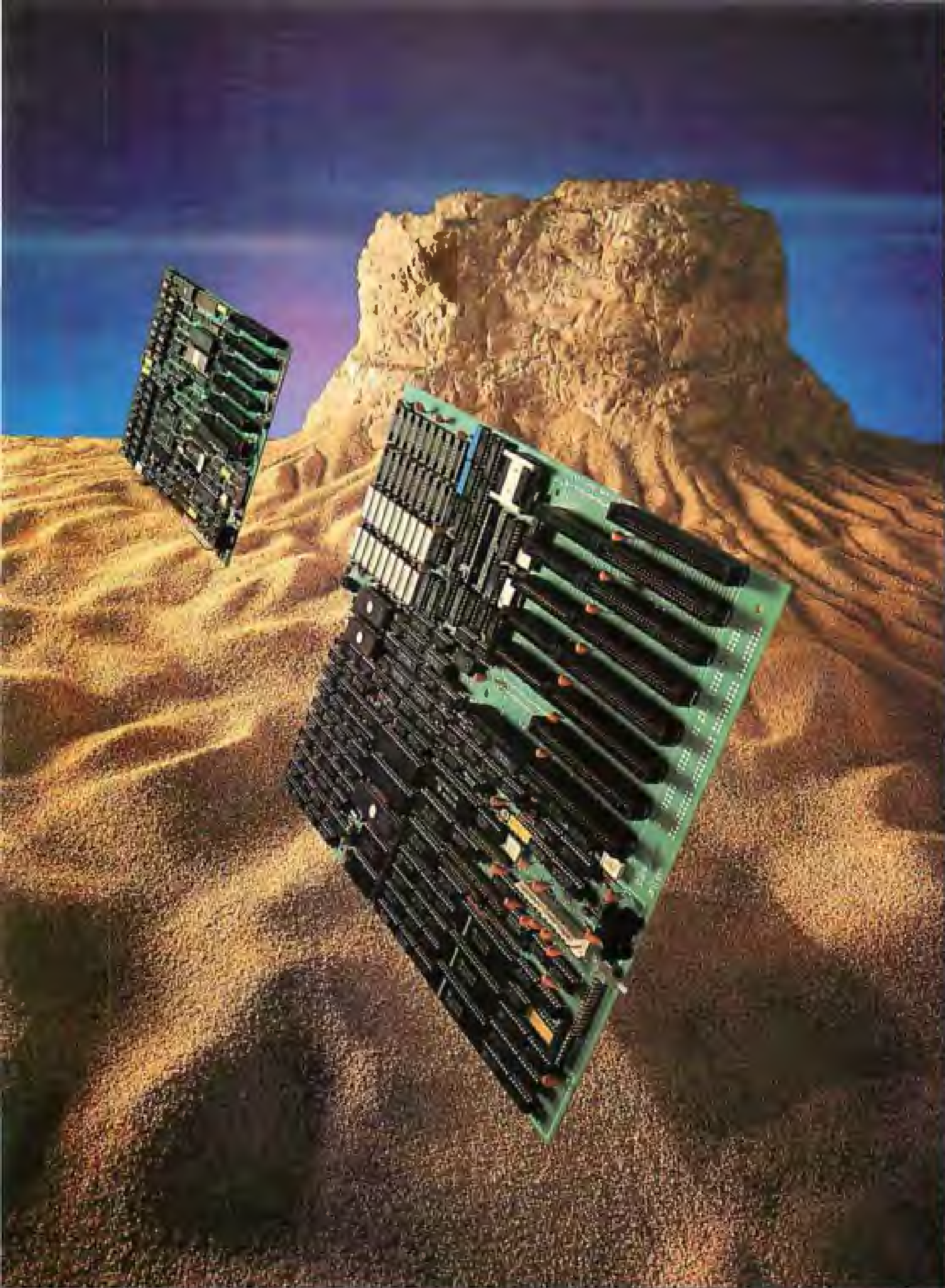
TRANSPORTER comes with our popular CROSSTALK data communications program added on. It communicates with any other system running TRANSPORTER or CROSSTALK. For details, see your retailer or write for a brochure.

Inquiry 247

MICROSTUF®
1000 Holcomb Woods Parkway
Roswell, Georgia 30076

For the IBM Personal Computer. Requires 128K RAM, two disk drives, PC-DOS, Asynchronous Communications interface or equivalent RS232 connection, and a modem compatible with the 'AT' command set.

TRANSPORTER™



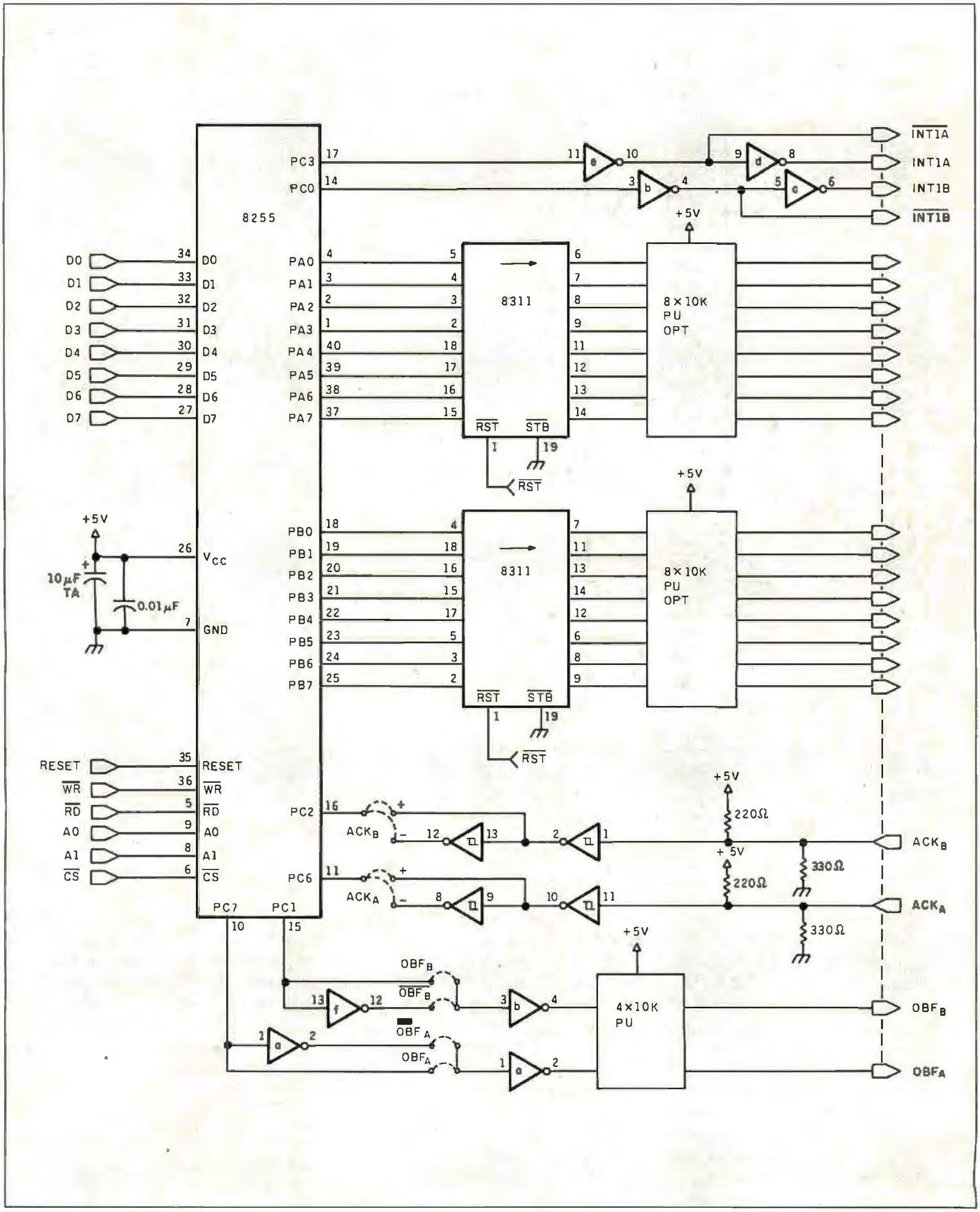


Figure 11: *16-bit buffered parallel output circuit.*

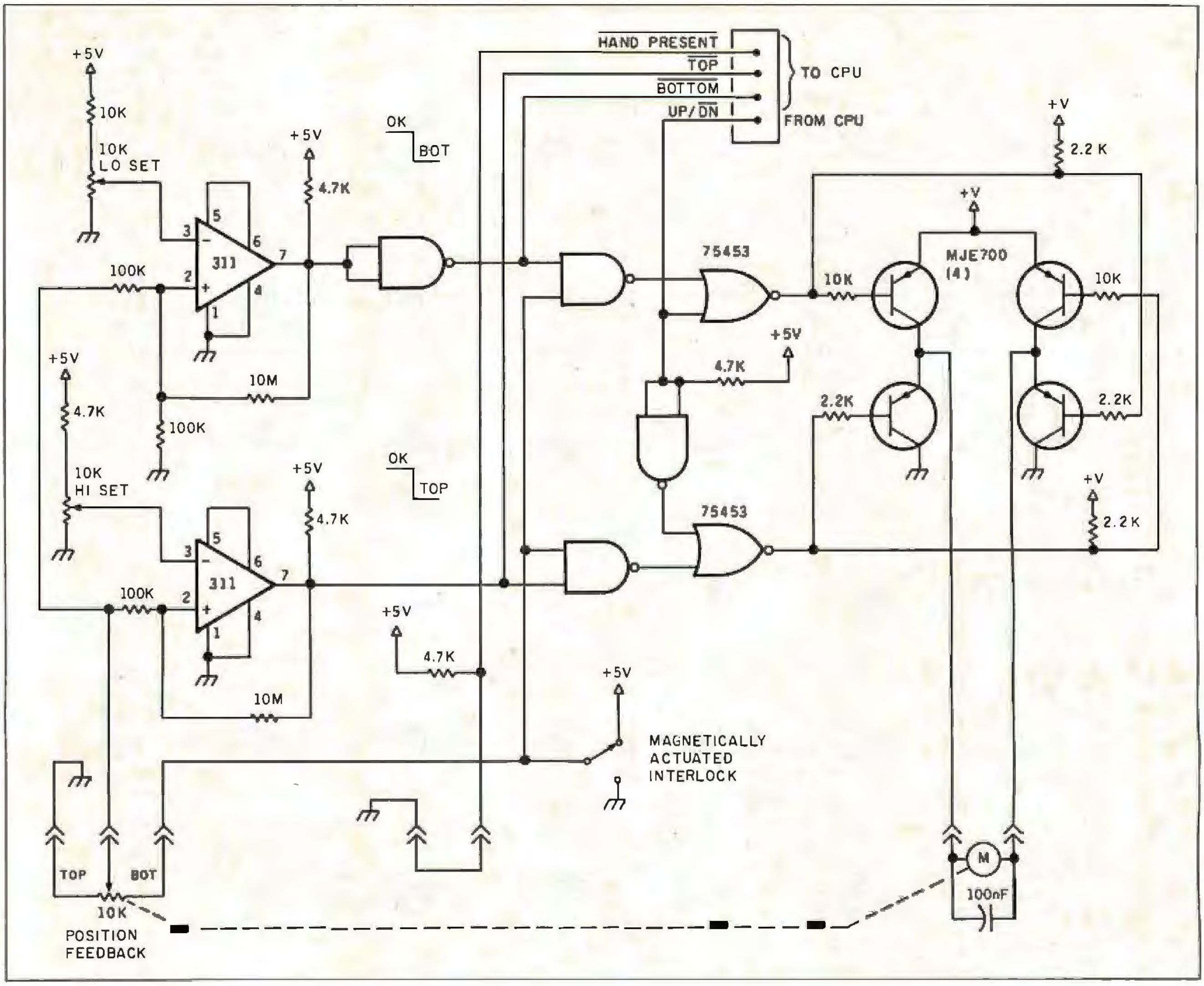


Figure 12: *Parked syringe hand drive circuit.*

retransmission of bad blocks. The most common request from the superior processor will be "Which syringe hand is clean and ready?" The subsystem must answer this question, but if no hand is available, it should give an estimate of when one will be ready. This allows the calling processor to set a countdown timer that avoids redundant requests for a clean hand when none is available. Another interaction with the calling processor is downloading a special cleaning procedure to be used in place of the default method. The local processor should be able to handle routine error conditions such as a pump losing its prime, but it will have to report fatal errors, like being out of solvent, to the superior processor.

A Look into the Future

In the evolution of this project, many problems like the syringe cleaner will continue to be encountered. Some can be sidestepped, others ignored, but many will require solutions. The software will be formidable, but hopefully the user interface will hide most of this so that the system will not intimidate its users. Even when complete in its present design, our system will require input from a highly trained chemist to produce useful results. This may not always be so. Rapid progress is being made in the parallel field of computer-aided synthetic design. The future marriage of an automated synthesis system such as ours and a synthesis-design computer will result in a quantum leap in organic chemistry: the ability to design, carry out, and optimize the production of a material under the guidance of a computer. ■

ACKNOWLEDGMENTS
We would like to note especially the hard work of Doug Lantrip, Mike Trueblood, and Roger Frisbee, without whom most of this system would still be on paper. Financial support by Hoffmann-LaRoche Inc., The Dow Chemical Co., Eli Lilly and Co., and the National Science Foundation (CHE-8406115) is gratefully acknowledged.

The personal computer that raised high performance to new heights.

If you work with high volumes of information, you need answers fast.

You need a personal computer that's up to the task.

Which is why IBM created the Personal Computer AT® system. It's changed a lot of ideas about business computing.

The idea of "fast" has become much faster. The idea of "data capacity" has become far greater.

There are new definitions of "power" in a stand-alone PC. While phrases like "sharing files" and "multi-user systems" are being heard more often.

And surprisingly, words like "affordable" and "state-of-the-art" are being used *together.*

Clearly, the Personal Computer AT is different from anything that came before. And what sets it apart can be neatly summed up in two words.

Advanced Technology.

If you've ever used a personal computer before, you'll notice the advances right away.

To begin with, the Personal Computer AT is extraordinarily fast. That's something you'll appreciate every time you recalculate a spreadsheet. Or search through a data base.

It can store mountains of information—literally thousands of pages' worth—with a single "hard file" (fixed disk). And now you can customize your system to store up to 30,000 pages with the addition of a *second* hard file.

The Personal Computer AT runs many of the thousands of programs written for the IBM PC family. Like IBM's TopView, the program that lets you run and "window" several other programs at once.

Perhaps best of all, it works well with both the IBM PC and PC/XT. Which is welcome news if you've already made an investment in computers.

You can connect a Personal Computer AT to the IBM PC Network, to share files, printers and other peripherals with other IBM PCs.

You can also use a Personal Computer AT as the centerpiece of a three-user system, with your existing IBM PCs as workstations.

Most important, only the Personal Computer AT offers these capabilities *and* IBM's commitment to quality, service and support. (A combination that can't be cloned.)

If you'd like to learn more about the IBM Personal Computer AT, see your Authorized IBM PC Dealer, IBM Product Center or IBM marketing representative. For a store near you, call 1-800-447-4700 (in Alaska, call 1-800-447-0890).

The IBM Personal Computer AT, for Advanced Technology.

Reviews

WE BEGIN OUR SYSTEM REVIEWS this month with a look at Canon's A-200 computer. The unit is based on an 8086 microprocessor running at 4.77 MHz and comes standard with 256K bytes of RAM, 16K bytes of ROM, and a 4K-byte permanent diagnostics routine in ROM. Other memory features are 4K bytes of video RAM if you choose a monochrome monitor and 16K bytes of video RAM if you get the unit with the color monitor. Reviewer Peter Callamaras was struck by what seems to be a good amount of room in the system housing for both expansion boards and a possible hard disk. It comes with two half-height 360K-byte 5¼-inch floppy-disk drives.

The Color Fox from Scottsdale Systems started its existence as the Sanyo MBC-555 computer. From there, however, some substantial modifications were made. The result, according to reviewer John Unger, is something that is generally more IBM PC-compatible than the earlier Sanyo but is still less so than such offerings as the Compaq or the Zenith Z-150. Mr. Unger makes the point that most of the enhancements to the Sanyo to create the Color Fox are hardware.

David D. Clark, in his review of Ecosoft's Eco-C88 C compiler for Z80 CP/M systems, notes that this is an update of a product that was less than sterling in its earlier incarnation. Now, however, he feels that the changes made to the compiler not only make it worth another look but have improved it to the point where he can give it a good recommendation.

Next, Douglas E. Hall gives us the benefit of his experiences with The Sider hard-disk drive for the Apple II+ and IIe. The 10-megabyte external hard disk not only was affordable but was offered with a 15-day free trial that was just too much of a good thing to pass up. How well did it live up to its advanced billing? As with everything, reports Mr. Hall, there are pluses and minuses.

Architectural differences between the IBM PC and the PC AT have created a new load of enhancement products that are designed to do for the latter what has long been available to owners of the former. A case in point is the subject of a review by TJ Byers: the Advantage! multifunction board for the AT from AST Research. You can load the Advantage! with almost 10 times the RAM of another AST product, the SixPakPlus, which is designed for the IBM PC. What you could wind up with is an extra 3 megabytes of memory in a single expansion slot.

Reviewer Steve King takes a hard look at an integrated software package called Enable from The Software Group. Here we have a $695 package claimed in its initial version to be a word processor, database manager, spreadsheet, and data-communications program. There are a lot of promising aspects to the package, says Mr. King, and indeed the producer has refined it in a subsequent version. However, you'll want to read this review for its thoughtful and well-documented analysis of a package undergoing evolution.

THE SMARTEST BUY YOU'LL EVER MAKE: 20 MBYTES OF *AUTOMATIC* TAPE BACK-UP FOR JUST $795.

ONLY FROM SYSGEN.™

The Sysgen Smart Image.™
More capacity. More features. More value.
The best-selling tape back-up system for the IBM® and compatibles gets even better!

Now the Sysgen Smart Image delivers *double* the storage capacity: 20 Mbytes on a high density cassette. It backs your data up *automatically*. And it comes in two convenient versions: The internal model, for just $795—or the slim, half-height external chassis for $895.

Only Sysgen gives you *unattended* back-up. Set the Smart Image once, like a VCR, and it will back up your data up to twice daily, seven days a week. And, if you're using your system, the Smart Image will wait until you're through, then back up your files automatically. *That's* smart.

You *can't* pass up a buy like this.
You won't find a smarter solution—or a better price. Sysgen's entire disk and smart tape family offers an unbeatable combination of capacity and value. Our systems are IBM® standard compatible, and run all software written for current versions of PC DOS.® Compare for yourself: For a Sysgen dealer near you, call **1-800-821-2151, Dept. 22**

SYSGEN
INCORPORATED

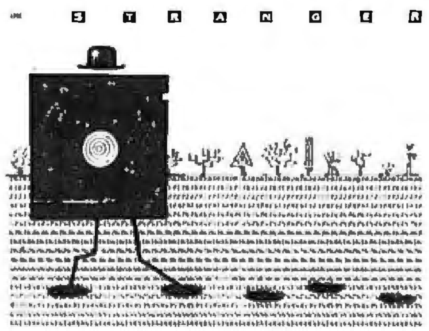
47853 Warm Springs Blvd., Fremont, CA 94539
(415) 490-6770, Telex 4990843

R·E·V·I·E·W·E·R'S N·O·T·E·B·O·O·K

We seem to have an endless supply of products to review. This month, I thought I'd give you a little preview of what's in store.

Consider Pocket APL from Scientific Time Sharing Corp. (STSC). APL's a language that has long been popular as a teaching tool but never left school with the graduating students. One of the reasons why it suffered in comparison with other languages was the fact that you needed relatively expensive and specialized hardware to implement it. For example, using APL used to mean that you had to have at least an 8087 numeric coprocessor and a special-character ROM (read-only memory). Now, with Pocket APL, you can go about your business with nothing more specialized than an IBM Personal Computer with 128K bytes of RAM (random-access read/write memory). Judging from the review now in process, this is a complete, though compact, implementation of APL with extended system and file functions, on-line help facilities, and sample workspaces on one disk.

On the other hand, Pocket APL looks like a learner's tool in that it emphasizes user-friendliness, and it would probably be of more use to you if your applications are going to be small. Further, it has at least one serious disadvantage in that it limits its workspace to 64K bytes, regardless of the size of the memory on your machine. You can get versions of APL from STSC that are more full-featured (greater memory utilization, full-screen editing, graphics, etc.). However, these implementations are proportionally more expensive than Pocket APL and are the ones you'll want to keep in mind if your learning experience on the compact version piques your interest about going further. The review reveals that the language has some surprising capabilities.



Other reviews we've got cooking for the months ahead include one on Ericsson's laptop portable computer. The company announced several months ago that it would no longer be selling this attractive, plasma-screen unit in the United States—which turned out to be both true and not true. Ericsson will no longer sell the computer line through retail outlets or through normal computer distributors. The computers will be available directly from the company, Ericsson tells us. (Ericsson telecommunications equipment is still being actively sold.) BYTE's readers throughout Europe will still be able to purchase the Ericsson laptop through normal channels. Whether or not the computer is worth the extra trouble it will take to own one in the U.S. is a good question. We're hoping this review will provide enough information to make it answerable.

An interesting example of resurgence is the Ace 2000 series from Franklin. The reorganized company claims that the 65SC02 processor used in its Apple II-compatible machine is functionally identical to the 65C02 used in both the IIe and IIc and is therefore a true work-alike for the IIe, II+, and IIc. Its "Franklin DOS" operating system is claimed compatible with both Apple DOS 3.3 and Apple ProDOS as well as being faster on disk-access functions. Further, it comes with its own version of BASIC in ROM. Franklin is now producing the Ace 2000 in models equipped with two, one, or no disk drives, and the monitor is an extra-cost option no matter which model you buy. As to price, the no-drive system was introduced at $699, with the one- and two-drive models costing $849 and $999, respectively. Standard features include 128K bytes of RAM, capability for 80-column display and double high-resolution graphics, and a parallel printer card. With a 67-watt power supply, it has more than enough power to support a hard disk.

All in all, you seem to get quite a bit for your money. We expect to have more to report when the review finally appears in print.

We're also looking at a review of an interesting data-storage and -retrieval device for the Commodore 64. Called the Quick Data Drive, from Entrepo Inc., it reads and writes data on miniature wafer-tape cassettes. The company claims its unit is not only 20 times faster than a cassette drive but is also faster at loading programs than the Commodore disk drive. Tape-loop lengths vary from a 56K-byte capacity of 20 feet up to a 62-foot model that will hold more than 170K bytes of data. You can designate up to 255 files on one wafer. A number of other intriguing aspects to this drive could make it worth investigating if you have a Commodore 64, and there are a number of things you're going to have to live with that may or may not present problems in your particular applications.

Other review topics for the near future will be: C compilers, expert-system development tools, high-speed modems, text- and data-compression products for storage and communications, more full systems, and peripherals from hard disks to printers.

—Glenn Hartwig
Technical Editor, Reviews

ILLUSTRATED BY MACIEK ALBRECHT

S·Y·S·T·E·M R·E·V·I·E·W

Canon's A-200

An IBM PC-compatible with room to grow

BY PETER V. CALLAMARAS

The Canon A-200 computer system is a three-piece unit consisting of a video display, a keyboard, and the computer itself. The computer is built around an 8086 microprocessor running at 4.77 MHz.

The A-200 comes standard with 256K bytes of RAM (random-access read/write memory) and 16K bytes of ROM (read-only memory). A 4K-byte permanent diagnostics routine executes when you turn the power on. With the monochrome monitor, you get 4K bytes of video RAM; with the color monitor, you get 16K bytes. You also get an RS-232C port, a Centronics parallel port, and a place to plug in an 8087 numeric data processor.

Five IBM PC-compatible slots are built into the A-200, but you can use only four, since one is for the video-interface card. Two of the slots are on a 16-bit data bus (one is used by the video-display adapter); the other three are 8-bit. One nice feature is the ability to add 256K bytes of RAM (from Canon) without using any of the remaining four expansion slots. You can go to a 512K-byte system and have four slots left for expanding.

The system reviewed had two half-height 360K-byte 5¼-inch floppy-disk drives. I saw no mention of a hard disk from Canon, but the system should accept any third-party IBM-compatible drive with no problem. [*Editor's note: Canon now has A-200 systems with a 10-megabyte hard-disk drive and a 360K-byte floppy-disk drive.*]

Internally, the drives take up most of the front right-hand side, the power supply and fan are behind the drives, and the expansion slots are on the left. There appears to be plenty of room for the necessary working space when you add boards. The ROM chips are readily accessible, just behind the left-hand disk drive, so any updates would be simple to make. Reading the names on the various components inside makes it evident Canon has gone to some pretty good subvendors for parts, with drive components from Sankyo and a Kyocera power supply/fan case (used in the Radio Shack Model 100 and the NEC PC-8401A laptop portable). One concern I have is how well the fan would do in cooling added components, since there doesn't appear to be any venting to draw air across the expansion-slot area. With a "full house" system, any potential for overheating needs to be considered.

THE KEYBOARD

The keyboard is a standard IBM PC-style unit with 10 function keys on the left side, a QWERTY keyboard in the center, and a numeric keypad on the right for a total of 83 keys. Unfortunately, Canon duplicated the IBM keyboard without any improvements—not even status lights on the Caps Lock key or a decent-size Return key (see photo 1). While the keyboard appears plug-compatible with the IBM PC (so you could use a third-party or IBM keyboard if desired), Canon could have made a lot of friends by improving the keyboard. The keys have a very light yet comfortable feel but offer no resistance or feedback when pressed. You can end up with a string of the same letters if you aren't light-fingered. I liked the keyboard, despite its shortcomings, because of the quiet keys.

THE DISPLAY

For the video display, you have a choice of color or monochrome (P-39 green) units mounted in a swivel/tilt housing that works nicely. I could just set it and forget it. The display is connected with a nine-pin cable running between the rear of the computer and the monitor.

The monochrome unit gives you the standard 80-character by 25-line display, but it's with the color monitor that the A-200 really shines. The color monitor is rated at 40/80 characters by 25 lines with a total of 16 colors available. You get 640 by 200 pixels in black-and-white mode and 320 by 200

(continued)

Peter V. Callamaras is a captain in the U.S. Air Force. His interests are computers, model railroading, photography, reading, and physical conditioning. He can be contacted at POB 408, Scott Air Force Base, IL 62225.

Leonardo DaVinci was not only a great artist, he was also a great engineer and architect. His innovative designs which blended art, science and technology stressed efficiency and detail and were years ahead of their time. Today, DaVinci's spirit lives on in QDP Computer Systems' new and exciting graphics card. . . VIVA!

VIVA DaVINCI!

QDP PRESENTS
THE ULTIMATE IN GRAPHICS CARDS

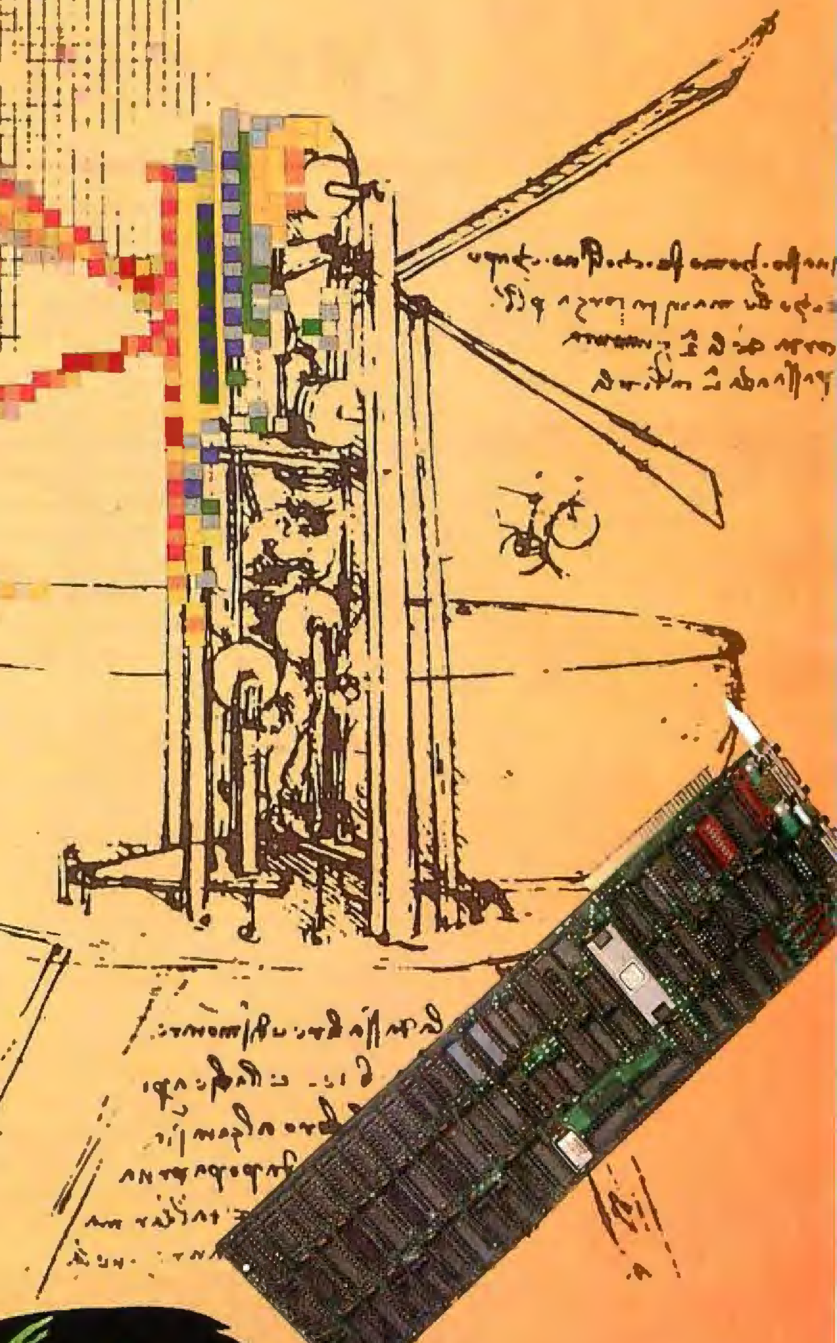
VIVA was designed for PC graphics software developers by providing graphics primitives in hardware, increasing productivity and reducing application development time.

VIVA was designed for graphics software users by providing compatibility with existing PC/AT software packages, ultra high resolution color and vastly increased drawing speed over standard graphics cards.

VIVA, like DaVinci, is now the new standard by which all other graphics cards must be measured. This is VIVA.

- **Compatible with IBM, PC/XT, PC/AT and clones.**
- **On-board video multiplexer**
  Allows a single monitor to be used for both normal text and graphics. Simply plug the output of your standard color graphics card into VIVA's input port. The display selection is controlled through software.
- **On-board 16 bit graphics coprocessor**
  Performs all screen drawing and display functions at high speed leaving your computer's CPU free to perform other tasks.
- **Use with standard IBM color TTL RGB monitors.**
- **Supports analog RGB monitors on the basic card.**
  (You get ultra high resolution color that is normally only available on mini and mainframe computers.)
- **Standard resolution of 640 by 400, 16 colors with 128K of video ram on the Silver Card.**
- **Maximum resolution of 1024 by 1024, 16 colors with 512K of video ram on the Gold Card.**
- **Expansion connector:**
  Allows upgrades which extend and enhance the features of the basic card—no more obsolete hardware. Planned extensions include:
  - *256 colors (8 bits/pixel) displayable from a pallete of 262,144 colors.*
  - *512 colors (9 bits/pixel) displayable from a pallete of 16,777,216 colors.*
- **Display characteristics are fully programmable**
  - *Interlaced mode allows use of low cost monitors.*
  - *Non-interlaced mode for flicker-free display*
  - *Display size up to 1024 by 1024 (40MHz bandwidth.)*
- **Flash hardware enable/disable on 4 colors (Layers) allows any of 4 specified layers to be temporarily "disabled" i.e., erased, then later can be "enabled", i.e., put back on the screen without being redrawn.** *This greatly increases speed of use.*
- **Light pen input port. (Permits a light pen to be used as a pointing or pick device)**
- **Hardware pan and zoom support. (Allows smooth panning, and zoom up to 16 times magnification)**
- **Compatible with existing software including AutoCAD, p-cad, VERSACAD, MasterCAD, etc.**
- **Software support. Planned software includes Tektronix emulation, Graphics support library.**

Get VIVA and bring your PC to life! VIVA is versatile, state of the art quality at a price you can afford. Call today and we'll be there—QDP! VIVA Da VINCI!



VIVA

This card accepted by over 3 million PCs nationally.

QDP computer systems

QDP Computer Systems, Inc.
10330 Brecksville Road
Cleveland, Ohio 44141
(216) 526-0838 Telex 241596
Cable: Quasdata, Brecksville

Inquiry 414

AT A GLANCE

Name
Canon A-200

Company
Canon U.S.A. Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700

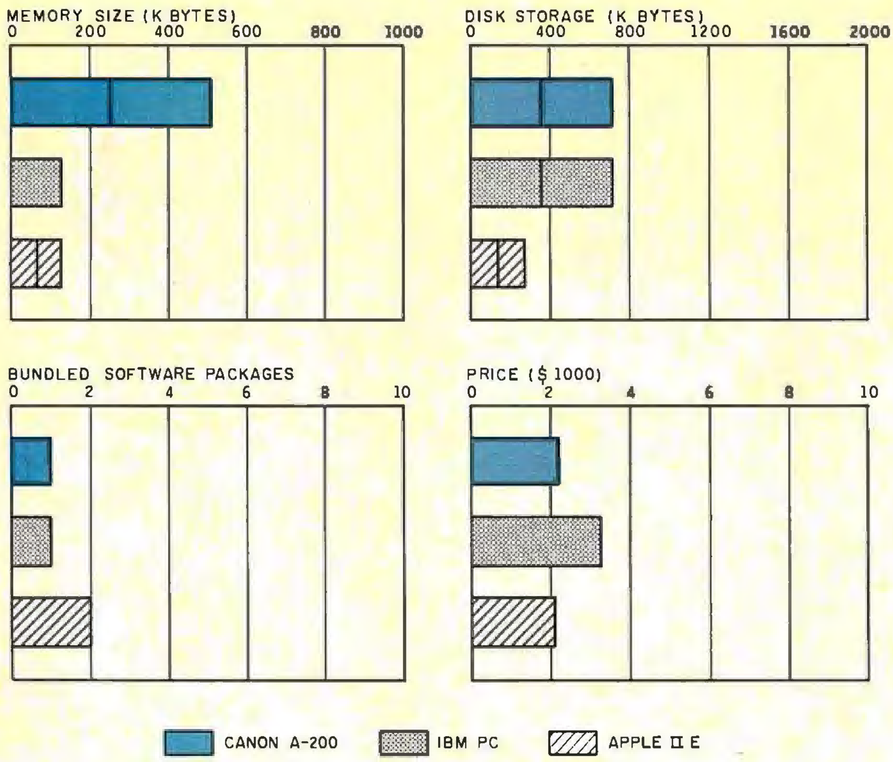
Components
Processor: 8086, 4.77 MHz
Memory: 256K bytes
Mass storage: Two 5¼-inch double-sided double-density floppy-disk drives, 360K bytes each
Display: 80 columns by 25 lines, 640 by 200 pixels (black-and-white); 40/80 by 25, 320 by 200 pixels (color)
Keyboard: 83 keys, including 10 function keys and numeric pad; IBM PC layout
I/O interface: Centronics port, RS-232C port, five expansion slots (two 16-bit, three 8-bit)

Software
MS-DOS 2.11, GW-BASIC, diagnostics

Options
256K-byte RAM module

Documentation
Manuals for software and machine

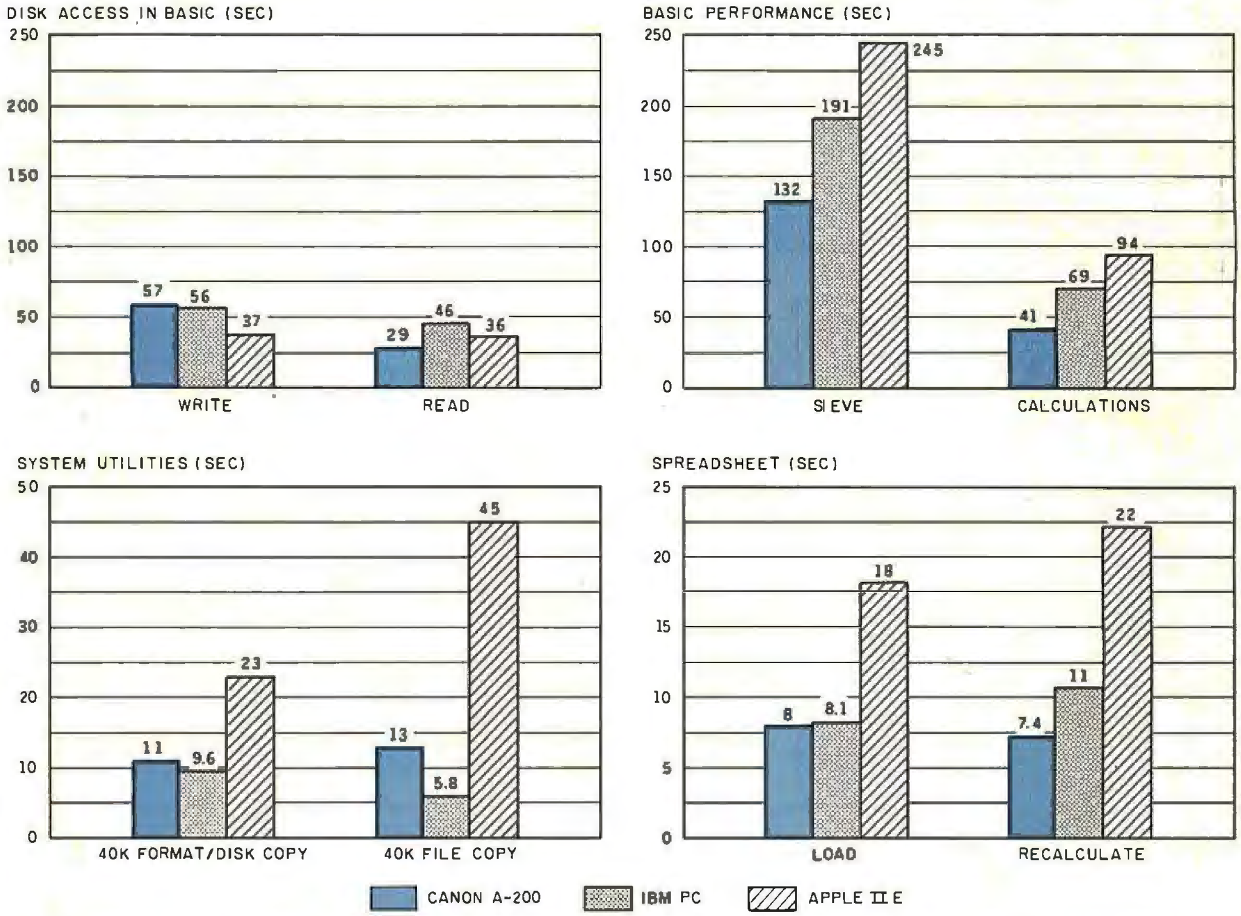
Price
A-200 M2 (256K memory, two floppy-disk drives, mono—chrome monitor) $2195
A-200 C2 (256K memory, two floppy-disk drives, color monitor) $2695



The Memory Size graph shows the standard and optional memory available for the three computers under comparison. The Disk Storage graph shows the highest capacity of one and two floppy-disk drives for each system. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of each system with two high-capacity floppy-disk drives, a monochrome monitor, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), and the standard operating system and BASIC interpreter for each system.

The rear view of the Canon A-200 shows (from left to right) the blower fan, power cord receptacles, serial port and parallel port, and expansion slots.

Inside the A-200. At the lower right are the expansion slots; the power supply is at the lower left. At the upper left are the floppy-disk drives.



The graph for Disk Access in BASIC shows how long it takes to write a 64K-byte sequential text file to a blank floppy disk and how long it takes to read this file. (For the program listings see June 1984 BYTE, page 327, and October 1984, page 33.) In the BASIC Performance graph, the Sieve results show how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. In the same graph, the Calculations column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted for 40K bytes of disk data) and to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers take to load and recalculate a 25- by 25-cell Microsoft Multiplan spreadsheet where each cell equals 1.001 times the cell to its left. The tests for the Canon A-200 C2 computer used MS-DOS 2.11 and GW-BASIC. The tests for the Apple IIe were done with ProDOS (except for the spreadsheet, which was done with DOS 3.3). The IBM Personal Computer was tested with PC-DOS 2.0 and BASICA.

Photo 1: *Keyboard of the Canon* A-200 *computer. It is identical to the* IBM PC *keyboard.*

pixels in four-color mode. This is a crisp, comfortable monitor to view, and I had no problem with text and graphics. Since you can mount the monitor on top of the basic computer system, the whole unit takes up only 17¾ by 15⅛ inches.

SOFTWARE AND MANUALS

Other items that come with the A-200 are MS-DOS 2.11, GW-BASIC 2.02, manuals for each, a 72-page manual for the computer, a self-prompting diagnostics disk, and a short pamphlet about the monitor. The manuals for DOS and BASIC (about 167 and 335 pages, respectively) are mainly for reference; you will have to supplement them with outside material if you don't know how to program in BASIC or want to work extensively with DOS. They are definitely not novice-level "how-to" manuals. The system manual is fairly well done and leads you through setup and operation. I did have a problem when it came to booting the system up the first time due to the manual's organization. I followed the manual in a serial fashion. I inserted a disk and then waited for it to boot; it wasn't until I turned to the next page that I read you're supposed to push in the head-lock button. The head-lock button actually has a dual function: to pop a disk out and to raise and lower the head. Warnings placed on a following page are seldom read in time, so they should be on the same page as the actions they relate to. Other than that slight anomaly, the manuals do their job in helping you get the system up and running.

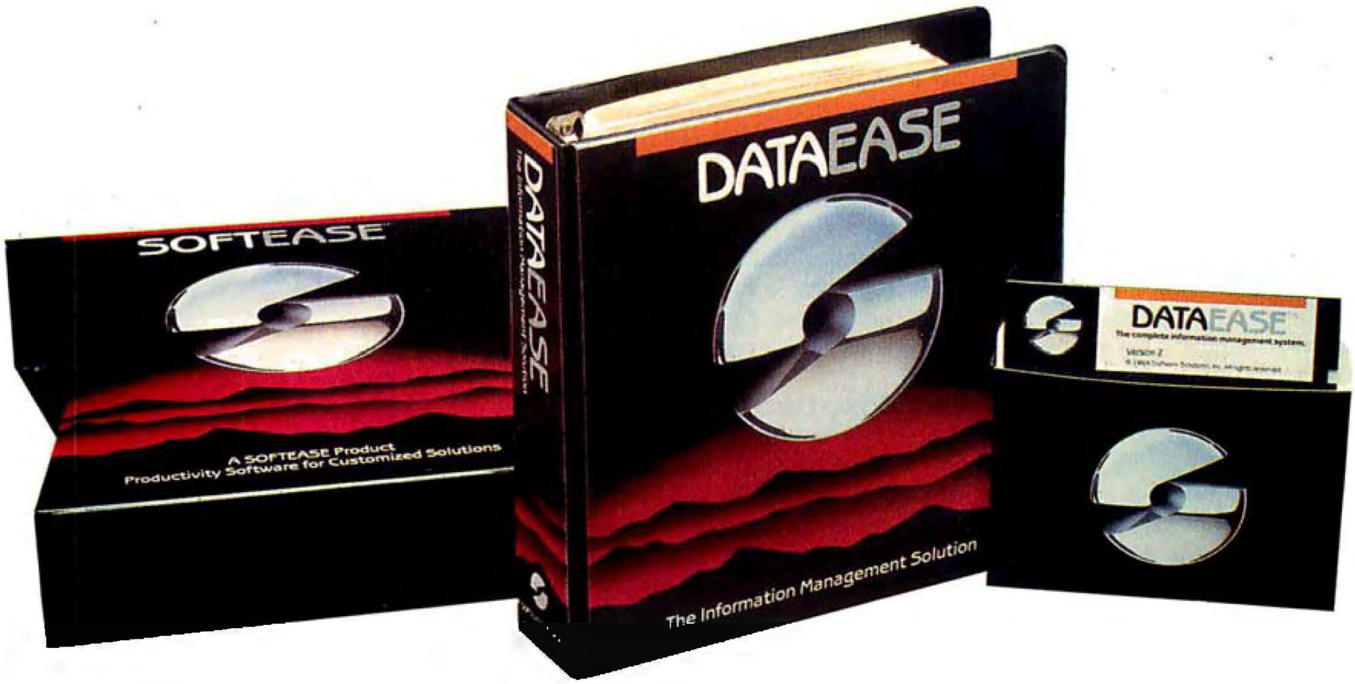
IBM COMPATIBILITY

The main question most users will have is just how IBM PC-compatible the system is. Happily, it is very PC-compatible. As mentioned earlier, the system comes with MS-DOS and GW-BASIC, so no problems there. The system also booted with PC-DOS 2.1 and 3.0, and I did not notice any problems. I also ran compatibility tests with WordStar, Lotus 1-2-3, and Flight Simulator, all without problems. Other programs (including FlashCalc, Dollars and Sense, and Statpro) also ran without any noticeable problems. Canon claims to have tested 400-plus programs, and the only programs reported to have had any problems were some games, but Canon mentions no names.

CONCLUSION

Overall, I found the A-200 with color monitor to be a very attractive system in terms of both looks and capability. I enjoyed using the system, and the color monitor is absolutely outstanding. It has been said that the Japanese incursion into the U.S. computer market follows their classic motto, "Take a product and then make it a little better and a little less expensive." While the Canon A-200 is not a quantum leap over the IBM PC, it is a less-expensive alternative in a capable package. ■

YOU CAN'T GET A GOOD FEEL FOR A SOFTWARE PACKAGE FROM AN AD.



If you're searching through the ads in this magazine for the "right" software package, good luck.

Let's say you're looking for a data base manager. You read a dozen ads. Each one offers its list of features. Each one talks about the ideal combination of power and ease of use. And each one promises to "solve your problems", "answer your needs", or both.

Don't Believe Anybody
We could make the same claims for DATAEASE. Even before Release 2.5, tens of thousands of users made DATAEASE the corporate data base standard. We could tell you that they found DATAEASE to be an invaluable productivity tool because of its fully relational capabilities, full screen editor and unique combination of menus and commands. But don't believe us.

More than 100 reviewers from major publications agree with our productivity claims. Data Decisions called DATAEASE "perhaps the most effective blend of ease-of-use and performance available for PC users to date." But don't believe the reviewers.

Application developers, MIS/DP/IC managers, and all kinds of other users from Fortune 1000 companies throughout the country have reached strikingly similar conclusions. A user at General Instruments reports that "those same factors that make DATAEASE preferable for non-programmers — ease of use and speed of development — make it the program of choice for many technical types, too." But don't even believe other users.

Nobody knows what you know.
Even if all these people are absolutely right about DATAEASE, does that mean it's the right product for you?

The best way to know if DATAEASE fits your needs is to get your hands on our free sample diskette. Fifteen minutes with the sample will give you a feel for our best DATAEASE yet — Release 2.5. It has features that appeal to all users; from developers to data entry people: A complete procedural language; quick reports at the press of a button; a direct interface to Lotus 1-2-3; the ability to move rapidly from file to file on a common piece of data; and built-in scientific, mathematical, financial, date, time, and string functions.

Productivity takes more than a good product.
It takes a good company, too. Buying a software package is the beginning of a relationship. Technical support, product upgrades, special corporate and dealer programs and informational seminars should all be part of this relationship. If the only thing you get is a product, forget about productivity. At Software Solutions, you find more than a product. You find software solutions.

Find out for yourself.
The advances in DATAEASE's Release 2.5, and the support behind it, offer you practical advantages that leave all the other data base managers far, far behind — including R:Base 5000® and dBase III™. But don't believe us. Call or write for information and your free sample diskette today.

Software Solutions, Inc.

CALL OR WRITE FOR YOUR FREE SAMPLE DISKETTE.

Send information and a free DATAEASE sample diskette for my PC (check one):

☐ IBM ☐ WANG ☐ DEC ☐ TI

Include materials relating to:

☐ Corporate Client ☐ Retailer
☐ MIS/DP/IC Professional ☐ VAD
☐ Other ____________

Name: ____________
Title: ________ Phone: ________
Company: ____________
Street: ____________
City: ______ State: ______ Zip: ______

Mail to: BYT 1/86

Software Solutions, Inc.,
12 Cambridge Drive,
Trumbull, CT 06611 Telex: 703972

Don't like samples? Then just call us. We'd be happy to talk about your information management needs and advise you.

800-243-5123

Scandinavia
WestSoft A/S, Alesund, Norway; (47) 71-41141

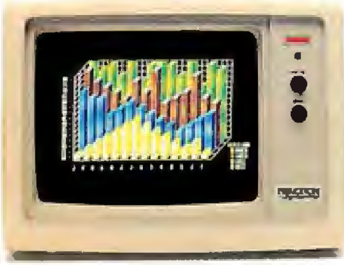
Switzerland, France
Softsource, S&A 1222 Vesenaz, Switzerland; 022-3518-55

United Kingdom
Sapphire Systems, Essex; 01-554-0582

West Germany, Austria
M&T Software Verlag, Munich; 089-4613-0

Meet The Princeton Graphic Systems Family.

The right monitor at the right price. Princeton Graphic Systems offers you a complete family of high performance personal computer monitors. Monitors that deliver the compatibility, resolution, and reliability you need for any application and any budget: from word processing to sophisticated business graphics.



HX-12. High resolution RGB monitor -640 x 200 lines noninterlaced -.31 mm dot pitch tube-Nonglare screen **-$695**

HX-12E. High resolution RGB monitor 640x350 lines noninterlaced - .28 mm dot pitch -Compatible with IBM Enhanced Graphics Adapter -Nonglare screen **-$785**

MAX-12. Amber monochrome -720 x 350 lines -Enhanced to interface with IBM color or monochrome adapter card -Nonglare screen -Can display 16 shades of amber **-$249**

HX-9/9E. Nine inch, high resolution RGB monitor non-interlaced -.28mm dot pitch tube -9E compatible with IBM Enhanced Graphics Adapter -Nonglare screen -Green/amber switch -Apple/IBM colors - Etched dark glass screen **-$650/$750** (9E)

R-12P. PGS's top of the line RGB monitor 640x480 lines noninterlaced - .26 mm dot pitch - Analog input allows for the display of 4,096 possible colors -Compatible with IBM Professional Graphics Adapter -Nonglare screen **-$999**

SR-12. Super-high resolution RGB monitor -640 x 400 lines noninterlaced -.31 mm dot pitch tube - Nonglare screen - Requires interface card **-$799**

Princeton accessory product line.
Undergraduate tilt/swivel monitor base, ColorView card, Green/Amber switch, RGB-80 card and Scan Doubler card.

Princeton Graphic Systems. The only real choice.

For office or home use, Princeton Graphic Systems has a monitor that's right for you. Inquire at your local computer store about our complete line of high resolution color and monochrome monitors; monitors that live up to the Princeton Graphic Systems 'tradition of quality, performance, and value. **Princeton Graphic Systems.** 601 Ewing Street, Bldg. A, Princeton, N.J. 08540. (609) 683-1660 Telex: 821402PGSPRIN **(800) 221-1490.** Ext. 304.

PRINCETON
GRAPHIC SYSTEMS
AN INTELLIGENT SYSTEMS COMPANY

IBM, IBM Enhanced Graphics Adapter, and IBM Professional Graphics Adapter are trademarks of International Business Machines, Inc. Compaq is a trademark of Compaq Computer Corp. Corona is a trademark of Corona Data Systems, Inc. Apple is a trademark of Apple Computer Corp. PC World is a trademark of CW Communications Inc. SR-12 screen courtesy of Mouse Systems, Inc.

Inquiry 288

Color Fox

Scottsdale Systems enhances Sanyo's MBC-555

BY JOHN D. UNGER

Scottsdale Systems has taken the basic Sanyo MBC-555 computer and put it together with some major hardware upgrades to create the Silver Fox. Scottsdale has replaced the 40-track double-sided double-density (DSDD) disk drives with 80-track double-sided quad-density (DSQD) drives for a formatted disk capacity of 800K bytes per drive. Included with the Silver Fox is Sanyo's video RAM (random-access read/write memory) expansion board, which makes the computer much more IBM PC-compatible than the standard Sanyo MBC-555 and allows it to run Lotus 1-2-3 and other PC-compatible software. Besides the packages normally bundled with the Sanyo MBC-555, Scottsdale Systems adds more programs, including the new operating system needed to use the high-capacity disk drives and the video board.

Scottsdale Systems has also added an NEC color monitor to the basic Silver Fox and dubbed this combination the Color Fox. The Color Fox is the model I review in this article, and unless otherwise stated, the only difference between the Silver Fox and the Color Fox is the monitor.

What you get when you buy a Color Fox is a complete computer system with sufficient software to carry out all the most common tasks that a microcomputer is called upon to do: word processing, spreadsheets, database management, and running BASIC programs. However, the Color Fox cannot be considered a "true" IBM PC-compatible machine like the Compaq or Zenith Z-150. If you must have some special piece of software for your specific application, make sure there is a version that runs on the Color Fox, either with or without the video RAM expansion board.

HARDWARE

The principal enhancements to the Color Fox are hardware, so I will spend most of the review discussing these aspects. As I mentioned, the basic hardware of the Color Fox is pure Sanyo. In spite of the new label on the front of the computer (see the photo in the "At a Glance" section), the plate with the serial number on the rear of the review machine reads "Sanyo MBC-555-2."

The most apparent difference between the Color Fox and the Sanyo MBC-555 is the substitution of the standard DSDD disk drives with two DSQD drives. The drives, TEAC model FD-55F, can read and write disks formatted in all the standard MS-DOS 40-track formats, either single- or double-sided. With a special operating system from Scottsdale Systems, the drives can read and write disks formatted with either 8, 9, or 10 sectors and 80 tracks for a maximum capacity of 800K bytes per drive. This special operating system is essentially a modification of MS-DOS 2.11 written for the Sanyo. It's called HAGEN-DOS. The computer must be booted with this special operating system to take advantage of the increased disk capacity.

These high-density drives are significantly noisier than either the original single-sided or the DSDD TEAC FD-55B drives I now have in my Sanyo MBC-555. The noise appears to come from the stepper motor as it moves the heads from track to track, but it does not seem to affect the performance of the drives.

I had not realized just how much you can store on one 5¼-inch disk when it has a capacity of 800K bytes. In fact, I began to make good use of MS-DOS's tree directory structure, which is normally useful only on hard disks, and partitioned my files into different subdirectories. While Scottsdale Systems recommends disks certified at 96 tracks per inch, I did not use anything other than disks certified for DSDD use in the quad-density drives, and I had no failures formatting even "generic" DSDD disks in 80-track format.

The Sanyo video RAM board is an expansion board that was introduced about a year after the MBC-555 came on the market.

(continued)

John D. Unger (POB 95, Hamilton, VA 22068) is a geophysicist for the U.S. government. At work he investigates the causes of earthquakes; at home he tries to keep up with the programming efforts of his two teenaged sons.

HAGEN-DOS *looks* *and acts just like* MS-DOS 2.11 *except*

Sanyo introduced this option to enable its computer to run Lotus 1-2-3; as a side benefit, the Color Fox and any other Sanyo MBC-555 with the board installed can run other IBM PC graphics software as well.

Technically, together with the special operating system, the video RAM board duplicates the 16K bytes of memory that is permanently set aside in the IBM PC for direct memory access by the graphics display. This tactic is necessary because the Sanyo MBC-555 uses a different section of memory for this purpose. The location of video RAM in the Sanyo also depends upon how much memory you have installed in your computer. Just to complicate things further, the display is "mapped" from RAM to the screen coordinates differently in the Sanyo than in the IBM PC.

The video RAM board mounts inside the case of the Color Fox and is electrically connected to the computer through the single expansion bus on the motherboard. Utilizing the video RAM board's capabilities can be somewhat awkward. The Color Fox comes with two versions of HAGEN-DOS. One version is for use when running the "straight" Sanyo memory model (that is, without the video board enabled). The other version is for use with software that requires the video RAM board. Also, you have to switch the monitor from its normal output port on the rear of the computer to a different port on the expansion board. Initially, this was quite a chore because the two ports have different types of sockets, so I was switching cables back and forth all the time. Scottsdale Systems now supplies a twin-lead cable connected to a two-position switch (standard with the Color Fox only). Still, when you want to change from using an application that requires the video board to one that doesn't, you must reboot the system with the proper version of HAGEN-DOS, switch the monitor cable selector, and then change the monitor SYNC setting from positive to negative.

I was disappointed with the NEC color monitor. There were no problems running graphics or games in color; the clarity and color separation in graphics mode were very good. My problems stem from trying to read text on the screen. The clarity and resolution of text were poor enough that, for the first time, I did not write the entire review on the actual computer I was reviewing. I lay the blame chiefly on the monitor because the Color Fox's text quality on a normal high-resolution monochrome monitor is quite acceptable. The character set is very similar to that formed on an IBM PC in graphics mode.

The overall quality of the display while operating in IBM PC-compatible mode with the video RAM board is clearly worse than the standard display mode. The screen scrolls in a jerky fashion, and the scrolling is accompanied by streaking and blurring on the display.

The Color Fox has all the open RAM sockets on its motherboard filled, giving it a total of 256K bytes of RAM. This is the maximum memory for the Sanyo and the Color Fox.

SOFTWARE

To run the bundled MicroPro and IUS software, or when running programs using Sanyo BASIC, you need to boot up under the version of HAGEN-DOS that disables the video RAM board. To run IBM PC-compatible software and the version of GW-BASIC included with the video board, you need to boot up under the version of HAGEN-DOS that enables the video board. Both operating systems support the quad-density disk drives and both include some nice utility programs not supplied by Sanyo, including a RAM-disk program and a screen-dump routine. The two operating systems and their extra utility programs are products of A-OK Computers and can be obtained separately and used with a normal Sanyo MBC-555. (A-OK Computers is located at 816 Easley St., Silver Spring, MD 20910; telephone (301) 588-8446.)

HAGEN-DOS looks and acts just like plain MS-DOS 2.11 except for the format program, which is more user-friendly and includes the option to format disks in quad-density. I had no problem reading from or writing to disks created in either single- or double-sided double-density format on the Color Fox or on any other MS-DOS or PC-DOS machine.

Scottsdale Systems spices up the Color Fox with three major pieces of bundled software not included with the Sanyo MBC-555. The programs are Spell, a spelling proofreader by Software Toolworks; Filebase, a simple database manager by EWDP Software; and Mail Track I, a mailing-list program by Sapana Micro Software. I found the best of the lot to be Spell. It runs faster and is easier to use than SpellStar, which is included with the WordStar series that comes with the Color Fox. Spell has an effective dictionary of more than 50,000 words and runs independently of the word-processing program you are using. It has no problems working with text files created by WordStar or with normal ASCII files, but it may not work with files written on some word processors.

BENCHMARKS

The benchmarks for the Color Fox are somewhat more complex than usual. Because the video RAM board changes the character of the computer completely, I ran each benchmark both with and without the board enabled. I used GW-BASIC for the BASIC benchmarks run with the video board and Sanyo BASIC without the video board. The numbers in the benchmarks do not tell the whole story, however. While changing from page to page or moving the cursor around the page in WordStar, the video-board version of this program runs much faster than the standard

(continued)

AT A GLANCE

Name
Color Fox

Type
Enhanced Sanyo MBC-555 with color monitor

Company
Scottsdale Systems Ltd.
617 North Scottsdale Rd. #B
Scottsdale, AZ 85257
(602) 941-5856

Size
15 by 14½ by 4⅖ inches;
21 pounds

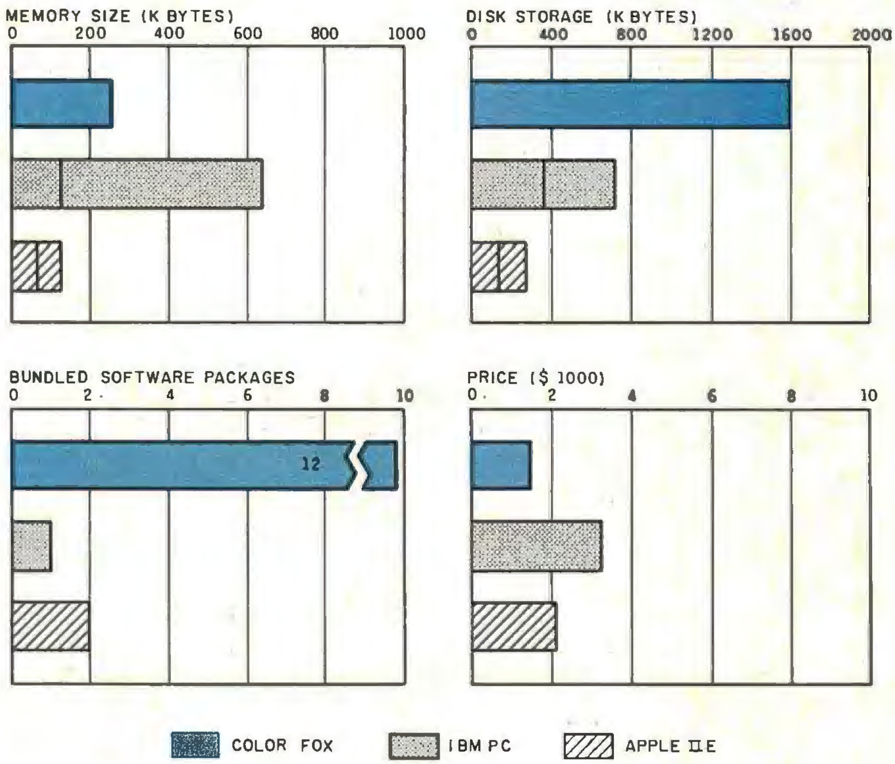
Components
Processor: 8088 at 3.6 MHz
Memory: 256K dynamic RAM standard
Mass storage: Two TEAC FD-55F double-sided quad-density 5¼-inch drives; 800K capacity per drive
Display: NEC JC-1460DA color display; 13-inch diagonal screen; 80-column by 25-line text; 320 by 200 graphics in IBM PC mode; 640 by 200 without video RAM; 640 by 400 with monochrome monitor
Keyboard: Detached QWERTY with five function keys and numeric pad
Interfaces: Parallel printer port, monochrome and color RGB ports on both motherboard and video board

Software
HAGEN-DOS (similar to MS-DOS 2.11), Sanyo BASIC, GW-BASIC, WordStar, SpellStar, MailMerge, InfoStar, CalcStar, Easywriter, Spell, Filebase, and Mail Track I

Options
RS-232C serial port

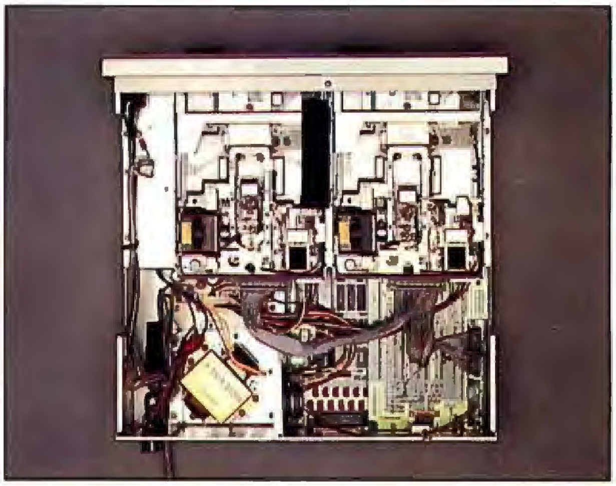
Documentation
Sanyo operator's guide, manuals for all software except GW-BASIC

Price
$1497

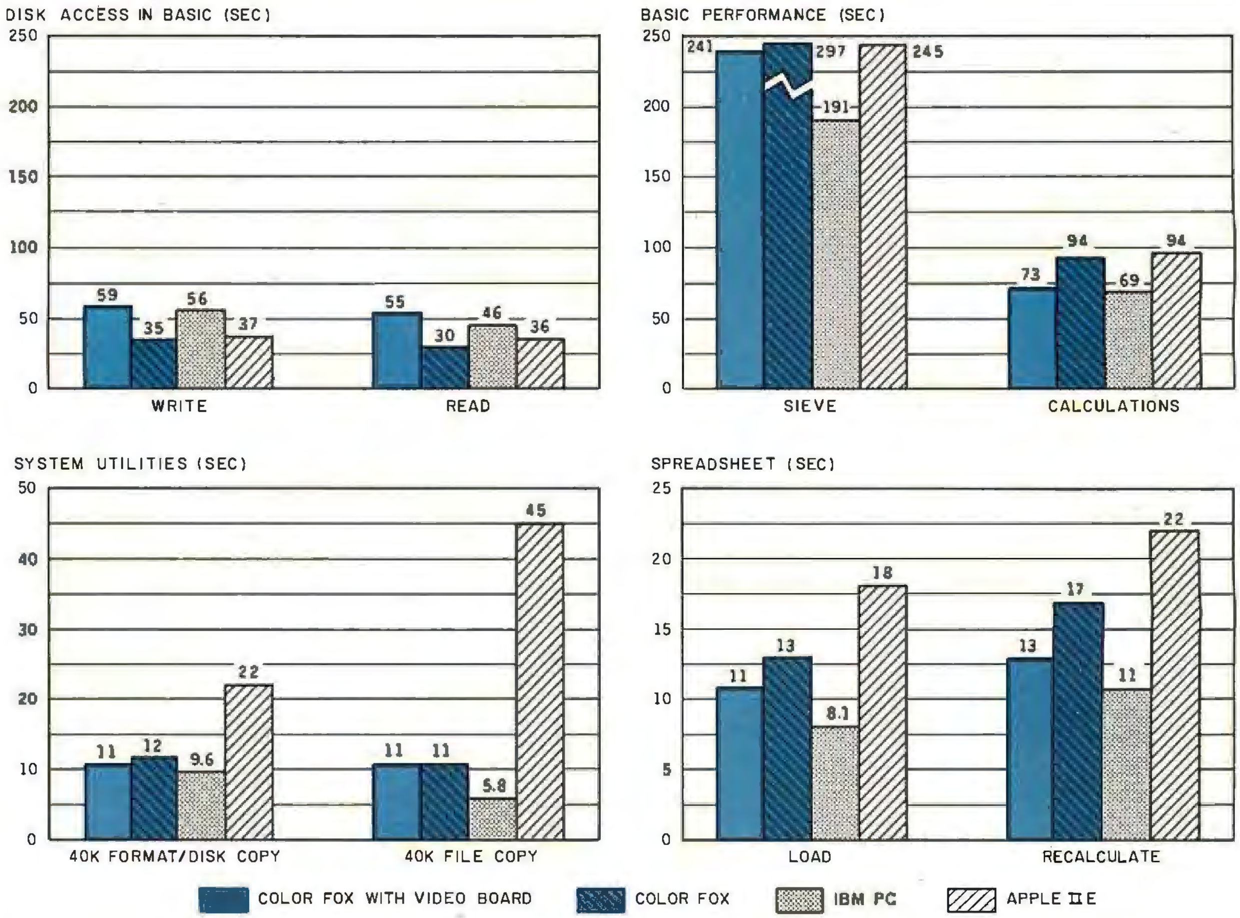


The Memory Size graph shows the standard and optional memory for the computers under comparison. The Disk Storage graph shows the highest capacity of one and two floppy-disk drives for each system. The Bundled Software Packages graph shows the number of packages included with each system. The Price graph shows the list price of a system with two high-capacity floppy-disk drives, a monochrome monitor, graphics and color-display capability, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), the standard operating system for the computers, and their standard BASIC interpreters.

The rear of the Silver Fox. An NEC color monitor distinguishes the Color Fox from the Silver Fox. Also, a twin-lead cable comes with the Color Fox to facilitate swapping between the RGB plugs on the motherboard and on the video RAM expansion board.



The inside of the Silver Fox. Notice the video RAM expansion board in the lower right corner.



In the Disk Access in BASIC graph, a 64K-byte sequential text file was written to a blank floppy disk and then read. (For the program listings, see the June 1984 BYTE, page 327, and October 1984, page 33.) In the BASIC Performance graph, the Sieve column shows how long it takes to run one iteration of the Sieve of Eratosthenes. The Calculations column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted time for 40K bytes of disk data) and to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers take to load and recalculate a 25-by 25-cell Multiplan spreadsheet where each cell equals 1.001 times the cell to its left. The tests for the Color Fox with the video board were done with GW-BASIC; the Color Fox without the video board was tested with Sanyo BASIC. The tests for the Apple IIe were done with the ProDOS operating system (except for the spreadsheet test, which was done with DOS 3.3). The IBM PC was tested with PC-DOS 2.0.

Sanyo version. This is because the video board can take advantage of direct video memory input/output, while the version of WordStar configured for the Sanyo or for the Color Fox without the video board enabled uses slower BIOS (basic input/output system) screen-scrolling routines to move through the text.

CONCLUSION

The Color Fox is an impressive package of hardware and software offered at an attractive price. Scottsdale Systems has taken a powerful yet inexpensive system, the Sanyo MBC-555, and made it more powerful, more IBM PC-compatible, and added even more software in the bargain.

The hardware enhancements that create the Color Fox from a Sanyo could be done by anyone. However, even if you bought the basic computer and the various components at bargain prices, you'd still end up paying about $300 to $400 more for your system than for the Color Fox.

On the negative side of things, the high-density disk drives are somewhat noisy, and the display quality leaves something to be desired, especially when using the video RAM board in text mode.

The Color Fox comes with a limited one-year warranty from Scottsdale Systems. Easterners may not be comfortable dealing with a company located as far away as Arizona. They might prefer to do business with one just around the corner. However, as far as I know, Scottsdale Systems is the only place to go if you want to buy the Color Fox. The people I talked to there were courteous and knowledgeable. Also, the basic core of the Color Fox, the Sanyo MBC-555, has proven to be a rugged and reliable computer during the past year and a half. The owner of a Color Fox should have no trouble obtaining post-warranty service for the machine from one of the many dealers set up to work on the Sanyo. ■

Editor's note: For a review of the Sanyo MBC-550/MBC-555, *see page* 270 *of the August* 1984 BYTE.

Eco-C88 C Compiler

An inexpensive MS-DOS C compiler

BY DAVID D. CLARK

In the spring of 1983 I noticed advertisements for a new C compiler for Z80 CP/M systems. I had a couple of C subset compilers at that time but wanted one that could perform floating-point arithmetic. That summer I purchased Eco-C version 1.51. I was rather disappointed with it as I indicated in a BYTE review (see "Two More Versions of C for CP/M," May 1984, page 246). Since I wrote that review, Ecosoft has made substantial improvements to the product. It became so good that I bought additional copies for my place of work and now recommend it without reservation.

Since the original review, I have purchased a Zenith Z-150 IBM PC-compatible computer. I saw that Ecosoft developed a version of its compiler for MS-DOS systems, but at $250 it was more than I could afford. When Ecosoft announced the new price of $49.95, I placed my order.

USING ECO-C88

Installing the compiler is easy. The batch-processing files supplied on the two distribution disks perform the installation automatically. There are two versions: INSTALLF.BAT for systems with two 360K-byte floppy-disk drives and INSTALLH.BAT for systems with a hard disk. The installation process is different from the sequence described in the user's manual because of a change in file sizes; it is documented in a README file on one of the distribution disks. On a floppy-disk system, the compiler and library are placed on one disk, while the header files, cc utility, linker, and editor of your choice are placed on the other. On a hard disk, the files are distributed among several subdirectories.

After installation is complete, you can create a C program using your own text editor. The full C syntax as defined in Kernighan and Ritchie (*The C Programming Language* by Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 1978) is supported, with the exception of bit fields and the #line macro preprocessor directive. Only the small memory model is supported, so programs contain a maximum of 64K bytes of code and 64K bytes of data. This is usually more than adequate. (See the text box "Eco-C88: An Update" on page 314 for the latest information.)

Compiling a program is simple; you type cc followed by the program name. The cc program is not actually part of the compiler proper. It is an auxiliary utility program that controls the flow of the compilation and accepts several options to alter its normal actions. One pleasant feature is the presence of a simple make command. For those not familiar with a UNIX version of the utility, the make command takes care of the compiling and linking of files that make up a program. It will only recompile those modules that have been altered since the last time you ran the program. The cc utility is also provided in source form, so you can customize it to fit particular system configurations. [*Editor's note: The* cc *utility requires* DOS 2.21 *or higher to run.*]

The cc utility makes automatic operation of the compiler convenient, but it is possible to individually invoke each of the compiler's passes. These passes consist of the preprocessor (XP.EXE), parser (XC.EXE), optimizer (XOP.EXE), code generator (XM.EXE), and assembler (XASM.EXE). An error pass (CE.EXE) is called automatically if one of the other passes detects an error. The compiler's output is an .OBJ-type object module that you must then link with routines from the library to produce an executable .EXE file. Although there is a separate assembler pass, it does not accept a human-readable text file as input. All communication between the separate parts of the compiler is accomplished by reading and writing data files (*.cwk) that are automatically created and erased as the programs run.

Error handling is performed just as it is in the Z80 version of the compiler, and it's one of my biggest gripes. If the compiler

(continued)

David D. Clark is a research chemist working at the Research and Development Center of the Colgate-Palmolive Company. He has a B.A. in chemistry from Indiana Central University and a Ph.D. in biological chemistry from the University of Nebraska. He can be reached at 126 Birchview Dr., Piscataway, NJ 08854.

AT A GLANCE

Name
Eco-C88 1.55

Company
Ecosoft Inc.
6413 North College Ave.
Indianapolis, IN 46220
(317) 255-6476

Necessary Hardware
MS-DOS 2.0 (or higher) 8088-based computer with 256K bytes of memory and two 360K-byte floppy-disk drives or one floppy-disk and one hard-disk drive

Documentation
92-page loose-leaf user's manual in a slip-cover binder

Price
$49.95

detects an error in the preprocessor, it informs you of what occurred but not always of where. For example, if it detects an unclosed comment, the compiler tells you that it is on the last line of the file and that a comment is not closed. It gives you no idea of where the offending comment starts. The only solution I have found is to place dummy #include directives in the file and see how many the compiler includes. If the parser detects an error, it falls into one of two general types: a warning or a fatal error. When this occurs, the line number, character number in the line, and offending token are displayed as well as the error message. The line numbers do not seem to be particularly reliable, however. I have had two succeeding errors with different tokens report identical positions in the file. Furthermore, I can't find either with a text editor. The compiler continues through multiple warnings, but compilation stops after detection of a single fatal error.

The manual describes the compiler's operation with the cc program quite well but contains little description of how to use the individual programs that make up the compiler itself. Two compiler command-line options, h and d, are mentioned, but the manual does not state their purposes. From reading the source text for the cc program, you can deduce that the h command tells the compiler which directory to search for header files. The d option enables you to do a "command-line define," meaning you can define a symbol to the compiler from the command line. This would be useful for switching on or off conditionally compiled debugging code in the program. Although it is not mentioned in the manual, the com-

(continued)

AT&T presents maxims for better international communication.

Sometimes, it's better to put all your eggs in one basket.

AT&T International Services offer the strongest, sturdiest basket for your telecommunications needs.

Because AT&T has a long history of making international connections and developing international services.

AT&T offers a wide range of international services for your company, whether you're involved in manufacturing, distribution, marketing or any other function. AT&T International Long Distance Service, for example, helps your company build better business relationships. AT&T International 800 Service encourages the steady flow of contact between customers, salespersons and suppliers, so you can maintain a competitive edge.

But how do you choose the services that are right for you? It's simple. Just contact your Account Executive or Sales Specialist at AT&T. They're experts in a wide range of businesses, and they can offer you our entire basket to accommodate your needs. Together you and your AT&T representative can tailor services and applications that work for you.

To learn more about AT&T's state-of-the-art telecommunications and the applications they have for your business, please contact your Account Executive at AT&T Communications now. Or call a Sales Specialist at the toll-free number below.

1 800 222-0400 Ext. 515

AT&T
The right choice.

piler accepts an n command-line option to disallow the use of nested comments in the source text.

THE LIBRARY

The library is included in object form only, but the source is available at extra cost ($15 according to the manual, $10 when I ordered). The library contains all the standard library routines you would expect after reading Kernighan and Ritchie. Additional groups of routines are for operating-system-dependent functions, terminal handling, and IBM-specific video routines. The library occupies about 150K bytes of disk space and, unlike the Z80 version, consists of only one file.

The floating-point routines can use an 8087 numeric coprocessor if one is available. If not, the software emulates the coprocessor's operations. The compiler determines the coprocessor's presence or absence by examining the value of an external variable, *__8087*. You can use this variable to force software emulation by setting it to FALSE. The software emulation insures that systems with and without the coprocessor will obtain the same results from a series of calculations.

An object-only version of the ISAM (indexed sequential-access method) functions is also available for $15.

BENCHMARKS

I used six benchmark programs when evaluating Eco-C88. Several are presented in listings 1 through 5; the results are summarized in table 1. For these evaluations, I used a Zenith Z-150, an IBM PC-compatible computer with 320K bytes of memory and two 360K-byte double-sided double-density floppy-disk drives. I performed compilations using the cc program previously described and the -nl command-line option to prevent automatic linking. I did linking by invoking the MS-DOS linker manually. I did all timing by hand using a stop watch and took the average of three measurements. File sizes are those given by the MS-DOS command DIR.

The Empty program in listing 1 pro-

Table 1: *A summary of the benchmark results in seconds. All timing was done by hand. The measurements recorded are an average of three. The compile/assemble times were most variable and seemed to depend on the history of file operations on the disk.*

Program	Compile/Assemble	Link	Execute	Size
Empty	59	26	—	962 bytes
Sieve	63	71	11	7894 bytes
Fib	67	68	43	7876 bytes
Deref	65	66	10	7896 bytes
Factor	70	73	18	8760 bytes
Savage	61	108	449	14,577 bytes

Listing 1: *The Empty benchmark tests for the system overhead required to create any program regardless of its useful content.*

```
/*
** empty.c — benchmark to get compile, assemble, link, and library
** overhead
*/
main()
{
}
```

Listing 2: *A corrected version of the Deref benchmark program, which examines the speed of pointer dereferencing.*

```
/*
**      deref.c — benchmark program to examine the efficiency
** of pointer dereferencing
*/
#define LOOPS     (unsigned) 50000        /* how many loops */
#define BELL      7       /* ASCII bell character */
struct cptr1 {
        char **************************ptr1;
        };
main()
{
unsigned i;
char yekdorb;
struct cptr1 **********************pointer;
        printf("%u loops \ n", LOOPS);
        for (i = 0; i < = LOOPS; i + +)
                yekdorb = **********************
                        (**********************pointer).ptr1;
        printf("%cfinished \ n", BELL);
        exit(0);
}
```

Listing 3: *The Factor benchmark tests the implementation of* long ints. *It uses the Pollard rho algorithm to find a factor of a large integer.*

```
/*
**      factor.c — a long integer benchmark in C
*/
#include        "stdio.h"
#define BIGNMBR 1394761        /* 1181*1181, number to be factored
*/
long p, x, y, cnt;
/*
**      gcd — return the greatest common divisor of a and b
*/
long gcd(a, b)
long a, b;
{
long q, r;
        if (b < 0)
                b = -b;
        if (a < 0)
                a = -a;
        if (a > 0)
        {
                b = b % a;
                if (b = = 0)
                        r = 0;
                else
                        r = 1;
                while (r > 0)
                {
                        q = a/b;
                        r = a - q*b;
                        a = b;
                        b = r;
                }
        }
        return (a);
}
main()
{
        puts("Factoring...");
        p = BIGNMBR;
        cnt = 0;
        x = 3;
        y = 3;
        while (gcd(y -'x, p) < 2)
        {
                cnt+ +;  /* Pascal or Modula can use Succ or INC */
                x = (x*x + 2) % p;
                y = (y*y + 2) % p;
                y = (y*y + 2) % p;        /* no, this is not a mistake
*/
        }
        printf("A factor of %ld is %ld \ n", p, gcd(y - x, p));
        printf("It took %ld iterations \ n \ n", cnt);
}
```

On a system that uses floppy disks, most of the time involved in compiling small programs is used by disk input/output.

vides an estimate of the overhead required just to compile and link a program and the minimum memory necessary to create an executable file regardless of its useful content. The results in table 1 lend support to the conclusion that, at least on a floppy-disk-based system, most of the time involved in compiling small programs is used by disk I/O (input/output).

The Sieve of Eratosthenes is *the* high-level-language benchmark for microcomputers. It uses an algorithm to find all the prime numbers between 3 and 16,381.

The Fib program calculates a series of Fibonacci numbers using a highly recursive algorithm. Because of the recursive function calls, this program gives a good estimate of how well a particular language implementation performs function calls. (Listings for the Sieve and Fib programs appear in May 1984 BYTE, pages 250 and 252, or you can download them from BYTEnet Listings at (617) 861-9764.)

When I wrote the review of Eco-C's CP/M version, I was new to C. I heard that pointers were an important part of the language and wanted to write a benchmark that could discern differences in the dereferencing of pointer variables. The result is the Deref benchmark in listing 2. Since the appearance of the first review, others have pointed out to me that the original program has a flaw. The error was in the declaration of

```
#define LOOPS     50000
```

My intention was that LOOPS be an

(continued)

unsigned integer. However, in the body of the program, that 50000 should be interpreted by compilers as a long int. If the declaration had defined LOOPS as a hexadecimal C350 or as an octal value, the listing would have been fine. However, according to Appendix A of Kernighan and Ritchie, a decimal number greater than the largest positive integer should be interpreted as a long integer. This causes problems for some compilers with the printf statement at the end of the program. Some compilers work because of the way the standard library is implemented. C subset compilers generally have no difficulties, since they usually do not implement long integers.

In order to fix the program, you can simply replace the statement in question with

```
#define LOOPS      (unsigned)
50000
```

Eco-C88 compiled and worked correctly with both versions. The version with the cast to unsigned produced a slightly smaller program that ran substantially faster.

Most compilers that fail to make it through this program do so because of the depth of indirection. It has been argued that there is no practical analog for such a construct in a program and that the proposed ANSI C standard will require only six levels of indirection. That might be true, but the syntax summary of the language in Kernighan and Ritchie specifies that indirection can be of any depth. In my opinion, the program is flawed on aesthetic grounds since what is pointed to through all those levels of indirection is a random byte of memory. If someone can devise a benchmark that has such a high proportion of dereferencing operations and is more practical, I'd like to hear about it.

The Factor program in listing 3 tests the efficiency of the implementation of long integers. It is based on a Pascal program by Richard E. Crandall (*Pascal Applications for Sciences*, John Wiley & Sons, 1983). It uses the Pollard rho algorithm to find factors of large numbers.

The program operates under the assumption that the number is indeed factorable. If given a prime number to operate on, the program will not return. The choice of BIGNMBR is arbitrary. It gives an easily measurable execution time. The program uses many of the arithmetic operators as well as long function parameters and function-return values. It gives a fairly well rounded indication of the efficiency with which long integers are implemented in a language.

The Savage program in listing 4 tests the speed and accuracy of floating-point calculations. This is a C version of a program originally proposed by Bill Savage in the September 1983 issue of Dr. *Dobb's Journal* ("16-Bit Software Toolbox" by Ray Duncan, page 120). The correct result for the pro-

(continued)

Listing 4: *The Savage floating-point benchmark. The program tests the speed and accuracy of floating-point calculations.*

```
/*
** savage.c — floating point speed and accuracy test. C version
** derived from BASIC version that appeared in Dr. Dobb's Journal,
** September 1983, pages 120-122.
*/

#define ILOOP  2500

extern double tan(), atan(), exp(), log(), sqrt();

main()
{
int i;
double a;
        printf("start \ n");
        a = 1.0;
        for (i = 1; i <= (ILOOP - 1); i++)
                a = tan(atan(exp(log(sqrt(a*a))))) + 1.0;
        printf("a = %20.14e \ n", a);
        printf("done \ n");
}
```

Listing 5: *This apparently innocuous Fopentst program will never run correctly, even if the correct file is present in the default directory, because of the register handling used by Eco-C88.*

```
/*
**  fopentst.c — test the operation of the fopen() function
*/

#include        "stdio.h"

main()
{
FILE *fp;
        if ((fp = fopen("MYTEXT.TXT", "w")) == NULL)
        {
                puts("Can't open MYTEXT.TXT \ n");
                exit(-1);
        }
        puts("Successfully opened MYTEXT.TXT \ n");
}
```

The Eco-C88 compiler is rather strict in its adherence to the C language as defined by Kernighan and Ritchie.

gram is 2500. When I ran the program, it printed a final value of 2.49999999968640E3, or an error of about one part in a billion. From the results in table 1, it would appear that Eco-C88 is rather slow. This is not entirely true. As I've mentioned, the software floating-point routines emulate the 8087 coprocessor. This means that doubles are 8-byte quantities with a dynamic range of about $+/-10^{308}$. That means you can calculate a number as large as 170 factorial without overflow. The other point to note is the accuracy maintained while calculating transcendental functions. Many implementations will only approximate such functions to six or seven significant digits.

From past tests of MS-DOS C compilers, the results for the comparable benchmarks seem to show that Eco-C88 is one of the fastest and produces relatively compact code. A possible exception is in the area of floating-point calculations where the software emulation of the 8087 might cost the compiler in speed. I am not aware of any directly comparable results for the long-integer benchmark, but I would say that performance in this area is quite adequate. The difference between the 16-bit MS-DOS version of the compiler and its 8-bit counterpart is quite pronounced, even though the 8-bit version is the fastest I have tested.

Another interesting point is that, although the Empty benchmark produced a code file of less than 1K byte, if you write a program that actually does anything, it requires a minimum of about 8K bytes. Overhead is about 1 minute due to disk thrashing on a floppy-based system.

Consider the Fopentst program in listing 5. It looks perfectly legal. As a matter of fact, it will compile and link without error. However, it will never be able to open the file, even if it is present in the default directory. The fopen() function is declared as a function returning a pointer to a variable of type FILE in the source code for the library functions. It is that way on almost all compilers. However, in the program listing, the type of the return value for the function is not declared and the compiler correctly assumes it to be of type int. The problem occurs because of the way Eco-C88 allocates registers: All return values of type int are returned in the AX register. All pointers are returned in the BX register. In order to get the program to work, the declaration

```
FILE *fopen();
```

must appear in the program or the return value gets lost. I should emphasize that nothing is wrong with the way Eco-C88 handles this. It is good programming practice to make such declarations, but it is unusual. Handling register usage in this way probably allows for certain speed and size optimizations not possible if pointer results were returned in the same registers as char, int, and unsigned results. I first ran across this problem when porting programs compiled on UNIX, MS-DOS, and CP/M systems. Mention of this in the manual would have been helpful.

CONCLUSION

Eco-C88 is a high-quality package, particularly at its new price. It is comparable to systems costing much more. It is convenient to use, works well, and produces acceptably compact and fast programs. The compiler is rather strict in its adherence to the language as defined by Kernighan and Ritchie, almost authoritarian for a C compiler.

A few elements do annoy me, mostly in the area of compiler error handling. Also, because of the large number of passes involved, the compiler spends a lot of time reading and writing disk files. It might be nice to be able to examine assembly-language output occasionally, but I have not really missed it. You cannot easily use the system to create programs that manipulate huge amounts of data in memory because only the small memory model is supported, allowing 64K-byte programs and 64K-byte data segments. However, all in all I am more than satisfied. ■

ECO-C88: AN UPDATE

Since the evaluation of Eco-C88 by David D. Clark, Ecosoft has made a number of revisions to its C compiler. The version now available is 2.81, as opposed to the 1.55 version reviewed.

The C library has been split into three separate libraries to provide support as needed. These files are ECOC.LIB (standard C functions), ECOT.LIB (transcendental math support), and ECOM.LIB (expanded memory support). The standard library, ECOC.LIB, has more functions, such as fgetc and fputc. The memory library, ECOM.LIB, lets you address outside of 64K bytes of data memory, but it does not support large models.

The cc utility has more options, some that are documented in a new manual, some in a README.DOC file.

The -a option, where supplied to the cc utility or the assembler-pass module XASM.EXE, produces human-readable assembly-code files. The MS-DOS assembler, MASM, can read these files.

Error messages can be directed to an output file using the -e<filename> option, and the line numbers for the error messages are accurate. In addition, enumerated data typing is supported.

A paperback book has replaced the loose-leaf binder for the new Eco-C88 manual.

1200 Baud Smart Duck

If it walks like a duck, sounds like a duck, and looks like a duck, it darn well better act like a duck. And ADC's new Hayes Compatible 1200 baud auto-answer/auto-dial modem is one heck of a duck. And, it's a market buster at just $169.

By Drew Kaplan

Hats off to Hayes. They've just about written the book on specs and protocol for the 1200 baud modem market.

Every professional modem bills itself as 'Hayes Compatible'. **But the big question is, how much does it really cost to make a top-of-the-line 1200 baud modem?** Or, who's getting rich?

ADC's modem is made in the same factory by the same people as one of Hayes's biggest competitors. And, ADC is a division of BSR, the enormous half-billion dollar electronics giant.

So for $169, you'll not only be getting a duck that quacks properly to Hayes modems, but sings like a nightingale to your pocketbook and can save you a fortune in time with its extra features.

DUCK SOUP

Any computer with an RS232 standard serial port, will work flawlessly with this modem. And, virtually any modem or terminal software that's compatible with Hayes, will be compatible with ADC.

We've even got intelligent programs, cables, and interfaces (if you need them) to activate your IBM PC or Clone, and your Apple IIE or IIC.

I've owned a Hayes 1200 baud modem for about 2 years. I just unplugged it and plugged in ADC's to operate my Hewlett-Packard dumb terminal which I use at home to monitor DAK's computer.

The only differences I noted were improved monitor sound, more screen displays and a help menu. And oh yes, one last extra. I use a few local data bases whose phone lines are always busy.

Well, ADC's intelligent modem recognizes a busy signal, hangs up and keeps retrying the number every 30 seconds.

There are less important (to me) extras like day, date and time, an extra phone jack and auto tone/pulse switching. So, you'll love it for discount services.

DO YOU NEED TO KNOW?

Just think, you can transform your PC into a terminal that can interact with main-frames. You can download information from your main office computer and run Lotus, Wordstar or you name it. It's all possible with your PC and modem.

You can exchange information with other computers. Say you're a writer, you can send a chapter from your home or office in Los Angeles to New York, have it edited and sent back to you.

You can even send it directly to typesetters and have a book or a newsletter prepared from your transmitted file.

It's really great when drafts of contracts are flying back and forth. Why retype everything over and over again?

Electronic mail lets you type in your message and you won't have to worry about playing telephone tag any longer.

You can get the weather in Baltimore, get the latest quote on your company's stock, or even reserve a seat on the next flight to Las Vegas. You can upload public domain software (there's an enormous amount of free software) or sample the newest programs before you buy.

There are pay data bases like CompuServe and The Source that have information about anything, and thousands of free bulletin boards about everything from Ham Radio to Parapsychology.

There's even a new book that lists and describes such diverse data bases as one with 6500 references about coffee, to one with 2,000,000 on agriculture.

Of course, economics, medicine, law and computers are all well represented.

THE TECHNICAL SIDE OR, WHY 1200 BAUD?

The ADC Modem will communicate at 1200 baud (about 120 characters per second) or 300 baud (about 30 characters per second) automatically, depending on the link at the other end.

So, it's clearly a decision of money and time. 1200 baud is roughly 400% faster than 300 baud, so if you transfer data across the country you save 400% on your phone bill. And think of the time $169 can save you!

If you download material from pay data bases, even though some charge more for 1200 baud, you still come out way ahead because of the amount of information you get per dollar.

It comes with a modular phone cord that you simply connect to any standard modular jack and it uses standard Bell 103 and 212A protocols. It operates in half or full duplex.

Its built-in microprocessors let you automatically answer in-coming data calls and act on all Hayes commands.

It even waits for dial tones and phone network tones during auto-dial. The modem is 9½" X 5½" X 2". It's backed by ADC's standard 1 year limited warranty.

HOOKING IT UP MADE EASY

All you need is a serial output, a cable and a modem program. All our modem programs on disk let you save, upload and download files. Look how easy it is.

If you own an IBM PC or a clone, usually you'll find an RS232 serial port already built-in. All you need is our cable and modem program on disk which we've packaged together for just **$29** plus **$3** P&H. But, before you order your cable, you may need a short sex education course.

Sex Education 1A. You need to determine whether your computer's RS232 connector is male or female.

If you look at the picture below this paragraph, you will note that the connector has holes going in. It's a female. If it had copper pins sticking out, it would be a male. Now wasn't that simple?

So, if yours is female, order our male cable and modem program Or. No. 4353. If you have male pins sticking out, order our female cable, Order No. 4354.

If you don't have an RS232 port, we have a serial interface card for your IBM or Clone complete with cable and modem program for **$99** ($4 P&H) Or. No. 4355.

For your Apple IIC, your serial interface is built-in. All you need is our cable and modem program on disk. They are just **$29.90** ($3 P&H) Order No. 4356.

For your Apple IIE, you'll need a serial interface with an RS232 port, a cable and a modem program. It's all yours for just **$89** ($4 P&H) Order No. 4357.

1200 BAUD SMART DUCK RISK FREE

For business or pleasure, you'll communicate, gather information and save time. If you aren't 100% satisfied, simply return it in its original box to DAK within 30 days for a courteous refund.

To Order Your ADC 1200 Baud Intelligent Modem risk free with your credit card, call toll free, or send your check for DAK's market busting price of just **$169** plus **$6** P&H. Order No. 4334.

The OnLine Directory of over 1,100 Data bases, complete with descriptions is just **$14.95** ($2 P&H) Order No. 4358.

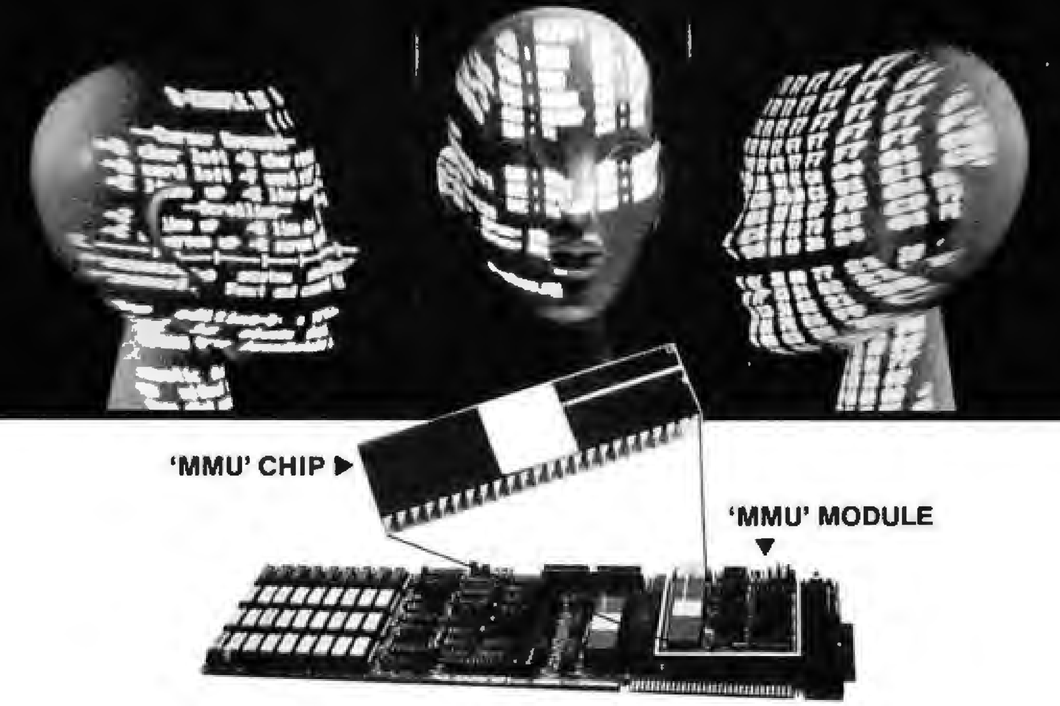
The ducks will sure to be quacking up a storm when they see BSR's factory direct, through DAK, price on this state-of-the-art 1200 baud intelligent modem.

Hayes, Lotus, Wordstar, IBM, and Apple IIE & IIC are registered trademarks of Hayes Microcomputer Products, Lotus Development, MicroPro, International Business Machines and Apple Computer.

DAK
INDUSTRIES INCORPORATED

TOLL-FREE ORDER LINE
For credit card orders call 24 hours a day 7 days a week
CALL TOLL-FREE. . .1-800-325-0800
8200 Remmet Ave., Canoga Park, CA 91304

THIS IS NOT BS (Bank-Switching)



THE NEW BREED OF MULTIFUNCTION CARDS.

ALL CARD AT1

With AST SIXPAK, QUADBOARD, JRAM, or the newer INTEL ABOVE BOARD, you limit your PC growth. The **ALL CARD AT1** is expandable to 2MB on board (4 MB in two slots) and FULL MEGABYTE POWER with the ALL "MMU" Module Option. **ALL CARD AT1** starts with all the multi-function features and 256K at $445. Even the standards are designed for software of the future —the calendar clock has non-volatile RAM with alarm interrupts and the serial port has multiple addresses. Also, mix 64 & 256K chips.

ALL CARD AT1/M

This model comes equipped with all the features of **ALL CARD AT1** plus the ALL 'MMU' Module Option which includes ALL/MOS (Memory Operating Software). With a simple menu-driven installation procedure, ALL/MOS converts your existing software to 1MB DOS, and delivers FULL MEGABYTE POWER.

'FULL MEGABYTE POWER'

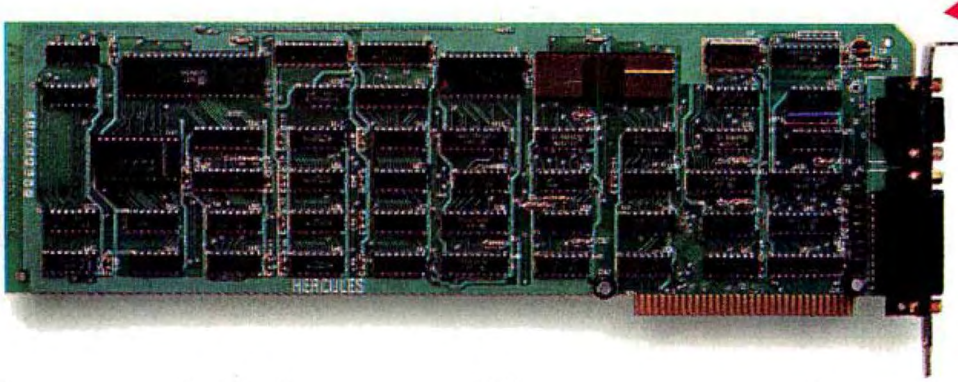
1 MEGABYTE DOS. Break the 640K barrier. Run existing versions of the popular business packages IN 1 MB including 1.2.3, SYMPHONY, FRAME-WORK, dBASE, APL, TOPVIEW, SIDEKICK, MULTILINK, CROSSTALK, TURBO PASCAL, C86, IBM MACRO ASSEMBLER, MULTI-MATE, WORDSTAR, NOVELL, PC NET......

4 MEGABYTE EXPANDED MEMORY SPEC. Run 4 megabyte software conforming to the LOTUS/INTEL/MICROSOFT specification,with enhancements. SYMPHONY 1.1 has already been released and 1.2.3, FRAMEWORK and others are coming.

MULTI-MEGABYTE, MMU PROTECTED RAM DISK. Run **ALL DISK** as large as you like with full assurance that it is fully hardware protected from inadvertent tampering by you, others, or programs with 'bugs'.

FUTURE INDUSTRY EXTENDED MEMORY SPEC. Run higher performance software conforming to the future specification for machines equipped with MMU. IBM PC AT is IBM's first personal computer with MMU. With **ALL CARD** your PC and XT also have MMU.

Full megabyte power means you can run all of the above either individually or together. And more. Provide Memory Management Unit (MMU) hardware for DOS/UNIX and other multitasking, multiuser and VM (Virtual Machines) operating systems of the future.



NOW COMES WITH FREE PRINTER CABLE!

The world's best selling monochrome graphics card for the IBM PC.

There are more Hercules™ Graphics Cards in more IBM® PCs, XTs™ and ATs™ than any other monochrome graphics card in the world.

Over a quarter of a million demanding users around the world use a Hercules Graphics Card to improve the performance of their software.

The Lotus® 1-2-3® Booster.

Consider Lotus 1-2-3. Hercules gives an off-the-shelf

copy of 1-2-3 the highest resolution possible on an IBM PC, XT or AT. More 1-2-3 users choose the Hercules Graphics Card to get crisper text and sharper graphics than any other monochrome graphics card.

And we bring the same performance to other integrated programs like Symphony™, Framework™, and SuperCalc®3.

But we don't stop there. The Hercules Graphics Card improves all kinds of software.

Like Microsoft® Word, a word processor that enables you to display text with subscripts, superscripts and italics.

Or pfs®: Graph, an easy-to-use business graphics program that converts your data into presentation quality graphs.

Or Microsoft® Flight Simulator, the high flying game for the overworked executive.

Or our own Graph X™, a library of graphics subroutines that eases graphics programming.

Or AutoCAD™, a computer aided design program that offers features normally associated with expensive CAD systems.

And we supply free software with each card to do hi-res graphics using the PC's BASIC interpreter.

State-Of-The-Art Hardware.

The Hercules Graphics Card gives you graphics resolution of 720h x 348v and a parallel printer port. Our unique static RAM buffer provides sharp 9 x 14 characters and flicker-free scrolling. Our exclusive safety features help prevent damage to your monitor.

State-of-the-art custom IC technology delivers unsurpassed reliability. Ordinary graphics cards use up to 30 ICs to do what one Hercules IC does. By using fewer parts, we reduce the possibility of component failure.

Which is one reason we warranty the Hercules Graphics Card for two years.

Unbeatable reliability. Advanced technology. Proven by over a quarter of a million users. Why settle for anything less than Hercules?

Call 1-800-532-0600 Ext 408 for the name of a Hercules dealer nearest you and we'll rush you our free info kit.

Hercules.

We're strong on graphics.

Address: 2550 Ninth St., Berkeley, CA 94710 Ph: 415 540-6000 Telex: 754063. **Trademarks/Owners:** Hercules, Graph X/Hercules; 1-2-3, Symphony/Lotus; IBM, XT, AT/IBM; Framework/Ashton-Tate; SuperCalc/Sorcim-IUS; Microsoft/Microsoft; pfs:/Software Publ; AutoCAD/AutoDesk. Printer cable offer expires February 28, 1986. Good only in U.S.A., offer subject to change without notice.

H·A·R·D·W·A·R·E R·E·V·I·E·W

Inside The Sider

A hard-disk drive for the Apple II+, IIe

BY DOUGLAS E. HALL

To run my own business as a microcomputer consultant for nonprofit organizations, it was clear that I would need a hard disk for storing my word-processing, spreadsheet, database, and program files, which filled more than 40 floppy disks.

A mailer I received from First Class Peripherals advertised a 10-megabyte hard-disk system for Apple II computers. Called The Sider, it sold for only $695. Not only was the price right, but the company offered a 15-day trial period during which I could return it with no questions asked. That seemed unprecedented for a piece of sophisticated computer equipment.

The disk drive is about the size of a shoebox, measuring 7.5 by 3.5 by 16 inches. The well-padded package from First Class contained the drive, interface board, installation manual, cable, installation software, and miscellaneous hardware.

INSTALLING THE HARDWARE

Although I have degrees in electrical engineering and once designed and wire-wrapped my own homebrew computer, that background was not adequate to help me determine the difference between an "anchor screw" and a "retaining screw," both of which were involved in installing the cable-clamp assembly to the back of my Apple IIe. First Class could have made the task easier by including a few more diagrams of hardware-installation steps in the manual. It would also help to have a diagram showing and naming each part and noting whether it is for the Apple II+, IIe, or both. Nevertheless, within 45 minutes I had the hardware connected. When the computer and disk were plugged in and turned on, the drive began to hum, and I figured I had at least approximated the correct cable installation.

INSTALLING OPERATING SYSTEMS

The Sider is partitioned to hold up to four operating systems: DOS 3.3, Pascal, ProDOS, and CP/M. You have to decide on the amount of disk space you want to set aside for each system, however, and then follow the step-by-step procedures in the manual. I installed only DOS 3.3 and CP/M. The "dynamic partitioning screen" for dividing the disk into sections for each operating system was confusing to use. Eventually it became clear that I had to adjust ProDOS for maximum partition size (even though I didn't need it at all) as a step along the way to dividing up the disk into CP/M and DOS 3.3 areas. That didn't make a lot of sense to me, but that's the way it had to be done.

In contrast to the Davong 15-megabyte hard disk, which I had used for nearly two years earlier, The Sider requires the entire disk to be partitioned during installation. You are not allowed to leave part of the disk undesignated as to operating system and assign it later when your actual need for space becomes more apparent. This forces you to make better estimates as to your space needs and could possibly cause problems later. In my case, if I decide next month that I want to install Pascal, there will be no hard-disk space available for Pascal files even though I may have lots of unused CP/M space. The only solution is to repartition the disk, install the operating system again, and then restore all the files to the disk from backup floppy disks. It would have been better to allow some of the disk space to remain unassigned until needed.

Once I had partitioned the disk, my next step was to break each partition into volumes as desired. Again the manual was not very satisfactory. It stated that "DOS is divided into small volumes (DOS-SV) and large volumes (DOS-LV)," without indicating what the actual sizes or limitations on use were for either. After I had guessed at what I might need, I was ready to format the disk and install my operating systems. I followed the manual meticulously and all went well. That isn't to say I understood all that was happening. For example, during the process

(continued)

Douglas E. Hall has B.S. and M.S. degrees in electrical engineering from Stanford University. He currently runs his own microcomputer consulting business. He can be contacted at MicroCraft, Lane Road, Chichester, NH 03263.

AT A GLANCE

Name
The Sider

Type
10-megabyte external hard disk with controller card for Apple II+, IIe

Company
First Class Peripherals Inc.
3579 Highway 50 East
Carson City, NV 89701
(800) 538-1307
(702) 883-4000 in Nevada

Size
7.5 by 3.5 by 16 inches; 11 pounds

Necessary Hardware
Apple II+ or IIe with one floppy-disk drive, monitor, and 64K RAM

Necessary Software
One or more operating systems (DOS 3.3, CP/M, Pascal, or ProDOS)

Features
10 megabytes of formatted storage

Options
A second Sider can be daisy-chained

Documentation
53-page installation manual

Price
$595

a lot of screens appeared with information on "Pre Comp Cycle," "Control Byte," "Interleave," "DOS Bounds," and other items meaningless to me. The manual explains these screens by saying, "A series of screens describing the boundaries of each partition are displayed next." It would seem to me that if these screens are important or useful enough to appear at all, then some explanation should be provided. If they are not useful to the user, then why display them?

After an hour, I had completed the software installation. I turned everything off and rebooted. The Sider worked perfectly. The main menu appeared on my screen and I was able to drop into CP/M or DOS or run a program from either a floppy-disk drive or from The Sider.

UTILITY PROGRAMS

The Sider manual lists, but does not explain, the various utility programs that are provided. It seemed logical to me to use the Backup/Restore utility to copy my floppy-disk volumes and files onto the hard disk. I couldn't get it to work; it kept telling me that my floppy disks were not "library volumes." The manual contains not a hint about what this utility expects.

A call to First Class Peripherals' toll-free telephone number resulted in a discussion with a technician who said that he was not sure of the purpose of the Backup/Restore utility. He suggested that I use a different utility called Image Copy. He stated that First Class is preparing a user's manual to supplement the installation manual, that people who had bought The Sider would eventually receive a copy, but that no date had been set for its release. He also stated that he had only a handwritten set of engineering notes to use in assisting callers experiencing problems.

I used Image Copy and it worked well. It took 48 seconds to copy a 140K-byte DOS 3.3 floppy disk to a similar volume on the hard disk. (Don't make the mistake of using Image Copy in place of Apple's COPYA program to copy one floppy disk to another, however. COPYA requires 1 minute 28 seconds to complete that task; Image Copy requires more than 20 minutes.)

One especially handy utility is the Hard Disk Catalog. It automatically catalogs each DOS volume on the hard disk in sequence. It is extremely helpful in searching for a particular DOS 3.3 file. The program as provided was written in Applesoft, so I was able to make a simple modification to send the catalogs to the printer as well as to the screen.

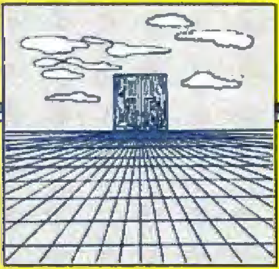
One utility The Sider lacks is an import/export utility, which allows you to copy a file from one operating system to another. I need this to move text files from CP/M, where they were

(continued)

Photo 1: *Front view of The Sider hard-disk drive.*

Photo 2: *Rear view shows extra connection for daisy-chaining.*

Contemporary Electronics Series



Trial Examination Order Form

YES! I'm interested in learning contemporary electronics and would like to examine the first module in the series. If I decide to keep it, I will pay just $19.95 plus $2.25 shipping and handling. I will then receive future modules automatically, one every 4 to 6 weeks. Each of the 15 modules in the series is $19.95 plus $2.25 shipping and handling and comes on the same 15-day Free Examination basis. There is no minimum number of modules that I must buy and I may cancel at any time simply by notifying you.

If I do not choose to keep the first module, I will return all materials in good condition and pay nothing. Future modules will be canceled and I will be under no further obligation.

Name ______________________________

Please Print

Street ______________________________

City/State/Zip ______________________________

Phone Number (   ) ______________________________

All orders subject to approval and payable in U.S. funds only. Available in U.S. and Canada only. **Add first class stamp and mail today!**

Covers every subject of modern electronics

- Digital logic
- Digital gates (TTL, CMOS, MOS)
- Flip flops
- Counters and registers
- Op-amps and applications
- Combinational logic circuits (ROM, PLA, decoder)
- Amplifier fundamentals
- Transistors (bipolar and FET) diodes and thyristors
- Linear and digital integrated circuits
- Microprocessors
- Oscillators
- Optoelectronics
- Fiber optics
- Robotics

2080-016

Post Office
Will Not
Deliver Without
First Class
Stamp

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue
Washington, D.C. 20016-2876

created with dBASE II, to Apple DOS, where they will be used in a mail-merge routine. I'd pay $50 for such a utility. Is anybody at First Class listening?

NOISE

One final complaint: noise. This problem is not unique to The Sider, of course. All hard disks have some noise. But The Sider is not among the quietest of hard disks. I often find myself turning it off so I can hear myself think. Without some special noise insulation, it would be distracting in any office setting.

SPEED

The Sider does its job. I've used it to rapidly create large database files for dBASE II under CP/M, which is something that was not possible with my floppy disks. The measurements that are given in table 1 show a comparison of access times for floppy disks and The Sider.

Table 1: *Benchmark comparisons for The Sider hard-disk system and Apple's DuoDisk floppy-disk system. (See the June 1984 BYTE, pages 334 and 336, for details.) The benchmark programs were written in Applesoft BASIC. They were executed on an Apple IIe running DOS 3.3 and having 128K bytes of memory.*

	The Sider	Apple DuoDisk
Write a 64K-byte file	2:43	3:04
Read a 64K-byte file	3:03	3:35
Copy a 40K-byte file	:31	1:32

CONCLUSION

I give The Sider an A for price, performance, and ease of use; a C for ease of setup; a D for documentation (at least until the user's manual is released); and an A for First Class's policy of 15-day return and one-year warranty.

I have necessarily dwelt on the problems I see with The Sider. But the best summary of my evaluation is the answer to the question, "Did I return The Sider to First Class at the end of the 15-day free trial period for the promised full refund?" Definitely not. For the very attractive price of $695, I am willing to live with The Sider's limitations. [*Editor's note: The price has since fallen to $595.*] ■

THE GREAT ESCAPE!

FROM IVORY TOWERS AND COLD COMPUTER ROOMS TO THE WARMTH OF YOUR OFFICE.

Artificial intelligence for business has arrived in a revolutionary new product. . . Guru.

At last, artificial intelligence designed especially for business! Guru brings together expert system capabilities of artificial intelligence, the productivity of familiar business computing tools and the ease of communicating with your computer using menus, commands or plain English. All available in a single, integrated program.

Guru works like human experts, considering uncertainties, reasoning through forward and backward chaining, asking for more information when needed, and explaining its recommendations.

Guru's expert system works hand-in-hand with all the familiar business computing tools like spreadsheets, statistical analysis, business graphics and a programming language, always available for both expert consultation and your everyday business computing needs.

Best of all, you won't need to learn LISP or PROLOG or buy fancy computers. . . Guru runs on your PC and communicates in plain English! Guru is artificial intelligence that means business.

For more information, call or write Micro Data Base Systems, Inc./Marketing & Sales, P.O. Box 248, Lafayette, IN, 47902, 317/463-2581, Telex 209147 ISE UR.

GURU™

ARTIFICIAL INTELLIGENCE THAT MEANS BUSINESS.

Inquiry 415

mdbs

The Avocet family tree

Avocet turns an ordinary PC into an extraordinary development system.

And saves you $20,000 in the process.

Now, there's a way to see all your best microprocessor designs take root, easily and effectively. Avocet cross-assemblers, simulators,

THE AVOCET CROSS-ASSEMBLER FAMILY.

Avocet Cross-assembler	Target Micro-processor	CP/M*-80	CP/M-86 IBM PC, MSDOS**
XASMO4	6804	$250.00	$250.00
XASMO5	6805	200.00	250.00
XASM09	6809	200.00	250.00
XASM18	1802/1805	200.00	250.00
XASM48	8048/8041	200.00	250.00
XASM51	8051	200.00	250.00
XASM65	6502/65C02	200.00	250.00
XASM68	6800/01,6301	200.00	250.00
XASM75	NEC 7500	500.00	500.00
XASM85	8085	250.00	250.00
XASM400	COP400	300.00	300.00
XASMF8	F8/3870	300.00	300.00
XASMZ8	Z8	200.00	250.00
XASMZ80	Z80	250.00	250.00
XASM6811	68HC11	250.00	250.00
XASM180	HD64180	250.00	250.00
XMAC682	68200	595.00	595.00
XMAC68K	68000/68010	595.00	595.00

* Trademark of Digital Research
** Trademark of Microsoft

emulators and EPROM programmers turn your personal computer into a sophisticated development system. No more searching for the ever inaccessible mainframe. Or, wondering how to pay for a $20,000 dedicated development system. Avocet products save time and money, and provide the most flexible development system available.

Avocet allows you to develop software for practically any microprocessor without switching development systems. And equally important, Avocet development tools are easy to install and easy to use. We provide you with everything you need to develop microprocessor software, from data entry through assembly, debugging and final EPROMs.

Now "debug" on your PC.

Avocet has realistic answers for users who want low cost debugging capability. Until now, engineers have been very much on their own in the area of testing. But now Avocet simulators and emulators virtually eliminate the frustrating and often costly "crash and burn" method.

New AVSIM family of full screen simulators.

Avocet's new software simulator/debuggers let you test your code in a crashproof, interactive environment, without additional hardware. Your PC's screen becomes a "window" into the simulated target CPU. Extensive break point, I/O, and interrupt facilities make AVSIM a truly useful development tool. Price $299.

New TRICE in-circuit emulator.

At last, an affordable in-circuit emulator! With the self-powered TRICE, you can examine target memory and register, set break points, single-step, trace and more; TRICE recognizes 34 different commands. Its serial interface lets you control emulation and download code from your terminal or PC. Priced from $498.

AVPROM programmers work with any PC.

The AVPROMs program over 37 different devices, including EPROMS through 27512, CMOS and E² PROMS, and MPU/EPROM combos, using fast "adaptive" algorithms. Intelligent, self-contained units work with any personal computer, using Avocet's GDX driver software...from $429. Gang programmers from $979.

To find out more about Avocet software development tools and accessories, call us toll-free:

1-800-448-8500

(In the U.S except Alaska and Hawaii.)

VISA and Mastercard accepted. Most popular disc formats now available—please specify. Shipping and handling additional—call for exact quotes. OEM INQUIRIES INVITED. Avocet Systems Inc., P.O. Box 490-B7, Rockport, Maine 04856, (207) 236-9055. Telex: 467210 AVOCET CI.

AVOCET SYSTEMS INC.®

At NEC, monitors and printers are not peripheral issues.

All too often, brand-name CPUs are "bundled" with mediocre peripherals — a practice that makes for profitable sales, but does nothing for the system's performance.

In Japan, where most computer peripherals are actually built, NEC is the largest personal computer company — by far. And NEC didn't make it to first place by offering second rate peripherals.

The monitors with the broadcast video heritage.

While dozens of companies market display monitors, only a handful possess the tube technology and manufacturing capability to actually *build* them. NEC is one of the few. In fact, NEC's complete line of color and monochrome monitors reflects the professional and broadcast video expertise that twice earned NEC Emmy Awards from the National Academy of Television Arts & Sciences.

Winning the printer race takes both speed and endurance.

Ask people who really know about printers, and they'll tell you that NEC builds the best. They may also point out that NEC builds printers for other computer companies. And if you ask them to choose one word to sum up what makes NEC printers stand out, it will probably be "reliable." This is why NEC has become the printer of choice for the most demanding installations.

So before you buy a peripheral from any name company, make sure the company puts more into the peripheral than just its name.

PC-PR105A IBM PC PLUG COMPATIBLE
TRI-MODE DOT MATRIX PRINTER

JB-1280DA IBM PC PLUG COMPATIBLE
GREEN PHOSPHOR BLACK SCREEN MONITOR

NEC®

NEC Home Electronics (U.S.A.) Inc.
Personal Computer Division
1401 Estes Avenue
Elk Grove Village, IL 60007
312-228-5900

Inquiry 264

Advantage! for the AT

Add-on memory and I/O ports for the IBM PC AT

BY TJ BYERS

The architecture of the IBM PC AT's 16-bit-wide bus, although similar to that of the 8-bit-wide IBM PC bus, is different enough that standard IBM PC cards are not compatible with the AT in most cases. Consequently, a new generation of IBM enhancement products has been developed for this machine.

One of the more versatile multifunction boards for the AT is Advantage! from AST Research (see photo 1). Advantage!, which is among the first of the third-party products for the AT to appear on the market, closely resembles AST's SixPakPlus multifunction board for the IBM PC. Of course, there are differences.

First, you will notice that the AST clock/calendar is absent. Since the PC AT has an internal clock and calendar, AST has not duplicated it. Second, you can load the Advantage! with almost 10 times as much RAM (random-access read/write memory) as a SixPakPlus.

Extra memory is really what the Advantage! is all about. The board's minimum memory configuration is 128K bytes of RAM, enough to take an enhanced IBM PC AT with 512K bytes of memory up to the machine's lower limit of 640K bytes. (The PC AT can use 640K bytes of RAM in its 1-megabyte real-address-mode address space.)

But the IBM PC AT doesn't stop there, and neither does the Advantage! multifunction board. Using the AT's protected-mode memory configuration, Advantage! can contain up to 1.5 megabytes of RAM. This is extended RAM that resides above the normal 1 megabyte of real-address-mode memory-address space that the AT uses for routine operation. You can use this protected-mode memory space for RAM disks such as the IBM PC-DOS 3.0 VDISK utility or for multiuser operating systems like IBM's XENIX package.

If that isn't enough RAM for your needs, Advantage! accommodates a special piggyback memory module that attaches to the board itself and extends the total on-board memory to 3 megabytes. This means that you can add a full 3 megabytes of RAM to your IBM PC AT while using a single expansion slot. Cascading more Advantage! boards, up to a maximum of five, results in 15 megabytes of protected-mode memory (the maximum the machine will accept). Furthermore, Advantage! offers several other memory-expansion options to meet your goal. You can choose either 64K-bit or 256K-bit RAM chips for maximum flexibility when upgrading your system's memory.

MEMORY-ADDRESSING CAPABILITY

Memory addressing, the function of Advantage! that designates where extra memory appears in the machine's address space, is also flexible. The total on-board memory can be split to fill space in both the base (real-address-mode) memory system and the protected-mode memory area.

In other words, if your AT has 256K bytes of base memory and you add a 1.5-megabyte Advantage! board to your system, you can choose to put all 1.5 megabytes in the protected-memory area and leave the base memory alone. This decision results in a machine with 256K bytes of base RAM and 1.5 megabytes of extended memory for use as a RAM disk or for multiuser functions.

Or you can split the extra memory between the two modes. Through the use of DIP (dual in-line package) switches, you can fully load the base memory by sectioning off 384K bytes of the 1.5 megabytes for use as base memory. The maximum base RAM is 640K bytes of the assigned 1-megabyte address space (in this case, 256K original bytes plus 384K bytes added by addressing the Advantage! board). This leaves 1116K bytes, or 1.116 megabytes, for use as protected-mode memory.

COMMUNICATIONS PORTS

The Advantage! multifunction board also contains a serial communications port and

(continued)

TJ Byers is the author of numerous books and articles on computers. His latest book is Inside the IBM PC AT *(McGraw-Hill). You can contact him at 9411 Soledad Canyon Rd., Canyon Country, CA 91351.*

AT A GLANCE

Name
Advantage!

Company
AST Research Inc.
2121 Alton Ave.
Irvine, CA 92714
(714) 863-1333

Computer
IBM PC AT

Features
Memory expandable to 1.5 megabytes on-board, memory expandable to 3 megabytes on-board with piggyback module; split memory-addressing capability; uses 64K- or 256K-bit memory chips; parallel printer port, serial RS-232C asynchronous port, and optional second serial port and game port

Documentation
75-page user's manual, tabbed function identification

Price

128K bytes of memory and serial/parallel ports	$595
3 megabytes of memory with piggyback board and serial/parallel ports	$2395

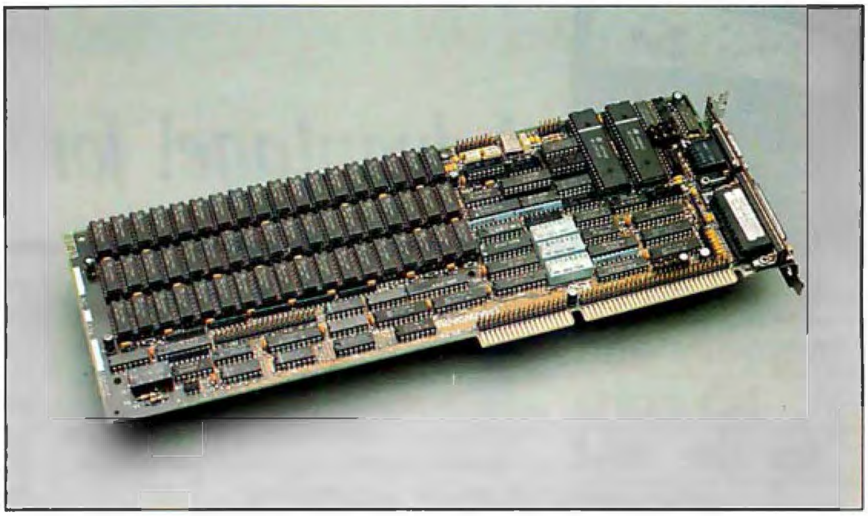


Photo 1: *The AST Advantage! multifunction board for the IBM PC AT, showing sockets for up to 1.5 megabytes of RAM, memory-address DIP switches, and parallel-port, serial-port, and game-port connectors. Note the rows of vertical pins in front of the RAM socket area and immediately above the printed-circuit fingers; these are for connecting the optional add-on 1.5-megabyte piggyback RAM board.*

a parallel communications port. The serial port is an RS-232C-compatible asynchronous communications port that you can use to provide a link between the AT and a modem, serial printer, mouse, or other serial device. Unlike on the IBM PC, which uses the industry-standard 25-pin DB-25 connector, Advantage!'s RS-232C port is interfaced via the 9-pin DB-9 connector that IBM is using as its new RS-232C standard. A second asynchronous serial port is offered as an option.

The parallel printer port is also standard on the Advantage! board. It performs exactly like any IBM parallel printer port, such as the one that comes on the IBM monochrome monitor, and can be used in conjunction with the AT's existing parallel port. The IBM PC AT can support three parallel ports, and you can configure Advantage! to respond to two of the three assigned addresses.

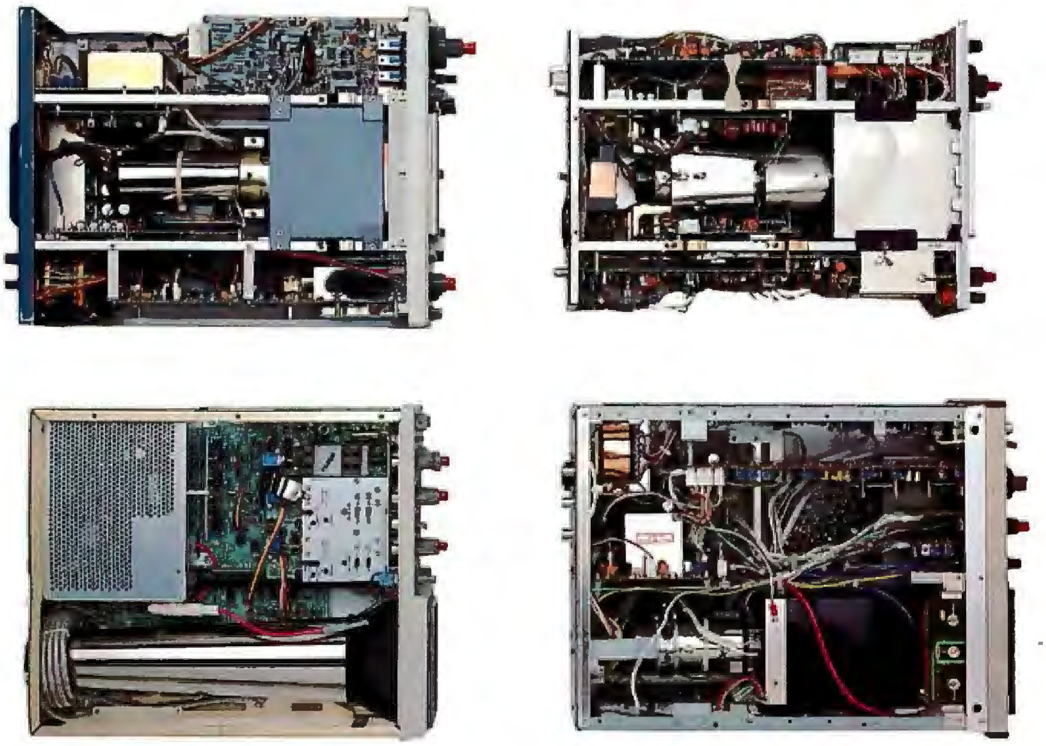
As a final option, you can install a game port. The game port is totally software-compatible with the IBM game adapter and you can use it with most joysticks. Due to a problem in the diagnostic program that accompanied some of the earlier AT machines, the port might not always show up on the listing of installed devices. This causes no problem in the use of the game port, so ignore it.

DOCUMENTATION

Probably Advantage!'s best feature is its documentation. It is clear, concise, and to the point. AST has broken down the operation of each function into a separate and extremely manageable chapter. The text is not overwhelming and the manual is well illustrated. The user's manual includes four appendixes that contain all possible switch settings and actual programs to modify or improve system performance. This is a welcome and noticeable improvement over some manuals I have used.

Priced at $595, Advantage! is a good buy with plenty of capability. Of course, prices increase as the number of memory chips you use increases, but that's to be expected. Advantage! lives up to everything it promises. I have used the Advantage! board for RAM disks and as extended memory with the XENIX operating system, and the results have been excellent. I highly recommend it for the serious AT user. ■

You can't judge a scope by its cover.



When you look at our simplified, practical internal design, you see why the Tek 2200 Series delivers unparalleled high performance and reliability in the field. You get quality that's unmistakably Tektronix in scopes so advanced, they cost you less to buy and own.

Through an innovative new concept in scope design we reduced the number of mechanical parts by 65%. Reduced cabling by 90%. Virtually eliminated board electrical connectors. And eliminated the need for a cooling fan.

The result: a scope with designed-in simplicity that increases reliability as it cuts downtime and repair costs. All of which means outstanding value in a compact, lightweight package that your service technicians will appreciate.

Plus, you get a selection of performance to precisely match your needs. There are the 60 MHz single time base delay 2213A at $1275* and the 60 MHz dual time base 2215A at $1525.* And at 100 MHz, the dual time base 2235 at $1750* and the 2236 with an integrated counter/timer/multimeter at $2650.*

The industry's first three-year warranty† is testimony to 2200 Series dependability. Adding value to value are a variety of optional service plans that can economically extend this coverage to five years.

Consider what you're paying now in downtime, in service, in back-up scopes. On the bottom line, a Tek 2200 Series scope will save you money, time and trouble now and in the years to come.

Contact your Tek Sales Engineer for a demo today. Or call 1-800-426-2200, Ext. 201. In Oregon, call collect: (503) 627-9000, Ext. 201.

Tektronix®
COMMITTED TO EXCELLENCE

Inquiry 351

*Prices F.O.B. Beaverton, Oregon
†3-year warranty includes CRT and applies to 2200 family oscilloscopes purchased after 1/1/83. Scopes are UL listed, CSA and VDE approved.

250,000 customers made us do it. The WYSEpc.

We established a precedent on better than 250,000 desktops with our terminals. So when our customers got ready to include PCs in their plans, they didn't think they should have to settle for less than Wyse style, performance and economy.

We agree. And now you can get the WYSEpc with IBM compatibility in hardware, software and expandability. We've thoroughly tested more than 350 software packages and accessories. It runs even the acid tests — Lotus 1-2-3 and Flight Simulator — in beautiful Wyse style.

Our price *includes* dual floppy drives, monochrome 14″ tilt/swivel monitor, height-adjustable keyboard, 256K RAM, two serial ports, one parallel port, MS-DOS with GW-BASIC — and more.

There's also an IBM PC/XT compatible model with a 10-Megabyte Winchester disk. A color graphics option is available on either model.

For more information about how much less all this costs from Wyse, call toll-free, today.

WYSE

Inquiry 388

Call 800-GET-WYSE

S·O·F·T·W·A·R·E R·E·V·I·E·W

Enable

Powerful, but not quite ready and able

BY STEVE KING

Enable, a $695 integrated software package from The Software Group, would appear to be ideal for certain applications on the IBM Personal Computer. Imagine, for example, writing a guide to restaurants and restrooms in your area. You could use Enable's word processor to write the text for the guide, its database manager to assemble the data, its spreadsheet to track the associated expenses and income of the project, and its communications module to transmit the finished manuscript to the typesetter. Throughout the project, Enable's window-management capabilities would apparently let you easily keep an eye on all these functions. You could even use Enable to prepare some charts and insert these into the text.

Unfortunately, an actual test of the software with such a project revealed several deficiencies in Enable. Of course, I used version 1.0. After I wrote this article, The Software Group released Enable 1.1, which is said to include some enhancements. No doubt this new version will fix many of the deficiencies I found. In the meantime, I will report on the software as I, and perhaps many customers, received it. [*Editor's note: The new version of Enable does indeed fix many of these deficiencies. See the text box "Enable 1.1" on page 334 for some notes on the new version.*]

Enable 1.0 comes on three disks: a system disk, an operation disk, and a tutorial/data disk (the new version comes on four disks). I evaluated the program with a Compaq Deskpro containing 640K bytes of RAM (random-access read/write memory) and two floppy-disk drives. Since Enable requires frequent disk swapping on a floppy-disk system, I recommend using a hard disk. By the time I finished this review, I was quite burned out by Enable, partially because of so much disk swapping. Not only do the program's many overlay files require frequent disk changes, but The Software Group also employs a copy-protection scheme that checks drive A occasionally to verify the presence of a bona fide system disk, even if you're running Enable from a hard disk. Fortunately, the new version of Enable is not copy-protected.

Enable's maintenance plan, which includes toll-free telephone support and free updates for a period of one year, costs $95.

In addition to a spiral-bound manual for each of its five modules (word processor, spreadsheet, database manager, communications, and overall system control), a getting-started booklet, a quick-reference guide, and a small binder of helpful hints, Enable comes with a large keyboard overlay that gives the word-processing and telecommunications commands on one side and the spreadsheet and database-management commands on the other. The Software Group has written all the documentation as a tutorial, which makes it difficult when you just want to look up something, even though the manuals contain extensive indexes.

INTEGRATION AND CONTROL

When you first start Enable, you proceed through a series of menus to your desired function. The software creates a border that displays messages. This border limits the display to a 78-column width.

Enable boots into the Master Control Module (MCM), which integrates Enable's functions. The MCM also controls windowing, file handling, extensive macro capabilities, and a profile of the hardware in your system.

The MCM duplicates most of the operating-system file-manipulation commands. The module lets you select, copy, rename, and erase files from a single menu. However, the MCM doesn't display files that were not created by Enable. The MCM also prevents you from accidentally erasing Enable's system files.

After you choose a profile, the MCM lets you select one of the four applications modules: word processing, spreadsheet/graphics, telecommunications (Telecom),

(continued)

Steve King is a program analyst for the state of California and a part-time writer and consultant. When not working with computers, he enjoys equestrian activities. He can be reached at 17625 Rancho de Oro, Ramona, CA 92065.

AT A GLANCE

Name
Enable 1.0

Type
Integrated software package

Company
The Software Group
Northway 10, Executive Park
Ballston Lake, NY 12019
(518) 877-8600

Format
Three 5¼-inch double-sided floppy disks, MS-DOS 2.0 format

Computer
IBM PC or compatible with at least 256K bytes of memory and two floppy-disk drives; hard-disk drive suggested

Features
Word processing, spreadsheet, database management, graphics, windows, macros, communications, context-sensitive help

Documentation
Five 7- by 9-inch spiral-bound manuals, approximately 150 pages each, three pamphlets, and one keyboard overlay

Price
$695

and database-management system (DBMS)/graphics. Then it helps you choose the file you wish to process. If you don't remember a file's name, enter a question mark and the MCM takes you to the file-control menu. To select the file you want, move the cursor to it and press the enter key.

The Software Group gave Enable's MCM impressive macro capabilities (the ability to execute stored keystroke sequences, including data entry and commands). You can tell Enable to record keystrokes for playback later or, once you have learned Enable's macro language, you can create macro files with the word processor. The Enable disks contain extensive tutorials that impressively demonstrate use of the macro powers.

WORD PROCESSING

I tried Enable's word-processing function first and it almost soured me on the rest of the program. When the word processor starts up, you must set your document margins each time you start a new file.

Next, Enable assumes you want a title page for every new document you create. However, you can move the cursor down past the title page and start entering your text. You can also type the key sequence F9-O-N-T to delete the title page.

The series of keystrokes necessary to delete the title page typifies one of Enable's big problems: In general, the commands are too complicated and require too much moving about the keyboard for easy learning. For example, F2 with the up-arrow and P keys takes you to the beginning of a paragraph; F2-P takes you to the end. Most cursor commands start with F2; most text-manipulation commands begin with F9.

You can also access most text-manipulation commands from a series of menus that the software displays at the top of the screen when you press F10. Since you can't access all commands (such as the title-page command) from the menus, you must frequently refer to the keyboard overlay or the manuals. The overlay is printed in very small type and contains rather cryptic explanations. It was frequently difficult to locate the keystroke sequence I wanted. Usually I resorted to thumbing the pages of the quick-reference guide.

Since the menu command sequences are not similar to the keyboard command sequences, the menus do not help you learn the keyboard commands. In fact, I found that this dissimilarity impeded my learning process. For example, when inserting a page break from the menus, you press F10-L-4; when using keyboard commands, you press F9-Ins-M-P. The Software Group should take a lesson from Mark of the Unicorn and use the same keystroke sequence for menu and keyboard command entry. Mark of the Unicorn's The Final Word brings up a menu if you pause after the command-initializing keystroke or lets you enter the command uninterrupted if you know the correct keystroke sequence.

Despite its clumsy, confusing command structure, the Enable word processor contains almost the same capabilities you'd find in The Final Word, WordPerfect, or WordStar 2000. This program can create headers and footers, tables of contents, indexes, and footnotes. The Enable word processor also has a mail-merge function and can perform extensive boilerplate text manipulation using MCM macros.

However, I had several reformatting problems when I edited my text. The program refused to move a small block of words from one place on a line to another place on that same line.

Sometimes when I deleted or moved a block of text, the software left two spaces in the place from which the block came. Since I couldn't persuade Enable to delete either of the spaces, I was left with two spaces between the remaining words.

If I inserted words into the middle of a sentence, thus forcing the end-of-sentence mark (usually a period) and the two spaces before the next sentence to wrap to the next line, the software dropped one of the two spaces. I had to manually reinsert

(continued)

Want to hear a demonstration of Hewlett-Packard's ThinkJet Printer?

another space to maintain the proper distance between sentences.

The word processor uses its own format for storing files on disks, but it can also store files in ASCII, Volkswriter, EasyWriter, and WordStar file formats. Enable is also supposed to be able to read those other formats. However, when I tried to get Enable to read the BYTE standard word-processor benchmark file, a 40-paragraph ASCII file, it would read only the first line. I used a public-domain utility to convert the benchmark file to WordStar format, but the Enable word processor still would read only the first paragraph of that format.

ENABLE 1.1

BY RICH MALLOY

The new version of Enable corrects many, but not all, of the deficiencies reported by Steve King.

Enable now comes on four floppy disks (utility, system, operation, and tutorial/data) that you must frequently swap in and out of disk drive A. All the disks are copyable, but an Install routine mentioned in the manual does not seem to work. Also, the disk-swap prompt is an irritating sound.

The new word processor can now handle text lines longer than 78 columns (up to approximately 160 columns). To help you set margins, a small window in the screen's lower right corner indicates which column the cursor is in. Also, if a reformatting operation leaves an extra space between words, you can delete the extra space with the Del key. You can turn off the automatic creation of a title page for each new document by changing your system profile. Finally, Enable can read ASCII files fairly easily.

The database manager can now easily merge data files.

The updated spreadsheet offers variable formats from 256 rows by 256 columns to 4095 rows by 15 columns. The spreadsheet can also easily read and recalculate Lotus 1-2-3 worksheets.

The telecommunications module now lets you set up a wide range of communications parameters. It also can do simple auto-log-on procedures. However, this module still has a few simple problems. For example, it stores your desired parameters on the utility disk, but the operation disk looks for these parameters on your data disk.

Some items were not mentioned by Steve King. Enable does not currently support printers made by Star Micronics, C. Itoh, or Mannesmann Tally. No provision lets you modify Enable for additional unsupported printers. When I set up Enable for an Epson MX-80, connected an IBM PC to a Star Micronics Gemini printer, and told the system to print, it locked up irretrievably.

The word processor seems to contain other shortcomings. Copying a block of text seems to cause some paragraph indentation in the block to be lost. And for some reason, the backspace key functions as a reverse space bar; it blanks out the character to the left but does not delete the space. You can change this to a normal backspace function by adjusting your system profile, but the backspace key sometimes reverts to its default behavior for no apparent reason.

Finally, in the system-profile section, you apparently cannot change that part of your system profile that refers to your modem.

After a brief test, I would judge the updated product to be much closer to its advertised claims than the version used by Steve King. Note that because of the extensive disk swapping required, I would discourage Enable's use on floppy-disk systems. Also, like Mr. King, I would have preferred that the publisher had made Enable's menu and command sequences identical. Finally, some procedures, such as Install and the one to set up a particular modem, do not seem to work.

All in all, on a hard-disk system and for certain applications requiring several different functions, Enable appears to be a viable, if somewhat idiosyncratic, product.

Rich Malloy is the New York editor for BYTE. He can be reached at BYTE, McGraw-Hill, 43rd Floor, 1221 Avenue of the Americas, New York, NY 10020.

DATABASE MANAGEMENT

Of Enable's functions, I found the database-management system and the spreadsheet to be the most logical and the easiest to use. The DBMS module contains almost all the capabilities of popular middleweight database managers such as dBASE II or Condor 3. However, Enable allows the use of, but not yet the merging of, multiple data files. Although the Enable DBMS module doesn't contain a built-in programming language, as dBASE II and Condor 3 do, the MCM's macro capabilities combined with Enable's report language let you design sophisticated data-management programs, such as general ledgers or inventory-control modules.

The Enable DBMS can read dBASE II data files directly. Since The Software Group also provides a utility program, Convert, that translates ASCII-format data files to Enable format, the Enable DBMS can use files created by almost any other database program. I imported a 1260-record mailing list into Enable that Condor 3 had created. I simply told Condor 3 to store the file with fixed-length fields in ASCII format and then used Convert to finish the conversion process.

Each record in an Enable database file can have up to 32 fields (like dBASE II and Condor 3) of entered data or up to 113 fields containing data that is derived or calculated from the entered data. However, each record is limited to 2000 characters.

With Enable, you design a database with a series of menus that lets you specify the type and limits for each field. The software lets you specify an amazing number of details about the limitations for each field, including whether data is entered from the keyboard, derived from another database or from another field, or copied from the operating system.

Next, Enable helps you design the data-entry forms for each database.

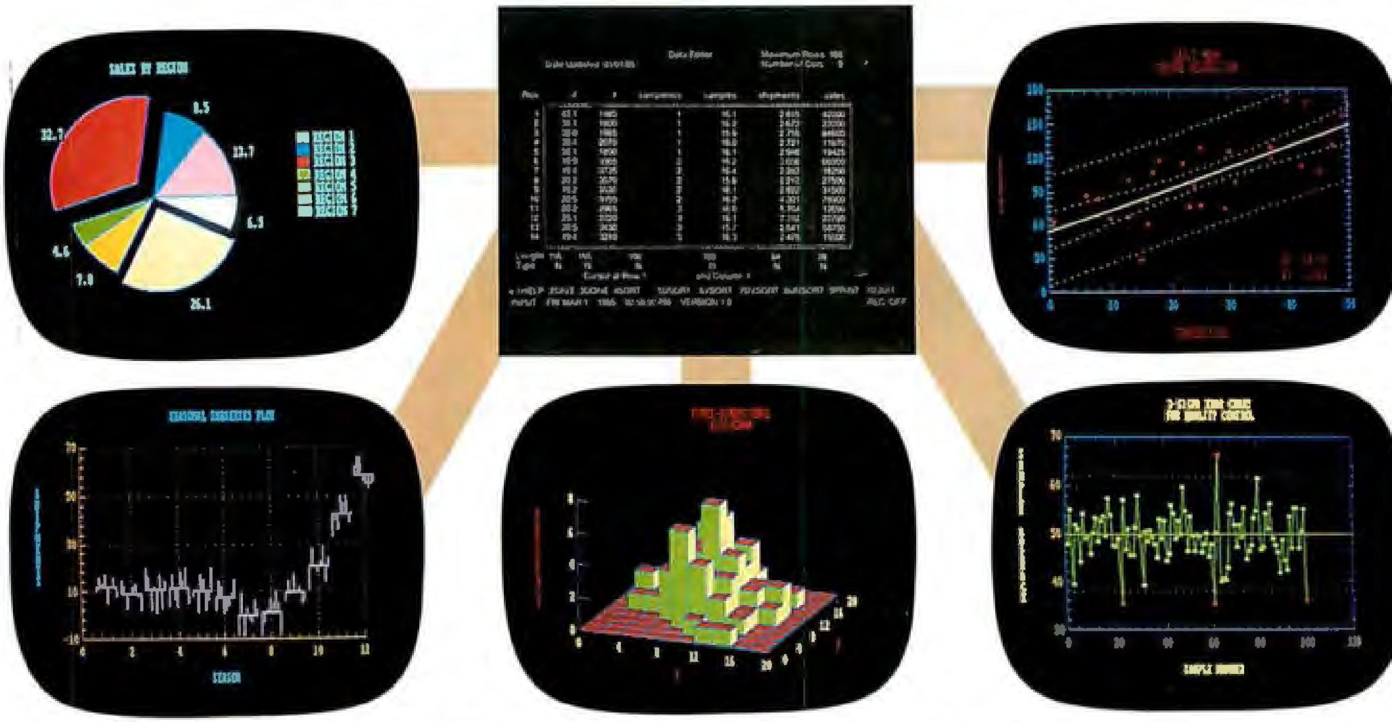
(continued)

*U.S. list price. PG02511

STATGRAPHICS®

ONE KEYSTROKE TURNS LIFELESS DATA...

NEW VERSION 1.



INTO VITAL STATISTICS.

Data. You live with it every day. What you need are the tools to make it come alive. Comprehensive analytical tools. Mathematical precision. And graphics capabilities to broaden your insights—to help you visualize, analyze, and communicate your findings quickly and convincingly.

And now you've got it. With STATGRAPHICS—a new PLUS★WARE™ product from STSC. STATGRAPHICS is the only PC software to fully integrate a wide variety of statistical functions with high-resolution color graphics. Giving you the power and precision you used to find only with mainframe software.

STATGRAPHICS' unique interactive environment allows you to generate graphs from within the statistical procedures. You can change a variable and see the effect—immediately. So your job is easier and you're more productive.

MORE OPTIONS FOR MORE COMPREHENSIVE ANALYSIS.

STATGRAPHICS features over 250 functions for analyzing data—including analysis of variance, regression analysis, experimental design, quality control procedures, multivariate techniques, nonparametric methods, and extensive forecasting and time series analysis.

It also lets you enter data at the keyboard or access data stored in standard ASCII files, LOTUS® 1-2-3 worksheets, and DIF files used by other popular software packages.

TELL A CLEARER, MORE DRAMATIC STORY.

STATGRAPHICS includes a wide variety of graphics programs such as two and three-dimensional line and surface plots, bar and pie charts, histograms, time sequence plots, and quality control charts.

The graphics are supported on color and monochrome graphics boards, dot-matrix printers, and pen plotters for presentation quality graphics.

SOPHISTICATED STATGRAPHICS IS SURPRISINGLY SIMPLE TO USE.

STATGRAPHICS is completely menu-driven, and includes a comprehensive user's guide, online HELP screens, tutorial, and handy reference card. And STSC's HELP-Line is only a phone call away—giving you ready access to our staff of technical experts.

TAKE A LOOK AT STATGRAPHICS. AND LOOK NO FURTHER.

STATGRAPHICS is the most advanced statistical graphics software available for PC's. And the complete system is just $695.

To order STATGRAPHICS, or for more information, contact your local dealer or call **800-592-0050** (in Maryland, **301-984-5123**). Or write STSC, Inc., 2115 E. Jefferson St., Rockville, MD 20852. Major credit cards accepted.

Inquiry 340

Problem-solving at the speed of thought.

STSC
A Contel Company

STATGRAPHICS operates on IBM PC's and compatibles under DOS, Version 2.0 or later. A minimum of 384K RAM, a graphics adapter and compatible monitor, and two double-sided disk drives or a hard disk are required. An 8087 math coprocessor and 512K RAM are recommended.

REVIEW: ENABLE

While designing an entry form, you can access the word-processing module to add text enhancements that give instructions to the data-entry person. You can also specify a verification method that requires entering a particular field twice when accuracy is important.

Finally, the DBMS module lets you design reports in almost the exact way that you design data-entry forms. However, The Software Group also has included a rudimentary programming language for creating reports in Enable. Using the word processor, you can construct a report with a series of dot commands (words preceded by a period, or dot). The report language contains .if, .elseif, .else, .exit, and .endif commands to handle conditional situations.

When you are not designing a new database, you can bypass the DBMS menu and enter direct commands to the software as you do when using the word-processing module. The F9 key initiates these commands but, once again, no relationship exists between the menu command sequence and the keyboard command sequence.

SPREADSHEET

Since I don't own Lotus 1-2-3, I borrowed a friend's copy for comparing it to the Enable spreadsheet. Enable's spreadsheet looks like 1-2-3 and has a similar command structure, but it offers a maximum worksheet size of only 255 rows by 255 columns. However, my friend, who is much more of a spreadsheet expert than I am, believes Enable's spreadsheet size is more than adequate for most uses.

Since I normally use the Report Manager spreadsheet from Datamension (Northbrook, Illinois), which allows 256 pages of spreadsheets as well as 256 rows and 256 columns per page, I found both the Enable spreadsheet and 1-2-3 somewhat limiting. Report Manager's third dimension (pages) lets you generate multiple related spreadsheets, such as a budget page for each month of a year.

The Software Group incorporated

(continued)


BOX. OFFICE HIT.
Most software companies would call it a stroke of luck if they designed a system so effective, it became the small business favorite.
We call it a stroke of genius.
CYMA
McGRAW-HILL
800-292-CYMA

most typical spreadsheet capabilities in Enable, such as range commands and global formatting. Enable also has many mathematical functions, including business functions (e.g., amortization payments and internal rate of return), scientific functions (e.g., sine and cosine), and logical/conditional functions (e.g., choose, if, true, and false). The Enable 1.0 spreadsheet can also save files in 1-2-3, VisiCalc, and DIF formats, but strangely enough cannot read files in those formats.

GRAPHING

Both the database and spreadsheet modules let you design graphics images on the video screen if your PC has graphics capabilities.

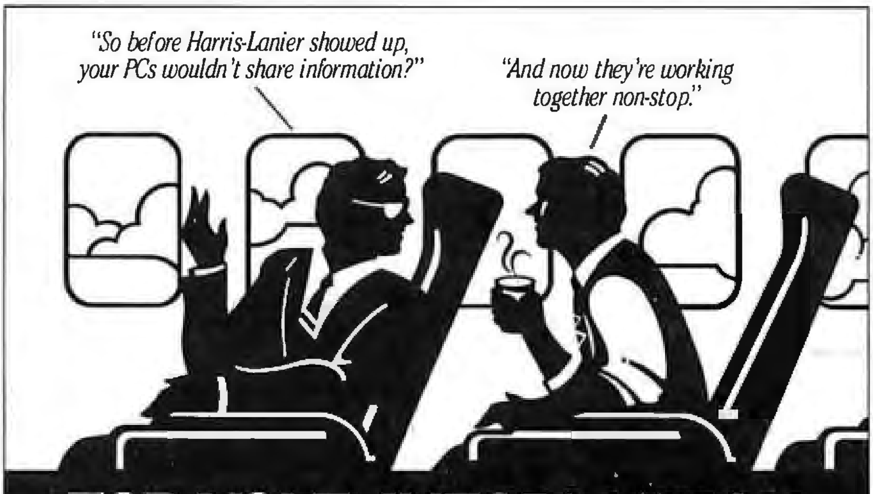
Enable can create vertical bar graphs in two and three dimensions, as well as pie charts and line graphs. I found Enable's graphs much easier to format and print than those created by 1-2-3, Report Manager, and Condor Graf. You can design various levels of titles for graphs and embellish them with nine different fonts.

TELECOMMUNICATIONS

Enable's telecommunications module is its weakest point. It requires even more disk swapping than the others and has some severe bugs. For example, after you choose Telecom from the main MCM menu, Enable lets you select Communicate or Setup. Setup supposedly lets you change communications parameters. When I tried to use Setup, however, the program beeped repeatedly and instructed me to insert the tutorial/data disk. Enable never accepted the disk asked for and, thus, never let me change the communications setup.

I did manage to convince Enable to communicate by using the Communicate selection to access the program's terminal mode. I called a bulletin-board system and tried to download a public-domain program using the XMODEM error-checking protocol. Unfortunately, after you tell Enable to receive a file using XMODEM, the program prompts you to swap a disk before it begins to receive the file.

(continued)

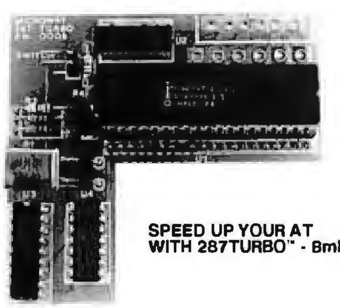


MicroWay is the world's leading retailer of 8087s and high performance PC upgrades. We stock a complete selection of 8087s that run at 5 and 8mhz. All of our coprocessors are shipped with a diagnostic disk and the best warranty in the business – one year! We also offer daughterboards for socketless computers such as the NEC PC and PCjr, and a board which increases the clock speed of the 80287 from 4 to 8 mhz. Our NUMBER SMASHER™ includes 512K ram. It will run the IBM PC at clock speeds up to 10mhz and achieves a throughput of .1 megaflops with 87BASIC/INLINE, Intel Fortran, or Microsoft Fortran. Software reviewers consistently cite MicroWay software as the best in the industry! Our customers frequently write to thank us for recommending the correct software and hardware to meet their specific needs. They also thank us for our same day shipping! In addition to our own products which support the 8087 and 80287, we stock the largest supply of specialized software available anywhere. For information call us at

617-746-7341

FASTBREAK™. . . MicroWay's software turns on your 8087 during 1-2-3™ execution. Recalculations run up to 36 times faster. When used with the NUMBER SMASHER™ it can provide a total increase in 1-2-3™ execution speed of up to 79 to 1. FASTBREAK provides you with the unique capability for running other programs on top of 1-2-3. These programs can be written in BASIC, PASCAL, Fortran or C and can access the current values in your 1-2-3 worksheet........................ **$79**

FASTBREAK & 640K NUMBER SMASHER ... $1099



SPEED UP YOUR AT WITH 287TURBO™ - 8mhz

MicroWay®
8087 Support

For the IBM PC, PC XT, PC AT and Compatibles.

NUMBER SMASHER™ The World's Fastest Accelerator Card for the IBM PC, XT, and Compatibles! Includes an 8086 and 8087 pair tested to 10mhz, and 512K bytes of high speed ram. Compatible with all software, operating systems and hardware! Your program speed is increased by a factor of 2.5 to 4.0. Floating point programs run up to 2.8 times faster on the PC than on an 80287 equipped PC AT **$1049**

MATRIXPAK™ manages a **MEGABYTE!** Written in assembly language, our runtime package accurately manipulates large matrices at very fast speeds. Includes matrix inversion and the solution of simultaneous linear equations. Callable from MS Fortran 3.3, 87MACRO, and 87BASIC/INLINE .... each **$150**

87FFT™ Written in assembly language, performs Forward and Inverse FFTs on real and complex arrays which occupy up to 512K bytes of RAM. Also does convolutions, auto correlations, hamming, complex vector multiplication, and complex to radial conversions. Callable from MS Fortran, 87MACRO, C, TURBO PASCAL or 87BASIC/INLINE......................... **$200**

87FFT-2™ performs two-dimensional FFTs. Ideal for image processing. Requires 87FFT **$100**

GRAPHICS PACKAGES

Grafmatic for Fortran or Pascal............ **$125**
Plotmatic for Grafmatic.................... **$125**
MultiHalo (one language)................. **$189**

DFixer™ – Eliminates the AT hard disk problem! A disk which thoroughly checks PC or AT hard disks for bad sectors and updates the MS DOS file allocation table accordingly...... **$149**

EPSILON™ - our favorite in-house editor lets you simultaneously edit up to 11 source files and concurrently run a compiler or linker. A real timesaver! **$185**

87BASIC/INLINE™ converts the output of the IBM Basic Compiler into optimized 8087 inline code which executes up to seven times faster than 87BASIC. Supports separately compiled inline subroutines which are located in their own segments and can contain up to 64K bytes of code. This allows programs greater than 128K! Requires the IBM Basic Compiler and Macro Assembler. Includes 87BASIC **$200**

87BASIC™ includes patches to the IBM Basic Compiler and both runtime libraries for USER TRANSPARENT 8087 support. Provides super fast performance for all numeric operations including trigonometrics, transcendentals, addition, subtraction, multiplication, and division.... **$150**

87MACRO/DEBUG™ - contains all the pieces needed for writing 8087/80287 assembly code including 8087 macros, object libraries for commonly used functions, including transcendentals, trigonometrics and conversions between strings and real numbers. Our 87DEBUG completes the package **$199**

OBJ→ASM™ - a multipass object module translator and disassembler. Produces assembly language listings which include public symbols, external symbols, and labels commented with cross references. Ideal for patching object modules for which source is not available **$200**

RTOS - REAL TIME OPERATING SYSTEM
RTOS is a multi-user, multi-tasking real time operating system. It includes a configured version of Intel's iRMX-86, LINK-86, LOC-86, LIB-86, OH-86, and MicroWay's 87DEBUG. Runs on the IBM-PC, XT, PC-AT and COMPAQ................. **$400**

INTEL COMPILERS[1]

FORTRAN-86.............................. **$750**
PASCAL-86............................... **$750**
PL/M-86................................. **$500**
ASM-86.................................. **$200**

[1]Requires RTOS or iRMX-86. All Intel compiler names and iRMX-86 TM Intel Corp.

8087 5mhz................ **$109**
Including DIAGNOSTICS and one-year warranty For IBM PC and compatibles.

8087-3 5mhz.............. **$175**
For the Tandy 1200.

8087-2 8mhz.............. **$175**
For Wang, AT&T, DeskPro, NEC, Leading Edge.

80287-3 5mhz............ **$199**
For the IBM PC AT and Compaq DeskPro 286.

287Turbo™ 8 mhz..... **$395**
With Reset Button and Diagnostics.

64K RAM Set.................. **$8**
256K RAM Set.............. **$29**
256K CMOS RAM Set... **$39**
128K RAM Set PC AT.... **$89**
AST Boards......................... **CALL**
JRAM-2™ (ØK)....................... **$169**
JRAM™ AT (ØK)...................... **$229**
JRAM-3™ (128K)..................... **$275**
INTEL ABOVE BOARD.......... **CALL**

FORTRAN, C and BASIC

Microsoft Fortran Version 3.3............ **$229**
IBM Professional Fortran.................. 545
Ryan-McFarland Fortran.................... 399
FORLIB+ or STRINGS and THINGS......... 65
Lattice C or Microsoft C Version 3.0........ 299
FLOAT87 150
IBM Basic Compiler Version 2.0............ 445
Microsoft Quick Basic 89
Summit BetterBASIC™....................... 175
True Basic.................................. 105

MACRO ASSEMBLERS

IBM Assembler with Librarian V. 2.0........ 155
Microsoft Assembler Version 3.01.......... 125

PASCAL and APL

Microsoft Pascal Version 3.3............... 199
Borland Turbo with 8087 Support............ 85
STSC APL★PLUS/PC........................ 450
STATGRAPHICS............................ 595
COSMOS Revelation........................ 750
Phoenix Plink86............................ 295
SPSS/PC 595

European Customers: Please call MicroWay in London at 01-223-7662.

MicroWay
P.O. Box 79
Kingston, Mass.
02364 USA
(617) 746-7341

The World Leader in 8087 Support!

After it has received the file, Enable prompts you for another disk swap before it returns to the terminal mode.

After three attempts, the public-domain program I downloaded would not run. Yet, when I downloaded the same program with another communications package, the public-domain software worked properly.

A Test

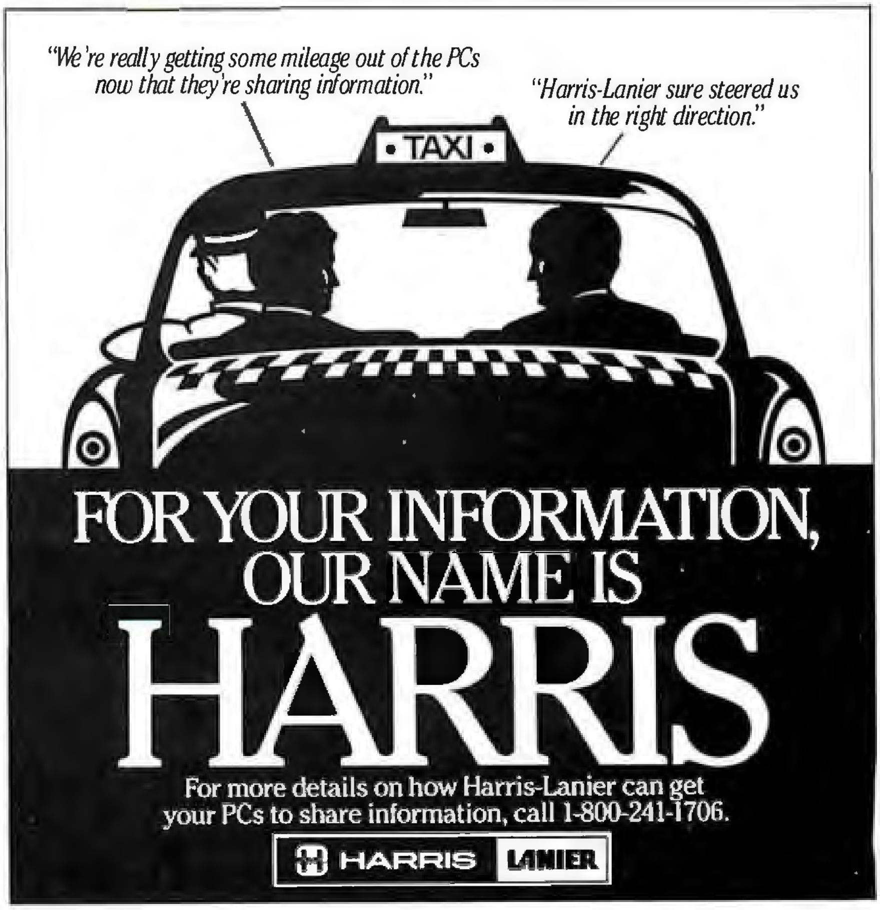
To put Enable to a good test, I used a data-entry-and-report form that my coworkers and I designed for collecting restaurant and restroom data in our area for use in a "restaurant and restroom survival manual." I originally designed two similar databases, one for restaurants and one for restrooms. But after some experimenting, I learned that the menu command allowing the merging of two databases was not yet implemented. So, I entered both types of facilities into a single database, using a true/false conditional field to differentiate between a restaurant and a restroom.

Next, I spent about 12 hours entering the data for the survival manual. Then I used the Enable word processor for several more hours to write a witty preface. Finally, with the Enable word-processing module running and the preface on the screen, I pressed F10 to access the program's command menu. It offered me a number of choices. I chose DBMS to integrate the restaurant and restroom database with my text. That's when Enable told me: "Function will be available in first Enable update."

Of course, maybe it was my own fault. I hadn't read anything about using that particular menu command in any of the manuals. Fortunately, the documentation did offer another method for combining the two files.

Following the manual's instructions, I rebooted the word processor with the preface text. With the MCM, I switched windows and ran the database module. I used the display command to access my database. It showed the database on the screen with each record occupying one line. However, if a database were to con-

(continued)



I ALWAYS GET THE BEST OF BOTH!

LOOK
NEW FEATURES

TURNOVER™

"Wireless file transfer" between IBM PC and APPLE II disk. Read, write and format APPLE II disks in your IBM disk drive. Transfer any disk file from APPLE to IBM, or from IBM to APPLE. No serial cables, no modems, no hassles and no problems.

The TURNOVER board plugs into any slot of your IBM PC, XT and some IBM compatible computers, supplied with special software running under PC-DOS or MS-DOS. TURNOVER will read, write and format APPLE-DOS 3.3, APPLE CP/M, Pro-Dos, APPLE p-System and Apple III SOS disks in your IBM.

TURNOVER is a fast and simple alternative to complicated modem and serial links for file transfer.

XENO-COPY PLUS™ 4.0

The latest release of an award-winning software utility. "Wireless file transfer" between IBM PC and most other disk formats. Read, write and format **220 different disks** in your IBM disk drive. Transfer any disk file from your "other" computer to IBM, or from IBM to your "other" computer. Eliminates slow, complicated serial links.

XENO-COPY PLUS reads, writes and formats 40 and 80 track 5¼" disks as well as 3½" disks. Transfer files from CP/M, MP/M. **XENO-COPY PLUS even handles non-IBM MS-DOS disk formats.** A new, fully-integrated user interface makes this software quick and easy to use.

XENO-COPY PLUS runs on the IBM PC, XT, AT and almost all compatibles under PC-DOS or MS-DOS.

XENO-DISK

The enhanced version of XENO-COPY PLUS for professional applications. XENO-DISK offers all the capabilities and features of XENO-COPY PLUS. In addition, XENO-DISK will read, write and format 8" disk formats. **Eight different 8" formats are supported** including 3741 and CP/M. An optional 5" and 8" disk controller card is also available.

XENO-DISK also reads, writes, and formats **Compugraphic MCS disks** for wireless file transfer between typesetters and your computer.

TURNOVER™

XENO-COPY PLUS™ 4.0

XENO-DISK™

Vertex systems inc.

INNOVATION IN MICROCOMPUTER PRODUCTS!
6022 West Pico Blvd.
Los Angeles, CA 90035 **213/938-0857**

SEE YOUR DEALER OR CALL FOR INFORMATION.

Inquiry 410 for End-Users. Inquiry 411 for DEALERS ONLY.

tain more than 78 characters per record, the program would let you scroll as far right as necessary to view the entire record, similar to a spreadsheet. Since my database contained two comment fields (for directions and comments) of 127 characters each, my records scrolled a long way to the right of the screen window.

Still following instructions, I marked the whole database as a block and returned to the word-processing window. I told Enable to move the block into my text. The program carried out my command, but each record extended to the right beyond the word-processor screen window.

Unfortunately, the word processor could not scroll to the right. When I tried to scroll to the right to look at the results, my PC locked up and I had to reboot and repeat the procedures. Then I tried to reformat the database, but that didn't work either and, after several tries, my computer froze again.

I finally gave up on Enable for the survival-manual project.

SUMMARY

As all reviewers do after completing their projects, I'm returning Enable to BYTE along with this review (needless to say, I did not write it with the Enable word processor). I am totally disenchanted with Enable's awkward, difficult-to-learn command structure and unimplemented features.

Software manufacturers encounter enormous costs and delays as they develop their products. However, I don't believe consumers should be forced to endure bugs and unimplemented features such as I found in Enable 1.0.

Enable is a powerful program and probably the most successful attempt so far at a single software package that integrates the most common uses for microcomputers: word processing, database management, spreadsheets, and communications. Although I've heard version 1.1 is better, I found Enable 1.0 not quite ready and able because it is plagued by bugs, incomplete functions, and a clumsy disk-swapping scheme. ■

R·E·V·I·E·W F·E·E·D·B·A·C·K

Toshiba P1340

I have become a bit puzzled about the reviews for printers in BYTE the past year or so, particularly after purchasing a Toshiba P1340 printer.

The review of the Epson LQ-1500 (BYTE, December 1984, page 293) gives a sample of print from the P1340 that was made with a printer that was not working properly (see Maxim Smith's letter in Review Feedback, May 1985, page 299). The same is true of reviews of the IBM Quietwriter (June 1985, page 385) and the P1340 itself (October 1985, page 305). The print samples from the P1340 in all three of these reviews were done with P1340 printers that were not working properly.

When I got my P1340, I was warned that it was common for the flexible cable from the printer body to the print head to work loose, or partly loose, and that I would need to be sure that it was securely connected. Until I did this, my printer did not print properly.

Whatever the cause, the P1340 can (and should) print better than the examples shown in BYTE. Reviews of the P1340 should warn buyers about the possibility of loose cable connection, or whatever causes the problem.

Dennis P. McGuire
Minneapolis, MN

I want to compliment your review of the Toshiba P1340 printer. I was particularly impressed that the reviewer, Rich Malloy, accurately reported the machine's usable fonts, rather than repeating the erroneous specifications advertised by Toshiba.

It should be emphasized to your readers that this machine does *not* have a usable letter-quality font at 12 characters per inch, despite the fact that Toshiba implies such a font in its advertising and in the user's manual for the P1340. In fact, my experience with Toshiba after purchasing a P1340 suggests a disdain on the part of Toshiba for its customers; this might be of interest to any of your readers contemplating the purchase of a Toshiba printer.

Readers should know that an executive of the company told me that since I had purchased the printer from a discount house, at a below-list price, I had no right to expect Toshiba to accept return of the printer. Had I purchased the machine from an authorized, "full-price" dealer, Toshiba would have accepted a return.

Altogether, my experience with the Toshiba P1340 was very unsatisfactory. That is too bad, because in many respects it is a very nice printer. My advice is to look for a manufacturer that has some regard for its customers and for the integrity of its advertising.

Eugene H. Levy
Tucson, AZ

Deskpro Graphics

In the August 1985 Review Feedback (page 283), Bryan Mumford made a note that the Compaq Deskpro will not run any of the popular graphics cards, such as the Hercules card. This is not quite the case. The monitor supplied with the standard Deskpro will not run on these cards.

When I saw this letter, I went to the local Micro Mart; they assured me that the Deskpro will run these cards. I have seen Deskpros running a Sigma Color Design 400 with a Princeton Graphic Systems SR-12 Monitor. They also claim that they have sold Deskpros with Tecmar Graphics Master cards and several other graphics cards, but not with the Deskpro monitor. One suggestion to Mr. Mumford: See if the Princeton Scan Doubler will work with the Compaq Graphics Adapter; that will give you 640 by 400 resolution on the Compaq monitor.

Andrew Bowen
Bethel Park, PA

Stearns Desktop

The review of the Stearns Desktop Computer (October 1985, page 264) by Wayne Rash Jr. mentioned some severe problems without correctly identifying the causes.

Though I left Stearns in May 1985, I was the hotline support specialist who answered Mr. Rash's telephone questions and inspected the Stearns computer after he returned it. The computer he used for the review was in BYTE's possession for over a year and had been visibly damaged in one (or more) of the three (or was it four?) shipments that BYTE arranged for the computer. The unit had been dropped so hard that the hardened plastic case cracked, freeing the case's retaining screws. One of these loose screws lodged under the main computer board (affecting the keyboard interface), a second was found in the power supply, and the third was near the disk controller. When the screws were removed, the keyboard and disk drives functioned perfectly. Few electronic devices function well (if at all) when shorted.

Perhaps, in retrospect, I should have been more insistent about shipping a replacement unit. After all, the first dealer service provided to Mr. Rash was removal of a piece of the plastic case from the interior of the floppy-disk drive. He repeatedly refused my offers to send a unit directly from the factory—an admirable attempt by BYTE to maintain continuity and integrity, but a mistake in this case.

Carol L. Jahnke
Bloomington, MN

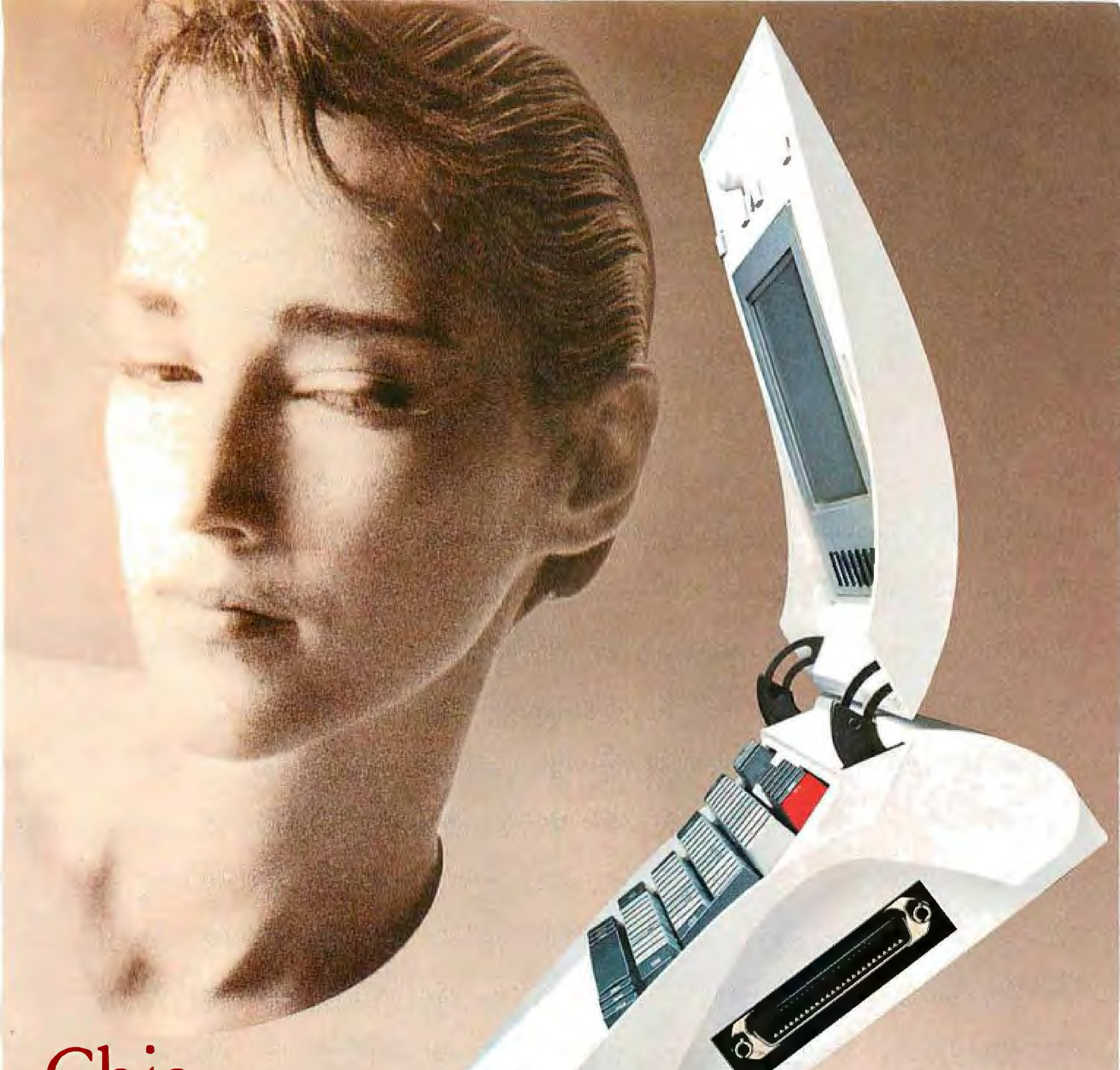
For the most part, Ms. Jahnke's reply may accurately reflect the condition of the computer when it arrived in the Stearns offices. I did not notice any severe damage to the machine when I had it, but it was shipped twice more after that. I should note, however, that I would have expected the local service representative to bring such damage to my attention during one of his numerous visits. Since the service rep said nothing, I had to assume that the machine was in optimum operating order.

I should also add that Ms. Jahnke was the model of patience and helpfulness during the time I had the computer. I wish that other computer companies would staff their hotlines with people like her.

Finally, let me add that even had the machine operated flawlessly, my findings as to the utility of the machine, its level of compatibility, and the level of documentation would still stand and would still lead me to make the same recommendation as to its desirability.

—Wayne Rash Jr. ■

REVIEW FEEDBACK *is a column of readers' letters. We welcome responses that support or challenge* BYTE *reviews. Send letters to Review Feedback,* BYTE *Publications,* POB 372, *Hancock,* NH 03449. *Name and address must be on all letters.*



Chic.

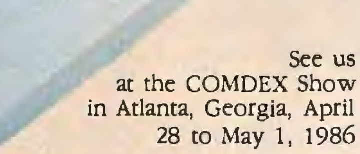
Seldom are computers thought of as beautiful.

But out of every thousand, there is always one that catches the eye. Such a computer is the stunning new *WS-1*.

The audition starts when you open the flip-top of this intriguing portable. Switch on, and the WS-1 becomes a word-processor, a spreadsheet, a database, or a graphics tool.

Stay in touch, with the WS-1's built-in autodial modem, speaker phone, and cassette mechanism. Send files, take calls, or even run the WS-1 as an answering machine!

See us at the COMDEX Show in Atlanta, Georgia, April 28 to May 1, 1986



The WS-1 offers some surprises inside too. Such as a powerful 16/32-bit 68000 microprocessor, ROM-based multitasking Operating System, and APL interpreter. Or features like the high-contrast 25 × 80 bit-mapped graphics LCD, RAM expansion up to 512K, and optional 3.5-inch microfloppy disk drives.

All this power comes in a sleek footprint of only 11 × 13 inches. We think you'll agree that the WS-1 really is one out of a thousand.

ampère

Inquiry 19

FOR DISTRIBUTORSHIP INFORMATION AND PRODUCT DETAILS PLEASE CONTACT:

ampère INCORPORATED Asahi Bldg., 7-5-20 Nishi-Shinjuku, Shinjuku-ku, Tokyo, Japan. *Phone:* 03-365-0825. *Telefax:* 03-365-0999. *Telex:* J33101 AMPERE. IP Sharp Mail Box Code AMP (Group Code APLWS).

WORK SPACE COMPUTER INC. U.S. REPRESENTATIVE OFFICE. 3848 Carson St. Suite 301 Torrance, California 90503, U.S.A. *Phone:* 213-540-1553. *Telex:* 322800 WORKSPACE

Kernel

One minor problem. That's all it was—nothing more. We've all had them. In fact, most of us have them every day. In Jerry's case, however, the one minor problem kept going on and on and on. It just happened to be the day before Friday the 13th. Although it turned out to be a day that Jerry would not care to relive, he did learn some lessons from it and still has the highest praise for what personal computers can do.

With the big move to Utah finally completed, Bruce Webster feels that he is ready to start working again. This month's According to Webster deals largely with the subject of benchmarks. Bruce discusses what characteristics they should have, how to interpret them, and factors other than performance you should consider. He also makes a number of predictions for 1986 and promises to review them at the end of the year.

This month in BYTE Japan, Bill Raike focuses on the new NEC computers in the PC-9801 series, which no longer have the 8086 but are quite a bit faster. Another new Japanese product that Bill reports on is the long-awaited Japanese-language version of the Macintosh and some software that comes with it. It is the result of the linkup between Apple and Canon and is actually a kanji-character ROM board that's been piggybacked onto the main board of a 512K-byte Macintosh. Finally, Bill discusses the Fujitsu lap-size portable computer that he reported on in last August's BYTE Japan. It is now called the FM-16π and is available at very reasonable prices, but only in Japan.

The events leading to the development of the Acorn RISC Machine, or ARM, is the topic of BYTE U.K. Dick Pountain covers the background provided by previous Acorn machines and describes the goals of the design team and how they were implemented in this RISC processor.

In Mathematical Recreations, Bob Kurosaka returns to the subject of repeating decimals, covered in his November column. That column concluded with an algorithm for converting repeating decimals into fractions. This month's column presents a program to implement that algorithm.

THE PROGRAMMER'S SHOP™

helps save time, money and cut frustrations. Compare, evaluate, and find products.

SERVICES
- Programmer's Referral List
- Compare Products
- Help find a Publisher
- Evaluation Literature FREE
- BULLETIN BOARD - 7PM to 7AM 617-826-4086
- Dealer's Inquire
- Newsletter
- Rush Order
- Over 700 products

[redacted]

ExpertEASE - Inductive. PCDOS Call
EXSYS - All RAM, Probability. Why. Trees, Solid, files, popular PCDOS $359
INSIGHT 1 - Probabilities, required thresholds, menus, fast PCDOS $ 95
INSIGHT 2 - adds backward, forward, partitions, dB2, lang. access. PCDOS $449
Others: APES ($359), Advisor ($949), ES Construction ($100), ESP ($845), Expert Choice ($449), more.

AI-LISP

	List	Our
GC LISP - "Common", rich.		
Interpreter - Interactive Tutorial	495	Call
LARGE Model - 2 to 15 meg.	695	649
Compiler and LM Interpreter	1190	1045

TLC LISP - "LISP-Machine" - like, all RAM, classes, turtle graphics, 8087, **compiler.** CPM-86, MSDOS $235
WALTZ LISP - "FRANZ LISP" - like, big nums, debug, CPM-80, MSDOS $149
Others: ExperLISP ($439), IQ LISP ($155), TransLisp-PC ($75), BYSO ($125), MuLISP-86 ($199)

[redacted]

ARITY PROLOG - full, debug, ASM, C, virtual. **Compiler** $1950 MSDOS $495
MPROLOG - Rich syntax, editor, segment work space, portable. PCDOS $725
Prolog-86 - Learn Fast. Standard, tutorials, samples MSDOS Call
Others: Prolog-1 ($359), Prolog-2 ($1895), MicroProlog ($229), Prof. MicroProlog ($359).

[redacted]

BRIEF Programmer's Editor - undo, windows, reconfigure PCDOS Call
C Screen with source 80/86 $ 75
EMACS by UniPress - powerful, multifile, windows, DOS, MLISP. programming. Source: $949 $299
Entry System for C - Bellesoft PCDOS $325
FirsTime by Spruce - Improve productivity. Syntax directed for Turbo ($69), Pascal ($229), or C ($239)
PMATE - power, multitask 80/86 $159
VEDIT - well liked PCDOS $119
XTC - multitasking PCDOS $ 95

Feature

Paragon PASCAL - for performance: extensions like "packages"; "Iterators"; 5 memory models; 64 bit 8087; strings. Space vs. speed optimization options. MSDOS $895

SERVICE: FREE NEWSLETTER

Software development and AI on micros: trends, forecasts, controversies, innovations, and techniques. Plus announcement of 80 NEW tools. CALL for "Newsletter Packet."

[redacted]

BDS C - solid value, fast CPM80 $125
C86 by CI - 8087, reliable MSDOS Call
Lattice C - from Lifeboat MSDOS $289
Lattice C - from Lattice MSDOS $339
Consulair Mac C w/toolkit MAC $299
Megamax - tight, full MAC $239
Microsoft C 3.0 - new, tight. MSDOS $259
Q/C 88 by CodeWorks - **Compiler source**, decent code, cross/native MSDOS $295
Williams - source debug. MSDOS $399
Wizard C - Lattice C compatible, full Sys. III, lint, fast. MSDOS $399

[redacted]

C-terp by Gimpel - full K & R, .OBJ and ASM, large progs. MSDOS $249
INSTANT C - Source debug, Edit to Run-3 seconds MSDOS $399
INTRODUCING C - Interactive C to learn fast, tutorial PCDOS $115
RUN/C - improved MSDOS $109

[redacted]

Blaise C Tools 1 ($109), C Tools 2 $89
C Food by Lattice - ask for source $119
C*LIB by Vance $125
C Utilities by Essential - 300+ $149
Greenleaf Functions - portable & ASM $149
Polytron - for Lattice, ASM source $ 99
Software Horizons - Pack 1 $129

[redacted]

COMMUNICATIONS: Asynch Mgr $175
Greenleaf - full, respected $149
Software Horizons - Pack 3 $139
FILES: Btrieve - multilanguage $199
C Index by Trio - full B + Tree, vary length field, multi compiler
/File is object only $ 89
/Pro is partial source $179
/Plus is full source $349
C Tree by Faircom - source, port. $349
dbcISAM by Lattice for dB2 or 3 $219
dbVISTA - full indexing, plus optional record types, pointers. Network.
Object only - MS C, LAT, C86 $179
Source - Single user $459
Source - **Multiuser** $929

Ask about Atari ST, Amiga

Note: All prices subject to change without notice. Mention this ad. Some prices are specials. Ask about COD and PO's. All formats available.

Call for a catalog, literature, and *solid* value

800-421-8006

THE PROGRAMMER'S SHOP™
128-B Rockland Street, Hanover, MA 02339
Mass: 800-442-8070 or 617-826-7531 1085

[redacted]

dBASE to C translator: dBX - no royalties, addon ISAM, MSDOS $ 350
Source $1000

[redacted]

C Debug - Source debuggers - by Complete Soft ($269), MSD ($149).
C Sharp - well supported, Source, realtime, tasks MSDOS $600
C Sprite Debugger by Lattice $149
C ToolSet - DIFF, xref, source $135
PC **Lint** - full C program checking and big, small model. All C's $119

[redacted]

ECO C/88 by Ecosoft $ 50
Introducing C - Step by step training $109
TransLisp-PC - "Common Lisp", tutorial, graphics, 230 functions, samples $ 75
Modula 2 by ITC - Windows, tight $ 80
Prolog-86 - enhanced, DOS, Edit Call
Quick BASIC by Microsoft - Compile BASICA, Link $ 79
Snobol4+ by Catspaw - Strings $ 85
Turbo Edit/Assembler $ 85

[redacted]

BORLAND: Turbo 3.0 $ 49
3.0 with 8087 or BCD $ 79
3.0 with 8087 and BCD $ 85
Turbo Graphix - graphs, windows $ 39
Turbo Toolbox or Editor $ 55
Turbo Tutor $ 29
TURBO . . . Asynch by Blaise, full $ 89
MetaWindow by Metagraphics $ 49
Power Tools by Blaise - library $ 89
Power Utilities - profiler, pp $ 89
Professional - interrupts, macros, $ 50
OTHERS: FirsTime ($69), Screen Sculptor ($99), Pascal Pac ($100), Tidy ($45), Multi Halo ($95).

[redacted]

Forlib+ by Alpha - graph, comm. $ 59
MACFortran by Microsoft - full '77 $239
PolyFortran - xref, pp, screen $149
Prospero - '66, reentrant $390
RM Fortran - enhanced "IBM Ftn" $429
Scientific Subroutines - Matrix $149
Strings and Things - registers, shell $ 59

[redacted]

Advanced Trace 86 Symbolic, rewrite Assembler $149
Btrieve/N ($469), single user $199
Codesifter - executive profiler $109
LMK Make by Lattice $159
MultiHalo - full $199
Panel - Screens, windows $239
Periscope II symbolic debugger $129
PFinish - Profile by line, routine $299
PLink-86 - 32 levels, overlays $289
PolyLibrarian - Manage .OBJs $ 89
TexSys - Source code control $ 89

COMPUTING AT CHAOS MANOR

One Minor Problem

BY JERRY POURNELLE

I've been back from Europe for nearly a month, during which time I've answered 532 letters, thrown out 11 9-gallon trash bags of paper, and caught the flu. Withal, things have almost settled to normalcy. The construction is finished, *most* of the archaeological layers of mail have been answered, many of my books have been taken from boxes and shelved, and some of the great software inflow has been organized. I've even had time to work on a novel. On the other hand . . .

Day of the Locust

It was *not* Friday the 13th. It was the day before.

It all started when Mrs. Pournelle made a weekend visit to Seattle. She took along Percy, the NEC PC-8201 lapboard portable. On the way back, she wrote a chapter for her new book and naturally wanted it transferred over to her machine, which happens to be the Zenith Z-150.

"No problem," said I. Little did I know.

Our usual method for transferring Percy's files is to use an RS-232C cable to connect him up to a port on the Golem, our big CompuPro 286/Z80 S-100 Dual Processor. The Golem now reliably runs Concurrent DOS 4.0 and can read and write to a lot of different disk formats: 8-inch and 5¼-inch as well as CP/M and MS-DOS. More on this later.

There is a minor problem: I don't yet have the proper Concurrent DOS software to transfer files in through the Golem's serial ports. Real Soon Now, they tell me. Meanwhile, it is only a minor problem. The Golem boots Concurrent DOS off the hard disk, but he first looks to see if there's a floppy in the top 8-inch drive. If there is, he boots that, which means I can bring him up in old-fashioned CP/M-86, and *that's* not only as solid as a rock but has all the usual CP/M capability for using PIP to transfer files in and out of serial ports. I can bring in files and stash them on the hard disk or in the memory drive, open the 8-inch drive door, press Reset, and everything's fine.

Well, there is another minor problem. The Golem has two terminals: our ancient (and extremely reliable) TeleVideo 950 and CompuPro's PC Video board, which is designed to make an S-100 system capable of running a fair number of MS-DOS programs under Concurrent DOS. The PC Video board naturally wants an IBM-PCompatible keyboard. We've been testing the Enigma 9000, which is a very good keyboard indeed, but it has an interesting feature: when you first turn on the machine, the keyboard squeals and howls until it gets a signal to shut up. This is fine if I'm booting Concurrent DOS, but when I boot with CP/M, nothing ever talks to that keyboard, so it's going to howl until doomsday, and that's irritating.

"No problem," I say, reaching behind the Golem to unplug the silly thing. My wife, who thinks computers don't like her even though she has made a truce with the Z-150 and actually likes the PC-8201 a lot, waited expectantly for her text. "Hmm," I said. "It doesn't seem to be booting. Maybe a bad boot disk."

I removed the 8-inch disk and hit Reset to let the Golem boot up with Concurrent DOS. Nothing. "Oh, I have to plug that keyboard back in." I did. Reset. Nothing.

"Do we panic yet?" Roberta asked.

"Yes." Actually, what I did was call Tony Pietsch. When Reset does nothing, you have a real problem.

He listened to the symptoms. "Don't know. That's hardware, all right. Have you done the usual? Check the fan filter? Take the cover off and push the boards in? Check the cable connections?"

"Uh, yeah," I said somewhat sheepishly. I hadn't told him about removing and replacing the keyboard cable. I managed to get off the line. Sure enough, the hard-disk cable connector next to the keyboard input socket had been partially displaced; it took about one second to fix that, after which everything worked fine.

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future.

(continued)

Well, there was a minor problem. The Golem has a *lot* of RS-232C connectors on the back. Concurrent DOS can support four physical terminals. The next hardware development here is to link the Golem with Zeke, the CompuPro Z80 I'm writing this with. I can also simultaneously connect up several different printers and under Concurrent DOS simply say PRINTER NEC or PRINTER HP, after which the Golem knows which port and printer protocol to use. That's necessary. The HP LaserJet is a fine printer for nearly everything, but it can't handle fanfold. Once a month I call in my accounting program, make journal entries for all the checks, and voilà!, I'm done with all that until next tax time; but, of course, the check-writing program expects the checks to be on fanfold paper.

Anyway, there are many cable connectors, and, alas, while each of those connectors has a label, I have never written down which one is the TTY port under CP/M-86. I mean, I've done this 20 times, right? It's obvious, right? Wrong. And indeed, I *did* write it down about a year ago in a logbook. Unfortunately, I never got around to indexing the log. Oh well, it's easier to experiment with different places to plug in than to search through that log. It's a simple experiment. Just put the PC-8201 in Terminal mode and enter STAT CON: = TTY:. When you get things plugged in in the right place, Percy controls the Golem and all's well.

Of course, there is a minor problem. You have to be sure Percy and the Golem's TTY port are set for the same baud rate. The PC-8201 is set for 9600 baud. I don't remember what baud rate we set for the TTY port under the old CP/M 2.2 BIOS (basic input/output system), but it doesn't matter. Changing the Golem's baud rate is simple. Just type Baud 06 9600 (port 6 is the TTY port). Of course, if the baud rate is wrong, you can't change it if you've already assigned the console to the TTY port. The machine's not listening to anything except the TTY port, and it won't hear anything coming in at the wrong baud rate... Reset takes care of that. Now change the baud rate, then use STAT, and plug the cable in...

After about 15 minutes of mucking about, I had *that* taken care of. The cable was connected, Percy and the Golem were on the same wavelength, and we were ready to send over Roberta's file.

There was one minor problem.

The simplest way to bring a file into a CP/M system from a port is to use PIP. True, if the file is larger than 16K bytes, CP/M has to go off and write some directory information at the 16K-byte boundary, but a 286 machine writing to a RAM (random-access read/write memory) disk will seldom lose anything, even at 9600 baud; certainly not more than a character or two. There are better ways for transferring important data or programs, but for text, PIP is the easy way to go. I invoked PIP.

"Requires Concurrent DOS," responded the Golem.

"Yeah, of course," I muttered. PIP.CMD is for Concurrent DOS. We'd kept the old CP/M 2.2 PIP, but renamed it. Only *what* had we called it? Directory-search time. Sigh. The Golem has a *lot* of files on the hard disk in the A0 area. There's a reason, of course: system files stored on the A: drive, user area 0, can be invoked from any user area of any disk drive. Search away. Eventually I found PIP22.COM, after which it took about 30 seconds to transfer Mrs. Pournelle's file over to the Golem and another 15 seconds to write it from the RAM disk to an 8-inch floppy. No matter what else happened, that file was *safe*. I disconnected the RS-232C cable, removed the CP/M 8-inch boot disk, reconnected the keyboard, and pressed Reset. Concurrent DOS came up fine.

LOOK AT THE DARNED THING

Of course, there were a few housekeeping details.

Now that I had her file in the M: drive, it was no trick at all to change it from the vanilla-ASCII format of the PC-8201 editor to WordStar; that's

(continued)

THE X-10 POWERHOUSE DOES EVERYTHING BUT PUT OUT THE CAT.

THE X-10 POWERHOUSE INTERFACES WITH YOUR COMPUTER TO CONTROL YOUR HOME...FOR SECURITY, COMFORT AND ENERGY SAVINGS.

This remarkable Interface lets you run your home through your Apple IIe or IIc, Commodore 64 or 128 and a mouse, keyboard or joystick.

When you're away, it makes your home look and sound lived in. When you're home, it can turn off the TV at night and wake you up to stereo and fresh brewed coffee in the morning. It can even turn on your air conditioner and control your heating.

SPECIAL COLOR GRAPHICS MAKE PROGRAMMING A SNAP. You simply pick a room from the display screen. Use your mouse, joystick, or keyboard to position graphics of lights or appliances. Then follow on-screen instructions to program any light or appliance to go on or off whenever you choose. You can even control thermostats, light intensity and more.

THE WAY IT WORKS. The X-10 Powerhouse Interface is cable-connected to an Apple RS-232 port or a Commodore "User" port and plugged into a standard 110V outlet. After it is programmed, the Interface sends digitally encoded signals through your home wiring to special X-10 Modules. To control a lamp or appliance, you simply plug the electrical device into a Module and then plug the Module into an outlet. The Interface can control up to 256 Modules throughout your home and won't interfere with normal use of lights and appliances.

There are plug-in Appliance Modules, Lamp Modules, Wall Switch Replacement Modules and Special 220V Modules for heavy duty appliances such as water heaters and room air conditioners. Plus Thermostat Controllers for central heating and air conditioning, Telephone Responders to control your home from any phone, and much more.

IT WON'T TIE UP YOUR COMPUTER. Use your computer only for programming. When you're finished, disconnect the Interface from your computer and keep it plugged into any convenient power outlet in your home. It will operate as a stand-alone controller with battery back-up and will run your home automatically.

SURPRISINGLY INEXPENSIVE. A Powerhouse System including the Interface, software and connecting cables costs less than $150. X-10 Modules are less than $20 each.

Software for IBM PC and compatibles available soon.

For the Dealer Nearest You Call: 1-800 526-0027 [in NJ: (201) 784-9700]
or, write to: X-10 (USA)
185A Legrand Avenue
Northvale, NJ 07647

X-10® POWERHOUSE
NUMBER ONE IN HOME CONTROL

Inquiry 389

done with Tony's FILTER.COM, a CP/M-80 (Z80) program that comes with the WRITE text editor. FILTER turns WordStar files to WRITE, WRITE to WordStar, and, for good measure, either WRITE or WordStar files to a standard ASCII with carriage return and linefeed at the end of each line (thus suitable for transmission over a modem to BYTEnet or BIX).

It's also *fast.* Even with a normal Z80 it is actually faster to exit WordStar, use FILTER to transform the WordStar file to ASCII, then use it again to put the file back into WordStar than it is to use the WordStar Control-QA global reformat routine; at least it is for files of any size at all. With the Golem's 8-megahertz Z80 slave board, the 286 to do housekeeping, and a RAM disk, it took less than a minute to make both .WS and .TXT transformations of her file. I even brought up WRITE, loaded in the text, and showed her.

"Fine, but how do I get it on my machine?" she asked.

"Nothing to it."

There really is nothing to it. Concurrent DOS on the Golem has a magical property: if I put a DOS disk in the 5¼-inch drive, I can read and write to it just as I would a CP/M disk. Not only does PIP.CMD work, but I can log onto that DOS disk while inside WRITE—which is an 8-bit program running on the Golem's Z80. I need only issue a SAVE on a DOS disk to transfer the file. I didn't do that, but only because it would save it in WRITE format, and she needed WordStar.

"What do you want me to save it on?" I asked. She handed me a disk. It had her book title on the label. I put it in the 5¼-inch drive and from habit displayed the directory.

There was one minor problem. No directory. The Golem wouldn't read that disk.

"Isolate the problem," I said to myself. "Make sure the disk is good. Read it in a DOS machine." I turned on the Kaypro 286i PC AT clone, which is the only fully PCompatible I keep up here.

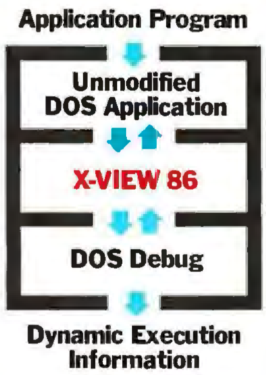
This time there was a major prob-

(continued)

X-RAY VISION

Get it with X-VIEW 86™

X-VIEW 86™ analyzes, profiles, and debugs DOS application software — for improved performance on the IBM PC and its compatibles.



X-VIEW 86 lets you observe the internal operations of DOS application software.

Helps you analyze, debug, test, port, or convert DOS application software — and get faster, more reliable results.

Real solutions to technical challenges.

Looking for code hot spots?
X-VIEW 86 helps you find them fast.

Irritated by bugs that DEBUG can't reach?
X-VIEW 86 captures them.

Sweating over hardware compatibility issues?
X-VIEW 86 pinpoints the trouble spots.

Struggling with a conversion that just won't work?
X-VIEW 86 breaks the deadlock.

What X-VIEW 86 does.

X-VIEW 86 saves you hours of time-consuming, tedious work. It automatically collects data on application programs:

- ☐ memory map references
- ☐ I/O space references
- ☐ INT call usage
- ☐ instruction set usage
- ☐ segment usage data

X-VIEW 86 can interrupt the application program

- ☐ on any processor I/O access
- ☐ on any processor INT instruction
- ☐ on a specified execution path address
- ☐ on a specified memory location reference

X-VIEW 86 can also start the application program execution at a specified address. And it displays the results of the analysis on screen.

Hardware and software requirements.

X-VIEW 86 runs on any member of the IBM PC family — or any operationally-compatible machine that has at least 64 Kbytes of memory. And it's not copy-protected. You use it with PC DOS DEBUG 2.0 or 2.1.

Exciting — not expensive.

X-VIEW 86 is priced at an affordable $59.95.

To order, call 1-800-221-VIEW.

In Texas, call 1-214-437-7411.
Then get ready for a whole new outlook on your work.

Inquiry 141

To order X-VIEW 86™ by credit card, call toll free 1-800-221-VIEW. In Texas call 1-214-437-7411. Or send the coupon today.

Customer Service
McGraw-Hill Inc.
8111 LBJ Freeway
Dallas, Texas 75251

X-VIEW 86™ is $59.95. All orders are subject to acceptance by McGraw-Hill, Inc. Prices are subject to change without notice.

☐ Check enclosed (Make check payable to McGraw-Hill Inc. Orders paid by check are subject to delay.)

☐ A.E. ☐ M.C. ☐ VISA ☐ D.C.

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________ State ______ Zip ______

Phone ( ) ____________

Qty ______ $59.95 Amt ______

Shipping ($2.00 per copy) Texas sales tax ($3.67 per copy) ______

Total ______

Signature ____________________

Name on card ____________________

Credit card no. ____________ Expiration date ______ em. It wouldn't boot.

The next few minutes are too painful to describe. Roberta insisted that computers don't like her, while I had a few choice remarks about experimental systems. Of course, I shouldn't have been much surprised by the Kaypro's problem; it had been having progressively more severe difficulties reading the hard disk. To get ahead of the story, it wasn't Kaypro machinery that failed, it was the Seagate hard disk; Kaypro doesn't make hard disks. At the time, though, that was cold comfort, and I still didn't know why the Golem couldn't read Roberta's disk.

"Calm," I kept telling myself. That often helps, although it's probably better not to shout it at the top of your lungs. Why wouldn't the CompuPro read Roberta's disk? Eventually I looked at it. Looked hard. It said: "10 Sector, Single Sided"; it was for her Apple II, not the Z-150. The CompuPro 286 running Concurrent DOS can do a lot of wonderful things, but it won't read a hard-sectored disk.

Eventually we found her real Zenith disks. The Golem had no trouble at all with those, and it took about one minute for PIP to transfer her file. Roberta went away to work, and I went back to answering mail.

THE END OF THE MATTER

There was one minor problem. While we were away in Europe, someone had disconnected the monitor from her machine. That one she dealt with, but they had also disconnected her highly portable MPI Sprinter printer, probably to take to a war-games convention. Roberta is at the stage where she'd rather write with a computer than a typewriter, but she also wants paper copies. I understand perfectly: it took me a couple of years before I was able to dispense with paper drafts and work exclusively on screen. She found her printer but wanted help connecting it. I hadn't set it up and couldn't remember if it was serial or parallel.

"Tell you what," I said. "It's getting late. We'll let Alex take care of that tomorrow. Let Don print it on the IBM PC." I went back to the mail...

After a while Roberta was back. Her file is in WordStar. Don Hawthorne, our assistant, was using XyWrite. FILTER on the CompuPro will transform a file from WordStar to XyWrite, but that's an 8-bit program. Don has a genuine IBM PC. If you read an untransformed WordStar file into XyWrite, you see Greek letters, and graphics symbols, and other extraneous matter, all designed to make you think your files have been corrupted and your text lost...

The next few minutes were again too painful to describe. Eventually I convinced her that nothing was lost. Of course, she still didn't have a paper copy.

"Please hook up my printer."

"It's almost suppertime. Here, I'll print it."

She looked a bit wary.

"It's no problem," I assured her. I took her disk upstairs and put it in the Golem's 5¼-inch drive. In seconds I had a copy in the RAM-disk drive. Seconds later I had used FILTER.COM to make a WRITE conversion of her WordStar file. I added commands to put in page numbering and double spacing and to print the date as a footer.

"While I'm at it, I'll make a really safe copy of all this," I said. Hard disks and 5¼-inch disks are all very well, but to me "really safe" means an 8-inch floppy backup. I formatted a disk and put all her files on it. "Now we're ready to print."

Of course, there was one minor problem. Although the Golem can run the HP LaserJet, he generally isn't connected to it; the printer is normally connected to Zeke, the machine I do all my books on. (I explained why I write with an ancient Z80 rather than one of the newer machines in the November 1985 column. Basically, I want *one* machine that no one experiments with.) It wouldn't be much of a problem. Zeke, being a CompuPro, has no trouble at all reading 8-inch disks written by the Golem. I turned the Z80 on.

Zeke is purely a writing machine; there's an autostart program that brings him up in WRITE. Zeke trundled for a moment, then was quiet. I looked at the screen. "Memory Error at CF61. Exiting WRITE."

I stared at that message. WRITE has a built-in memory-test routine, but I had *never* seen any result from it before. I pushed Reset. Same result. "Memory Error at CF61."

"Is it time to panic?" Roberta asked.

"I *will* keep calm," I kept saying, but in truth it was close to panic time; any other machine can fail without disastrous consequence, but Zeke is absolutely vital. "Logic," I told myself. Check the fan filter. Shake the cables. Open the box and push the boards in properly. Turn on the machine again. "Memory Error at CF61. Exiting WRITE."

"Now it's time to panic."

Fortunately, early training prevailed. In the old days—prior to 1981—computers were *expected* to glitch. Zeke was from that era. When Tony built the machine, he insisted that I buy spare boards. Zeke proved so reliable I'd never needed them, but in fact I have enough boards to build a new computer.

Locating them wasn't easy, but eventually I found a CompuPro RAM-17 64K-byte memory board. Blow the dust off the box. Take out the board. Now pull out Zeke's memory board. Study the switch settings. This should be simple . . .

There was one minor problem. The phone rang. When I got rid of the caller, I realized I didn't know which of those two identical boards had come out of Zeke and which was the spare. Worse, they had different switch settings, and of course the bad board was the one with the switches set the right way. Now which was which? I put in a board and turned on Zeke. It was downright comforting to see "Memory Error at CF61. Exiting WRITE."

Five minutes later Zeke was working fine, and five minutes after that Roberta had her paper copies. The day before Friday the 13th was over.

REFLECTIONS

I wouldn't want to repeat that day, but it did have its useful aspects.

First lesson: I've been spoiled. When I first began writing with computers, I bought a modular system because I *expected* glitches. In the old days, I would *always* push in boards, shake cables, and generally muck about looking for obvious problems. If that didn't work, I'd systematically replace boards.

No longer. For five years Zeke has been on 8 to 12 hours a day, seven days a week, with time off only when I take trips; and in that time I have replaced one disk drive (the heads got out of line and began eating disks) and done one general housecleaning after moving the machine from one

(continued)

room to another; now I've had one memory-failure error. Except for the time the drive went bad, I haven't even had (8-inch) *disks* fail. No wonder I was lulled into a false sense of security! But I should have remembered what to do.

Second lesson: don't put the computer memoranda into the day book. Keep a *computer* log, and log *everything*. Baud rates. Port numbers. Cookbook instructions on how to do stuff that's important but infrequently needed. I always kept a complete computer log in the old days. It doesn't cost much. My local drugstore sells those mottled black-cover composition books for $1.89—never mind that when I bought my first computer the same book cost 45 cents—and it's plenty easy to keep one in the bookcase next to the machinery.

Third lesson: years ago I concluded that "the best business microcomputer is a year-old development system." It no longer makes sense to talk about "the best business micro." Too much depends on business needs and the software base. Even so, there's a bit of truth to the maxim. The Golem is an advanced experimental development system. Viasyn (CompuPro) still dominates the development-system market, and Dr. Godbout is forever sending down new refinements; but the heart of that modular S-100 system doesn't change, and the machine gets the job done.

I can't say I'm entirely happy with the way CompuPro treats software. I wish mightily they'd take at least one more step toward PCompatibility. Even so, I'm still running all the 8-bit programs I wrote and refined and tailored to my needs. I've recompiled some in Compiling CBASIC CB-86 so they run even faster. (For all my fascination with Modula-2, my accounting system and most of the business programs I rely on are written in Compiling CBASIC, which is one heck of a good language.) In addition, I can run Lotus 1-2-3 and a number of other PC programs; indeed, with Concurrent DOS I can run Lotus 1-2-3, my accounting program, WRITE, and three other things at the same time. I can read from and write to a dozen disk formats.

Computer users have to make choices. A long time ago I thought I'd made mine: I was going to be a *user*, not a hacker; I wasn't going to learn programming, I didn't care about the innards, I didn't know or want to know one chip from another. In times of stress I talk as if I still thought that way; but in fact that's a silly attitude. Powerful machinery gives me capabilities other people don't have. It also demands that I learn something about how to use it. The trade-off is worthwhile.

Example: in about an hour, Larry Niven and Steve Barnes are coming over to work on *The Legacy of Hereot*, a three-way collaboration. (Actually, it's a collaboration between Larry Niven and Jerry Pournelle, who make up one auctorial entity, and Steve Barnes, who is another; but that's for a different discussion.) The point is that while Niven and I have identical machines, Barnes uses a PCompatible and WordStar 2000. My big CompuPro 286/Z80 will read his disks and transform his text into WRITE files. We'll work for the afternoon, and when we're done, we'll put one copy back into DOS for Barnes and another onto an 8-inch disk for Niven.

Do that with your off-the-shelf PClone.

Development-quality machinery isn't for everyone. Being state of the art has costs. On the other hand, it wasn't the Golem's fault that I shook a cable loose.

When all is said and done, Roberta did manage to write a chapter while on an airplane. We did manage to get it out of the machine and onto paper. I was able to write a column, several chapters of a novel, and a ton of notes while traveling in Europe, and *all* those safely reside on disks. So we had a bad day. We also got things done that a few years ago I'd have thought impossible.

I love these little machines.

LOOK FIRST

If you are contemplating buying a CompuPro machine—and I like mine

(continued)

You would think when IBM needs EPROM Programmers they would choose the best and the most expensive.
They don't. They only choose the best. GTEK.

MODEL 7956 (w/RS-232 option) $1099
MODEL 7956 (stand alone) .... $ 979
GTEK's outstanding **Gang Programmer** with intelligent algorithm can copy 8 EPROMS at a time! Use the 7956 in a production environment when you need to program a large number of chips. Programs *all* popular chips through the 27512 EPROMS; supports CMOS EPROMS through the 27C256; supports EEPROMS through the X2864A; supports Intel's 2764A & 27128A chips. The 7956 will also program single chip processors.

MODEL 7228 .... $ 599
GTEK's 7228 has all the features of the 7128, plus **Intelligent Programming Algorithms!** It supports the newest devices available through 512K bits. The 7228 programs **6 times as fast** as standard algorithms. It programs the 2764 in one minute! Supports CMOS EPROMS through the 27C256; supports EEPROMS through the X2864A; supports Intel's 2764A & 27128A chips. Supports Tektronics, Intel, Motorola and other formats.

MODEL 7324 .... $1499
The 7324 has a **built-in compiler.** It programs all MMI, National and TI 20 & 24 pin PALS. It has **non-volatile memory** and operates standalone or via RS-232.

MODEL 7128 .... $ 429
The 7128 has the **highest performance-to-cost-ratio** of any unit. It supports the newest devices available through 256Kbits.

MODEL 7322 .... $1249
Same as Model 7324 but operates only via RS-232.

MODEL 7316 .... $ 749
This PAL PROGRAMMER programs Series 20 PALs. It has a built-in PALASM compiler.

MODEL 7283 .... $1199
This BI-POLAR PROM PROGRAMMER programs all popular BI-POLAR PROMS. It operates stand-alone (for production) or RS-232 (for development).

MODEL 705 .... $ 299
68705V3, R3, P3 PROGRAMMER.

EPROM, PROM & PAL
PROGRAMMERS
— These features are standard from GTEK —

Compatible with all RS-232 serial interface ports • Auto select baud rate • With or without hand-shaking • Bidirectional Xon/Xoff • CTS/DTR supported • Read pin compatible ROMS • No personality modules • Intel, Motorola, MCS86 Hex formats • Split facility for 16 bit data paths • Read program, formatted list commands • Interrupt driven—program and verify real time while sending data • Program single byte block or whole EPROM • Intelligent diagnostics discern bad and/or unerased EPROM • Verify erasure and compare commands • Busy light • Complete with Textool zero insertion force socket and integral 120 VAC power (240 VAC/50Hz available) •

UTILITY PACKAGES

GTEK's PGX Utility Packages will allow you to specify a range of addresses to send to the programmer, verify erasure and/or set the EPROM type. The PGX Utility Package includes GHEX, a utility used to generate an Intel HEX file.

PALX Utility Package—for use with **GTEK's Pal Programmers**—allows transfer of PALASM* source file or ASCII HEX object code file.

Both utility packages are available for CPM,* MS-DOS,* PC-DOS,* ISIS* and TRSDOS* operating systems. Call for pricing.

CROSS ASSEMBLERS

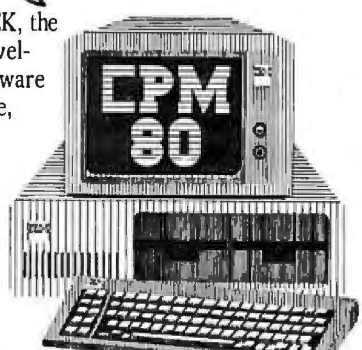
These assemblers are available to handle the 8748, 8751, Z8, 6502, 68X and other microprocessors. They are available for CPM and MS-DOS computers. When ordering, please specify processor and computer types.

ACCESSORIES

Model 7128-L1,L2, L2A (OEM Quantity) $259.
Model 7128-24 .... $329.
Cross Assemblers CPM-80 .... $200.
MSDOS; .... $250.
PGX Utilities .... Call for pricing
PALX .... Call for pricing

Erasers DE4 $80; PE14T $129 C25 $349; C50 $599
U/V Eraser DE-4 .... $ 80.
RS-232 Cables .... $ 30.
8751 Adapter .... $174.
8755 Adapter .... $135.
48 Family Adapter .... $ 98.

"All you CPM people who wanted to move to IBM, but couldn't... now you can—and bring your CPM software with you!"



From GTEK, the leader in development hardware and software, comes the CPM user's dream.

The majority of advances being made in the computer industry today are being made for PC-DOS and MS-DOS machines.

If you are a CPM user who wanted to convert to these operating systems but didn't because you had to abandon or rewrite your CPM programs, now you can make your move without losing or rewriting a single program!

The dream from GTEK is a package that makes your PC-DOS (IBM PC, XT, AT) or MS-DOS (IBM clones like COMPAQ, Leading Edge, Televideo) machines think they're being run by an 8080 or Z80 microprocessor with CPM!

The GTEK package contains a CPEmulator™ and CPM Conversion Utility that allows you to read and write popular CPM disk formats such as Kaypro and Osborne.

If you've been using CPM on any of these machines you can now move to PC-DOS or MS-DOS operating systems.
Kaypro • Osborne • Heath/Zenith • Radio Shack • Epson • DEC • IBM • Morrow • Xerox • HP • Sanyo • Intertec • Cromenco • Televideo • Compupro.

How easy is it to use? Two steps. (1) Use the Conversion Utility to copy the CPM program to an MS-DOS or PC-DOS diskette. (2) Use the Bind Utility to attach the CPEmulator to your program. And that's it. It's ready to run.

You won't see any difference when you run the CPM program! Now all the work you did in CPM is still valuable when you change to your PC-DOS or MS-DOS machine.

And here's the happy ending to the dream. The CPEmulator is just $199.

Call GTEK's CPM Hotline...
1-601-467-9019

GTEK Development Hardware/Software
P.O. Box 289, Waveland, MS 39576
601/467-8048; telex 315-814 (GTEK UD)
, INC.

GTEK, PALASM, CPM, MS-DOS, PC-DOS, ISIS, TRSDOS, & CPEmulator are registered trademarks.

a lot—you might want to know more about what you're getting into. C-Pro, the independent CompuPro User Group (POB 2146, Woodbridge, VA 22193), publishes an increasingly useful magazine as well as maintaining a bulletin board. There have been a number of debates over software, there are tips about support, and there is enough information to make it well worth subscribing to. If you already have a CompuPro and aren't a member, you're really missing something.

A WHOLE LOT OF STUFF

Every shelf in my office is a potential guilt trip; the place is *crammed* with interesting software. Sigh. Even giving short shrift to each won't get them all mentioned, much less do justice to them. In other words, my apologies: it's that time again, when I race along giving brief mention to programs that deserve a lot more space than they're going to get.

First, there's SpaceWar for the IBM PC. This is a full implementation of the classic game first done at MIT. It can be played by one player or two, with or without star and gravity fields. It has phasers and torpedoes, and the ships move in inertial space, meaning that if you accelerate you'll keep moving in a straight line until you rotate the ship and blast again. It has nearly everything. Great game.

SpaceWar is user-supported software, meaning that you can get a copy from anyone who has one, but you should send the author $20 if you like it and use it.

Next, there's Bridge Parlor, which plays a very good game of bridge; I've been using it to relax after work at night. This one also runs on PCompatibles, including the Kaypro AT clone. It needs 192K bytes of memory, and I do wish the author had been a little fussier in his use of graphics; here and there I have to look closely to see what's going on.

However: Bridge Parlor plays good, standard bridge. Opponents signal. Normal conventions apply. You can set it for defense practice so that you're never declarer, or you can always sit South with those wonderful hands that South always gets in the newspaper bridge columns. It does all this smoothly, fast, and well. Bridge Parlor isn't as nice as finding three congenial people to play bridge with, but it's the next best thing. Recommended.

I mentioned last month that there's no good computer program that can play go. That's still true. However, you can get Nemesis, the *best* go program (as tested in tournaments). If you've any skill at go, it won't ever beat you,

(continued)

COMPUTERS

PC, 256K, 360K FLOPPY, 10 MEG HD	$2049.00
PC, 256K, 360K FLOPPY, 1.2 MEG FLOPPY, 10 MEG HD.	$2299.00
PC, 256K, 360K, FLOPPY, 1.2 MEG FLOPPY, 20 MEG HD.	$2659.00
AT-512K, 1.2 MEG FLOPPY, 360K FLOPPY, 20 MEG HD.	$3877.00
AT-512K, 1.2 MEG FLOPPY, 360K FLOPPY, 40 MEG HD.	$4349.00

PORTABLE

256K WITH 2-360K DISK DRIVES	$1919.00
256K WITH 1-360K FLOPPY AND 10 MEG HD.	$2449.00
256K WITH 1-360K FLOPPY AND 20 MEG HD.	$2639.00

DESKPRO SYSTEMS

MOO. 2-256K, 2HF/HT	$1949.00
MOD. 3-256K, 1HF/HT, 10 MEG HD.	$2795.00
MOO. 4-640K, 1 HF/HT, 10 MEG HD.	$2949.00

286 SYSTEMS

286 PORTABLE, 256K ANO 1.2 MEG FLOPPY	$3299.00
286 PORTABLE, 640K, 1.2 MEG FLOPPY, 20 MEG HD.	$4645.00
286 PORTABLE, 640K, 1.2 MEG FLOPPY, 20 MEG HD B/U	$5159.00
DSKPRO 286-256K, 1.2 MEG FLOPPY	$3129.00
OSKPRO 286-512K, 1.2 MEG FLOPPY 30 MEG HD.	$4419.00
DSKPRO 286-512K, 1.2 MEG FLOPPY 30 MEG HD. B/U	$4940.00

SOFTWARE

WORD PROCESSING

WORDSTAR 2000	$239.00
WORDSTAR 2000 PLUS	$289.00
WORDSTAR EASY	$ 87.00
SAMNA PLUS	$299.00
SAMNA III	$239.00
PFS. REPORT	$ 69.00
PERFECT WRITER	$125.00
WORDPERFECT W/SPELLER	$211.00
PERSONAL WORDPERFECT	$ 85.00
MICROSOFT WORD	$210.00

SPREADSHEETS & DATABASES

LOTUS 1-2-3	$299.00
SYMPHONY	$429.00
SPELLING CHECKER	$ 87.95
TEXT OUTLINER	$ 87.95
SPOTLIGHT	$ 44.95
DBASE III	$345.00
FRAMEWORK	$345.00
SUPERCALC	$197.00
REFLEX	$249.00
POWER BASE	$199.00
R BASE 5000	$344.00
PERFECT CALC	$125.00
VISICALC	$125.00
MULTIPLAN	$109.00

FINANCIAL SOFTWARE

HOME ACCOUNTANT	$84.00
MONOGRAM DOLLARS & SENSE	$99.00

ACCOUNTING

BPI GENERAL ACC.	$ 297.00
BPI INV. OR JOB CST	$ 471.00
BPI A/P OR A/R	$ 297.50
FIS 2001 ACC SYS	$2750.00
GREAT PLAINS GL, AR, AP, INV. OR PAYROLL	S 389.00
SORCIM AR, AP, OROER ENTRY OR INV.	$ 297.00

HARDWARE

AST

SIX PACK PLUS	$227.00
AT ADVANTAGE CARD	$359.00
5251 EMULATION CARD	$543.50

QUADRAM

MICROFAZER PAR	$204.00
QUADBOARD 64K	S225.00
QUADMEG-AT	$305.00

KEYTRONIC

5151 KEYBOARD	$149.00
AT PROM KIT	$ 14.95

COMPUTER ACC.

POWER DIRECTOR	$79.00

MOUSE SYS

MOUSE SYS W/PAINT	$138.00

PRINTERS

EPSON

FX-185	$475.00
FX-85	$349.00
LQ-1500	$899.00

STAR MICRONICS

NLQ30	$193.00
NLQ40	$269.00
NLQ50	$369.00

BROTHER

HR-25	$519.00
HR-35	$892.00
TWINWRITER	$913.00

HEWLETT PACKARD

LASERJET	$2175.00
6-PEN PLOTTER	$1375.00
THINKJET	S 369.00

Call for prices on C.ITOH DIABLO, NEC, APPLE, IBM

MODEMS

HAYES

SMARTMODEM 300	$129.00
SMARTMODEM 1200	$379.00
SMARTMODEM 2400	$614.00

DISKS

MAXELL HI-OEN	$42.95
MAXELL DS-DD	$19.95
VERBATIM	$21.95

GRAPHICS BDS

HERCULES

GRAPHIC CARDS	$289.00
COLOR CARD	$145.00

PARADISE

GRAPHICS CARD	$272.00
MULTIDISPLAY CD	$197.00

PERSYST

COLOR CD/RGB COMP	$199.00
BOB SUPER HI-RES	$389.00

TECMAR

GRAPHICS MSTR BD	$445.00

MONITORS

PRINCETON GRAPHICS

HX-12 HI RES	$543.00
SR-12 W/DOUBLER	$714.00

AMDEK

COLOR 300	$269.00
COLOR 300 RGB	$359.00
COLOR 710 HI-RES	$579.00

IBM

PROF. GRAPHICS MON	$969.00
ENHANCEO GRAPHICS MON.	$599.00

DISK DRIVES

TALLGRASS

TAPE BACKUP 60 MEG	$1511.00
25 MEG DISK/ 60 MEG TAPE	$2559.00
35 MEG DISK/ 60 MEG TAPE	$3259.00
80 MEG DISK/ 60 MEG TAPE	$5359.00

CONTROL DATA SYSTEMS

18 MEG EXTERNAL HD	$1299.00
30 MEG EXTERNAL HD	$1559.00
30 MEG INTERNAL IBM-AT	$1299.00

IOMEGA

SINGLE 10 MEG HD	$1799.00
DUAL 10 MEG HD	$2495.00
CARTRIDGES	$ 43.00

SHUGART

10 MEG HD W/CONT.	$431.00

Call for prices on NOVATION, RACAL-VADIC VEN-TEL AND OTHERS

PRECISION DS/DD $9.95 BOX OF 10

COMPATIBLE

PC COMPATIBLE
640K, 135 W P/S keyboard, 2 DS, DD drives, ser port, par port, mono graphics card.

$775.00

XT COMPATIBLE
640K, 135 W P/S keyboard, 360K floppy, 10 meg HD, controller card, ser port, par port, mono graphics card.

$1495.00

AT COMPATIBLE
256K, Keyboard, 192 W P/S, 20 meg HD, 1.2 meg floppy, 360K floppy, cont. cards & cables, mono graphics card, 384K multifunction card w/clock/ calendar, ser. & par ports, game port (optional).

$2695.00

IBM PROPRINTER **$395**
IBM QUIET WRITER ... **$1,049**
IBM COLOR JETPTR **$549**
IBM WHEEL PRINTER **$1,389**

MULTIFUNCTION CARD
Serial and parallel ports, 384K expandable, clock/calendar, game option port.

$95.00

SERIAL CARD **$44.00**
PARALLEL CARD **$29.00**
COLOR GRAPHICS CARD **$74.00**
MONO GRAPHICS CARD **$94.00**
I/O MULTIFUNCTION CARD **$95.00**

IBM SPECIAL #1

IBM, 1-320K DS, DO DISK DRIVE, 10 MEG. HARD DRIVE, AMBER OR GREEN MONITOR, 256K, PAR PORT PFS. WRITE AND FILE.

$2350.00

IBM SPECIAL #2

IBM AT-1/20 MEG HARD DRIVE, 1.2 MEG FLOPPY, PAR PORT, 512K, MONO MONITOR CARD, AMBER OR GREEN MONITOR.

CALL $$$

ORDER LINE 1-800-334-8989 IN CALIF. CALL 1-818-341-9193
OPEN 6 DAYS/WEEK, MON.-SAT. 6 A.M.–6 P.M. Pacific Std. Time

*No surcharge for credit cards, free express-shipping on orders of $100.00. COO's accepted. 3% added for insurance. No monitors, computers, printers, paper included in express-shipping. Prices subject to change without notice. Visa, MC, American Express accepted. Company purchase orders also accepted. +IBM is a registered trademark. Call for RMA# on all returns.

Price-Line Computers, Inc.
9710 Topanga Canyon Place, Chatsworth, CA 91311

but it does let you practice. If you have never played the game, you can learn using the program; it will ruthlessly exploit dumb mistakes, so that when you graduate from it to a human opponent, you'll be a more interesting player.

Go players are rated in ranks called kyu, with the lowest being best; Bruce Wilcox, inventor of Nemesis (The Go Master), claims this program is at 20 kyu. I haven't played serious go in 10 years; I can beat the program consistently, but I do have to pay attention to what I'm doing. Whether it's worth $75 depends; if you've much interest in go, you'll probably be playing it long after you've tossed out most other computer games. Wilcox claims there will be stronger versions available Real Soon Now.

It's Glorious!

Every now and then we get wonderful, if somewhat specialized, programs to review.

One such is MandelZoom from Token Software. Those of you who read *Scientific American* will recall the August 1985 cover story on the Mandelbrot set, which is said to be quite possibly the most complex set in mathematics. Mark Bolme of Token Software has done a program that will let you play with Mandelbrot sets on your color PCompatible; and it's glorious.

The disk comes complete with cookbook instructions and a setup to let you examine all the stuff from the *Scientific American* article; if you want to know more, go look it up. With MandelZoom you can step back and look at the big picture or zoom in to examine fine structure. I can't imagine a better way to waste an afternoon or two. No color PCompatible is complete without a copy of this; get one and see what I mean.

Looks Great to Me

Cardiovascular Systems and Dynamics by Nils Peterson and Diana Armstrong is another specialized program; if you need this one, you need it bad.

Their introduction states: "Simulation brings to life the dynamics of a physiology laboratory while avoiding the high costs of animal care and modern equipment."

Most of us are disturbed by the cost of medical training; not merely the money costs, but other ones: the psychic or spiritual costs of using animals not only for research but also for student training. I do not care to become bogged down in the intricacies of this debate. I would suppose that there is no one in the world who *prefers* that animals be sacrificed to train students; the debate is over the necessity.

The late C. S. Lewis said once that he imagined a science that would not do to a vegetable what is often done in experiments to human beings. One of the wonders of computers is their ability to simulate things that we really would not want to do in the real world. As micros become both cheaper and more powerful, we may yet realize Lewis's dream.

The Peterson/Armstrong program simulates cardiovascular systems on a PCompatible machine. I'm not competent to determine how accurate the simulation is, but I had an M.D. and a veterinarian look at it, and both were impressed. I'd very much like to see efforts like this succeed.

Take That

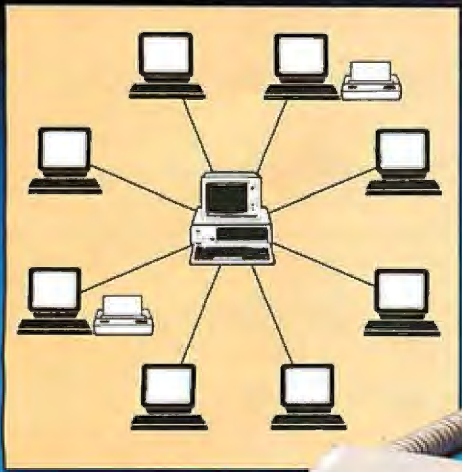
Barry Workman has a new PC disk in his Software Anthology Series. This one contains Sweep for PCompatibles. CP/M Sweep is still one of Workman's most popular items; the new one is from the same authors and works more or less in the same way. With PC-Sweep, you can easily transfer files from one disk or directory area to another, rename, delete, make directories, print files, squeeze and unsqueeze, and a lot more. I use it all the time. Like the original Sweep, PC-Sweep is shareware; if you buy it through Workman, you become a registered user and the authors get their fee.

As usual, the Workman disk contains a mixed bag of shareware, freeware, and public-domain programs.

(continued)

Kimtron

MULTI-USER SOLUTION for IBM PC, XT, AT



Compare the Solution!

The Multi-User Solution of the future is now available.

Convert your IBM PC, XT, AT or Compatibles to a true multi-user system while maintaining display, keyboard and software compatibility.

Since the KT-7/PC display is the same as your PC monochrome monitor, with its look-alike keyboard, operators will feel they're using an IBM PC and can also use the same software manual. Kimtron's multi-user solution includes file and record locking, shared data access, and communication between users. It is **the** intelligent alternative.

The KT-7/PC supports Time Sharing, Enhanced Time Sharing and Multi-Processor implementation under PC DOS, MS DOS, UNIX, XENIX, CPM 86, Multilink, Concurrent PC DOS, and other compatible multi-user operating systems.

Kimtron's multi-user solution may be tailored for cost effectiveness; as low as $1095 for an additional user, and for speeds more than ten times faster than LAN. You can add one or as many as 31 additional users per PC. Kimtron delivers the future now by allowing an ever-widening network of multi-user PC's.

The KT-7/PC may be complemented with one (or more) I/O Card, Memory Card, 8086 Speed Enhancer Card, 80286 AT Card, 8088 Multi-Processor Card, 80186 Speed Enhancer Card, 68000 Card, and related software.

For more information about Kimtron's Multi-User Solution, or general video data terminals for other mini or micro multi-user systems, call your local computer dealers, distributors or Kimtron Corporation Today!

(408) 286-8790
TWX 910-338-0237

1705 Junction Court
Building #160
San Jose, CA 95112

Kimtron

NOTE: IBM PC, XT, AT, PC DOS, MS DOS, UNIX, XENIX, CPM 86, Multi-Link, Concurrent PC DOS are registered trademarks of IBM Corporation, Microsoft Corp., Bell Labs., Digital Research Inc., Software Link Inc. respectively.

All have been tested and work more or less as Workman says they will, although in some cases you may need some ingenuity. I count 20 programs on the disk; PC-Sweep is pretty well worth the $32.50 by itself. There's also FUPROLOK.COM, a demon that will let you run programs that have been protected with Vault's PROLOK from a hard disk. It's quick, transparent, and works. There are other "unprotect" programs also.

I may be repeating myself, but I think Workman's Software Anthology Series is one of the best software bargains going.

COPY ALL

Every copy-protection scheme can be defeated. In the PROLOK scheme, a hole is burned on the original disk; you can copy the disk, but when you try to run the program, it will at some point or another try to write to that bad disk sector; if it gets back good data, the program knows you're not running the original disk and takes action: it either demands the original disk or dumps your program. Indeed, some Vault officials threatened much more drastic action, including the insertion of software time bombs that would damage your computer.

The remedy to this one was obvious from the beginning. Using the information from Crayne's *Serious Assembler* (Baen Books), I was able to write a demon that resides in high memory, watches for the PROLOK call, and satisfies the program that there's a bad sector just where the program wants to see one. I never got around to publishing my demon, largely because I wasn't that sure I'd done it right; but it wasn't long before FUPROLOK appeared on bulletin boards across the country.

Other copy-protection programs rely on doing odd things to the disk format: that is, they deliberately introduce errors onto the disk, then in software try to compensate for them. Most of these schemes use "undocumented features"—really quirks and errors—of the PC floppy-disk controller. The Copy II PC program from Central Point Software will take care of nearly all those schemes. When publishers found that out, they escalated the war.

Central Point's answer to *that* is a new board. You plug it into your PC and connect to your floppy drives, then run the cable from your PC disk controller to the Copy II PC option board. This allows you to defeat most of the new protection schemes.

The option board works fine in a PC, and it's easy enough to install. It's a bit harder to get into a Compaq or PC AT because you have to change jumpers around, but the instructions are clear enough. Once installed it works automatically, and you're set until the next round in the copy-protection wars.

That's one remedy. Another is to Take The Pledge and not buy copy-protected software—a movement that seems to be gaining ground.

It's having results, too. Living Videotext, which makes the excellent ThinkTank program, has given up copy protection. They're to be commended. I hope a lot of others get the message.

ITEMS DISCUSSED

BRIDGE PARLOR . . . Price unavailable
Parlor Software Company
POB 2100
Liverpool, NY 13089

CARDIOVASCULAR SYSTEMS AND DYNAMICS . . . . . . Price unavailable
Command Applied Technology Inc.
West 400 Main St.
Pullman, WA 99163-0511
(509) 344-6145

COPY II PC PROGRAM $39.95
COPY II PC OPTION BOARD AND PROGRAM $95
Central Point Software Inc.
9700 Southwest Capitol Hwy., #100
Portland, OR 97219
(503) 244-5782

MANDELZOOM $25
Token Software
POB 3746
Bellevue, WA 98009
(206) 455-4130

NEMESIS (THE GO MASTER) $75
Bruce Wilcox
34 Oak St.
Lexington, MA 02173

SOFTWARE ANTHOLOGY SERIES
$32.50 per disk, disk 2 of PC Series includes FUPROLOK
WRITE $239
includes FILTER
Workman and Associates
112 Marion Ave.
Pasadena, CA 91106
(818) 796-4401

SPACEWAR $20
Bill Seiler
317 Lockwood Lane
Scotts Valley, CA 95066

WILDERNESS
for Apple II $49.95
Electric Transit
501 Marian St.
Thousand Oaks, CA 91360

THE HACKER ETHIC

Steve Levy's book *Hackers* discusses "the hacker ethic" of free software. Some of the old MIT free-software people have decided to do something about it. Richard M. Stallman and others have formed the Free Software Foundation (1000 Massachusetts Ave., Cambridge, MA 02138). I don't know all those people, but I've known RMS for some time; and while his views of the world are not mine, I respect his intelligence and his integrity.

They're looking for help. Write and ask for their brochure, and since they don't have much money, slip a buck in the envelope to help them cover the expense of mailing it to you.

WINDING DOWN

It's late, Niven and Barnes are here, and the deadline is due; which is all right, because I am out of space.

The game of the month is still BIX, which takes up more of my time than anything else; but while I was suffering from the flu, I found a strange

Pyramid of Peril has interesting puzzles and a good scenario.

satisfaction in fooling about with the Macintosh version of Wizardry, while the boys continue to play both Gato and Pyramid of Peril on the Mac. Pyramid is really quite nice, with interesting puzzles and a good scenario.

I have somehow managed to neglect Wilderness, an expert-system game developed by Charlie Kohlhase. Charlie's normal job is programming spacecraft; about the time you read this, *Voyager* will get to Uranus using his mission plan. Wilderness is fun and instructional and can teach a lot about living in wilderness areas. Recommended.

The first book of the month is *Klass: How Russians Really Live* by David K. Willis, formerly Moscow bureau chief of the *Christian Science Monitor* (St. Martin's, 1985). Excellent. Example from page 42: "Since I left Moscow, an American personal computer has become the mark of immense klass." If you want to understand life in the Soviet Union, this is the book.

The other book of the month is *Modula-2 Programming* by Ed Knepley and Robert Platt (Reston–Prentice-Hall, 1985); this is a good text for those who already know something of programming and want to learn more about Modula-2.

BIX, meanwhile, continues to improve. I now find myself committed to having a BIX party next month; it was going to be a few friends and now looks to be bigger than that. I hope the place survives. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE *Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.*

Contact us for other low prices on hardware and software.
Next Day Air Extra, Call for latest prices.

FREE SHIPPING
in the Continental United States

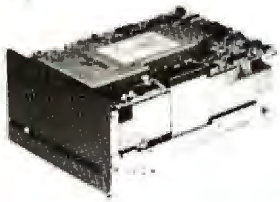
NO SURCHARGE FOR MasterCard OR VISA

20 MEG Hard Disk System for PC

Internal $469
External $619

Includes Seagate Hard Disk, Western Digital Controller, Cables, Manual, Software, and Mounting Hardware.
Boots From Hard Disk   One Year Warranty

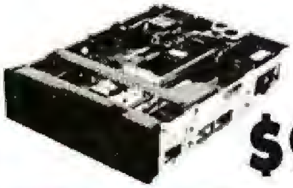
20 and 30 MEG High Speed 40 MS Hard Disks for AT



20 MEG $579
30 MEG $699

Includes Seagate Full Height Hard Disk, Cables, Manual, and Mounting Rails.
Boots from Hard Disk. One Year Warranty.

Floppy Disk Drive



$95

TEAC
55-B, Half-Height, DS/DD

MITSUBISHI
(Japan's Best)
Half-Height, DS/DD

SOLVE YOUR POWER PROBLEM.
XT™ POWER 135W

$89

25 or more $75 each

Directly replaces power supply in PC.™
Fully XT™ compatible.   One Year Warranty

Call us for competitive prices on larger quantities of RAM chips.

64K RAM

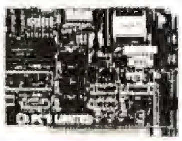
$8 per set

Set of 9 chips, 200 or 150 Nanoseconds

256K RAM $29
Set of 9 chips 150 Nanoseconds

128K RAM for the AT™.
Set **$39**

300/1200 Baud Hayes Compatible Modem Fits in Short Slot



$159

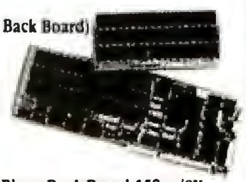
PC'S LIMITED Six Function Card

- Upgradable to 384K
- Clock/Calendar
- Includes Software
- Parallel Port
- Serial Port
- Game Port

Two Year Warranty   **w/384K $129**

PC's Limited AT Multifunction Card

- Expandable To 3 Meg (1.5 on Board/1.5 on Piggy Back Board)
- Supports 64 or 256K Rams
- Parallel Port
- Serial Port (2nd Serial Optional)

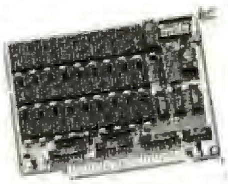


$199 w/0K

Piggy Back Board $59 w/0K

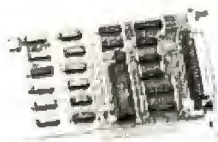
PC's Limited PC-576 RAM Board W/0K

- Expandable to 576K
- Supports 64K or 256K RAMS
- Fits in Short Slot



$69

PC's Limited Floppy Controller Card



$49

- Supports Up To Four Drives

68000 Objection

Dear Jerry,

In the July BYTE ("Quo Vadimus?" on page 309) you mention that many ignore the Motorola 68000 family despite its fine architecture. For those of us in the scientific world, there is an important reason that 68000-based microcomputers have not yet caught on. That is the lack of a 32-bit floating-point math chip for the 68000 series, analogous to the 8087 family for the 16-bit 8086/8088 series. Motorola has promised such a chip, but it has not yet materialized at the user level. The Skye board, which does do floating-point operations, yields about a factor of 3 increase in speed. A 4.77-MHz 8088-based Compaq with an 8087 will do floating-point calculations approximately 10 times faster than a 68000-based system with a Skye board. The 6-MHz 80286/80287-based IBM PC AT and the 8-MHz 8086/8087-based AT&T 6300 push this ratio to something like 20:1. While 68000-based systems compile and link a lot faster, when you have to start crunching numbers in a language like (I know you hate this) FORTRAN, the next step after Intel's 16-bit series is something like a VAX, which has good floating-point hardware available.

Joel S. Davis
Albuquerque, NM

They tell me that Motorola is fixing this Real Soon Now. Meanwhile, I don't hate FORTRAN; I just don't think there's an easy-to-use implementation of it for micros. Certainly there wasn't back when MacLean and I were first learning about these little machines; FORTRAN was the only higher-level language I'd had any experience with (or read any books about). If there had been a good implementation, I'd probably have been a real champion of RATFOR for micros!

I expect there are good micro FORTRANs now, but I've lost the knack.

Best.—Jerry

Sour Apples

Dear Jerry,

Being a late convert to the world of the microcomputer, I have always been amazed at the biased and bizarre views of so-called computer hackers. I am currently astonished by the childish behavior of hackers who are in reality Apple fans. I continue to read with amusement their immature ramblings on how we all must join with them to save the world from IBM. These California throwbacks to the Aquarian age are so detached from reality that they may never come back. First, let's look at what IBM did. Its people designed a computer using a microcomputer chip (the venerable 8088) from a third-party vendor (Intel), using an operating system from a third-party vendor (Microsoft), and gave out bus and interconnection information so that anybody could design expansion cards and accessories for it. IBM did make some stupid decisions on the monochrome-versus color-display format and that infamous keyboard that opened the door for even more third-party action. But this is hardly Orwell's 1984. Even the most casual perusal of BYTE reveals that numerous small companies are reaping the benefits of what IBM has done.

Now let's look at the Apple Macintosh to see where Apple is headed. Well, it appears that we have a closed system and a proprietary operating system. On top of that, if you want to do program development, you have to sign a licensing agreement that forbids any criticism of Apple (now that sounds like 1984). Look how Apple treated its early Mac supporters by charging them $900 for the memory upgrade to 512K bytes. Contrast that to IBM's decision to send all early PCjr buyers a free replacement keyboard.

Now Apple is trying to call the Mac a business machine. The Macintosh design team was a group of immature computer whiz kids who obviously did not give any thought to creating a business computer. If they did, it's obvious that none of them knew what a business computer is, or should be. Anyone attempting to design a business computer must consider the following basic criteria:

1. Ergonomic keyboard. Since a business requires both text and numerical entries and easy scrolling, you need a good-quality keyboard with a separate numeric keypad and cursor pad.
2. Versatile, clear display: Businesses require the option to use either a monochrome or color display. Since many workers do not have excellent vision, the display must be large (at least 13 inches diagonally) and have excellent resolution. Also, the monochrome and color formats should be the same (sorry, IBM).
3. Two disk drives. A minimum of two disk drives are required to reduce annoying and time-consuming disk swaps and to simplify backing up disks.
4. Built-in expansion slots. Since all businesses have unique requirements, expansion slots must be available to tailor the computer to the needs of the business. To minimize desk clutter and to maximize performance, the expansion slots should be in the main unit, directly connected to the main buses on the motherboard.

The Mac falls short in all four categories. Sure, you can clutter up your desk and spend extra money buying a numeric keypad and a second external disk drive. But you can't have a cursor pad, a color display, or any expansion slots. A mouse is a great editing tool, but it is irritating and difficult to use during keyboard-intensive text entry or when entering numerical data in a spreadsheet. Anyway, with the numeric keypad and second disk drive taking up all your desk space, where are you going to roll the stupid mouse?

As to your problems with the MacTribesmen, you do not have to be converted. The Mac is seriously flawed in both design and execution. Apple had a real chance with the development of the Lisa to set the standard for all future computers. Instead, it assembled a design team of brilliant, but naive, kids and let them develop a nice little toy. Then Apple decided to close the system. On top of that, Apple released a virtually unusable 128K-byte system. Let's hope that all those Mac fans out there get the message and pass it on to Apple. If Apple's arrogance hurts sales enough, maybe Apple and other manufacturers will mend their ways.

David Brandt
Oakdale, NY

Well, you put things a bit more strongly than I would. Stay well.—Jerry ■

CompuPro Opens The Door...

...For Total Solutions With Our Family of Multi-User Systems And System Components.

Sometimes it seems like opportunity is just behind the door. At CompuPro, we've created a family of multi-user systems and system components that open many doors—from high performance multi-user business systems to industrial control.

CompuPro products have earned an enviable reputation for delivering performance, quality and reliability—at prices that shut the door on the competition.

So whether you use systems or build them, let CompuPro open some doors for you.

CompuPro™

Inquiry 373

Viasyn Corporation
26538 Danti Court
Hayward, CA 94545-3999

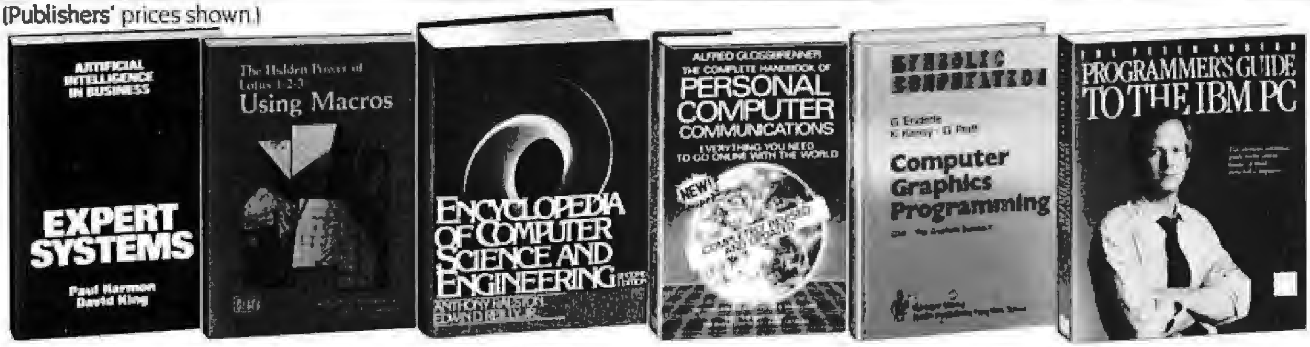
800-842-7961
800-842-7962 (California)

As your introduction to

The Library of Computer and Information Sciences

Take any 3 books

(Publishers' prices shown.)



47100 $24.95

52799 $18.95 (Softbound)

44904-3 $87.50 (Counts as 3 choices)

39797 $14.95 (Softbound)

39985-2 $39.00 (Counts as 2 choices)

68430 $19.95 (Softbound)

39763 $26.95

61613-3 $63.50 (Counts as 3 choices)

85372-3 $69.90 (2 volumes count as 3 choices) (Softbound)

32272 $28.95 (Softbound)

32439 $15.95

52173-3 $77.50 (Counts as 3 choices)

74259 $19.95

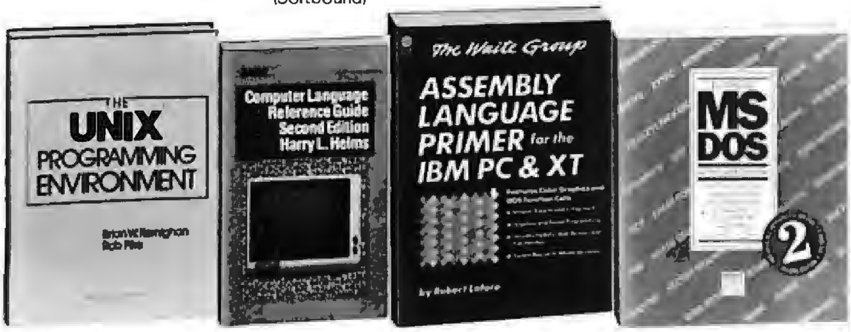
37206 $22.50 (Softbound)

37194 $22.95

38220 $24.95

70734 $18.95

52183-2 $55.95 (Counts as 2 choices)



85375 $26.95

39986 $9.95 (Softbound)

34620 $24.95 (Softbound)

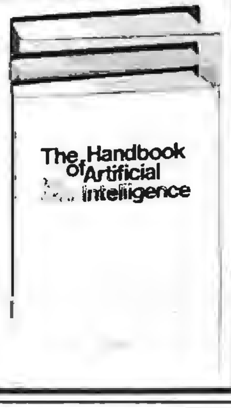
74781 $21.95 (Softbound)

Special Value!

THE HANDBOOK OF ARTIFICIAL INTELLIGENCE (Volumes 1–3)

The *Handbook* was conceived and produced by leading scientists and researchers at Stanford University. It makes available the concepts and techniques of this rapidly expanding computer universe to scientists, engineers, students, and hobbyists who are encountering AI for the first time.

52150-3 $141.95 (Counts as 3 choices)



THE LIBRARY OF COMPUTER AND INFORMATION SCIENCES

(the oldest, largest, and most respected computer book club in the world)

Please accept my application for trial membership and send me the three volumes indicated, billing me only $1.00 each, plus shipping and handling. I agree to purchase at least three additional Selections or Alternates over the next 12 months. Savings range up to 30% and occasionally even more. My membership is cancelable any time after I buy these three books. A shipping and handling charge is added to all shipments.

A few expensive books (as noted) count as more than one choice. No-Risk Guarantee: If I am not satisfied—for any reason—I may return my introductory books within 10 days. My membership will be canceled, and I will owe nothing.

Name ______________________

Name of Firm ______________________
(if you want subscription sent to your office)

Address ______________________ Apt. ______

City ______________________

State ____________ Zip ____________

(Offer good in Continental U.S. and Canada only. Prices slightly higher in Canada.) BYTE 1/86

7-DG4

THE LIBRARY OF COMPUTER AND INFORMATION SCIENCES

(the oldest, largest, and most respected computer book club in the world)

Please accept my application for trial membership and send me the three volumes indicated, billing me only $1.00 each, plus shipping and handling. I agree to purchase at least three additional Selections or Alternates over the next 12 months. Savings range up to 30% and occasionally even more. My membership is cancelable any time after I buy these three books. A shipping and handling charge is added to all shipments.

A few expensive books (as noted) count as more than one choice. No-Risk Guarantee: If I am not satisfied—for any reason—I may return my introductory books within 10 days. My membership will be canceled, and I will owe nothing.

Name ______________________

Name of Firm ______________________
(if you want subscription sent to your office)

Address ______________________ Apt. ______

City ______________________

State ____________ Zip ____________

(Offer good in Continental U.S. and Canada only. Prices slightly higher in Canada.) BYTE 1/86

7-DG4

10-Day Free Examination

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 230 RIVERSIDE, N J

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

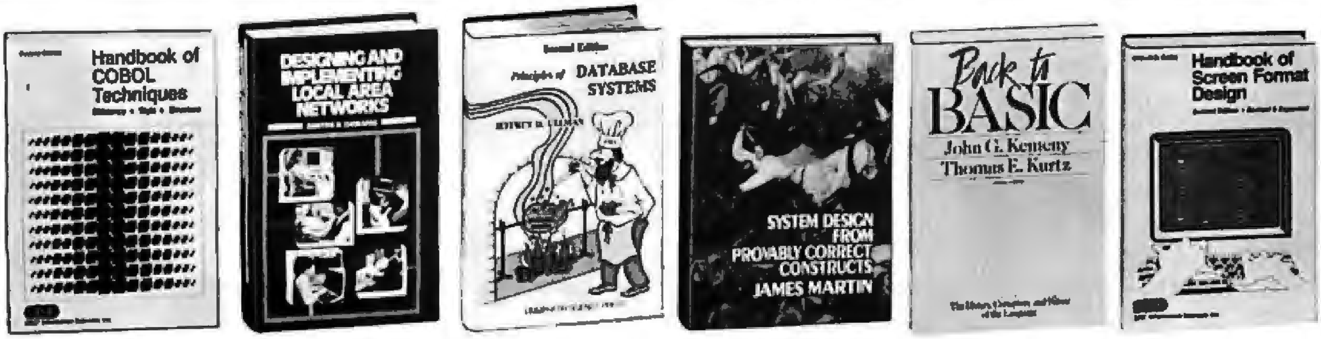
THE LIBRARY OF COMPUTER AND INFORMATION SCIENCES

Riverside, New Jersey 08075-9889

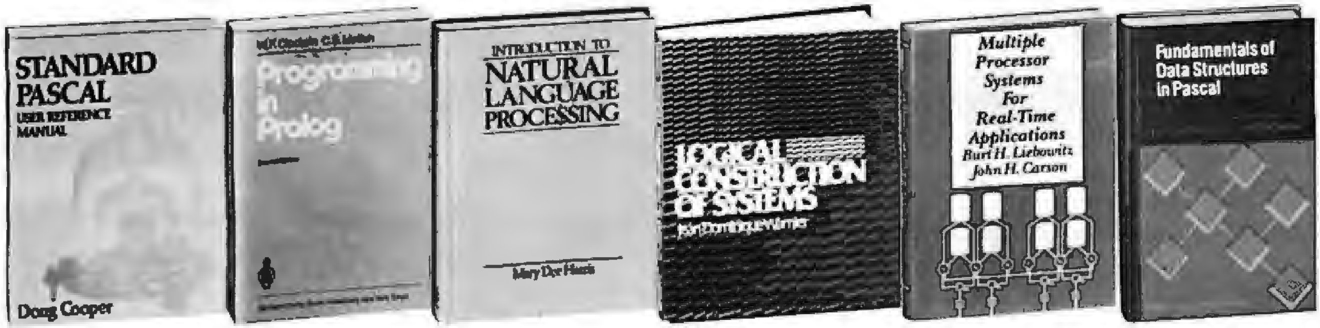
for only $1.00 each

Values to $86.40

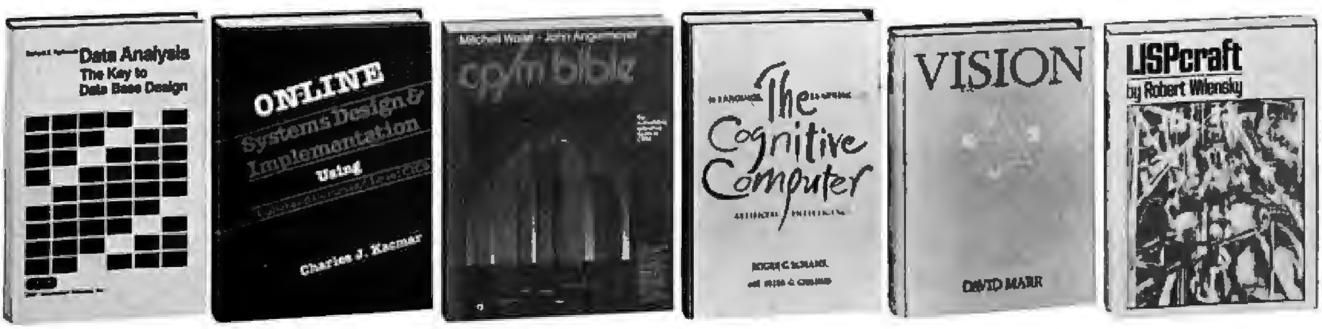
You simply agree to buy 3 more books —at handsome discounts—within the next 12 months.



52655 $9.50 (Softbound)	41969-2 $32.95 (Counts as 2 choices)	70206 $24.95	81844-2 $37.50 (Counts as 2 choices)	35495 $12.95 (Softbound)	52336-2 $31.50 (Counts as 2 choices) (Softbound)



80158 $12.95 (Softbound)	70728 $17.95 (Softbound)	56285 $27.95	58811 $24.95	63235-2 $37.95 (Counts as 2 choices)	49353 $26.95



41620 $29.50	65400 $26.95	40830 $19.95 (Softbound)	38985 $17.95	85857-2 $32.95 (Counts as 2 choices)	58635 $19.95 (Softbound)

4 Good Reasons to Join

1. The Finest Books. Of the hundreds of books submitted to us each year, only the very finest are selected and offered. Moreover, our books are always of equal quality to publishers' editions, *never* economy editions.

2. Big Savings. In addition to getting the 3 books for $1.00 each when you join, you keep saving substantially, up to 30% and occasionally even more. (For example, your total savings as a trial member, including this introductory offer, can easily be over 50%. That's like getting every other book free!)

3. Bonus Books. Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings up to 70% off the publishers' prices.

4. Convenient Service. At 3–4 week intervals (16 times per year), you will receive the Library of Computer and Information Sciences News, describing the Main Selection and Alternate Selections, together with a dated reply card. If you want the Main Selection, do nothing, and it will be sent to you automatically. If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

If the reply card has been removed, please write to **The Library of Computer and Information Sciences, Dept. 7-DG4, Riverside, N.J. 08075** to obtain membership information and an application. Byte 1/86

We call him Asher the Slasher. Not to insinuate that he's the violent type. Let's just say that Asher carries his job as media director to a kind of quasi-psychotic extreme; the way he slices up ad copy is a copywriter's nightmare.

But when he ordered us to write this ad for Final Draft, the new word processor from CYMA/McGraw-Hill, we started feeling pretty brave. Because we use Final Draft every day. And we know exactly what to say about this incredibly simple and unbelievably powerful system. Without Asher's slashes.

So we wrote about the edit commands. They're alphabetically assigned so that you can learn them easily. All *35*, not 305 like some of the other systems we've struggled with. In fact, Final Draft is so simple, you can learn to use it the first day and master it the second. We did.

And then we described the feature list: automatic red-lining and strike-out, table of contents, floating footnotes, thesaurus, spelling check . . . power you won't find in comparably-priced systems.

But, as usual, the Slasher had some descriptions all his own. "You call this an ad?! I've read better copy in comic books! I'd better get a *real* ad by 5 o'clock, or heads will roll!"

This time, he couldn't scare us. Because we knew it was a great ad. So we stored it with the canned paragraph feature, wrote 37 memos to the execs at CYMA, and read the ad into each one. And they loved it. Absolutely raved. Put it in all the magazines, and since then we've canned all our work with Final Draft.

Now we're working on Asher.

FINAL DRAFT ™
The word processor
from CYMA/McGraw-Hill.
Call 800-292-CYMA.

Inquiry 96 for End-Users.
Inquiry 97 for DEALERS ONLY.

THIS AD WAS CANNED 37 TIMES

A·C·C·O·R·D·I·N·G T·O W·E·B·S·T·E·R

Benchmarking

BY BRUCE WEBSTER

Well, I made it. I and my belongings got to Utah relatively intact, and I managed to get everything unpacked and organized a day or two ago, so I'm ready to really start working again. I appreciate your patience over the last few months; these columns have been a little bit sparse, but that should change now.

INDUSTRY UPDATE

It is late September when I write this, and Apple has just announced several new products, including a 20-megabyte hard disk for the Macintosh (reportedly priced at $1495) and a 3½-inch 800K-byte disk drive for the Apple IIe and IIc (at $499). Other products include a new version of the Imagewriter printer and two high-resolution color monitors for the Apple II computers. Not having seen any of them, I can't really comment except to say that it's good to see Apple taking a more aggressive role in the marketplace. I've taken swipes at Apple just about every month, mostly out of frustration at the mixture of brilliance and lack of brilliance coming out of Cupertino. Apple's innovative edge had dulled a little, but common sense seems to be making a strong comeback, and it bodes well for Apple as well as the industry as a whole.

On another front, IBM has been very quiet for the last few months, having said little since announcing that earnings for the rest of 1985 were not going to be very good and that the PC II did not, does not, and will not exist. I am not quite sure what this means, but I see two possibilities: Either the Entry Systems Division is in disarray since the mandated relocation of 200 of its executives from Florida to New Jersey, or IBM is planning to make some stunning announcement and has managed for once to keep it quiet. If it's the latter, the people at IBM will probably have made the announcement by the time you read this—they like the November/December period for such things.

In the Atari 520ST versus Commodore Amiga battle, it appears Atari has won the first skirmish by getting machines out the door, onto dealers' shelves, and into users' homes. Commodore is just this week getting demo units of the Amiga to dealers. I do not yet have either machine. As I type, though, an Atari 520ST is winging its way to me from the BYTE offices in Peterborough. No word yet, though, on when an Amiga might show up. Look for a side-by-side-by-side comparison of the 520ST, Amiga, and Macintosh as systems and development software become available.

Meanwhile, the "Christmas wars" should be over by the time you read this. Going out on a limb, I think that the Atari 520ST will be the big winner, with the Amiga also doing well (but not as well as the Atari). The big loser will be the Apple II, barring a drastic price reduction down to less than $600. Right now, the Apple II falls between the 520ST and the Amiga in price but looks rather pitiful next to either one in performance. The software advantage has carried the Apple II for a long time, but consumers now have some affordable alternatives that make up in sheer power what they may lack in available software. (For more on all this, see the "Predictions for 1986" section later in the column.)

BENCHMARKS AND LANGUAGE SELECTION

Speaking of performance, a discussion of benchmarks has been going on for the last week or two in the Pascal conference on BIX (BYTE Information Exchange). The consensus is that the (in)famous Sieve of Eratosthenes (see listing 1) is not adequate by itself as a benchmark and that you should run several different programs to exercise various aspects of a given compiler or computer. The trick, of course, is coming up with the right set of programs.

What characteristics would the right set of benchmarks have? First, such a set would

(continued)

Bruce Webster is a consulting editor for BYTE. *He can be contacted c/o* BYTE, POB 1910, *Orem*, UT 84057.

need to cover the different aspects of a computer language. The Sieve, at first glance, doesn't do a bad job: It includes integer arithmetic and comparisons, array indexing, loops, and conditional tests. And the Sieve works well for getting "rough order of magnitude" comparisons between languages; for example, the benchmark times shown in my August 1985 column give a pretty good idea of the comparative speeds of, say, MacPascal versus Mac-Modula-2 versus Megamax C. But the Sieve is probably not so reliable by itself for comparing all the C compilers on the Macintosh. Why? The bulk of the time is spent with just a few statements: assigning a constant value to a one-dimensional Boolean (or, for C, integer or short) array, increasing an integer value by another integer value, and testing if one integer value is less than or equal to another. By optimizing those few operations, a compiler/language can look good running the Sieve but might not perform so well with a broader mix of tasks.

Let's say, then, that we're going to design a set (or suite) of benchmark programs for comparing compilers and languages. What aspects should be covered? The list might be as follows:

- Integer arithmetic. Addition and subtraction will be fairly straightforward, since the underlying processor can prob-

(continued)

Listing 1: *The Sieve of Eratosthenes program written in Pascal.*

```
program Prime(Input,Output);
{
  purpose       calculate first 1891 prime numbers 10 times
}
const
  Size                        = 8190;
var
  Flags                       : array[0..Size] of Boolean;
  I,Prime,K,Count,Iter        : Integer;
begin
  Writeln('size of flags:   ',SizeOf(Flags));
  Writeln('10 iterations',Chr(7));
  for Iter := 1 to 10 do begin
    Count := 0;
    for I := 0 to Size do
      Flags[I] := True;
    for I := 0 to Size do
      if Flags[I] then begin
        Prime := I + I + 3;
        K := I + Prime;
        while K <= Size do begin
          Flags[K] := False;
          K := K + Prime
        end;
        Count := Count + 1
      end
  end;
  Writeln(Chr(7),Count,' primes')
end. { of program Primes }
```

CHAIRMAN OF THE BOARDS

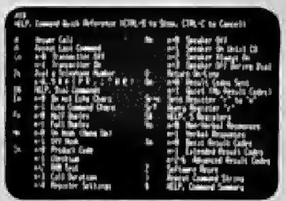
THE 2400 bps MODEM FOR IBM-PCs & COMPATIBLES.

Plug the new USRobotics Microlink 2400™ modem board into any slot in your IBM PC or compatible — to give your computer full 2400 bps data communications capability.

The Microlink 2400 can communicate twice as fast as 1200 bps modems. (It transmits a double-spaced page of text in as little as 7 seconds!) Faster communication means lower phone bills and increased productivity. The modem can even redial busy numbers until it gets through — freeing you for other tasks.

Microlink 2400 displays call status and length on your screen, as well as operational parameters, including the command set and S-register settings. The modem's auto-answer feature automatically adjusts from 2400 bps to 1200 or 300 bps to match the speed of incoming transmissions. What's more, a powerful equalizer assures peak performance on every call.

SOFTWARE COMPATIBILITY, SUPERIOR PERFORMANCE



Help Screens

The Microlink 2400 is CCITT and Bell compatible, and responds to the full AT command set. You can use it with any of the popular telecommunications software packages including Telpac™ by USRobotics, Crosstalk™, PC Talk™ and Smartcom™. In addition to the features you'd expect, our new, improved Telpac enhances Microlink 2400's performance with such features as easy-to-use windows, multilevel security, and log files to monitor your outgoing calls.

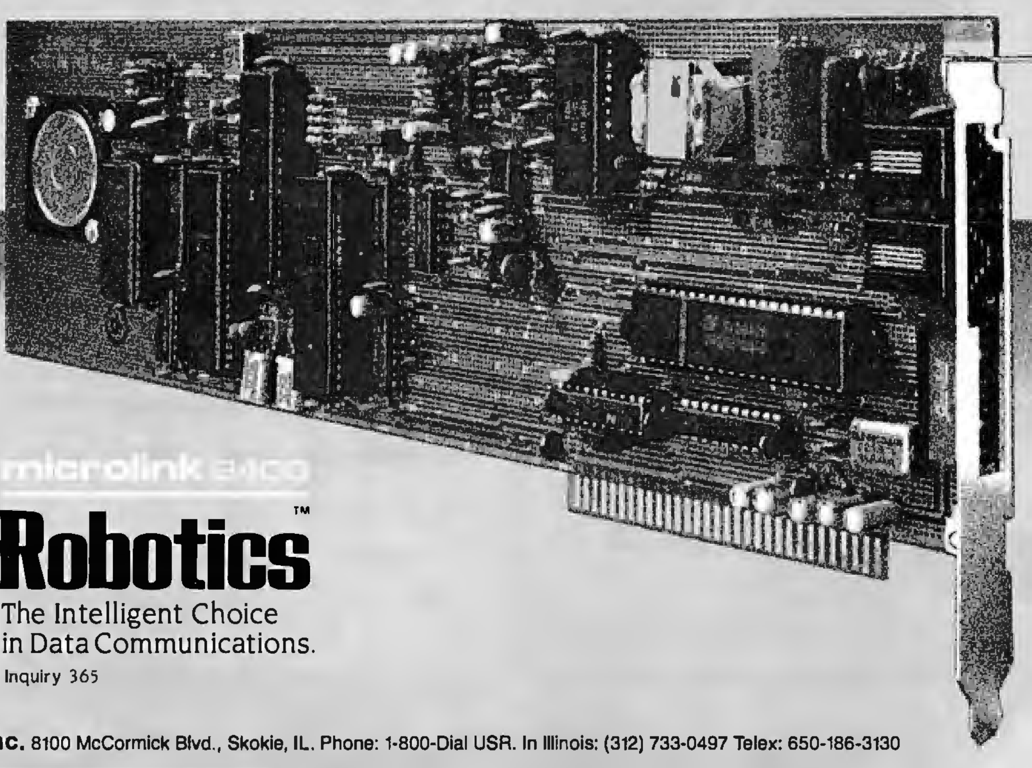
ALL THIS PLUS HIGH RELIABILITY AND LOW COST, TOO

Courier 2400™

Microlink 2400's low chip count results in exceptional reliability — backed by a full 2-year manufacturer's warranty. But best of all is the price — only $699! And if you prefer an external modem, our new Courier 2400™ will deliver the same superior performance at the same affordable price.

We set out to build the best modems on the market. Now, they're ready. Microlink or Courier.

Being faster is important. But being best was our goal.



USRobotics™

The Intelligent Choice in Data Communications.

Inquiry 365

USRobotics, Inc. 8100 McCormick Blvd., Skokie, IL. Phone: 1-800-Dial USR. In Illinois: (312) 733-0497 Telex: 650-186-3130 ably handle them well. Multiplication and division, though, should get special attention, since they're more difficult and time-consuming, making them better targets for compiler or run-time library improvement.

- Real arithmetic. Typically, most compilers call run-time routines to perform real-number math, so speeds will vary widely depending upon how well written those libraries are. My own benchmark experience bears that out, with significant speed variations between different compilers. Also, precision is as important, if not more so, than speed; more on that later.
- Array manipulation. Arrays are the closest thing to a universal data structure, found in just about all programming languages. They should be read from and written to. Multidimensional arrays with multibyte elements provide the best test of performance.
- Character and string manipulation. The perception of computers as number crunchers lives on, but micros probably do more text processing than any other single function. Different types of string manipulations, including assignments and comparisons, are worth timing.
- Manipulation of other data structures, like records or sets. Pascal, C, and FORTH all allow complex data structures; assignment and manipulation of subfields should be timed.
- Control structures. Loops and IF. . .THEN and CASE statements all need to be tested. These are usually straightforward enough, but some care must be taken to provide accurate comparisons. The code within the control structures must have closely matched or well-measured performance between different compilers.
- Subroutine calls. As with control structures, you should be sure you're measuring the call and return performance rather than code within the subroutine or bracketing the call.
- Screen input/output. I/O performance tends to be fuzzy because the operating system often stands in the way. Even so, some compilers handle this better than others. On the other hand, those that perform better often do so at the expense of portability by using machine-specific features.
- Disk I/O. Again, the hardware and the operating system play a big role here, but with those two factors held con-

Table 1: *Times, in seconds, recorded by seven different Pascal implementations running four benchmarks. These programs were all run on the same computer.*

Implementation	Sieve	Matrix	Sort	Reals
1	15.3	4.9	12.3	8.4
2	12.3	9.9	3.1	8.0
3	15.2	12.3	14.6	109.0
4	164.3	13.3	17.2	4.2
5	20.9	4.5	10.7	4.2
6	234.3	27.5	26.9	19.9
7	23.8	12.4	11.5	19.9

ACCORDING TO WEBSTER

stant, language performance can be safely compared.

The second characteristic is that these aspects should be isolated into different programs so that performance in each area can be measured. This isn't always easy; for example, it's hard to test control structures (loops, etc.) without having something in them—but that something might create a speed difference. Likewise, to test, say, integer arithmetic, you may want to set up a loop—but how much effect does the loop have? Still, with work and care you can get a pretty good idea of what aspects of each benchmark program are critical. By separating the benchmarks, you can develop a profile for each compiler or language. This will help you decide which one to use for a particular application.

Third, the issue of true comparison versus optimization must be dealt with. For example, at the start of the Sieve, the array Flags is initialized using a FOR loop. Many compilers and languages support a fast fill routine (such as FillChar in UCSD and Turbo Pascal or the FILL word found in many FORTH implementations); using such implementation- or language-specific features can speed execution, while strict adherence to an independent form provides a more "accurate" (though possibly less relevant) comparison. So the question is this: Should the benchmark programs be adjusted for each compiler/language to take advantage of special features, or should they remain as identical to other versions as possible? This is another argument for a set of benchmark programs; with multiple programs, you reduce the possibility of a specific feature or extension resulting in deceptively good performance for a single program.

Finally, be aware of compiler options that can affect speed. Turbo Pascal, for example, has a number of options (range checking, user interrupts, etc.) that are turned off by default, resulting in very fast execution. If you turn just one of them—$U+, for user interrupts—back on, your benchmark programs will slow down by a factor of 10 or so. In contrast, IBM Pascal (version 1.0) has a number of similar options (covered by the metacommand $DEBUG) turned on by default, resulting in slower execution. When you run benchmarks, make sure that the compiler options are identically set, preferably with as many options turned off as possible.

INTERPRETING BENCHMARKS

Once you've run those benchmarks through a number of compilers or languages, you may find that the results are not as clear-cut as you would like. A particular implementation may do well with a few of the benchmarks, so-so with some others, and poorly with one or two. For example, table 1 shows the results of running four benchmarks—the Sieve, an integer matrix multiplication, a string sort, and a real-number arithmetic exercise—through seven different versions of a particular language on the same computer. Note the dramatic differences. For example, imple-

(continued)

mentation #3 looks pretty good with most of the benchmarks but does horribly with the real numbers. Likewise, implementation #4 beats all the others with the real numbers (except for #5, which it ties) but is terribly slow on the Sieve and less than exciting on the other two. Implementation #5 seems to be the closest to an all-around winner; it comes in first on the second and fourth benchmarks and does acceptably well on the first and third. (For those of you dying of curiosity, the different implementations are unmasked at the end of the column.)

So the question is this: Which one do you go with? Well, as with just about any decision involving micros, "That depends." Upon what? Upon what you want to do with it. If you're going to be doing a lot of real-number calculation, you probably won't choose implementation #3. Likewise, for functions similar to the Sieve, you don't want #4 or #6. But performance alone may not give you sufficient information to select one compiler or language over another. For example, the benchmarks for implementations #1, #2, and #5 are close enough that, for a general mix of functions, performance is going to be pretty much equal. So how do you choose?

MORE THAN SPEED

Once you have eliminated performance as a criterion for selecting a compiler or language, you should consider other factors. Some of these are

- Precision of real numbers (mentioned above). There are many pitfalls in doing real arithmetic, like cumulative round-off errors, subtraction of nearly identical values, and so on. Compilers typically have a set of library routines for doing real arithmetic; the quality of these routines can dramatically impact the quality of your results beyond the simple issue of how many significant digits the compiler supports.
- Memory models. Most compilers perform well for small programs; what happens when you want to write a large one? How large a program can you have? How much memory can you actually use, and what can you use it for? What mechanisms exist for getting around those limits?
- Compiler size and speed. This wasn't considered an issue until Borland International released Turbo Pascal, which was an order of magnitude smaller and one or two orders faster than anything else out at the time. I, for one, wonder now why many other compilers are so big and so slow.
- Adherence to standards. This can be for the language itself or for the libraries supplied. Again, Turbo Pascal has been controversial in this respect; critics have pointed out the ways in which Borland ignored the ISO (International Standards Organization) and Wirth definitions and the problems caused thereby, while apologists have countered by claiming Turbo itself is a de facto standard because more copies of Turbo are in existence and use than any other Pascal implementation (and, probably, more than all other implementations combined).

- Access to hardware/ROM (read-only memory)/operating system. How well does the compiler let you use the computer you're running on? This can include graphics, I/O ports, mass-storage devices, math coprocessors, and calls to ROM or operating-system routines.
- Utilities. Does the language have support programs, like editors, debuggers, linkers, and libraries? How many are included in your package, how much do the rest cost, and how well do they work?
- Cost, licensing, technical support, and upgrades. If you're planning to do a lot of work in a given language, cost is not that big an issue (unless, of course, you don't have the money). If you're planning to do commercial work, licensing is a big issue, although more and more firms are dropping licensing fees (inspired, perhaps, by the death of SofTech Microsystems, which used to ask incredible fees). Likewise, good technical-support and upgrade policies are important for serious development, since most compilers are undergoing constant improvement.
- Your environment. If all your coworkers are using C, it may not be a good idea to select Pascal, and vice versa. This is especially true if someone else is going to maintain your program (fix bugs, add features, etc.) after you've written it.
- Aesthetics and philosophy. Some people really like C; others swear by Pascal; yet others prefer FORTH, or LISP, or assembly language, or even (gasp!) BASIC. The reasons are many, complex, and often inalterable; in this respect, a person's language preference becomes as firm as religion or politics. What's really ironic is that, given all the benchmarks and other valid issues, this last point is often the deciding one, and the others are shamelessly manipulated to support the predetermined decision.

As you can see, there is much, much more to consider in selecting a given language or compiler than how fast it runs the Sieve program. Of course, this is all assuming that you're running on one given computer. If we start talking about different configurations (memory, disks, etc.), not to mention entirely different computers, the issues become even more complex.

PREDICTIONS FOR 1986

I'm not sure what it is that makes us get such a kick out of trying to predict the future, but it is fun. I am, perhaps a bit unwise to try it myself; not only am I writing this before 1986 even starts (late September, to be exact), but I don't have much in the way of inside information, especially living up here in the Rockies. But, as the song says I've been a fool for lesser things, so here goes.

- There will be a big upswing in the "mythical" home computer market. This will start toward the end of 1985 and will continue strong through most of 1986. What's more, the public—having learned their lesson from the millions

(continued)

of C-64s, TI-99/4As, and VIC-20s gathering dust on bookshelves—will be willing to put out the bucks to buy powerful, expandable computers. The result is that...

- Commodore and Atari will both do well, much to everyone's surprise. People will buy the 520ST and the Amiga, looking for a system that can do serious work and yet run nifty games. The Apple II has been the only computer on the market for years that has really filled that bill, and its aging technology has caught up with it. This means that...
- Sales of the Apple II will plummet, only to be spurred again by dramatically reduced prices. This, of course, will hurt Apple, since the IIe/IIc models have been the real cash cows, helping to subsidize the Lisa and the Macintosh. As a result...
- Apple will be scrambling, trying to rectify its mistakes of the last two years. The computer-as-toaster concept of the Macintosh has failed. It remains the easiest computer around to use, but the crippling hardware limitations have held it back. A Mac-like machine with slots, a fan, a faster processor and disk drives, more memory and mass storage, a larger display, and possibly even color will be released. With these changes...
- An MS-DOS card for the new Macintosh will be released. Probably not from Apple, it will most likely come from either Dayna Communications (the MacCharlie people) or AST Research. The card will have cables leading to a pair of 5¼-inch disk drives, and the whole system will let the new Mac look like an IBM PC. Once this happens...
- The Macintosh will finally start to penetrate the corporate business market—two years late, and in nowhere near the numbers that Apple had hoped. Nevertheless, it will generate some cash and (more important) confidence from Wall Street, sending Apple stock up from its long-term slump. However, in the meantime...
- An MS-DOS box—with 8088 processor and a BIOS (basic input/output system) from the folks at Phoenix—will be released for the Amiga. It will plug into the Amiga's expansion bus and take over the machine, using the 68000 as an auxiliary I/O processor. It may have its own 5¼-inch drives, or it may use the optional 5¼-inch Amiga drives. At the same time...
- UNIX, despite its many serious flaws, will also do well, much to everyone's surprise (except all those UNIX hackers who have sworn by it all along). Versions of UNIX will appear almost simultaneously for the new Macintosh, the Amiga, and the upgraded (1-megabyte) 520ST. All three machines will become popular in university and engineering environments, as those same UNIX hackers discover the delight of having a computer all to yourself. The upshot of all this is that...
- The 68000 will have a good year, not only because of the successes of the new Mac, the Amiga, and the 520ST, but because of other 68000-based systems aimed at home, educational, and scientific markets. Indeed, the 80x86 versus 680x0 dichotomy will cause déjà vu in those who have seen the IBM versus DEC mainframe and mini-

computer market divisions over the years. Speaking of whom . . .

- IBM will mostly sit on its lead (and its hands), content to rely on momentum and its name to sell products. The only new product to see the light of day will be its laptop portable, which will be decently designed but poorly marketed and received. Instead, this market will be snatched up by the clone-makers, much as the desktop portable market was, and possibly by the same firm: Compaq. And speaking of the clone-makers . . .
- IBM-compatible computers will continue to grab a larger share of the business market, eating into IBM's sales. Should IBM be so foolish as to introduce a proprietary operating system, that share will actually increase, as both software developers and consumers shy away from locking themselves into IBM-only software and hardware.

Well, that's that. Those are my predictions for 1986. A year from now, I'll review them and see how I did. None are terribly dramatic, and there will undoubtedly be major developments that are unanticipated here.

IN THE QUEUE

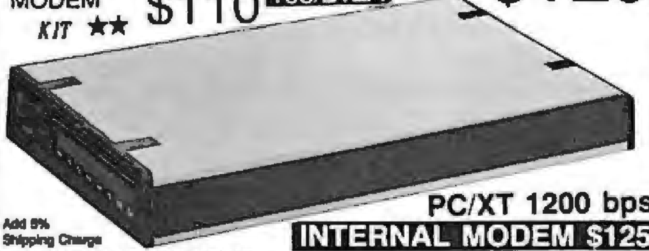
Well, the Atari 520ST arrived safe and sound and is now set up and running. Next month's column will be devoted to first impressions of the machine, which I think will sell very well. I'll also look at a significant piece of development software for the 520ST: a native-code Modula-2 compiler from TDI Software Ltd. Other programming tools will be covered, too, including two new native-code Pascal compilers for the Macintosh and a useful set of diagnostic tools for Turbo Pascal development under MS-DOS. An Amiga computer is now on its way, so the following month (March) will have benchmarks and other comparisons between the Mac, the 520ST, and the Amiga.

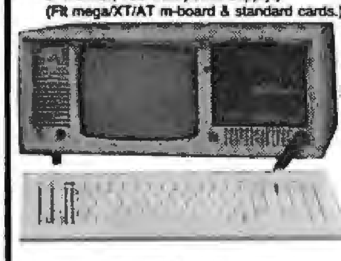
AND THE ANSWER IS . . .

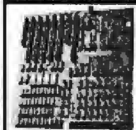
For those of you who are curious as to the identities of the language implementations in table 1, here's the story. All of these are Pascal implementations running on a Compaq portable under MS-DOS 1.1. Since all were done in the spring of 1984, they are out of date; new versions of most (if not all) of the implementations have since been released. If I had had the latest versions of all the Pascals, I would have rerun the benchmarks, but I didn't. As such, these should *not* be considered accurate or current. The envelope, please:

#1: Turbo Pascal, version 2.0, Borland International
#2: IBM Pascal, version 1.0, IBM (Microsoft)
#3: Pascal/MT+, version 3.1, Digital Research Inc.
#4: UCSD Pascal, version IV.1, Network Consulting Inc.
#5: Same as #4, but run through the native-code generator
#6: UCSD Pascal, version IV.1, SofTech Microsystems
#7: Same as #6, but run through the native-code generator

Incidentally, these were all run with as many compiler options turned off as possible. ■







Technical Bulletin
No. 2 in a series.

SUBJECT: Engineering a LAN for Maximum Flexibility.

Quantum Software Systems Ltd. proudly announces QNX 2.0 — the Ultimate Distributed Network Operating System. QNX 2.0 is now available for the IBM-PC, IBM-AT, PC compatibles, DEC Rainbow and TANDY 2000. If you have been waiting for a Real-time Multi-tasking Multi-user Operating system with fourth generation LAN support, then QNX 2.0 can offer you today what the competition can't even begin to promise for the future.

QNX 2.0 integrates the Local Area Network architecture right into the heart of the operating system, at the fundamental level of intertask communication allowing tasks to communicate transparently with other tasks across the whole network. This means that any task (program/application) may access ANY serial port, ANY printer or ANY disk on the network. There are no artificial restricitons. Every PC with a disk is a potential file server. PCs without disks will automatically BOOT over the network.

QNX on the IBM-PC AT:

QNX is the first Multi-tasking Multi-user Operating system available for the AT. It is available in both networked and single machine configurations. At about 2.5 times faster than the QNX 8088 PC based systems, and 10 times faster than other multi-tasking operating systems on the same processor, QNX is the ideal program development environment.

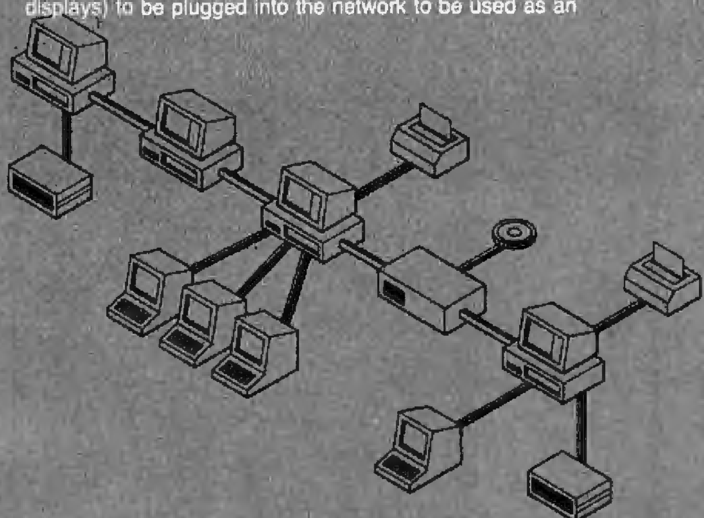
O/S	Computer	Processor	Measured time
QNX ™	IBM-PC AT	80286	480 usec
XENIX ™	Intel-286	80286	4,930 usec

File Security:

Designed with extensive file security features, QNX 2.0 provides login protection with network wide file permission checking based on 255 groups of 255 users. In addition, each PC user may control network access to devices attached locally to their machine.

Distributed Processing:

The QNX LAN supports distributed processing as well as distributed devices. Tasks may be executed on remote stations as easily as they may be executed on the local work station. This allows pure processing elements (PCs without keyboards or displays) to be plugged into the network to be used as an un-committed processing resource. This is ideal for real-time, process control, data acquisition and data communication applications.



Global Communications:

QNX supports a full implementation of X.25 allowing connection to public networks such as Telenet and Datapac. This allows you to link geographically separate LANs together providing true global area networking.

Cost Effective Growth and Flexible Solutions:

QNX is affordable, and will work with the PCs you use today and those you will use tomorrow. You may mix and match different brand PCs on the same QNX network with absolute ease. Multi-user expansion may be accomplished by adding terminals to PCs or PCs to the network. You can start your multi-user application on a single PC with 1 to 10 attached terminals. Once your single processor starts to show signs of degradation, add another PC and connect terminals to the new processor. If the disk becomes the major bottleneck, you may add hard disks to other attached PCs to distribute the processing. Applications which are very CPU intensive may wish to limit a single user to each processor and expand the system with low cost diskless PCs used as work stations. QNX does offer a truly cost effective and flexible solution to your applications needs.

Portability:

QNX 2.0 is portable. The operating system is independant of the physical local area network. It is available in a form suitable for porting to other 8088/8086/80186/80286 computers in the consumer, educational and industrial market place. QNX is ROMable and can operate in as little as 128Kb RAM.

DOS Compatibility:

PC-DOS version 2.1 can run as a task under the QNX 1.2 or 2.0 operating systems. QNX will also allow transparent access to the DOS file system partition and floppies.

QNX Products:

QNX Operating System	PC-DOS Emulator
Full Screen Multi-terminal Editor	Electronic Mail
Extended Utilities	Electronic Teleconferencing
C Compiler & 8086 Assembler	Full Screen Menu Developer
Basic Compiler	Isam File Utility
Qbol (dibol) Compiler	Networking Board
Text Processor	OEM Customization Kit
Real Time Spelling Checker	(to port QNX)

Established:

Quantum sold over 10,000 copies of its operating system during 1984, into all business systems environments, to developers of real time applications, government and educational systems, to software developers/integrators, universities and research establishments.

QUANTUM SOFTWARE SYSTEMS LTD.

Moodie Drive, HiTech Park, 215 Stafford Rd.
Ottawa, Canada K2H 9C1 (613) 726-1893

Inquiry 302

バイト

Favoring Kanji

NEC's PC-98XA, PC-9801VF2, PC-9801VM2, PC-9801VM0, PC-9801U2, and V30, DynaMac, EgWord, EgBridge, and FM-16π

BY WILLIAM M. RAIKE

As this is being written, the autumn *O-bon* holidays are behind us, along with the last of the muggy weather. It looks as if I may finally catch up with some postponed chores, like having the straw covers of my *tatami* mats turned over, mending the paper *shoji* screens on my sliding doors, buying new *futons* (sleeping mats), and checking the disk drives for mildew.

NEC UPGRADES THE PC-9801

Recently, NEC has introduced so many new models in its PC-9801 series that I wonder if it's been taking its cues from automobile manufacturers. The most popular personal and office computers in Japan, the PC-9801 series is the domestic version of the APC III that NEC sells in the U.S. I first mentioned the PC-98XA in BYTE Japan last October (page 381): it's the top-of-the-line model, based on the 80286 microprocessor (the same one IBM uses in its PC AT). In the same column, I mentioned the oddly timed introduction of the PC-9801U2, a version that uses 3½-inch microfloppy-disk drives and has less main RAM (random-access read/write memory) and graphics video RAM than the mainstays of the product line, the F2 and M2 models. All the previous PC-9801 models had been based on the 8086-2 microprocessor, and they differed primarily in the capacities of their built-in 5-inch floppy-disk drives. NEC uses the suffixes U2, F2, M2, M3, etc., to distinguish among PC-9801 models with different disk-drive configurations, memory capacities, etc., but they are all just variations of the basic PC-9801.

Besides the PC-98XA, the new-model lineup includes the PC-9801VF2, VM2, and VM0, in addition to the PC-9801U2. NEC has switched over to a microprocessor it developed itself, the V30, instead of using the 8086 originally developed by Intel Corporation in the U.S. The V30 microprocessor (its actual designation is the μPD-70116) is completely software-compatible with the 8086, meaning that it can run all programs that run on the 8086 or 8088 microprocessors used in most current 16-bit computers. The only difference is that it executes them quite a bit faster—typically 30 to 50 percent—even when running at the same clock speed. In the VM0 and VM2 models, a slightly faster version of the V30 is used, and there's a switch so that you can select either of two clock speeds. The 8-MHz rate is compatible with older versions of the PC-9801 line, for programs that involve critical timing loops and the like, while the 10-MHz rate gives a 25 percent speed boost. Unfortunately, the 10-MHz rate is too fast for the old-type expansion RAM boards, so people upgrading from the older PC-9801 models will either have to use the slower 8-MHz clock rate or buy the new high-speed expansion boards NEC sells along with the new machines.

The F in the VF2 suffix refers to the 640K-byte floppy-disk format; the 2 means there are two built-in 5¼-inch floppy-disk drives. The VM0 model has no built-in floppy-disk drives, although it does house both 5¼- and 8-inch interfaces because it's designed for users who intend to use external disk drives or for factory-automation applications. The VM2 has two built-in 1-megabyte floppy-disk drives, although in this model they are also supposed to be able to read disks recorded on earlier NEC machines in either 640K-byte or 320K-byte formats. Based on the experiences of people I know with earlier models of the PC-9801, I suspect that the ability to read disks recorded in different formats depends on which operating system you use.

The NEC machines can run Japanese-language versions of either CP/M-86 or MS-DOS. NEC spokespersons say the company plans to make CCP/M, Microsoft Windows, and MS-DOS 3.1 available here in the near future. In the past, the PC-9801's ability to read various disk formats hasn't worked for people running under CP/M-86.

(continued)

William M. Raike, who has a Ph.D. in applied mathematics from Northwestern University, has taught operations research and computer science in Austin, Texas, and Monterey, California. He holds a patent on a voice scrambler and was formerly an officer of Cryptext Corporation in the United States. In 1980, he went to Japan looking for 64K-bit RAMs. He has been there ever since as a technical translator and a software developer. He can be contacted c/o BYTE, POB 372, Hancock, NH 03449.

The long-awaited Japanese-language version of the Macintosh is finally in the showrooms here.

Other improvements that are now standard were extra-cost options on earlier models. For instance, all models now include a full 6000-plus kanji-character ROM (read-only memory), and the VM2 and VM0 models now have 384K bytes of RAM, while the VF2 has 256K bytes. A mouse interface is now standard on all models, too, as are 192K bytes of graphics video RAM (except on the U2 model, which has only 96K bytes of graphics video RAM and 128K of main RAM).

Although discounts of 20 or even 25 percent are common, the list prices of these computers are not too high considering the technology they represent. The PC-9801VF2 costs about $1480, while the PC-9801VM2 costs about $1765. The VM0 model costs only about $1255. If these prices sound a little higher than those I've mentioned recently in this column, it's because they reflect the recent drop in the value of the dollar against the yen.

DYNAMAC

When I reported on last year's springtime computer shows, I had very little good to say about Apple's attempts to introduce the Macintosh to the Japanese market. You can now find features like mice and windows as low-cost options on Japanese-made computers (along with plenty of software). The biggest drawback of the Mac at that time was that it couldn't speak Japanese (except for some strange katakana displays kludged up using graphics).

But Apple's reshuffling of its Japanese distribution setup and its linkup with Canon seem to have made a difference. The long-awaited Japanese-language version of the Macintosh is finally in the showrooms, and it looks as if it's been done properly and professionally. They've piggybacked a small kanji-character ROM board onto the main board of a 512K-byte Macintosh and written some software to take advantage of it. The result is the DynaMac. It's a package consisting of a 512K-byte Macintosh with the kanji ROM installed (no, it's not available in the U.S.), an external disk drive, and a printer. (The printer is the Seikosha SP 1000 AP, which offers a very readable kanji font, but you can order the standard Apple Imagewriter instead.) The kanji ROM incorporates only the JIS (Japan Industrial Standard) No. 1 set of 3400 or so characters, which is enough for lots of applications, although all the top-ranking Japanese personal computers also include the additional 3000 or so characters in the JIS No. 2 character set. The limitation is unlikely to be serious because, like other Japanese machines, the system includes the ability to incorporate additional user-defined kanji in the phrase dictionary stored on a floppy disk.

I visited the exhibition where the DynaMac made its debut, courtesy of HI-TECS Company Ltd. in Tokyo, a local Apple distributor. In contrast to similar earlier affairs staged by other companies, the demonstrations were professionally organized. There were plenty of machines available, and there was enough well-informed staff on hand that no visitors ended up wandering around looking lost. I asked to see a demonstration of the Japanese-language word-processing program first. It makes effective use of the mouse and pull-down windows, and it seemed at least as usable and powerful as some other popular programs, including the JWORD package that came with my previous Fujitsu computer.

THE CONVERSION PROCESS

The real key to evaluating a Japanese word-processing program is how well it performs kanji conversion. A kana shift, available on all Japanese personal computers, lets you use each key to input one or two katakana (or hiragana, depending on the manufacturer) phonetic characters. But most people are unfamiliar with the layout, and typists generally prefer to enter Japanese text phonetically using the Roman alphabet rather than the kana alphabet. The conversion routine then looks up the appropriate kanji characters in a stored dictionary. Sophisticated programs accept entire phrases, rather than individual words or even individual syllables. The EgWord program that comes from HI-TECS with the DynaMac does that. (EgWord is not pronounced the way you might think. Because Japanese are taught to mispronounce the word "easy" as "eejee," the spelling of EgWord is an attempt to systematize a mispronunciation of "easy word.") As you type with EgWord, the phonetic katakana characters corresponding to the Roman letters typed on the keyboard are displayed in a screen window. When you reach the end of a phrase or sentence, pressing one of the mouse buttons causes the machine to look through its phrase dictionary, which is partly in memory and partly on a floppy disk. It then converts the phonetic text to ordinary Japanese, which is a mixture of kanji characters and phonetic hiragana characters used primarily for inflected word endings (e.g., verb tenses).

The conversion is a fairly sophisticated task because there are many kanji characters that are pronounced the same but have completely different meanings. A good conversion routine has to guess the right kanji correctly from context a high proportion of the time. Of course, if the computer's first guess is not the characters you really wanted, you can back up and examine alternative character combinations one by one, using the mouse for selection. Lots of good Japanese word-processing programs do this; this one does it as well as most.

EgWord does have some shortcomings, however: It doesn't handle English-language text input very well (it doesn't have word-wrap, for example, because it's unnecessary in Japanese), and the distinction between standard-width and double-width Roman letters, important for professional-looking Japanese text, is handled clumsily.

Bridging the Gap

In addition to EgWord, a program called EgBridge (similar pronunciation reasoning as in EgWord) is supplied with the DynaMac. EgBridge is a pro-

(continued)

Whether the Mac will be able to compete against sophisticated Japanese hardware and increasingly versatile Japanese software will probably be decided by prices.

gram that lets you enter Japanese characters as well as conventional alphanumeric characters into standard Mac software like Multiplan, MacPaint, MacProject, Microsoft Chart, and Microsoft File. It doesn't convert the English-language messages built into the original program, but it does allow you to enter Japanese text. Even though the resulting screen displays are a hodgepodge of English and Japanese, EgBridge is an attempt to bridge the gap between the worlds of western software and the Japanese language.

EgBridge is much more limited than EgWord; it does kanji conversion on a syllable-by-syllable basis, and it requires a user-supplied kanji dictionary (up to 3000 characters). Nevertheless, companies like HI-TECS are offering customized versions of standard software packages for purposes such as inventory management, building design, scheduling, sales management, etc., at prices ranging from about $550 to $800. The president of HI-TECS, Mr. Haneda, says they'll put together any kanji dictionary the customer wants at no extra charge.

All in all, this is the first time that the Mac has had a chance to succeed in Japan. Whether it will be able to compete against sophisticated Japanese hardware and increasingly versatile Japanese software is another story—one that probably will be decided by prices. HI-TECS is offering the DynaMac, including the kanji ROM, printer, and external floppy-disk drive, for the equivalent of about $4575 and will throw in EgWord, which normally sells for about $240, for early customers. Since that's nearly double the price of systems like the new NEC PC-9801VM2 or the dual-floppy-disk version of the Fujitsu FM-16β with a good kanji printer, people are really going to have to be impressed with the DynaMac for it to be a commercial success. Mac enthusiasts who want more information on this machine can contact HI-TECS Company Ltd., 4-1 Kodemmacho, Nihonbashi, Chuo-ku, Tokyo 103, Japan.

MORE ON FUJITSU'S FM-16π

In last August's BYTE Japan (page 331) I reported on the debut of the then-anonymous lap-size portable computer from Fujitsu. The machine is now called the FM-16π. It's been on dealer's shelves for some weeks, and even though it's not a technological wonder, I think it's a tremendous value. If I needed a lap-size computer (it's about two inches thick and the size of a sheet of stationery), I'd think seriously about buying this one.

The main processor is an MBL8086L, a CMOS (complementary metal-oxide semiconductor) version of the 8086 microprocessor, running at a clock speed of 5 MHz. The machine comes in three versions, with a main RAM of either 128K, 288K, or 488K bytes. It is available with either the standard JIS (alphanumeric and katakana) keyboard or a phonetically arranged "goju-on" keyboard layout. A kanji ROM containing the 3400-odd JIS No. 1 set of characters is standard, and the ROM also includes a 19,000-word kanji dictionary for Japanese word-processing purposes. The liquid-crystal display is one of the best I've seen; it's far easier to read, for example, than that of the Data General/One. It can display 25 lines of 80 alphanumeric (or kana) characters, or 11 lines of 40 kanji characters in a legible 16- by 16-dot font. You get a built-in floppy-disk interface and bar-code-reader interface as standard, in addition to a parallel printer interface and an RS-232C serial interface. There's no built-in modem, because by the time you read this, it will only just have become legal to hook up a direct-connect modem to the Japanese phone system; however, you can buy a separate acoustic coupler.

Unfortunately, the FM-16π doesn't have a built-in microfloppy-disk drive; instead, like the Epson laptop machines, the machine has a microcassette drive built in. Supposedly, you can write over 200 characters per second to the tape; that comes to about a minute for a 10-page document, which is too long if you plan to save your word-processing results frequently. Nonetheless, I think I could live without a built-in floppy-disk drive. The machine runs under the CP/M-86 operating system, and you can configure part of the main RAM as a RAM disk, which ought to be acceptable for medium-term storage, since a backup battery makes the CMOS RAM relatively nonvolatile.

You can buy software in the form of optional ROM cartridges that sell for a little more than $200 each. Right now you can choose from two cartridges: one includes Fujitsu's version of BASIC plus a communications program and the JWORD Japanese word-processing program, while the other contains the kanji COBOL Level II runtime system and a communications program.

I have only one reservation about the FM-16π. The keyboard feel and layout are both good, with one glaring exception: The space bar is actually three short bars, and only the middle part (extending from just under the middle of the V key to just under the middle of the N key) works as a space bar. The outer parts are intended to control kanji conversion when you use a Japanese word-processing program. They are labeled (in Japanese) "Convert" and "No conversion"; they have no effect in the alphanumeric mode. For me, it made ordinary typing very inconvenient and almost intolerable. I suppose you could get used to it, but I'd be tempted either to "hot-wire" (cut and jumper) the keyboard (and I don't know if that's feasible) or to glue a steel bar over all three segments!

The FM-16π is reasonably priced. You can buy the 128K-byte version for only about $810, while the prices of the 288K-byte and 488K-byte versions are only about $1020 and $1225, respectively. You'll have to buy one in Japan, though; they're not exported.

Coming Up

In the February issue, I'll focus on two shows I attended here in Japan in October—one on software and the other on data. I'll also discuss highlights of several new printers. ■

The Acorn RISC Machine

A commercial RISC processor

BY DICK POUNTAIN

Acorn Computers Ltd. is one of the U.K.'s most successful computer companies, but like many others, it had its share of financial problems during the depressed year of 1985. Set up in 1979 by two Sinclair alumni, Chris Curry and Hermann Hauser, the Cambridge-based firm (4a Market Hill, Cambridge CB2 3NJ, England) started out manufacturing a set of modular single-board controllers based on the MOS Technology 6502 processor. These small boards stacked together to make up complete industrial-control systems. The following year the Acorn people launched the Atom personal computer, a packaged but expandable machine that arose out of their experience with 6502 systems. For a while, at around £200, the Atom was the cheapest hobby computer available here, and it attracted a strong following, particularly among those who are as handy with the soldering iron as with the assembler. Hopped-up Atoms can still be found to this day.

Acorn's next product, initially called the Proton, was designed to meet a very advanced—for the time—specification published by the BBC (British Broadcasting Company), which was requesting bids to supply a personal computer around which an educational television series would be produced. Acorn won the contract, after a strong and often acrimonious contest in which Sinclair Research, whose 48K-byte color Spectrum was already on the market, lost out.

After a frustratingly long delay due to quality-control problems with the ULAs (uncommitted logic arrays), the BBC computer was launched and proceeded to corner the market in schools and universities. Acorn became a very wealthy company, with a turnover reputed to be £100,000,000 per annum at its high point.

The BBC Micro (alias the Beeb) is still quite a deluxe machine, with better high-resolution color graphics than any of its competitors, and quite a bit faster, thanks to its 2-megahertz 6502. Another plus is the provision of a 10-MHz bus, called the Tube, to which second processors can be attached. Acorn charges a lot of money for this sophistication though, and the Beeb has kept its £400 price long after competitors have slashed theirs to below the £200 mark.

Acorn had from the start paid more attention to software than most manufacturers, recruiting the brightest Cambridge University computer science graduates for its software division. As a result, the Beeb acquired a range of languages unrivaled by any machine but the Apple II, including an advanced structured BASIC, LISP, Logo, FORTH, Pascal, BCPL (Basic Combined Programming Language), and more. But despite all these positive points, the Beeb has a major drawback, a shortage of memory. The ambitious specification, combined with the limited addressing capabilities of the 6502, left it with a maximum of 32K bytes of workspace (only this year upgraded to 64K bytes), and in the higher-resolution graphics modes this can be reduced to a mere 8K bytes. That doesn't get you very far in LISP or Logo.

So at the height of its prosperity, Acorn set a team to design, in secret, its own processor to replace the 6502. This may seem like an ambitious, even rash, undertaking, but the people on the Acorn team were so wedded to the simplicity and speed of the 6502 architecture that they found it hard to countenance any of the commercially available 16-bit replacements. The BBC operating system is heavily interrupt-driven, and the sluggish interrupt latency of 16-bit chips, such as the Intel 8086 and Motorola 68000, would have meant introducing DMA (direct memory access) hardware and all sorts of other undesirable complications. Acorn did, in fact, adopt the National Semiconductor 32016 as a second processor for the Beeb, but only after first offering a 3-MHz 6502. And so they conceived the idea for the

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, POB 372, Hancock, NH 03449.

Only Toshiba printers combine the beauty of the daisy with the speed of the dot.

The Toshiba 3-in-One™ printers.

Toshiba's 3-in-One printers are the IBM PC-compatible printers that give you the best of everything.

Because their 24-pin printhead gives you beautiful letter-quality type like a daisy. Combined with the quiet speed and perfect graphics of the matrix.

In the world of business printers this combination makes Toshiba the leader in the letter-quality matrix category. And our 3-in-One printers a breed apart. So your printouts stand apart from the crowd.

Toshiba's 3-in-One 136-column printers also give you both downloadable type fonts and plug-in type font cartridges for an almost unlimited number of ways to express yourself.

For more information, call 1-800-457-7777, Operator 32. And tell us you'd like to see the beauty of the daisy and the speed of the dot.

In Touch with Tomorrow

TOSHIBA

TOSHIBA AMERICA, INC. Information Systems Division

Inquiry 360

Acorn RISC (reduced instruction set computer) Machine, or ARM.

THE ARM

The ARM was a very well-kept secret indeed. Until its announcement in August 1985, when it had already been created and was available in sample quantities, no word of its existence appeared in the computer press.

Acorn's designers worked in collaboration with the U.S. firm VLSI Technology Inc. (San Jose, CA) who supplied them with CAD (computer-aided design) workstations and design software and made the chips. The Acorn team already had some experience in VLSI (very-large-scale integration) design from working on the ULAs for the BBC microcomputer, but none in processor design. At the time these were some of the most complex ULAs ever made. In a mere 18 months the Acorn team designed ARM from scratch, and it worked as specified from the first silicon. This is not only a great testament to Acorn's design skills, but also a remarkable vindication of the RISC design philosophy. (See "RISC Chips" by John Markoff, November 1984 BYTE, page 191.) It's highly unlikely that such a feat could have been achieved using any of the colossal architectures currently in fashion, like the 68020.

The Acorn people on the design team were inspired by the virtues of the venerable 6502 and by other RISC researchers, such as those on the Stanford and Berkeley teams. However, they departed in several ways from previously used techniques. The design goals they set were high execution speed, a small and regular instruction set, and a very short response time to interrupts (in particular, one much better than that of present 16-bit chips). In addition, the Acorn people required that the chip be capable of supporting virtual-memory operation. Since they started in 1984, it made sense to go straight to a 32-bit processor, as the 16-bit era was already drawing to a close.

The ARM design started, quite properly, with the instruction set rather than the hardware. In fact, the whole design, debugging, and proving of the chip were performed by software simulations—some running on BBC microcomputers with the 3-MHz 6502 second processor—with no hardware prototype at all. The first fabricated chips were also the first hardware realization of the project.

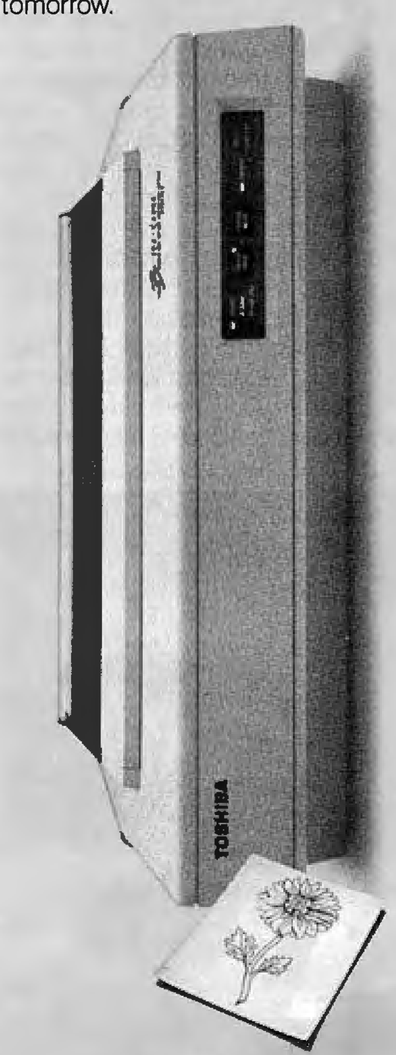
ARM uses a heavily pipelined architecture to achieve a performance of 3 MIPS (million instructions per second) from a small (7 millimeters square) chip containing 25,000 transistors. For comparison, the 68020 is around 9 mm square, contains 192,000 transistors, and achieves about 2.5 MIPS. Clocked at the equivalent of 5 MHz, ARM runs BASIC benchmarks almost exactly 10 times faster than the IBM PC AT and comfortably faster than the TDI Pinnacle with its 12-MHz 68000. The first version of ARM uses fairly conservative 3-micron CMOS (complementary metal-oxide semiconductor) design rules with double metal level and uses so little power that it doesn't become even detectably warm in use. The device is packaged on a square 84-pin Jedec chip carrier.

Later versions will go to 2.4-micron design rules, resulting in an even smaller chip. A smaller chip means a higher yield, and Acorn estimates that it will be more than four times cheaper to manufacture than current megachips such as the 80x86 and 680x0 series. Acorn hopes to sell it to manufacturers of low-cost personal computers, as well as to the artificial intelligence workstation sector.

ARM has 25 full 32-bit registers, a 32-bit data bus, and a 26-bit address bus that enables it to address 64 megabytes of memory to byte boundaries. Only 16 registers are normally available to the programmer. During interrupts the extra registers become available to the processor to simulate a DMA channel without needing to save any of the user's registers. Register 15 contains the program counter; it also holds the status flags in its first 6 bits, there being no separate flags register.

All instructions are 32-bit words

(continued)



(aligned on word boundaries), divided into several fields, and fetchable in one clock cycle. All operations are performed on 32-bit quantities. If you wish to fetch bytes, certain of the load-and-store instructions will extract them and zero-extend them to 32-bits, making use of the on-chip barrel shifter. The advantage of this scheme is that having everything the same length simplifies instruction fetch and sequencing. A potential disadvantage, shared by many RISC designs, is that a minimum 4-byte instruction generates a lot of code compared to older machine designs. With today's memory prices, however, that is not too great a concern.

There are 44 basic instruction codes that can be divided into five categories: load-and-store single-register, load-and-store multiple-register, arithmetic and logical, branch, and software-interrupt instructions. ARM supports no multiply or divide instructions. Each instruction type has several fields, and by setting appropriate option bits you can synthesize a large number of different instructions from the basic set.

Following the Berkeley and Stanford models, ARM has a load-and-store architecture. Only the load-and-store instructions can access memory, and all operations on data are register-to-register.

All the instructions are conditional; that is, they include a test that must be true before they will execute. The first 4 bits of each op code are used to select one of 16 possible conditions. This reduces the number of branches required in a program because branches reduce the efficiency of pipelining. When a program takes a branch, it has to throw away the next (already fetched and decoded) instructions; this causes a time-consuming break or "bubble" in the pipeline. You can write many programs without branches using this "skip-on-test" feature, which is available in every instruction.

The ARM has only two addressing modes: base-relative and program-relative. However, you can easily synthesize other modes from these. Base-relative mode permits either a 12-bit immediate value or a second register—in each case shifted if necessary by the barrel shifter—to be used as the offset. The result of this offset operation may be optionally rewritten to the base register—signaled by turning on a "rewrite" bit in the instruction. Since offsets may be positive or negative, it's easy to get the same effect as the 68000's pre- and post-automatic decrement and increment modes.

The ARM's barrel shifter is also used for arithmetic and logical shifts and (without programmer involvement) to align data words and to extract fields from instructions. As an example, to multiply a number in a register by 17, ARM could add the number to itself shifted left four times and could do it in a single clock tick.

Branches use a 24-bit offset that allows branching to anywhere in memory. There are no separate long and short jumping instructions and no reason to want them, as they would save neither space nor time. If you set the optional "link" bit in the branch instructions, register 15 (the program counter) is copied into register 14 as a return address so that jumps and subroutine calls and returns are accomplished by the same instruction.

All ARM instructions can be executed in one clock tick, except for the load-and-store multiple-register instructions, which require one tick per register. These load-and-store multiple-register instructions provide a fast way of saving the processor state and, therefore, very efficient context switching for procedure calls in high-level languages.

Figure 1 is a block diagram that

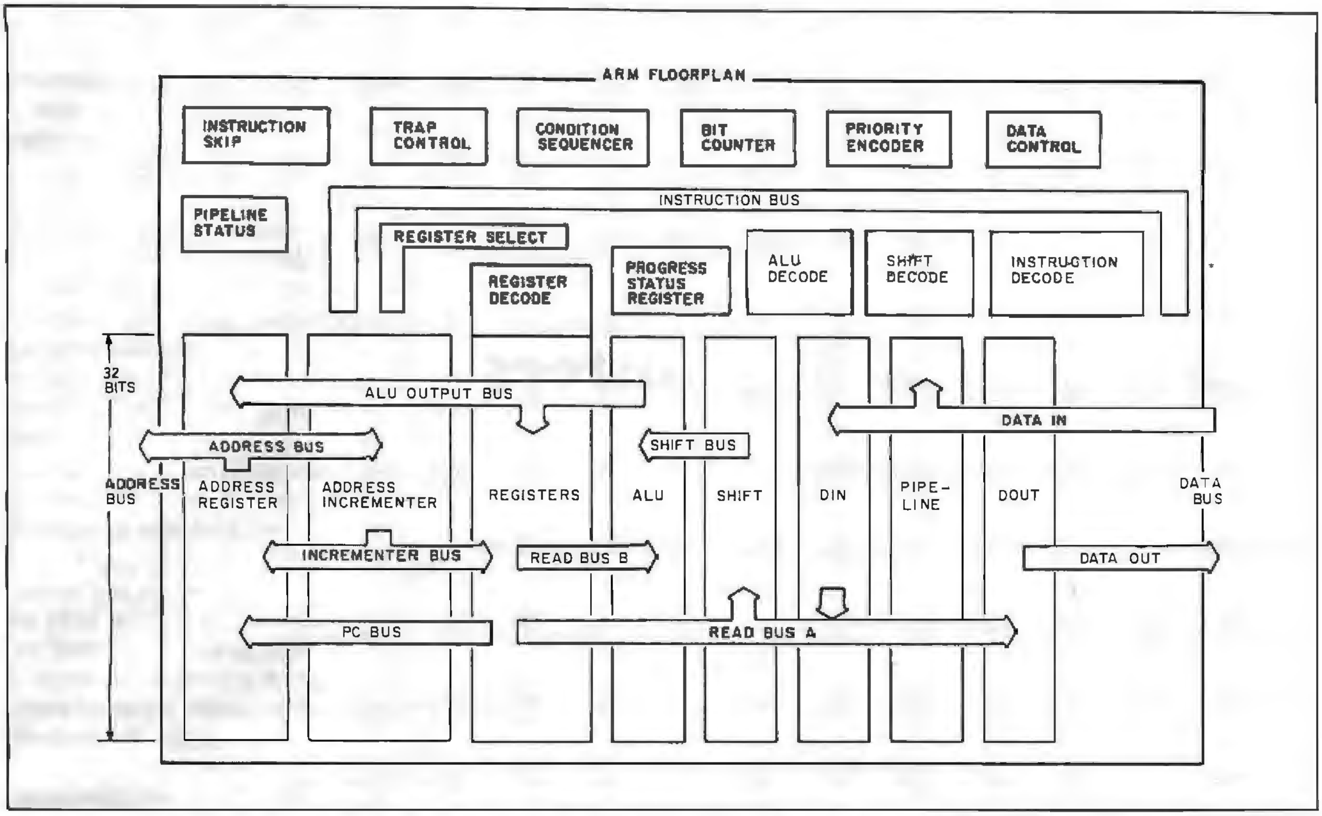


Figure 1: *Block diagram of the 32-bit data path through the* ARM *chip and some of* ARM's *main functional units.*

shows the 32-bit data path through the ARM chip and some of ARM's main functional units. The flow of data through this pathway is not controlled by a single control unit, as in conventional processors, but by a number of separate functional units. The instruction decoder is a programmable logic array in which the instructions are hard-wired. There is no microcode ROM (read-only memory); indeed

(continued)

there is no microcode. Bits in the actual instruction word provide most of the control information.

ARM may fetch an instruction from memory while the previous instruction is being decoded and that instruction's predecessor is finishing execution in the ALU (arithmetic logic unit). This state of affairs, which maximizes processor throughput, persists as long as ARM is performing register-to-register operations consecutively without branching. The load-and-store architecture pays dividends in pipeline efficiency. Acorn has measured ARM's maximum processor-to-memory bandwidth (the rate at which it can transfer data) at 18 MHz.

The condition-sequencer and instruction-skip units implement the skip-on-test feature. If the current instruction's condition test fails, the instruction is discarded without breaking the pipeline of following instructions.

Acorn departs firmly from the Berkeley model, however, on the subject of delayed branching. The Berkeley RISC avoids the problem of pipeline breaks by delaying branch instructions; it redefines branches so that they take place *after* the next instruction; thus, you can always safely prefetch the next instruction. Acorn was initially attracted to this idea but later rejected it because part of Acorn's design goal was to support virtual memory.

A processor that works in a virtual-memory environment must have restartable instructions; if a memory-accessing instruction—for example, a store—tries to access a part of memory that is not available, the memory manager will order an abort. When the processor receives an abort signal, it must restart the offending instruction, having restored the processor state and taken some appropriate remedial action. With a delayed branching scheme, this is difficult to do if an abort occurs while prefetching the instruction following a branch.

Acorn's team instead chose the skip-on-test route and thus has made all the ARM instructions restartable. However, the hardware itself won't do all the repair work; it only preserves the information necessary so that user-supplied software routines can restore the processor state.

ARM has achieved the desired short interrupt latency, partly thanks to the virtual absence of uninterruptible multicycle instructions and partly due to the presence of dedicated system registers that avoid the need to save user registers.

ARM's extremely high processor-to-memory bandwidth is achieved by the wide nonmultiplexed data and address buses and the quite modest cycle time (150 nanoseconds) and therefore does not need to employ expensive static-memory parts. The chip has control signals that can extract 30 percent extra performance from cheap 4-MHz dynamic RAMs (random-access read/write memories) by exploiting page-mode cycles.

SOFTWARE

Unlike most new chips, ARM is already quite well supplied with software. Acorn has a small concurrent operating system running on the chip, derived from that on the BBC computer. Acorn showed me a BBC BASIC interpreter and a LISP compiler working with a windowing full-screen editor. Compilers for BCPL and Modula-2 are also available, while C, Pascal, FORTRAN, and Prolog are all in the works to cater to the scientific and artificial intelligence communities.

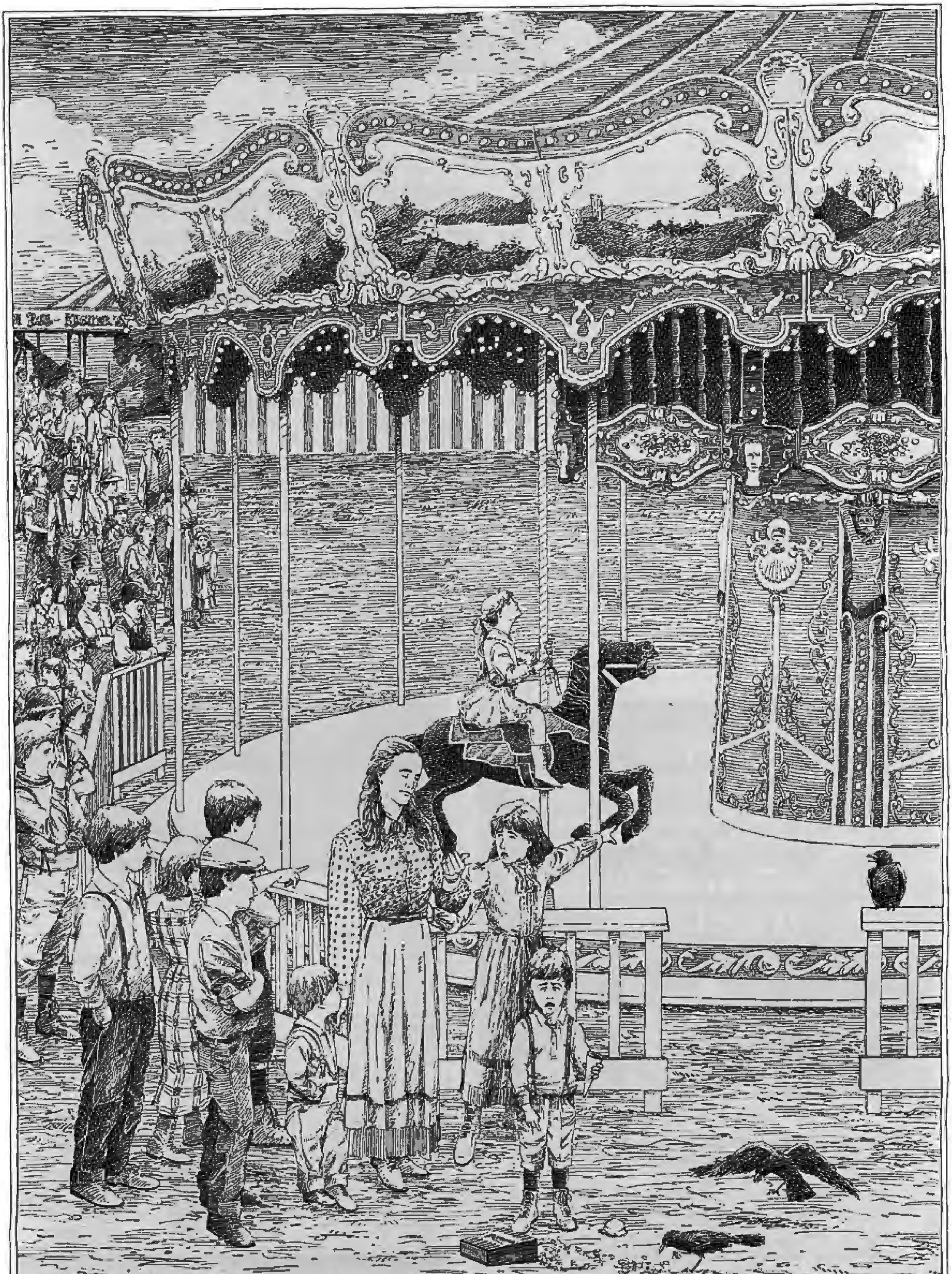
Acorn's business division, one of the new departments that were set up after the takeover by Olivetti, is responsible for the design and manufacture of ARM, but it is rather tight-lipped about current marketing plans. Clearly, Acorn will use ARM in future products, but it has not announced any yet. Acorn has announced that an evaluation board will be available soon and that it will be selling the chip to other OEMs (original equipment manufacturers), several of whom have had evaluation units for some time.

CONCLUSION

The Acorn story nearly ended early in 1985, when the City of London panicked and drove Acorn's share-price (i.e., stock price) down through the floorboards during the post-Christmas computer-sales holocaust. The Italian company Olivetti rescued Acorn and now has a majority shareholding. Informed rumor contends that the Olivetti people didn't know about the ARM project when the rescue was first launched; if that is true, they must have been pleased when they found out.

In ARM, Acorn/Olivetti has one of the first commercial RISC processors in the world and an exceptionally able one. ARM could revolutionize the performance of even modestly priced home computers. It represents a striking vindication of the RISC philosophy in terms of performance, the time it took to develop, and its ease and low manufacturing cost.

Regular readers of this column may have noticed that I'm a bit of a nut for RISC processors, and it's a source of some vicarious pride to me that by the time you read this column, three powerful examples of the breed, all designed in Britain, will be available. In addition to Acorn's ARM announcement, the INMOS Transputer was launched on October 1, 1985, and the first Metaforth MF16LP has been delivered. ■



COMMON SENSE IN DATABASE MANAGEMENT
NUMBER FIVE IN A SERIES.

SOME THINGS CAN NEVER BE SHARED. OTHER THINGS SHOULD BE.

The people who make database software have some strange logic. They tell you information is the most valuable thing in the world. And then they design their products for single-user systems. Which means that every time different people actually need to use your data, they have to stand in line for it.

INTRODUCING R:BASE™ 5000 MULTI-USER.

At Microrim, we have a much better idea of the way offices work. So we've developed a multi-user version of R:base 5000 that lets users update their database while other people analyze it. And we've made this new version fully compatible with our single-user version. Which means any application you develop on the single-user version today can be run on our multi-user version tomorrow.

DATAPRO RANKS R:BASE 5000 #1.

Of course, we gave the multi-user version all the features that convinced the Datapro Research Corporation to rate our single-user version as the best DBMS on the market. But we've also designed it to make optimum use of all the extra capabilities offered by the IBM PC Network (IBM PC DOS 3.1). To optimize data sharing, R:base 5000 Multi-User takes full advantage of the front end processing power of the PC. As a result, multiple users will be able to work with the same database at the same time.

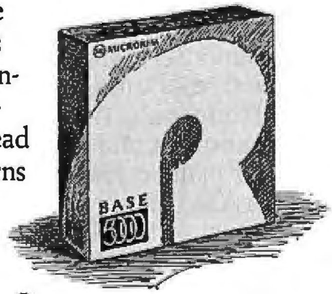
While editing, data integrity is protected by a locking mechanism that operates at the item level. This important feature lets the other users work with columns and rows of the same table. Instead of making them wait around for the other guy to finish his editing job.

SEE FOR YOURSELF: 1-800-547-4000.

The full price is $1500, complete with three sets of documentation. But if you believe in common sense as much as we do, you won't make a decision this big till you get your hands on a copy and see for yourself. And that's just what we'd like you to do. For only $50, we'll send you a copy of the program that has all the features, one set of documentation, and all the functionality of the full product, except for limitations on the numbers of rows, columns and tables.

Just call 1-800-547-4000 and ask for Dept. 888. From Oregon, or outside the U.S., call 1-503-684-3000, Dept. 888. Or head straight for a leading software store or computer dealer.

And see how nice it is to take advantage of information. Instead of taking turns at it.



R:BASE 5000 MULTI-USER
FROM MICRORIM

IT ALL COMES DOWN TO COMMON SENSE.

100% compatible with IBM XT, AT, and PC protocols. Does not support IBM 36.
IBM is a trademark of International Business Machines, Inc.
Datapro Report on Microcomputers is published monthly by Datapro Research Corporation.

AT&T'S ADVANCED PHONE SYSTEM WILL SAVE YOU A BUNDLE.

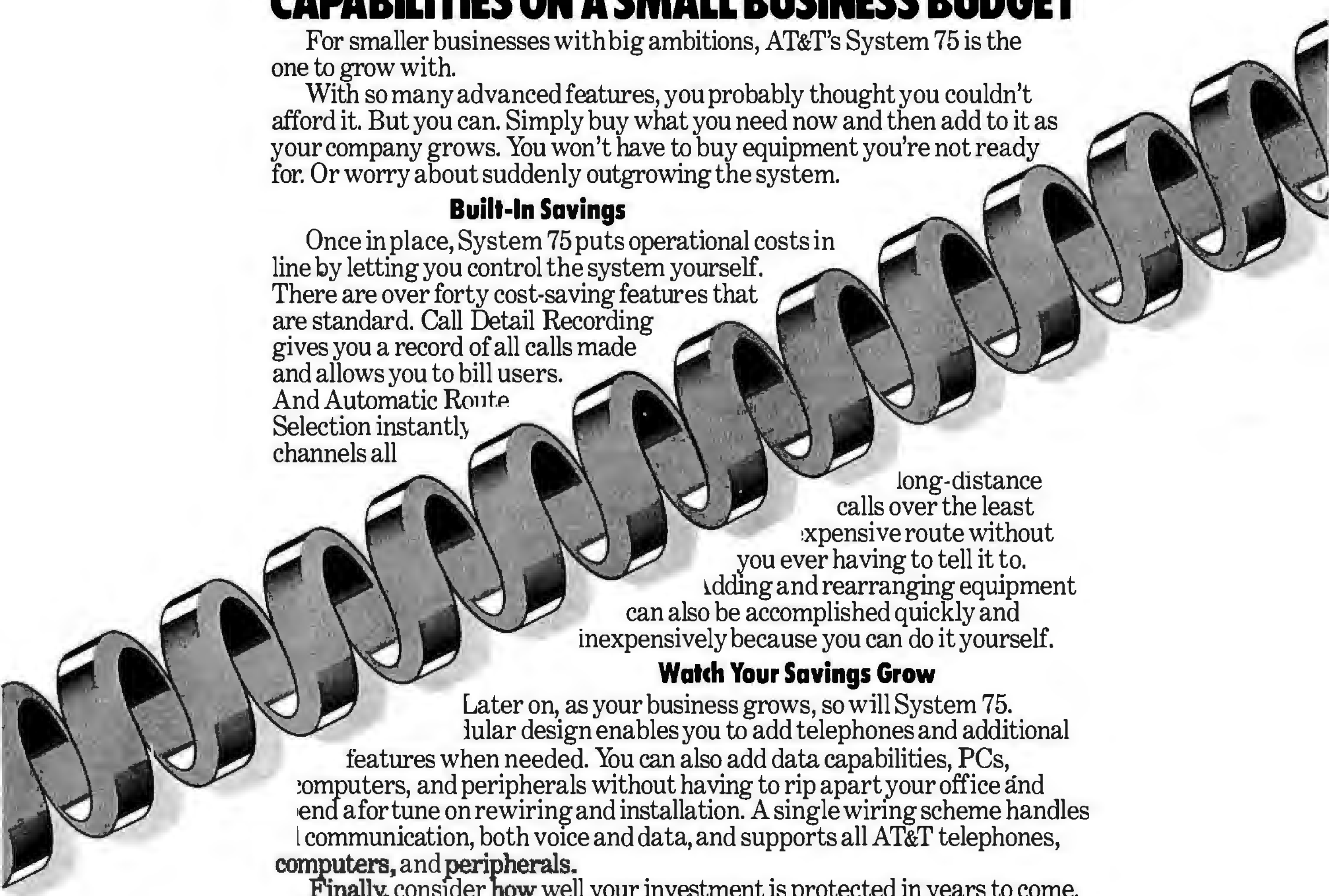
AT&T'S SYSTEM 75 DELIVERS BIG BUSINESS CAPABILITIES ON A SMALL BUSINESS BUDGET

For smaller businesses with big ambitions, AT&T's System 75 is the one to grow with.

With so many advanced features, you probably thought you couldn't afford it. But you can. Simply buy what you need now and then add to it as your company grows. You won't have to buy equipment you're not ready for. Or worry about suddenly outgrowing the system.

Built-In Savings

Once in place, System 75 puts operational costs in line by letting you control the system yourself. There are over forty cost-saving features that are standard. Call Detail Recording gives you a record of all calls made and allows you to bill users. And Automatic Route Selection instantl channels all



long-distance calls over the least xpensive route without you ever having to tell it to. dding and rearranging equipment can also be accomplished quickly and inexpensively because you can do it yourself.

Watch Your Savings Grow

Later on, as your business grows, so will System 75. lular design enables you to add telephones and additional features when needed. You can also add data capabilities, PCs, omputers, and peripherals without having to rip apart your office and end a fortune on rewiring and installation. A single wiring scheme handles communication, both voice and data, and supports all AT&T telephones, computers, and peripherals.

Finally, consider how well your investment is protected in years to come. An AT&T team will custom-design and install the system. With one of the largest service forces in the industry behind it, you'll get prompt service whenever and wherever you need it.

With all these cost-saving features, the question isn't whether you can afford to buy AT&T's System 75. It's whether you can afford not to.

For more information, call AT&T's Small Business Connection. 1 800 247-7000.

AT&T
The right choice.

M·A·T·H·E·M·A·T·I·C·A·L R·E·C·R·E·A·T·I·O·N·S

Euclid's Algorithm

GCDs, LCMs, and repeating decimals

BY ROBERT T. KUROSAKA

In my last installment in November, I examined fractions that form repeating decimals. This month, I am going the other way and will look at how to represent repeating decimals as fractions. I concluded the November column with a presentation of the algorithm for converting repeating decimals to fractions. This month's column will include a program to implement that algorithm, which is shown in figure 1.

The most irritating part of the algorithm is step 5, reducing the fraction to lowest terms. Just how do we do that? First, we must find a common divisor, an integer that divides into both the numerator and the denominator. (For this column, "divides into" also implies "without remainder.") Although 24/30 can be reduced to 12/15 by dividing the numerator and denominator by 2, we must reduce again to 4/5 by dividing through by 3. However, I'm sure we all saw that the greatest common divisor (GCD) was 6 and reduced the fraction in one step. As the numerator and denominator get larger, it becomes more difficult to determine what divides into them.

There are a surprisingly large number of folkways for finding divisors of large numbers. Everyone knows that a number is divisible by 2 if its last (rightmost) digit is divisible by 2. A number is divisible by 4 if the last two digits are divisible by 4. For example, 7536 is divisible by 4 since 36 is divisible by 4. This basic pattern can be extended to higher powers of 2: A number is divisible by 8 if its last three digits form a number divisible by 8, and so on.

Similarly, we all know that a number is divisible by 5 if it ends in 0 or 5. A number is divisible by 25 if its last two digits are divisible by 25, by 125 if the final three-digit number is divisible by 125, etc.

As I mentioned in the last column, 2 and 5 are special cases in base 10, so it's not surprising that we can't generalize this to numbers other than powers of 2 and 5. However, there are some methods for other numbers. I'll briefly run down the list of techniques for other numbers up to 9.

A number is divisible by 3 if the sum of its digits is divisible by 3. For example, 312,798 is divisible by 3 since 3+1+2+7+9+8=30. Further, it is divisible by 6 because any even number that is divisible by 3 is divisible by 6. A number is divisible by 9 if the sum of its digits is divisible by 9. Thus, 312,798 is not divisible by 9, but 312,795 is (3+1+2+7+9+5=27).

The test for divisibility by 7 is rather amusing: "Detach" the last digit and double it, then subtract the result from the rest of the number. If the answer is divisible by 7, the original number is divisible by 7. For example (not that this method needs any clarification), to test 378, we detach the 8 and double it, then subtract 16 from 37. Since the answer, 21, is divisible by 7, so is 378. Try a larger number, 33,929. Detach the 9, double it, and subtract from 3392, giving 3374. Now, is 3374 divisible by 7? You don't know? Apply the test to 3374. (Why is no one laughing?)

Before giving up on these strange tests, let's look at 11. The divisibility test for 11 is a bit complicated but rather impressive. Add every other (alternate) digit in the number; add the remaining digits; if the difference of the two sums is divisible by 11, the number is divisible by 11. In 9,370,845, the first sum is 9+7+8+5=29, and the second sum is 3+0+4=7. Since their difference, 22, is divisible by 11, the entire number is divisible by 11. Note also that the sum of all the digits is 36, which is divisible by 9, and that the number ends in 5. Hence, with simple eyeballing, you can be the hit of the party by announcing that 9,370,845 is divisible by 495 (11×9×5).

Similar to our last example, you can determine that a number is divisible by 100 by applying our rules for divisibility by 4 and 25. (What? You have an easier way?) Well, perhaps you're beginning to feel that we need a more general method for finding common divisors of fractions. Our first im-

(continued)

Robert T. Kurosaka teaches mathematics in the Massachusetts State College system. He invites your correspondence c/o BYTE, *POB 372, Hancock, NH 03449.*

1. Let x equal the decimal:	x =	0.7363636. . .
2. Multiply the equation by 10^ (# of digits in the cycle)	$100x$ =	73.6363636. . .
3. Subtract 1. from 2.	$99x$ =	72.9
4. Solve for x	x =	72.9/99 = 729/990
5. Reduce the fraction	x =	81/110

Figure 1: *The steps in converting repeating decimals to fractions.*

(a)		(b)		(c)	
	1		10		3
1581	1734	153	1581	51	153
	1581		1530		153
	153		51		0

Figure 2: *Step-by-step application of Euclid's algorithm to the problem of finding the greatest common divisor of* 1734 *and* 1581.

pulse is to use prime factorization. This is certainly a correct approach, but most prime-factorization subroutines are cumbersome or time-consuming. I will show you a delightfully direct method of finding the GCD of two numbers that is easily programmed and requires no guessing, no trial and error, and no prime factorization. This remarkable method is called Euclid's algorithm.

Let us reduce the fraction 1581/1734. The steps are

1. Divide the larger number by the smaller. In figure 2a, 1734/1581 = 1 with a remainder of 153.

2. If the remainder is not 0, divide the divisor by the remainder. In figure 2b, 1581/153 = 10 with a remainder of 51.

3. Repeat step 2 until a 0 remainder occurs. In figure 2c, 153/51 = 3 with a remainder of 0.

 Inquiry 113 Inquiry 86

The last divisor is the GCD of the two numbers (most texts call it the last nonzero remainder). In figure 2c, the last divisor is 51. Therefore, the GCD of 1581 and 1734 is 51. And, sure enough, the fraction reduces to 31/34.

An obvious but necessary remark: If the GCD is 1, the two numbers are relatively prime; the fraction is already expressed in lowest terms.

Listing 1 offers a program that reduces a fraction to lowest terms by Euclid's algorithm. [*Editor's note: The Microsoft* BASIC *listings in this column are available for downloading from* BYTEnet *Listings at* (617) 861-9764.]

An annoyance related to reducing fractions arises when adding or subtracting fractions with unequal denominators. We need to find the least common denominator (LCD). Before finishing our cyclic decimal-to-reduced-fraction routine, let's take a side trip to shine some light on LCDs.

In 1/9 + 5/12, we see that the LCD is 36. But precisely what are we seeing?

(continued)

Listing 1: A BASIC *program using Euclid's algorithm to reduce a fraction to its lowest terms. The routine begins at line* 310 *so that, when listing* 3 *is merged with it, the unnecessary lines* (310 *to* 410) *are overwritten.*

```
310 '***********************************************************************
320 '*                EUCLID'S ALGORITHM FOR GREATEST COMMON DIVISORS       *
330 '*                          BY ROBERT T. KUROSAKA                       *
340 '***********************************************************************
350 CLS
360 PRINT "This program calculates the greatest common divisor"
370 PRINT "of a positive fraction"
380 PRINT "and reduces the fraction to lowest terms."
390 PRINT :PRINT
400 INPUT "ENTER THE FRACTION'S NUMERATOR";NUM:NUM=ABS(NUM)
410 INPUT "ENTER THE FRACTION'S DENOMINATOR";DEN:DEN=ABS(DEN)
420 DIVISOR=NUM:DIVIDEND=DEN 'SAVE ORIGINAL VALUES FOR LATER DISPLAY
430 REM IF EITHER TERM IS NOT A WHOLE NUMBER, CLEAR THE DECIMAL.
440 IF DIVISOR<>INT(DIVISOR) OR DIVIDEND<>INT(DIVIDEND) THEN DIVISOR=DIVISOR*10:
      DIVIDEND=DIVIDEND*10:NUM=DIVISOR:DEN=DIVIDEND:GOTO 440
450 IF DIVISOR>DIVIDEND THEN SWAP DIVISOR, DIVIDEND
460 WHILE DIVISOR>0
470       QUOTIENT=INT(DIVIDEND/DIVISOR)
480       REMAINDER=DIVIDEND-DIVISOR*QUOTIENT
490       DIVIDEND=DIVISOR:DIVISOR=REMAINDER
500 WEND
510 PRINT :PRINT
520 PRINT "THE FRACTION ";NUM;"/";DEN;" HAS A GCD OF ";DIVIDEND
530 IF DIVIDEND=1 THEN PRINT "THE FRACTION IS ALREADY IN LOWEST TERMS.":GOTO
    560
540 PRINT "THE REDUCED FRACTION IS: ";NUM/DIVIDEND;" /";DEN/DIVIDEND;
550 IF DEN/DIVIDEND=1 THEN PRINT " = ";NUM/DIVIDEND
560 END
```

The LCD is the smallest integer that is evenly divisible by both denominators. To put it another way, the LCD is the least common multiple (LCM) of the denominators. While any common multiple of 9 and 12 will suffice for adding the fractions (e.g., their product, 108), we prefer the least value because it will simplify reducing the fraction later.

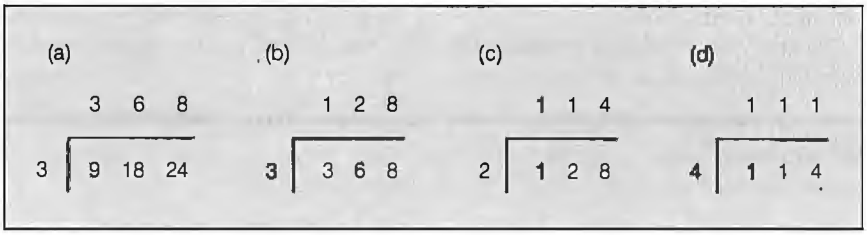


Figure 3: *Finding the least common multiple of three numbers using triple division.*

With larger denominators, the task of finding the LCD becomes increasingly difficult. In 5/12 and 3/14, it is not easily seen that the LCD is 84. Many methods have been devised for finding the LCD, most of which require prime factorization. One rather mystical method works for any number of denominators.

Suppose we want the LCM of 9, 18, and 24. Find a common divisor for all three numbers, if possible. If not, find a common divisor for any two of them, if possible. (If not, the numbers are relatively prime; the LCM is merely the product of the three numbers.)

Listing 2: A BASIC *program to find the least common multiple of a set of numbers using* Euclid's *algorithm.*

```
10 '**************************************************************************
20 '*                     LEAST COMMON MULTIPLE ALGORITHM                      *
30 '*                         BY ROBERT T. KUROSAKA                            *
40 '**************************************************************************
50 CLS
60 PRINT "This program calculates the least common multiple"
70 PRINT "of a set of positive integers."
80 PRINT
90 INPUT "HOW MANY INTEGERS ARE IN THE SET";TERMS:TERMS=INT(ABS(TERMS))
100 IF TERMS<2 THEN 400
110 REM NUMBER ARRAY HOLDS THE SET OF INTEGERS FOR WHICH THE LCM IS SOUGHT.
120 DIM NUMBER(TERMS)
130 PRINT :PRINT "ENTER THE INTEGERS ONE AT A TIME."
140 FOR I=1 TO TERMS
150      INPUT NUMBER(I)
160      NUMBER(I)=INT(ABS(NUMBER(I)))
170      IF NUMBER(I)=0 THEN PRINT "ILLEGAL ENTRY.":GOTO 150
180 NEXT I
190 REM BEGIN LCM PROCEDURE.
200 LCM=NUMBER(1)      'THE LCM OF A SINGLE NUMBER IS ITSELF.
210 FOR I=2 TO TERMS
220      REM FIND GCD OF ACTIVE ENTRY AND WHAT PRECEDED IT (GCD WILL BE STORED
            IN 'DIVIDEND' BECAUSE LINE 290 ASSIGNS LAST VALID DIVISOR TO DIVIDEND).
230      DIVISOR=NUMBER(I):DIVIDEND=LCM
240      REM LINES 250-300 ARE THE SAME AS 450-500 OF THE GCD ROUTINE.
250      IF DIVISOR>DIVIDEND THEN SWAP DIVISOR,DIVIDEND
260      WHILE DIVISOR>0
270               QUOTIENT=INT(DIVIDEND/DIVISOR)
280               REMAINDER=DIVIDEND-DIVISOR*QUOTIENT
290               DIVIDEND=DIVISOR:DIVISOR=REMAINDER
300      WEND
310      LCM=NUMBER(I)*LCM/DIVIDEND
320      REM THE LAST LCM WILL BE LCM OF ALL THE ENTRIES.
330 NEXT I
340 PRINT :PRINT
350 PRINT "THE LEAST COMMON MULTIPLE OF";
360 FOR I=1 TO TERMS
370      PRINT NUMBER(I);
380 NEXT I
390 PRINT "IS";LCM
400 END
```

SAVE 50% *

4216

United States	☐ One Year $21	☐ 2 Years $38	☐ 3 Years $55
Canada/Mexico	☐ One Year U.S. $23	☐ 2 Years U.S. $42	☐ 3 Years U.S. $61
Europe	☐ $69 (air delivery), U.S. Funds enclosed		
Worldwide	☐ $37 (surface mail), U.S. Funds enclosed		

☐ BILL ME. If I'm not completely satisfied with my first copy, I'll simply write "cancel" across your invoice, mail it back, and my subscription will be cancelled.

☐ Check Enclosed ☐ Bill VISA ☐ Bill Mastercard

Please allow 6-8 weeks for processing your subscription.

Name ______________________

Address ______________________

City/State/Zip ______________________

Card # ______________________ Expires ________

Signature ______________________

*off newsstand price of $42.00

SAVE 50% *

4216

United States	☐ One Year $21	☐ 2 Years $38	☐ 3 Years $55
Canada/Mexico	☐ One Year U.S. $23	☐ 2 Years U.S. $42	☐ 3 Years U.S. $61
Europe	☐ $69 (air delivery), U.S. Funds enclosed		
Worldwide	☐ $37 (surface mail), U.S. Funds enclosed		

☐ BILL ME. If I'm not completely satisfied with my first copy, I'll simply write "cancel" across your invoice, mail it back, and my subscription will be cancelled.

☐ Check Enclosed ☐ Bill VISA ☐ Bill Mastercard

Please allow 6-8 weeks for processing your subscription.

Name ______________________

Address ______________________

City/State/Zip ______________________

Card # ______________________ Expires ________

Signature ______________________

*off newsstand price of $42.00

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 39 MARTINSVILLE, NJ

POSTAGE WILL BE PAID BY ADDRESSEE

BYTE

Subscription Dept.
P.O. Box 597
Martinsville, NJ 08836-9956

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 39 MARTINSVILLE, NJ

POSTAGE WILL BE PAID BY ADDRESSEE

BYTE

Subscription Dept.
P.O. Box 597
Martinsville, NJ 08836-9956

We will perform a triple division on these three numbers. In figure 3a, we divide the common divisor 3 into all three numbers. Note that we did not divide the first two numbers by 9 because our precedence of rules requires us to first look for divisors of all the numbers.

Next, we repeat the procedure for the three quotients: 3, 6, and 8. The first two are divisible by 3 again (figure 3b). Important: If the divisor does not divide into a particular number, merely *copy* the number. In figure 3b, the 8 is brought up. This procedure is repeated until all the quotients are 1s. In figure 3c, the 2 and 8 are divided by 2, with the 1 being brought up. Finally, in figure 3d, we divide by 4 and obtain all 1s in the quotients. The LCM is the product of all the divisors used. That is, the LCM of 9, 18, and 24 is $3\times3\times2\times4=72$.

You might enjoy trying to write a program to implement this method. There is, however, yet another method for finding the LCM, and, not surprisingly, it employs Euclid's algorithm.

The LCM of two numbers a and b is the product of the numbers divided by their GCD. That is, $LCM(a,b)=a\times b/GCD(a,b)$. This becomes apparent if we look at a simple example: 10 and 14. Their product, 140, is a multiple, but it isn't the smallest one. Since $10=2\times5$ and $14=2\times7$, their LCM needs only $2\times5\times7$, while their product is $2\times5\times2\times7$. Dividing by their GCD of 2 eliminates the overlap. In the language of elementary set theory, the LCM is the union of the two sets of factors. The formula above instructs us to "add" the two sets together and then "subtract" their intersection.

Since we already have the GCD program, we are only one step away from finding the LCM of two numbers. That's the good news. The bad news is that this method works only with two numbers at a time. To find the LCM of three or more numbers (say, 8, 10, and 14), we first find the LCM of 8 and 10 (40) and then find the LCM of 40 and 14 (280). This is no problem for a computer, but you may feel that it is less efficient than our triple-division approach. Anyway, listing 2 presents my version of the LCM routine using Euclid's algorithm.

I use strings, of course, because you can't directly enter a repeating decimal into the computer.

Finally, we are ready to return to our initial problem of converting a repeating decimal to a fraction. Listing 3 shows my routine for doing steps 1 through 4 of figure 1. The program is mostly a lot of string-handling. I use strings, of course, because you can't directly enter a repeating decimal into the computer. So I use a "_" to signify where the cyclic part begins and enter the number through one iteration of the cycle. This is analogous to the way of writing repeating decimals like 0.333. . . as $0.\overline{3}$. Not only are you unable to enter repeating decimals into the computer, the computer is unable to hold any infinite series. However, the point of step 3 is to get rid of the cyclic part. All of the action in the method happens in the nonrepeating part and the first iteration of the cycle. So that is all that we use in our program.

The only really interesting part of this routine is in line 420. After I find the value of the unreduced fraction's numerator and denominator, I convert the values into strings and then back to numbers. Why?

When I first tried writing the routine in listing 3, I used the number $0.7\overline{36}$ as one of my test cases. The routine displayed the numerator value as 72.9 and the denominator value as 99. However, when I merged the routine with listing 1, I got strange results. It seems that Microsoft BASIC's guard digits were nonzero, so when the GCD routine tried to clear the decimal from the 72.9, the fraction became $7.29\times$

(continued)

Listing 3: A BASIC *program to convert a cyclic decimal number into an unreduced fraction. You can merge this program with listing 1 to make a complete implementation of the algorithm in figure 1.*

```
10 '*************************************************************************
20 '*              REPEATING DECIMAL TO FRACTION CONVERTING ROUTINE          *
30 '*                         BY ROBERT T. KUROSAKA                           *
40 '*************************************************************************
50 CLS
60 PRINT "This routine can be used with the greatest common denominator"
70 PRINT "program. Load the GCD program, then MERGE this routine into it."
80 PRINT "The MERGEd program is designed to determine the reduced fractional"
90 PRINT "representation of a repeating decimal.":PRINT
100 PRINT "To ENTER a repeating decimal:":
    PRINT " Type the nonrepeating part, then a '_' before the cycle."
110 PRINT "For example, 1.2_345 is the proper entry for 1.2345345345. . . "
120 PRINT "The decimal should always precede the '_', i.e., .333. . . . is entered":
    PRINT "as '._3'. Reversing the '.' and '_' will cause an error.":PRINT
130 INPUT "ENTER REPEATING DECIMAL";NUMBER$
140 REM NONREPEATING PART OF NUMBER IS THAT PART UP TO "_". VAL OPERATOR
        IGNORES ALL NUMBERS AFTER A NONNUMERICAL CHARACTER. THUS, IN
        1.2_345,VAL("1.2_345") WILL BE 1.2, ETC.
150 NONREPEATING.PART=ABS(VAL(NUMBER$))
160 REM DEFINE A MORE READABLE FUNCTION TO USE FOR THROWING THE LEFTMOST
        CHARACTER OF A STRING AWAY.
170 DEF FNDROP.LEFT$(A$)=RIGHT$(A$,LEN(A$)-1)
180 REM FIND DECIMAL POINT
190 WHILE LEFT$(NUMBER$,1) <> "."
200         NUMBER$=FNDROP.LEFT$(NUMBER$)
210 WEND
220 NUMBER$=FNDROP.LEFT$(NUMBER$)
230 REM FIND OUT HOW MANY DECIMAL PLACES THE REPEATING CYCLE IS OFFSET FROM
        THE DECIMAL POINT.
240 WHILE LEFT$(NUMBER$,1) <> "_"
250         OFFSET=OFFSET+1
260         NUMBER$=FNDROP.LEFT$(NUMBER$)
270 WEND
280 REM THROW AWAY REPEATING PORTION MARKER, "_"
290 NUMBER$=FNDROP.LEFT$(NUMBER$)
300 REM HOW MANY DECIMAL PLACES ARE IN THE CYCLE? SINCE THE REPEATING CYCLE
        IS EVALUATED AFTER THROWING AWAY THE DECIMAL POINT, MULTIPLY BY
        10^-(TOTAL NUMBER OF PLACES TO THE RIGHT IT SHOULD BE SHIFTED).
310 CYCLE.LENGTH=LEN(NUMBER$)
320 REPEATING.CYCLE=VAL(NUMBER$)*10^-(OFFSET+CYCLE.LENGTH)
330 REM NUMBER=NONREPEATING PART+REPEATING CYCLE. SINCE THE FIRST
        ITERATION OF THE CYCLE IS THE ONLY ONE THAT DOES NOT CANCEL ON
        SUBTRACTION, ONLY USE IT.
340 NUMBER=NONREPEATING.PART+REPEATING.CYCLE
350 REM "CLEARED.NUMBER IS THE VALUE OF THE SUBTRACTION THAT DOES AWAY WITH
        THE INFINITE CYCLE (STEP 3 IN THE BYTE ARTICLE ALGORITHM).
360 CLEARED.NUMBER=NUMBER*10^CYCLE.LENGTH-NONREPEATING.PART
370 REM NOW, ASSIGN THE VALUES OF THE NUMERATOR AND DENOMINATOR TO THE
        VARIABLE NAMES USED IN THE GCD ROUTINE.
380 NUM=CLEARED.NUMBER:DEN=10^CYCLE.LENGTH-1
390 REM I CONVERT NUM AND DEN TO STRINGS AND THEN BACK TO CLEAR THE GUARD
        DIGITS IN THE NUM AND DEN VARIABLES. SEE BYTE ARTICLE FOR DETAILS.
400 NUM$=STR$(NUM):DEN$=STR$(DEN):NUM=VAL(NUM$):DEN=VAL(DEN$)
410 PRINT "THE EQUIVALENT UNREDUCED FRACTION IS:";NUM;"/";DEN
```

10^7 before the decimal-clearing routine gave up in disgust. By converting the values calculated in listing 3 to string values, I clear the guard-digit garbage out of the numerical representation. When I then reconvert the values into numbers, the GCD routine functions properly.

As always, I welcome your comments, criticisms, and suggestions. I've been getting some interesting mail on previous columns and will devote some space in an upcoming column to some of the more interesting insights. ■

C·I·R·C·U·I·T C·E·L·L·A·R F·E·E·D·B·A·C·K

Conducted by Steve Ciarcia

MUSEUM CONTROL

Dear Steve,

I have used the BSR X-10 system to control a museum exhibit. One problem I encountered, which an engineer at BSR confirmed, was that the lamp modules would not properly control low-wattage light bulbs (25 watts or less). Do you have any ideas about how I can get around this problem cheaply?

Also, what happens if two controllers send commands at the same time? For example, controller *x* sends an ON command to unit A3 at the same time controller *y* sends an OFF command to unit B2. Wouldn't a hopelessly jumbled signal result?

TIMOTHY S. GOODFELLOW
Raleigh, NC

Your letter does not state what problems you experienced with lamp modules controlling low-wattage bulbs, so it is hard to give you an exact answer. During development of the Home Run Control System (April through June 1985), I did a lot of testing using a 7-watt nightlight, and the lamp modules were able to turn it on, off, and dim it correctly. Perhaps BSR has improved the modules since you experienced the problem. One solution would be to use higher-wattage bulbs and dim them to the level that you want. (The Home Run system can do this for you automatically.)

You are quite right that two BSR controllers transmitting simultaneously would result in a jumbled signal. The BSR works by sending bursts of 120 kHz at 2.778-millisecond intervals in a pattern that the modules decode. (See my article in the May 1985 BYTE for details on BSR operation.) If a second controller starts transmitting after the first has started, the timing between the pulses would be altered, and the modules would not be able to decode the signal.—Steve

LOOKING FOR A UART

Dear Steve,

I am an electronics student who is planning to build a scrolling LED display similar to your April 1984 project.

I plan to use my 8085 minisystem with 2K bytes of EPROM and 1K byte of RAM. The user will be able to enter messages through an ASCII keyboard. Could you please let me know where I can purchase an inexpensive UART, so that the message is transmitted serially to the display?

Also, would the Hewlett-Packard "union jack 1-inch" 16-character display be more cost-efficient and less complex to build than the one in your project?

MICHAEL SARRETT
San Francisco, CA

You can purchase a UART from most of the mail-order electronics supply houses. The Intersil IM6402IPL costs $6.90 as Digi-Key part number NT5000-ND. Order from

Digi-Key Corporation
Highway 32 South
POB 677
Thief River Falls, MN 56701
(800) 346-5144

Any common-anode dot-matrix LED display can be used in place of the single LEDs used in my project as long as it has a sufficient dot matrix (5 dots per row by 7 dots per column). The electronics can be modified to handle larger or smaller LED matrices.—Steve

PARALLEL PROCESSING

Dear Steve,

In your article "Build the Microvox Text-to-Speech Synthesizer" (September and October 1982), you stated that the more sophisticated text-to-speech programs required up to 80K bytes of memory, half of which contains words that are exceptions to the rules. It has occurred to me that if such a program were implemented on a single microprocessor, even a fast and powerful one, the time required to generate speech would be prohibitive. Would it be possible to run several processors in parallel, one containing the rules and several others containing words that are exceptions to the rules?

Also, in "The Lis'ner 1000" (November 1984), the caption for photo 4 states that 64 concurrent available words form a reasonable search vocabulary. Are more possible? If not, could parallel processing be used to overcome this problem?

ALAN ADEN
Camp Point, IL

Parallel processing is the wave of the future. Supercomputers are rapidly approaching the upper limit of speed for a single processor, and the only way to solve a problem any faster is to put several processors to work on the problem in parallel. The way to accomplish this in the manner you suggest is feasible but may not gain much speed. Looking up an item in a sorted table can be done rapidly by using a binary search and even faster if a technique called hashing is used. A table having 8000 entries would require 13 tests to find the desired word. Splitting the table in half and putting each half on a separate processor would reduce the number of tests to 12 on each processor—not much of a gain. The greatest gain would be to have one processor performing a text-to-speech algorithm while a second one searches for the word. If the word is found in the search, the text-to-speech algorithm would be stopped and the word from the table fed into the synthesizer.

Your second idea of applying parallel processors to speech recognition could increase the number of words it could recognize almost linearly with the number of processors you have working on the input word. The only problem you might encounter would be when two or more processors think they have a match, and another processor would have to pick one of the candidates.—Steve ■

Over the years I have presented many different projects in BYTE. I know many of you have built them and are making use of them in many ways.

I am interested in hearing from any of you telling me what you've done with these projects or how you may have been influenced by the basic ideas. Write me at Circuit Cellar Feedback, POB 582, Glastonbury, CT 06033, and fill me in on your applications. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

N·E·W S·E·R·V·I·C·E·S

Ordering Disks of BYTE Listings

Source-code listings in the form of text files of programs that accompany BYTE articles are now available from BYTE on disk. To order a disk of these listings for noncommercial purposes, indicate the issue (the first available is December 1985) and the kind of disk below. Enclose a check or money order in the correct amount made out to BYTE Listings. All prices include postage.

BYTE issue: ______________________

COMMON 5¼-inch FORMATS
(all cost $5 per disk in North America, $6 in Europe and South America, $7 in Asia, Africa, and Australia)

- ☐ IBM PC
- ☐ Apple II 5¼-inch DOS 3.3
- ☐ Apple II 5¼-inch ProDOS
- ☐ Commodore 64
- ☐ Hewlett-Packard 125
- ☐ Kaypro 2 CP/M
- ☐ TRS-80 Model III
- ☐ TRS-80 Model 4
- ☐ Texas Instruments Professional
- ☐ Zenith Z-100
- ☐ Atari

COMMON 3½-inch FORMATS
(all cost $6 per disk in North America, $7 in Europe and South America, $8 in Asia, Africa, and Australia)

- ☐ Apple Macintosh
- ☐ Atari 520ST
- ☐ Commodore Amiga
- ☐ Hewlett-Packard 150
- ☐ Data General/One

CP/M STANDARD 8-inch FORMAT
($6 per disk in North America, $7 in Europe and South America, $8 in Asia, Africa, and Australia)

- ☐ Single-sided single-density

OTHER FORMATS
(all cost $6 per disk in North America, $7 in Europe and South America, $8 in Asia, Africa, and Australia)

Size	Machine
☐ 8-inch	______________
☐ 5¼-inch	______________
☐ 3½-inch	______________

SEND DISK TO:

Name ______________________
Street ______________________
City ______________ State or Province ________
Postal Code ________ Country ________
Check or money order enclosed for $________

Bulletin Boards in Canada

Listed below are some Canadian computer bulletin boards that will carry program listings from BYTE. Programs are for noncommercial use in connection with BYTE articles only. There are no usage charges but you must pay your own telephone charges.

Western Canadian Distribution Center (101 11112 101st St., Edmonton, Alberta, T5G 2A2) will be supplying listings to its member bulletin-board systems.

Canadian Remote Systems, Toronto, Ontario, (416) 231-9202

Edmonton, Alberta, (403) 454-6093

Meadowlark, Alberta, (403) 435-6579

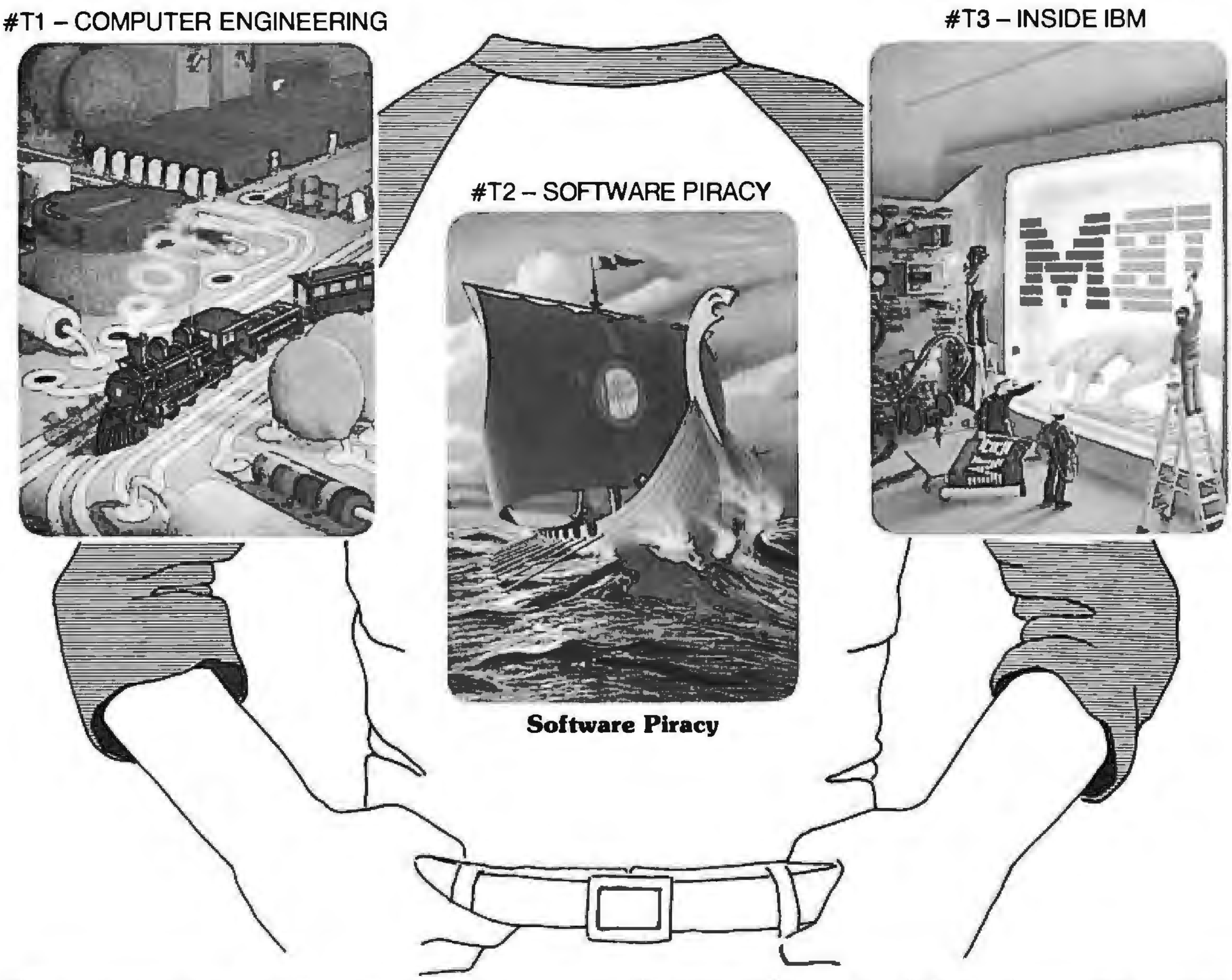
Prince George, British Columbia, (604) 562-9519

Regina, Saskatchewan, (306) 586-5585

Winnipeg, Manitoba, (204) 452-5529

In addition, BYTEnet Listings are available from or arrangements are being made with one or more system operators in the following nations: Australia, Canada, Chile, Denmark, France, Hong Kong, Ireland, Italy, Japan, Norway, Singapore, United Kingdom, Uruguay, and West Germany. Contact us at (603) 924-9281 for an up-to-date list.

CLASSIC BYTE T-SHIRTS!



Three classic Byte covers – and boy, do they look great on this ¾ sleeve "baseball shirt"! The vivid royal blue sleeves and neckline really complement the full-color design. And don't mistake this for a rubbery patch that cracks and peels off after a few washings. This is true four-color process: the permanent inks are silk-screened into the fabric, resulting in a beautiful, full-color image that lasts!

You'll also appreciate the shirt itself: a real heavyweight made of 50% cotton, 50% polyester. You'll enjoy cotton comfort in a tough, sporty shirt that keeps its crisp, fresh look through many washings – with almost no shrinking! The price for each Classic Byte T-Shirt is only $12.50 ($11.50 each for 3 or more). Be sure to include shirt size: **C**-(child 10-12), **S**-(34-36), **M**-(38-40), **L**(42-44), **XL**-(46-48). Your order will be shipped within a week.

Please send me the following shirt(s) at $12.50 each, or $11.50 each for 3 or more. I have included $2 for shipping and handling ($5 overseas).

#	TITLE	SIZE	AMOUNT
			$
			$
			$
			$
			$
	Shipping & Handling (see above)		$
	TOTAL		$

☐ I have enclosed check or money order.

☐ VISA ☐ MasterCard ☐ Free Brochure

Card #: ________________

Exp. Date: ________________

Ship my shirt(s) to:

Name: ________________

(Business): ________________

Mail this coupon to:

Robert Tinney Graphics
1864 North Pamela Dr.
Baton Rouge, Louisiana
70815

For VISA or MasterCard Orders or for more information
Call 1-504-272-7266


"The Boys Club helped me run my life."
—Pres., O.J. Simpson Enterprises
O.J. Simpson

LETTERS

(continued from page 32)

Intel has adhered to two of the unwritten rules of benchmarking. It used benchmarks developed outside Intel and contracted an outside company to run the benchmarks on its machines. What Intel did not do is have the results interpreted by an objective, independent party.

Intel did contact me prior to publication of the report, but only for permission to reprint the listings (which the company trimmed the comments out of) and not in an advisory capacity. I gave the company reprint permission. I expected that the benchmarks would be used carefully and according to the guidelines of my article. Clearly, Intel could have avoided the problems mentioned above if it had had an outside independent party evaluate its benchmarking methodology and its interpretation of results. At first, I was upset that Intel did not reference me as author of the BYTE benchmarks. Upon reflection, I am glad it did not.

DAVID HINNANT
Research Triangle Park, NC

POSITIONING PRINTER PAPER

Part of my job as an electronics technician requires me to make considerable use of computers and printers. Additionally, I am the owner of a personal computer. Something that I (and I'm sure, many others) have noticed is how difficult it is to get the paper positioned "just so" when first loading it into the printer, so that the printer doesn't print on the perforations, the spacing is right from top to bottom, etc. I think I may have a solution to the problem, which I would like to suggest to the printer and paper/forms manufacturers.

My suggestion is that the printer makers get together with the manufacturers of paper and forms and devise/implement a method for advancing paper/forms to the top of the sheet. I'm aware that some printers have a top-of-form function, but this is usually a variant of a formfeed. What I propose is a method of advancing the paper until the first *printable* line is under the print head, regardless of sheet size or position.

I've given the matter quite some thought, and I think that this could be implemented fairly easily by using the following scheme.

During the manufacturing process for the paper, a dark band or spot would be printed on the paper (between feed holes) some distance from the top of the sheet. This should be fairly easy to do since most paper I've seen has the manufacturer's name already printed on it, and this band or spot would be easily added.

Then, on the printers, a sensor (possibly an MCA-7 optical sensor) would be placed in such a position as to detect that dark band/spot when the first printable line is under the print head. Judging from the number of printers I've seen, this would probably be located in the area immediately under the platen of the printer, perhaps two or three inches lower than the print head. Such a distance would allow the use of full-sized paper, as well as formfeed checks, etc.

By using such a technique, when a top-of-form button was pressed (or command issued) the paper would advance appropriately and stop. Such a system might even prove to be a replacement for the more traditional formfeed command/button, since it would *reliably* position the paper/form every time (regardless of sheet size), even after paper/form changes or completely powering down the printer.

I would be happy to hear any comments, suggestions, and criticisms BYTE readers might have about this idea.

DAVID K. MERRIMAN
Fullerton, CA ■

NEW SYSTEMS

PC-Compatible Kaypro

The Kaypro PC is an MS-DOS machine based on a 4.77-MHz Intel 8088 microprocessor, with a socket for the Intel 8087 math coprocessor. It comes with 256K bytes of RAM, expandable to 640K bytes, two double-density 360K-byte floppy-disk drives, and room for either a full- or half-height hard-disk drive. Its multivideo adapter supports monochrome, color graphics, and composite video output. System boards use three of the nine IBM PC-compatible expansion slots, leaving the user with three full-length and three half-length slots. Its 132-watt power supply can support a hard disk. It has both serial and parallel ports.

The Kaypro PC comes with a 12-inch monochrome monitor and an IBM Selectric–style detachable keyboard with the same layout as the Kaypro 286i and PC AT keyboards.

Kaypro is bundling MS-DOS 2.11, WordStar, Mailmerge, CorrectStar, StarIndex, MITE, Polywindows/KDESK, and GW-BASIC with the system. It costs $1595. Contact Kaypro Corp., 533 Stevens Ave., Solana Beach, CA 92075, (619) 481-4300.
Inquiry 565.

The Kaypro PC.

Single-Board VS-186

Virtual Systems' VS-186 is a PC-DOS–compatible, single-board computer that can accept up to 512K bytes of ROM and up to 1-megabyte of parity-checked RAM. The 8½- by 11-inch computer board is aimed at the measurement and control market and therefore is self-contained and built to work in extreme industrial environments.

Standard operating systems for the VS-186 are PC-DOS, C/PM-86, and Virtual Systems' UNIX-style QNX.

The VS-186 is founded on an 8-MHz 80186 microprocessor and contains a socket for an 8087 math coprocessor. ROMs can be installed in six EPROM sites; two other ROM sites are occupied by the system code. The VS-186 comes with 256K of parity-checked RAM controlled by an 8208 memory controller chip and arranged as two banks, yielding a no-wait-state system that lets the 80186 run at full speed.

The VS-186 has two RS-232C serial ports, a programmable parallel port, a Centronics-compatible parallel port, a SASI/SCSI interface for disk and tape drives, and a processor-bus extension. The serial ports are controlled by a dual serial-channel controller and can operate asynchronously or synchronously. Four iSBX expansion connectors are wired to the 80186's DMA channels for high-speed I/O.

The VS-186's price is $950. Contact Virtual Systems, Suite 406, 1500 Newell Ave., Walnut Creek, CA 94596, (415) 935-4944.
Inquiry 566.

128K Color-Graphics Single-Board Quark/150

The Megatel Quark/150 is a color-graphics single-board computer based on the Z80B microprocessor. It includes a 128K-byte dynamic RAM, two serial ports, four parallel ports, a floppy-disk controller, and RGB video output. The floppy-disk controller can handle up to four drives of any size in any combination.

The RGB interface can be configured 16 different ways using three resolution modes: 2 colors at 640 by by 240, or 16 colors at 160 by 240. A graphics software package with 27 (TeleVideo TPC I-compatible) functions gives you eight fill patterns, eight line styles, multiple character heights and widths, ellipse and arc functions and lets you change the resolution mode for any line.

The Quark/150 is a 4- by 6-inch Eurocard. It comes with CP/M 2.2 BIOS, the Megatel graphics primitives, and a transition board that provides an interface to standard peripherals for $695. Contact Megatel Computer Technologies, 2311 South Anthony Blvd., Fort Wayne, IN 46803, or call (416) 745-7214.
Inquiry 567.

XT-Compatible GMS PC/286

The IBM PC XT-compatible Gulfstream Micro Systems Professional Computer/286 has an 80286 microprocessor running at 8 MHz with zero wait states. An 80287 numeric coprocessor is optional. The system comes with 256K bytes of on-board memory, expandable to 640K on the motherboard, and eight expansion slots. Video boards, ports, and monitors are not provided.

The system is sold in three model groups. The first group consists of computers with one or two 360K-byte floppy-disk drives. Model Group 2 adds the choice of a 10-, 20-, or 30-megabyte hard disk. Model Group 3 adds a 10- or 60-megabyte internal tape backup.

Prices for Model Group 1 start at $2995; for Model Group 2, $4420; for Model Group 3, $5388. Contact Gulfstream Micro Systems, 5500 North Federal Highway, Boca Raton, FL 33431, (305) 994-6500.
Inquiry 568.

PERIPHERALS

Eight-Pen Color Plotter from HP

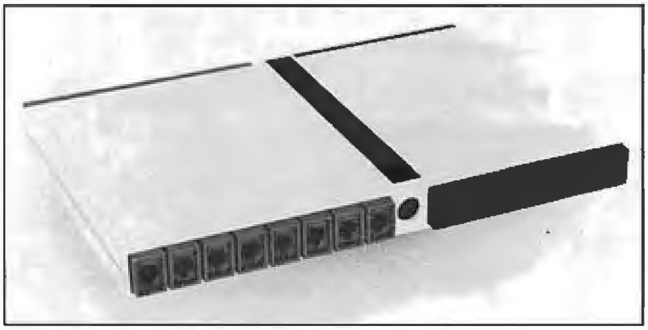
Hewlett-Packard's ColorPro is an eight-pen plotter that can produce multicolor pie, bar, and line graphs and text charts on 8½- by 11-inch paper or on overhead-projector transparencies. Its high resolution of 0.001 inch is said to give it a fine-line quality as much as four times better than comparable plotters. Such resolution improves the drawing of both straight lines and solid fills.

The ColorPro moves pens at 15.7 inches per second. You can select pens from the carousel through software or front-panel commands. Pens in the carousel are automatically capped. HP offers pens in two widths and 10 colors for paper. Transparency pens are available in seven colors.

A slot for ROM cartridges lets you expand or customize the ColorPro's capabilities. An HP graphics-enhancement cartridge adds a larger buffer and more advanced graphics commands.

Lotus's 1-2-3 and Symphony, Decision Resources' Chart-Master and Sign-Master, and HP's Graphics Gallery and Textcharts are some of the programs that work with the ColorPro. The HP-GL programming language is built into the plotter.

Available with an RS-232C or an IEEE-488 interface, the ColorPro costs $1295 and works with HP, IBM, Apple, Compaq, and most other personal computers. The graphics-enhancement cartridge costs $195. Contact Hewlett-Packard, Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, CA 94303.
Inquiry 569.



Matrix's Alliance cluster controller.

2400-bps Modem from UDS

Universal Data Systems' FasTalk 2400 is a Hayes-compatible modem that connects to your personal computer via the RS-232C port. It uses V.22 and V.22bis asynchronous modulation for full-duplex operation at 2400 bps over public switched telephone networks. It will also work as a Bell 212A or 103 series modem at 1200 or 300 bps.

FasTalk 2400 comes with an asynchronous communications package called SignOn for IBM and compatible personal computers. SignOn stores up to 100 phone numbers in a directory and dials any one of them with a single keystroke. You can store automatic log-on sequences, and you can set dates and times for unattended data transfer.

The FasTalk 2400 modem and SignOn cost $625. Contact Universal Data Systems, 5000 Bradford Dr., Huntsville, AL 35805, (205) 837-8100.
Inquiry 570.

RS-232C Networking with Alliance

The Alliance cluster controller allows networking of 2 to 20 IBM PCs and peripherals using standard RS-232C serial ports and proprietary software. The basic Alliance controller includes a Hitachi 64180 (an enhanced Z80-compatible) microprocessor, software both in the Alliance and for each PC on the network, and eight serial ports; additional modules with four ports each can be added. An optional 480K-byte printer buffer can also be installed, as can a serial-to-parallel converter. Information is transferred through the network at 115K bits per second, which is relatively slow compared to other PC networks.

The basic eight-port Alliance should be available this month for a list price of $895. Each four-port expansion module is $349. Contact Matrix Communications, 112–116 Washington St., Marblehead, MA 01945, (617) 639-1211.
Inquiry 571.

RAM Box for Macintosh

MacVentures' QuickDrive is an external RAM-disk box that works with the Apple Macintosh. The basic QuickDrive contains 510K bytes of RAM that is designed to behave like a fast disk drive. You can get more RAM with the 1-, 1.5-, or 2-megabyte versions of the device or by adding up to three 510K-byte expansion modules to the basic QuickDrive box.

You connect QuickDrive to the printer port or, for AppleTalk users, the modem port. You can then attach your printer to a second port on the QuickDrive. QuickDrive has its own switching power supply, which will accept 12 volts AC or DC, and a connector to tap standard wall voltage. Because QuickDrive doesn't depend on the Mac for power, it retains any information on the RAM disk even if the Mac accidently loses power or is turned off. You don't have to modify the Macintosh hardware in any way to use QuickDrive.

QuickDrive does not use any of the Macintosh's memory space. MacVentures claims that it is five to ten times faster than floppy-disk drives because its data-transfer rate is greater than 900 kbps. It also claims QuickDrive can launch MacWrite in 7.4 seconds and MacPaint in 5.1 seconds.

QuickDrive comes with a menu-driven program that lets you configure the size and number of disk volumes you want to use and lets you set up a print spooler that can handle printing as a background task.

The basic QuickDrive costs $499, has a 90-day warranty, and includes 510K of RAM, a printer port, a cable, a power supply, and the controlling software. The 1-megabyte, 1.5-megabyte, and 2-megabyte versions of QuickDrive cost $649, $799, and $949, respectively. The 510K-byte expansion modules cost $169 each. Contact MacVentures, POB 6123, Aloha, OR 97007, (503) 645-9696.
Inquiry 572.

(continued)

ADD-INS

10-MHz 80286 Board for IBM PC

Applied Reasoning's PC-elevATor Model 2100 allows the IBM PC to operate at up to twice the speed of IBM's PC AT, by adding an 80286 microprocessor running at 10 MHz with no wait states. An optional 5- or 8-MHz 80287 floating-point coprocessor can also be added to the card to speed up computation-intensive programs. The card also has 1 megabyte of memory.

The PC-elevATor is priced at $2695. For more information, contact Applied Reasoning, 765 Concord Ave., Cambridge, MA 02138, (617) 492-0700.

Inquiry **573.**

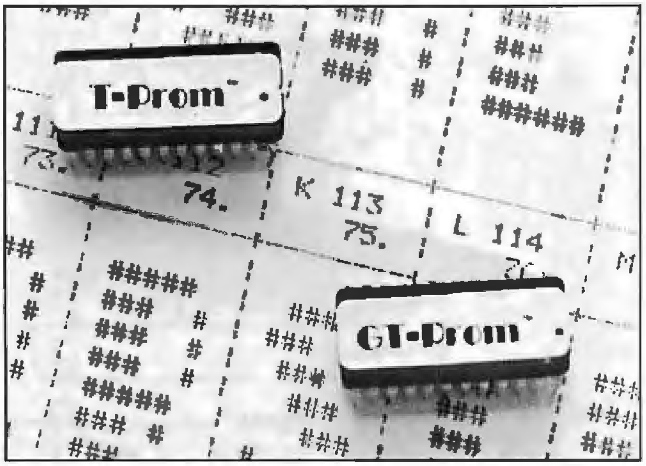
Hardware-assisted Bug Zapper

The Bug Zapper is a hardware-assisted debugging tool for the IBM PC. The IBM PC half-slot expansion card provides a "zap" circuit that monitors memory addressing and interrupts a program when it overwrites specified locations, enabling the programmer to search through memory to find out where the program went off track. Also available at all times is a "halt" button, which interrupts program execution even when normal interrupts have been disabled, also allowing registers and memory to be checked to locate the cause of unwanted behavior.

Guardian, the monitor program included with the Bug Zapper, is installed at boot time; the halt and zap functions both turn control over to the Guardian monitor or optionally to another host debugging program such as Microsoft's SYMDEB. Guardian performs standard debugging functions including view or overwrite memory or registers, port input or output, trace, and unassemble.

The Bug Zapper, with both the expansion card and Guardian, is priced at $195. For more information, contact Microtech International, 9906 Norwood Court, Dept. M-3, Largo, MD 20772, (301) 350-1068.

Inquiry **574.**



Norcom chips for enhanced text.

Enhanced Text Mode for Heath/Zenith 89 and 19

The T-Prom character-generator chip from Norcom provides an enhanced character set for the Heath/Zenith 89, 89A, 19, and 19A computers. The replacement character ROM chip enhances 94 text characters, while maintaining graphics compatibility by not changing any of the graphics characters. Another chip, the GT-Prom, combines the T-Prom features with the graphics enhancements of Norcom's earlier G-Prom on a single chip.

The T-Prom chip is priced at $19.95; the GT-Prom is $24.95. For more information, contact Norcom, 9630 Hayes, Overland Park, KS 66212, (913) 888-6237.

Inquiry **575.**

Breadboards for Eurocard, PC Buses

Augat has added two breadboards to its Unilayer II product line. The company is now offering a 220-mm dual Eurocard and an IBM PC AT-compatible board.

The Eurocard has a high-density universal pattern and will accommodate up to 150 16-pin DIP equivalents. It has a primary I/O connector, two 96-pin DIN connectors, and an I/O header that supports two 64-pin DIN connectors.

The IBM PC AT-compatible board also has a high-density universal pattern and will accommodate 94 16-pin DIP equivalents. The I/O supports the IBM PC AT-compatible edge connector, a 37-pin D-subminiature, and a 50-pin header area.

Augat will wire the boards for you if you transmit the wiring data to Augat electronically; wired boards can be delivered within four weeks. Unwired, the Eurocards cost $220 apiece or $1505 for 10. The AT-compatible boards cost $197 each or $1590 for 10. Contact Augat Inc., Systems Division, 40 Perry Ave., POB 1037, Attleboro, MA 02703, (617) 222-2202.

Inquiry **576.**

ImageMate Emulation Card

Orange Micro's ImageMate card enables Apple's Imagewriter II printer to emulate an Epson FX-80 or IBM Graphics Printer, while also adding a printer buffer with 64K bytes of memory (expandable to 128K). The ImageMate also includes an adapter cable and DIP switches to select IBM or Epson emulation.

For Apple computer owners who don't need Epson or IBM emulation, Orange Micro announced a similar card that adds an intelligent printer buffer to the Imagewriter II. The ImageBuffer card adds 64K or 128K bytes of buffer memory and can also print multiple copies of buffered documents. A clear-buffer feature is also provided to eliminate the need to power-off the printer when unwanted information is in the buffer.

Both ImageWare expansion cards will retail for approximately $120 each. Contact Orange Micro, 1400 North Lakeview Ave., Anaheim, CA 92807, (714) 779-2772.

Inquiry **577.**

Modeling in Three Dimensions

MacModel is a solids modeler for the Macintosh that lets you draw three-dimensional objects and view them from many vantage points in wide-angle or telephoto perspective. You can create models of objects as small as molecules or as large as tall buildings.

The software handles constructive solid geometry. You can start with basic objects like spheres and cubes, then combine them with union, intersection, or subtraction to form any object. Also, you can move, stretch, or rotate any object with the mouse. After you've drawn an object, MacModel lets you calculate or change physical properties such as size, weight, density, and reflectance. Drawings can be printed with an Imagewriter or LaserWriter.

MacModel runs on any Mac, but synoptics recommends the 512K-byte version. The software costs $40. Contact synoptics, Suite 213, 1075 Bellevue Way NE, Bellevue, WA 98004, (206) 747-7633.

Inquiry 578.

PC-to-PL/M Connector

CompuFirm has released an interface library of more than 150 functions and utilities designed to provide a connection between an IBM PC and Intel's PL/M compiler. This debugged set of assembly-language functions enables you to write various applications in the PL/M language using the Intel compiler.

PL/M Connection provides access to all of a PC's DOS and BIOS functions and high-speed graphics functions that interface directly with the color-graphics and monochrome display adapters. The package offers development support for software control of such peripherals as floppy and hard disks, communications devices, printers, video displays, and keyboards. The compiler generates in-line code automatically for the 8087 floating-point coprocessor.

The program consists of four main libraries plus utilities written in PL/M and assembly. For programmers unfamiliar with using PL/M to make a DOS program, CompuFirm has provided step-by-step sample programs explaining how to create such a program from the source code.

PL/M Connection comes on a double-sided PC-DOS disk with source code in PL/M and assembly, demo programs, and a 200-page manual with examples of each function. The package has a license fee of $295 per user. Quantity discounts and site licenses are available. Contact CompuFirm Corp., Suite 204, 7677 Ronson Rd., San Diego, CA 92111, (619) 571-0228.

Inquiry 579.

On-line Correction Aid

The Resident Speller from S & K Technology is a memory-resident spelling-correction system for the IBM PC and compatibles. The program checks spelling as you type. It operates with many popular word processors, including WordStar, Microsoft Word, MultiMate, pfs:Write, WordPerfect, Volkswriter, and PeachText 5000. The Resident Speller can also be used as a stand-alone spelling checker for standard ASCII text files.

As a resident utility, the program occupies 25K bytes of memory; its 49,000-word dictionary takes another 64K bytes. You can turn checking on and off from within your word-processing environment. Configurable features include the interpretation of individual characters, the marking symbol and method, and default filenames. The main dictionary and alternate dictionaries can be expanded.

The Resident Speller costs $99. Contact S & K Technology Inc., 4610 Spotted Oak Woods, San Antonio, TX 78249, (512) 492-3384.

Inquiry 580.

Lessons in Speedy Reading

Achievement House claims its FASTread program can help increase your reading rate with its 80 lessons of self-instruction, practice, and testing. The program also teaches the mental and physical aspects of fast reading to help you increase comprehension and retention along with speed.

The lessons use "real world" material with a difficulty level equivalent to what's found in industry and education. You set your own pace and goals, and the software tracks your progress. The program keeps tabs of where you finish in a lesson so you can resume with subsequent material quickly.

FASTread costs $59.95 and comes with a 30-day guarantee. It runs on an IBM PC, XT, or AT with at least 128K bytes, one disk drive, an 80 by 25 display, and DOS 2.0 or later. Contact Achievement House, 103 Great Plain Rd., Danbury, CT 06811, (800) 551-1133; in Connecticut, (203) 748-0277.

Inquiry 581.

PLZ Compiler

KCSystems has developed a resident PLZ compiler that follows Lattice C calling conventions and can be used with any Lattice C-compatible library. The company said its compiler implements the complete Zilog PLZ language, including the extensions of the Z8000 PLZ (32-bit data types, structure operations, etc.). A version for the 68000 running under CP/M-68K is also available.

KCSystems said the compiler is best suited for ROM-based 8088/8086 or 68000 systems, systems-level programs, and any application where C or Modula-2 would otherwise be used.

The package costs $75 and consists of the compiler, user's manual, *Report on the Programming Language PLZ-SYS* (T. Snoock et al., Springer-Verlag, 1978), and a year of free updates. Or you can buy the manual and text for $20; the money is credited toward purchase of the compiler. A money-back guarantee runs for 30 days. Contact KCSystems, 20 Lamington Dr., Succasunna, NJ 07876, (201) 927-9104.

Inquiry 582.

(continued)

SOFTWARE • OTHER COMPUTERS

Two for the Amiga

MaxiCorp has released a set of business-oriented modules and a serial communications program for the Commodore Amiga.

Maximillian contains four modules: MaxiCalc, a spreadsheet that can handle 256 rows by 256 columns; MaxiWord, a word processor; MaxiGraph, for drawing bar, line, and pie charts; and MaxiTerm, a communications program that can operate with data speeds up to 9600 bps. With a 256K-byte Amiga, you can use any one of the applications; with a 512K-byte machine, you can use all four together.

MaxiComm, another communications program, is capable of terminal emulation and file transfers between the Amiga and online services and data transfers between Amigas. Both XON/XOFF and XMODEM protocols are available.

Maximillian lists for $195. MaxiComm is $49.95. Contact MaxiCorp, 2817 Sloat Rd., Pebble Beach, CA 93953, (408) 625-4104.
Inquiry 583.

RAM Disk, RAM Upgrade for 520ST

Lamar Micro has developed a RAM-disk program for the Atari 520ST. Called RAM Overdrive, the program lets a 520ST with 1 megabyte of RAM address the upper 512K bytes of random-access memory as a RAM disk.

One way to fatten your Atari so it can use the RAM disk is with Lamar's 1-megabyte RAM upgrade. When used with a word-processing program such as ST Write, this RAM expansion lets approximately 688K bytes (or 344 typewritten pages) reside in memory at all times. The operating system automatically detects this increase and makes the 688K bytes available to the application.

RAM Overdrive costs $34.95. The RAM upgrade is $300. You have to send your keyboard to the company for installation of the RAM. Contact Lamar Micro, 2107 Artesia Blvd., Redondo Beach, CA 90278, (213) 374-1673.
Inquiry 584.

Pascal for Ataris

Draper Pascal lets you create, compile, and execute Pascal programs on the Atari 400, 800, XL, or XE computers. It incorporates features from UCSD and ISO standards and has extensions, such as sound and graphics, that take advantage of Atari hardware.

Machine-language subroutines can be loaded and called, and program chaining is supported. Draper puts no limit on the size of source-code programs. A one-pass compiler generates pseudocode directly; maximum size of program pseudocode is 30K bytes. Execution debugging tools include instruction trace and stack display. No linking is required.

Draper Pascal needs only one disk drive and 48K bytes of RAM. It costs $44.95 (plus $2 shipping) and comes with a manual and sample programs. Contact Draper Software, 307 Forest Grove, Richardson, TX 75080, (214) 699-9743.
Inquiry 585.

CP/M for Z8000

Digital Research and Zilog have jointly developed CP/M-8000 for the Z8000 16-bit microprocessor. CP/M-8000, which is being marketed by Toshiba and Zilog, features an enlarged directly accessible memory space beyond 64K bytes. The developers say the new CP/M has an improved file manager and command repertoire as well as increased capability for library maintenance.

CP/M-8000 comes with a C compiler, assembler, linker, debugger, and utilities. Personal BASIC, Compiler BASIC, FORTRAN, and Pascal/MT+ are slated as options. Toshiba's offerings for the operating system are a PL/M compiler, a macro assembler, a PROM writer, a download utility, and a screen editor.

The new CP/M can operate with a Z8001, Z8002, Z8003, or Z8004; a minimum of 176K bytes (256K is recommended); and up to 16 disk drives. It comes on single-sided single-density 8-inch floppy disks or on double-sided double-density 5¼-inch disks. Prices start at $340.

Contact Toshiba Corp., 1-1-1, Shibaura, Minato-ku, Tokyo 105, Japan; telephone: (03) 457-2104; Telex: J22587.
Inquiry 586.

Atari Tools

Volume One of the Atari ST Toolbox contains five utility programs on a single disk. The programs are Disk File/Sector Editor, Memory Editor, Fast Format & Copy, Deleted File Recovery, and Directory Print. Volume One costs $39.95.

Contact Mirage Concepts Inc., Suite 108, 4055 West Shaw Ave., Fresno, CA 93711, (209) 227-8369.
Inquiry 587.

Software-Development System

Described as a fourth-generation language, Sculptor is designed to reduce programming time by using menus written in plain English and screens created with any text editor. Microprocessor Developments Ltd. says Sculptor can cut programming time by as much as 80 percent.

The system uses a B-tree access method. It's transportable to a variety of computers using MS-DOS or PC-DOS. Multiuser applications can be developed for systems running under UNIX, UniFLEX, and OS-9.

Contact Microprocessor Developments Ltd., 1/3 Canfield Place, London NW6 3BT, England; telephone: 01-328-2277. The U.S. representative is Gander & Flynn Ltd., 225 Dyer Rd., West Palm Beach, FL 33405, (305) 832-0131.
Inquiry 588.

WHERE DO NEW PRODUCT ITEMS COME FROM?
The new products listed in this section of BYTE *are chosen from the thousands of press releases, letters, and telephone calls we receive each month from manufacturers, distributors, designers, and readers. The basic criteria for selection for publication are: (a) does a product match our readers' interests? and (b) is it new or is it simply a reintroduction of an old item? Because of the volume of submissions we must sort through every month, the items we publish are based on vendors' statements and are not individually verified. If you want your product to be considered for publication (at no charge), send full information about it, including its price and an address and telephone number where a reader can get further information, to* New Products Editor, BYTE, *70 Main St., Peterborough,* NH 03458.

THE BUYER'S MART
A Directory of Products and Services

THE BUYER'S MART is a monthly advertising section which enables readers to easily locate suppliers by product category. As a unique feature, each BUYER'S MART ad includes a Reader Service number to assist interested readers in requesting information from participating advertisers.

RATES: 1x—$375 3x—$350 6x—$325
Prepayment must accompany each insertion.

AD FORMAT: Each ad will be designed and typeset by BYTE. Advertisers must furnish typewritten copy. Ads can include headline (23 characters maximum), descriptive text (250 characters maximum), plus company name, address and telephone number. Do not send logos or camera-ready artwork.

DEADLINE: Ad copy is due 2 months prior to issue date. For example: June issue closes on April 1. Send your copy and payment to THE BUYER'S MART, BYTE magazine, 70 Main Street, Peterborough, NH 03458. For more information call Karen Burgess at BYTE 603-924-9281.

ACCESSORIES

SOFTWARE PACKAGING, DISKS
Cloth binders & slips like IBM's. Vinyl binders, boxes, and folders—many sizes. Disk pages, envelopes, & labels. Low qty. imprinting. Bulk & branded disks. Much More! Low prices. Fast service. Call or write for FREE CATALOG.
Anthropomorphic Systems Limited
376-B East St. Charles Road
Lombard, IL 60148
1-800-DEAL-NOW (312) 629-5160

Inquiry 651.

GASP!
THAT IS THE SOUND OF YOUR ALTOS AS IT FILLS WITH BUGS, DUST AND OTHER GUNK! Protect your investment in your 586/986 Altos. Enclose it in a filtered solid wood enclosure box. $199.95 Each.
BOB'S BOX CO.
314 Sutton Street, Maysville, KY 41056
(606) 564-3932

Inquiry 654.

LESS NOISE! MORE COOLING!
Stop irritating fan noise & overheating problems with the SILENCER cooling system. It utilizes a super quiet (84% less noise), West German, all metal, 4½" fan. Provides up to 100% more cooling. Mounts on the back of the IBM PC. $79.95 + $4 s/h VISA/MC
PC COOLING SYSTEMS
31510 Via Ararat Dr., Bonsall, CA 92003
(619) 723-9513

Inquiry 726.

DISTRESS SALE
Export order cancelled on 5,000 new, factory boxed, Canon F-60 and 1080A printers. The letter quality F-60 is similar to IBM's Quietwriter selling for $1,395. Distress priced from $129 to $179. The 1080A has same specs. as FX-85, 160 CPS, NLQ, etc. Priced from $139 to $189.
PC SYSTEMS
8 a.m. — 5 p.m. EST 305-746-3407
800-826-4839 305-746-3407

Inquiry 727.

BLANK FUNCTION KEY TEMPLATES
Write convenient commands next to your function keys on reversible plastic templates. Styles to fit IBM-PC, Compatibles, HP-150, Keytronics 5151, and others. Custom also available.
$4.95 Pkg. of 3 (Plus $1 s&h)
1-800-231-5413
In CA 1-800-523-5441
Free catalog of other helpful products available by circling number below on inquiry card.

Inquiry 670.

ACCESSORIES

Self-Inking Printer Ribbon
For users of **Okidata** and other open spool ribbon printers. Controlled Printout Devices are a new kind of printing ribbon that re-ink themselves, and will last 15 times longer than the ribbon you are now using. For further information please call or write.
CONTROLLED PRINTOUT DEVICES, INC.
POB 869, Baldwin Rd., Arden, NC 28704
(704) 684-9044

Inquiry 667.

BOOKS / DISKS / VIDEOS

C LANGUAGE TRAINING
Train your entire staff for less than 1 student seminar fee. Use the best & most professional video training package. Complete 5 hour video production. Learn all aspects of C from basics through pointers. $995 includes 6 video modules plus textbook plus workbook.
Call: **Retrieval Technology**
3 Courthouse Lane, Chelmsford, MA 01824
617-458-1130 x108

Inquiry 734.

VIDEO STORES
We need ambitious dealers in all U.S. states and Canada to market a powerful system to computerize video tape rental stores.
WINCHESTER DATA PRODUCTS INC.
3301-Executive Drive, #204, Raleigh, N.C. 27609
(919) 872-0995

Inquiry 752.

SMART ANSWERING MACHINE
SAM transforms your IBM PC into an intelligent phone answering & real-voice messaging center. FEATURES: 999 personal messages, call screening, message forwarding, timed or grouped message delivery, sortable phonebook/autodialer, time/date log, voice prompted remote access, AND MORE!! All hardware & software included. Retail $295. VISA/MC.
DIALECTRON, INC.
2035 California St., Ste #17, Mountain View, CA 94040
(415) 960-3040

Inquiry 676.

CONTRACTS

FOR ENTREPRENEURS
Legal contracts for hardware/software developers. Employee agreement, non-disclosure form, contracts for sale (hardware and/or software), consulting, development, hardware & software maintenance, non-competition, project delivery & more.
$50 **Waters Publishing** $50
8235 Douglas – Suite 1000
Dallas, TX 75225
800-628-2828

Inquiry 749.

DISK CONVERSION

CONVERSION SERVICES
Convert any 9 track magnetic tape to or from over 500 formats including 3½", 5¼", 8" disk formats & word processors. Disk to disk conversions also available. Call for more info. (312) 459-6010
Pivar Computing Services, Inc.
★ ★ 47 W. Dundee Road
Wheeling, IL 60090 ★ ★

Inquiry 729.

INCOMPATIBLE WORD PROCESSORS?
We convert to and from: XEROX, DEC, IBM, LANIER, WANG, PC-DOS, CONVERGENT TECHNOLOGY, WORDSTAR, MULTIMATE, SAMNA ASCII, MICOM.
Also most CP/M systems.
LOWEST PRICES
DATA CONVERSION INC.
6310 Caballero Blvd. • Buena Park, CA 90620
(714) 522-7762 (800) 824-4851 In CA.

Inquiry 674.

DOCUMENTATION

Computer Assembly Manuals
BIG BLUE SEED for IBM™ BUILDERS: parts list, placement diagrams, instructions for assembling over 55 IBM-compatible bare cards - $14.95.
APPLE SEED II for APPLE™ BUILDERS: in the style of the *BIG BLUE SEED* with instructions for assembling 70 Apple-compatible bare cards - $12.95.
BOTH ASSEMBLY MANUALS FOR $25.00
NuScope Associates
P.O. Box 790 • Lewiston NY • 14092

Inquiry 723.

WESTERN TRANSDATA, INC.
Why risk duplicating your important programs on your computer, when *our* equipment is designed solely to duplicate disks & verify their perfection 100%? Over 600 formats. 3½", 5¼" & 8". Plus serialization, copy protection, labeling, packaging, shrink-wrapping and *fast*, personalized service.
WESTERN TRANSDATA, INC.
1701 E. Edinger Ave. A-4
Santa Ana, CA 92705
714/547-3383 (collect)

Inquiry 751.

DUPLICATION SOLUTIONS
We have the answer to your duplication needs, no matter what the volume. We supply autoloaders, disks, and technical support. We provide copy protection, serialization, package assembly, and distributive shipping.
MegaSoft
P.O. Box 1143, Freehold, NJ 07728
1-800-222-0490 201-462-7628 (in NJ)

Inquiry 707.

THE BUYER'S MART

ENTERTAINMENT

BIBLE ADVENTURE GAME
"Keys of the Kingdom" is an exciting Bible adventure game in which you acquire the armor of God, confront the devil, meet characters from the Bible, and solve mazes and puzzles using the Bible. Runs on MS-DOS computers. Price: $25.00
Peterson Computer Co.
P.O. Box 40067
Bellevue, WA 98004

Inquiry 728.

TRAIN DISPATCHER
Train Dispatcher is a realistic simulation of a railroad traffic control center and was created by designers of CTC systems for operating railroads. Learn how dispatchers route rail traffic. IBM PC - $37; graphics card required. Apple II - $32; color monitor recommended. MC/VISA accepted.
SIGNAL Computer Consultants, Ltd.
P.O. Box 18222, Dept. 36
Pittsburgh, PA 15236
(412) 655-7727

Inquiry 739.

HARDWARE

Tandy 1000 Hardware
TanPak Multifunction Cards............ **$329**
Memory to 512K, RS232, Clock, DMA
TanPak Secondary.................... **$249**
Memory to 256K, RS232, Clock
10 Meg Hard Drive with Controller....... **$549**
20 Meg Hard Drive with Controller....... **$749**
Hard Drive Specialist
1-800-231-6671 or 1-713-480-6000
16208 Hickory Knoll, Houston, Texas 77059

Inquiry 692.

Cleans up your line power!
Isobar protects computer from damage caused by high voltage spikes and AC line noise. It prevents errors, malfunctions, false computer printouts and discskips, plus audio and video hash. Isolated filter banks isolate the outlets to prevent equipment interaction! 3-way spike protection! Free catalog.
Indus-Tool
730 W. Lake St., Chicago, IL 60606
Phone **312-648-2191**

Inquiry 696.

EPROM/EEPROM PROG. $250
Programs 2716-27256, 25xx and 68764/66 eproms via RS-232. Also 874x micros and 28xxA & 52Bxx EEPROMs. Automatic baud rate select, built in help menus, no personality modules!
16 BIT I/O MODULE $75
Low cost control via RS-232. Expands to 512!
INTELLITRONICS
P.O. Box 3263, Tustin, CA 92680
(714) 669-0614

Inquiry 698.

APPLE & IBM PERIPHERALS!
FACTORY DIRECT! IIe 64K/80 Column Bd. $39. II+/IIe Cooling Fan $24.95. II+/IIe Mouse w/SFWR $49.95. Joystick III w/fire on stick Apple or IBM $24.95. 10 Ft IBM Parallel Cable $12.95. RAM Set/9 PC-$5 XT-$7. Add $3 Shipping. Write for complete list.
NEXO DISTRIBUTION
8824 Golf Drive - Spring Valley, CA 92077
(619) 589-7928

Inquiry 722.

HARDWARE

XPNDR2 PROJECT CARDS
FOR THE COLOR COMPUTER DISK SYSTEM
The 6809E signals are brought out to pins on a 40-pin wirewrap connector; on top the disk controller mounts vertically. 4.3X7.2" drilled for ICs; 5V and GND buses; all the right stuff. Includes App Notes. Cardguide available. Free Brochure.
ROBOTIC MICROSYSTEMS
BOX 30807, SEATTLE, WA 98107
(206) 782-6809

Inquiry 736.

BDS LASER PRINTER! — $2,559.00
COMPLETE WITH SOFTWARE!
8 Pages per Minute, 9 Type Fonts, (16 with optional Cartridge), Down-Loadable (Design your own) Fonts, Parallel (Centronics, IEEE-488) and Serial (RS-232C) Interfaces, Landscaping (Graphics Intermixed with Text), Magnification, Sideways Print, and Non-Volatile Memory for Control Features.
HIGH TECHNOLOGY, INC.
9312 W. 92nd Ave., Westminster, CO 80020
(303) 431-7596 VISA and MASTERCARD Accepted!

Inquiry 694.

TURBOCHARGER FOR IBM
- Increases processing speed over **300%**
- Full software compatibility with PC and XT
- Supports Intel 10 MHz 8087 coprocessor

Everett/Charles® Marketing Services
6101 Cherry Avenue
Fontana, CA 92335
800-443-1860 Calif. 800-821-0589

Inquiry 684.

1/2 IN. 9 TRACK COUPLER
READ and WRITE 1/2 in. magnetic tape with formatted 9 track drives. Runs all speeds and densities in PC, XT, & AT running MS-DOS or IBM XENIX. Data transfers up to 904K bytes/second. Couplers start at $880. Complete sub-systems start at $2995.
Overland Data, Inc.
5644 Kearny Mesa Rd., Ste. A, San Diego, CA 92111
(619)-571-5555 and TELEX 754923 OVERLAND

Inquiry 724.

MULTIFUNCTION BOARDS
US Made, Memory to 384K, Printer, I/O ports: clock, battery, and more. . .
Under $200
Everett/Charles® Marketing Services
6101 Cherry Avenue
Fontana, CA 92335
800-443-1860 Calif. 800-821-0589

Inquiry 685.

GOULD COLORPLOTTERS
Model 6120-HP Equivalent
small footprint under $1000.
Everett/Charles® Marketing Services
6101 Cherry Avenue
Fontana, CA 92335
800-443-1860 Calif. 800-821-0589

Inquiry 686.

HARDWARE

BUYING A PROGRAMMER?
Information on EPROM programmers for Engineering, Production and Field Service.
Specifications and prices upon request.
SHERMAN PIRKLE, INC.
617-861-6688

Inquiry 738.

PCjr ADD-ON DRIVES
Upgrade your PCjr with our user-installed add-on drive system. It includes a replacement disk controller (operates up to 3 drives), a 2 drive cable, external 360K drive(s) & software for operating the extra drives. Prerequisite: DOS 2.1, $295 (one drive), $449 (2 drives), $149 (controller only), $6 shipping.
Call (505) 292-4182
J & M Systems, Ltd.
15100-A Central SE, Albuquerque, NM 87123

Inquiry 701.

IBM-PC BREAKTHROUGH
X5 -PC PERFORMANCE IMPROVED 500% + EMS 10MHZ SUPER 86 + ½ MB RAM INSTALLED SOCKETS FOR UP TO 3MB OF EXPANDED MEMORY AND 8087 (XR CARD ADDS ANOTHER 5MB MAX) X5 $539 - 1MB XR $369 - ½ MB RAM $72
TRAILRIDGE ASSOCIATES
14300 WEST 50TH AVE., GOLDEN, CO 80401
303-441-9109

Inquiry 746.

POWERLINE GREMLINS??
POWER FAILURES??
The MEIRICK STANDBY POWER SYSTEM is the TOTAL SOLUTION to your powerline problems.
240 watt system - $365; 400 watt system - $495; 800 watt system - $795
MEIRICK Inc., POWER SYSTEMS DIV.
Box 298, Frisco, CO 80443 **303-668-3251**

Inquiry 708.

MULTI-FUNCTION Bd $149.95
includes 384K of RAM, Serial, Parl., Clock, Software
256K RAM Card (full) for IBM's........... **109.95**
Team 300/1200 modem, int. or ext.,
Hayes Compt......................... **199.95**
Radio Shack 64K Color Computer II....... **139.95**
External Drives 5¼" for Radio Shack in case **115.95**
Epson Printers, Cheap! Call for quotes.
C.C. Distributing 5512 Poplar Ave.
Memphis, TN 38119 **901-761-4565**

Inquiry 662.

$99 HARD DISK CONTROLLERS
These NEW SHUGART 1610 controllers emulate other SASI controllers and mount directly on any 5¼" drive. 1610-1 emulates DTC 510...1610-3 emulates XEBEC S1410...1610-4 emulates SCSI similar to ADAPTEC 4000. Controllers work with BYTE's COM180, ACS 1000, ISI 5160, AMPRO, WAVEMATE, TRS80 III, IV, APPLE, MAC, OTHERS. Controller-$99. Manual & Schematic-$8. COD & Shipping $5. Quantity pricing available. California add 7% sales tax.
COMPUTER SURPLUS STORE
3675 DeSoto Ave., Santa Clara, CA 95051
408-248-0134

Inquiry 666.

THE BUYER'S MART

HARDWARE

LOW COST EPROM BURNER
Read, burn, and verify popular 28-pin EPROMs and EEPROMs, including 2764, 27128, 27256, 27512, 2817 and 2864. No personality modules. Uses intelligent programming algorithm for high speed burning. Operates through parallel port. Intel and Motorola hex formats supported. Complete hardware/software package.
Atari 520ST EPROM Burner $139.95
IBM PC/PC compatible EPROM Burner $199.95
Hippopotamus Software, Inc.
985 University, Suite #12, Los Gatos, CA 95030
(408) 395-3190
Price, availability, and specifications subject to change without notice.

Inquiry 695.

HAVE YOU SEEN???
If you have missed us in the November Issue of BYTE, MicroSystems Journal, or even at Comdex, look us up in the February 86 Issues of these magazines for our HD 64180 master processor and dual 8/16 bit slave processors.
Intelligent Computer Designs Corp.
9252 Garden Grove Blvd.
Garden Grove, CA 92644

Inquiry 754.

DISCOVER ROBOTICS
Robot Experimenter™ magazine shows you how to take the next step in the computer revolution by freeing your computer to roam about the house. REx is designed for both educators and experimenters. Subscribe now to explore the world of tomorrow.
• $24.00 for 12 issues. MC/VISA/CHECK •
Robot Experimenter
POB 458, Peterborough, NH 03458
603/924-3843

735.

PC 5¼" HARD DISK REPAIR
10-day repair service on Seagate, Tandon, Miniscribe, Rodime. ALSO, component level repair on • WD1002 Drive Controller PCB, and • IBM PC&XT Motherboard PCB. Send for free brochure or call **(714) 550-9303.**
APPLIED DISK TECHNOLOGY, INC.
1017 N. Baker St., Suite B
Santa Ana, CA 92703

Inquiry 652.

DATA ENTRY SYSTEM
Heads-down data entry with two-pass verification for the PC/XT/AT & compatibles. Loaded with features like: Auto dup & skip, verify bypass, range checks, & table lookups. Fully menu driven only $395.
Call for free 30 day trial period.
COMPUTER KEYES
6519 193 SW, Lynnwood, WA 98036
(206) 776-6443

Inquiry 665.

ENHANCE YOUR PRINTER!!
Print in a variety of fonts and sizes with your Epson (or compatible) printer. Prints SIDEWAYS too. Great for letters, spreadsheets, . . .even signs and banners! Create your own fonts to print. DigiCon Print Package—$49.95 (for IBM PC).
Digital Concepts, Inc.
P.O. Box 8345, Pittsburgh, PA 15218
(412) 823-8314

Inquiry 677.

SOFTWARE/BUSINESS

TAX-PREP '86
MAKES TAXES EASIER
Multiplan, 1-2-3 or Excel users, easily prepare totally professional tax returns. 22 linked schedules, IRS approved printout. IBM, Apple, TRS-80, CP/M $129.95; MAC $99.95. Call now for full information.
EZWare Corporation
(215) 667-4064

Inquiry 687.

LP88-LINEAR PROGRAMMING
A powerful menu-driven system for solving linear programs w/ up to 255 constraints & 2255 variables. Features include interactive & batch operation, spreadsheet-style input & editing, storage of problems & bases, Simplex Algorithm restart, report generator, sensitivity analysis. Req. IBM PC, 192K. $99 w/8087 support, user's guide. VISA/MC.
EASTERN SOFTWARE PRODUCTS INC.
P.O. Box 15328, Alexandria, VA 22309
(703) 549-5469

Inquiry 681.

TSA 88-TRANSPORTATION
A GENERAL-PURPOSE system for solving transportation, assignment and transhipment problems. Solves transportation problems with up to 510 origins and/or destinations by applying the Transportation Simplex Algorithm. Menu-driven with features similar to LP88. Requires 192K, $99 with 8087 support user's guide. VISA/MC.
EASTERN SOFTWARE PRODUCTS, INC.
POB 15328, Alexandria, VA 22309
(703) 549-5469

Inquiry 682.

dFELLER Inventory
A **business inventory** program written in modifiable dBASE **source code.** The menu-driven program lets you locate items by inventory name or number. It keeps track of reorder points, vendors, average cost, and other info. Requires dBASE II or III. PC-DOS/CPM **$150.**
Feller Associates
550 CR PPA, Route 3, Ishpeming, MI 49849
(906) 486-6024

Inquiry 688.

STANDARD FORMS
Easy to use with on screen step by step prompts. Prints data required in proper spaces on any preprinted form that fits in your printer. Free phone support. $79 (VISA/MC/AMEX). MS-DOS/CPM-80. Other original software. **FREE** catalogue.
MICRO-ART PROGRAMMERS
173 Birch Avenue, Cayucos, CA 93430
(805) 995-2329 (24 hours)

Inquiry 709.

► TIME & BILLING ◄
400 clients/20 partners/80 job & 40 out of pocket categories/20 areas of practice/fixed fee or hourly/more! Prints billing/statements/aged rec's/more! Free phone support. $149 (VISA/MC/AMEX). MS-DOS/CPM-80. Other original software. FREE catalogue.
MICRO-ART PROGRAMMERS
173 Birch Avenue, Cayucos, CA 93430
(805) 995-2329 (24 hours)

Inquiry 710.

SOFTWARE/BUSINESS

PC-File III™ Version 4
Search, sort, browse, global changes, macros, mailing labels, format reports with selection & calculations, subtotals, totals, averages, encryption. Exchange data with 1-2-3, WORD, WordStar. Over 190,000 users. $59.95 + $5 s/h. For IBM PC.
ButtonWare, Inc.
P.O. Box 5786, Bellevue, WA 98006
1-800-J-BUTTON

Inquiry 655.

PC-File/R™
All the power of PC-File III plus: Relational link to other databases, integrated letter writing & mail-merge, context sensitive pop-up help windows. New binary search retrieves data hundreds of times faster. $149.95 + $5 s/h.
ButtonWare, Inc.
P.O. Box 5786, Bellevue, WA 98006
1-800-J-BUTTON

Inquiry 656.

PC-Type™
Fast, compact, capable & easy! Help panels, hands-on tutorial, macros, multiple-line headings & footings, DOS path support, print spooling, block operations, etc. ASCII files. Install program allows customization. $59.95 + $5 s/h. For 128K IBM PC.
ButtonWare, Inc.
P.O. Box 5786, Bellevue, WA 98006
1-800-J-BUTTON

Inquiry 657.

PC-Calc™ Version 3
64 columns x 256 rows, math and stat. functions, horizontal bar graphs, title locking, individually adjustable column widths, IF. . .THEN, link to other spreadsheets or PC-File databases, much more. Requires 256K IBM PC. $59.95 + $5 s/h.
ButtonWare, Inc.
P.O. Box 5786, Bellevue, WA 98006
1-800-J-BUTTON

Inquiry 658.

1985 TAX PREPARATION
Fast, easy to use package prepares and prints 1985 Federal income tax returns using form 1040. Fully interactive, menu driven. Follows IRS forms. Supports 26 forms plus multiples. MS/PC-DOS, 128K; Prof. $149.00; Pers. $39.95; VISA/MC ($5 SH)
Dunphy Systems, Inc.
P.O. Box 326, Worthington, OH 43085-0326
614-459-2349 (orders 800-622-4070; Ill. 800-942-7317)

Inquiry 679.

MY WORD!® is just $35.00
Complete word processing plus sort, add rows & columns, mergeprint, quickprint, macros, math, micro-justify, use all 256 char. Source: add $35. 150 page printed manual. *30-day money-back guarantee.* IBM PC or compatible, 128K, one drive, any printer.
T.N.T. SOFTWARE, INC.
34069 Hainesville Road, Round Lake, IL 60073
(312) 223-8595

Inquiry 745.

THE BUYER'S MART

SOFTWARE/LANGUAGES

CBTREE FOR C PROGRAMMERS
Provides enhanced file handling calls directly into C programs. Maintains balanced B-trees, supports unlimited number of keys, data records, and key lengths. Fast. Flexible. Efficient. No royalties. Source Code Included.
New Low Price: $99
PEACOCK SYSTEMS, INC.
2009 Hileman Rd., Falls Church, VA 22043
(703) 893-0118

Inquiry 755.

Minnesota **SNOBOL4** *Language*
Powerful string & data handling facilities. Interpreter compatible with mainframe SNOBOL4. 32K strings, 32 bit integers, 8087 for float & large memory model. Sample pgms include ELIZA. For >128K IBM PC/MS DOS or compatible. Authoritative "green" book by Griswold available.
Guide + 5¼" diskette $44.95
Guide + green book + dkt..................$59.95
Green book only...........................$24.95
Postpaid in USA. In NY add tax. VISA/MC (914) 271-5855
BERSTIS INTERNATIONAL
POB 441, Millwood, NY 10520

Inquiry 653.

JOIN THE "C" GUILD
Membership includes quarterly distribution of all public domain submissions and 50% discount on catalogue items including "C" **source code** for PC utilities, small C compiler, adventure games and 2D & 3D fractals, graphics, and spreadsheet routines, etc. VISA
"C" Guild, Inc.
116 W. 6th St., Bloomington, IN 47401
1-800-554-3874

Inquiry 661.

UNIVERSAL CROSS-REFERENCER
—WORKS WITH ALL LANGUAGES—
BASIC, C, Pascal, FORTRAN, COBOL, ASM. . .
You name it!
MS/PC-DOS V2+, IBM PC, XT & compatibles
Unbeatable at $39.95 + $3 s/h. MC/Visa/Check
DALSOFT SYSTEMS
3565 High Vista, Dept E2
Dallas, TX 75234 (214) 247-7695

Inquiry 673.

BYSO® LISP
for IBM PC
INTERPRETER **$150**
(includes Visual Syntax®)
COMPILER **$395**
for stand alone expert systems, etc.
Levien Instrument Co.
POB 31, McDowell, VA 24458
(703) 396-3345

Inquiry 705

CROSS ASSEMBLERS
Develop microprocessor programs on your IBM PC or MS DOS computer.
* Macros * Conditional Assembly * Editor *
Complete support for most 8 bit microprocessors
Linker and EPROM Programmer Driver
MicroComputer Tools Co.
1255C Kenwal Rd., Concord, CA 94521
(415) 825-4200

Inquiry 716

SOFTWARE/LANGUAGES

Tools for CB80 & CB86
BDOS, DOS, and BIOS calls from CB80 and CB86! CBC Tools includes functions for directory access, string ops, a debugger, radix conversion, command line parsing, quicksorts, bit and byte ops, and much more. Available for CP/M-80, CP/M-86, and PC-DOS for $180.00.
Minnow Bear Computers
POB 2233 Sta. A, Champaign, IL 61820-8233
(217) 398-6883

Inquiry 717.

68020
Motorola compatible macro Assembler Package features linker, object librarian, symbol report generator with cross reference. Produces S-records and ROMable code. For CP/M-68K, MS-DOS $750. Portable Source in C $3500. AVAILABLE NOW.
Quelo, Inc.
2464 33rd Ave. W. Suite 173, Seattle, WA 98199
206/285-2528 **telex 910-333-8171**

Inquiry 732.

SOFTWARE/SCIENTIFIC

PC ARRAY PROCESSING!
VECTOR87 has 60 array processor subroutines: **FFT**, 2D FFT, convolution, dot product, real & complex vector operations, linear equations, etc. Up to **18 times faster** than compiled code. For MS Fortran, Pro Fortran, Lattice C, MS C. **$120** each version **with source**, no royalties.
Vectorplex Data Systems Ltd.
Box 138 Station M, Calgary, Alberta T2P 2H6, Canada
(403) 248-1250

Inquiry 748.

Affordable Engineering Software
CALL or WRITE for FREE CATALOG
Circuit Analysis • Root Locus • Thermal Analysis • Matrix Manipulation • Signal Processing • Filter Design • Graphics • Text Proofreader
BV Engineering
2200 Business Way Suite 207, Riverside, CA 92501
VISA/MC **(714) 781-0252**

Inquiry 659.

SYSTEM DESIGNER
SD is a tool for the design of hierarchical systems and processes, representable by trees. **SD** breaks a task of designing a large system into a great number of small, easy tasks while keeping track of all pieces. **SD** plots a graph of a tree representing the proposed system. The price is $399.
CUSTOM SYSTEMS
23 Crestwood Ct., Lansdale, PA 19446
(215) 468-7773

Inquiry 671

BEAM ANALY. & SPRING DESIGN
Beam analysis program calculates shear, moments, reactions, slopes and deflections in beams. Price: $50.00.
Helical spring design program for compression, extension and torsion springs. Price: $75.00.
Both packages include disk and documentation. For Apple II series of computers or IBM PC, PCjr and compatibles.
SYLCA CORPORATION
33-47 14 Street, Dept B, Long Island City, NY 11106
718-278-4604

Inquiry 743.

SOFTWARE/SCIENTIFIC

► SCIENTIFIC CALCULATOR ◄
Memory resident emulation of the HP-11C plus direct insertion of results in foreground program, graphically presented, decimal, hex, binary, & octal operations, boolean functions and more. Mouse support. 8087 or Standard versions $49.95 + 3.00 s&h.
K SOFTWARE HOUSE
Rt. 2, Box 83B1 Unionville, TN 37180
(615) 294-5090

Inquiry 703.

PC TECHNICAL GRAPHICS
TEKMAR is a graphics library for the Tecmar Graphics Master. Similar to PLOT-10, includes WINDOW, VIEWPORT, AXIS. Support for HP, HI plotters. Curve fitting, complete plotting program. Log, semi-log, multi-axis, 3-D, contours. Demo disk, literature available.
Advanced Systems Consultants
18653 Ventura Blvd., Suite 351, Tarzana, CA 91356
(818) 407-1059

Inquiry 650.

CADD for $99.95
FEATURES: Drawing layers • User Defined Fonts • Component Libraries • Video & Digitizer Menus • Color Graphics.
Autocad™ file conversion - $24.95
Dot Matrix Printer/plotter option - $24.95
MC, VISA, COD, add $3.00 for shipping.
60 day money back guarantee.
GENERIC SOFTWARE
6 Lake Bellevue #203, Bellevue, WA 98005
1-800-228-3601

Inquiry 690.

Digital Logic Design on the Macintosh™
The LogicWorks™ series allows you to create, test and document digital circuitry on your Macintosh. Full simulation capability lets you catch design errors before committing your circuit to hardware. From $79.95 (US). Demo pkg. $10. *Visa/MS Accepted.*
Capilano Computing Systems Ltd.
Box 86971, N. Vancouver, B.C., Canada, V7L 4P6
(604) 669-6343

Inquiry 660.

AutoCAD IC LIBRARIES
Integrated circuit symbol libraries allow rapid capture of electronic schematics with AutoCAD 2.X. Symbols can be inserted, scaled up/down, rotated, copied, moved, dragged, put on new layers, erased, made into blocks, and used with data attributes.
LS TTL Library..................$295
Z80 Family Library..............$195
Schematic Library...............$295
TKF Systems (301) 730-3542
5478-A3 Harpers Farm Rd., Columbia, MD 21044
AutoCAD is a registered trademark of Autodesk, Inc

Inquiry 702.

DISK DRIVE DIAGNOSTIC
Memory Minder, from J & M Systems, is **a disk diagnostic program** for the IBM PC, PCjr, & IBM compatibles. It checks your drives for head alignment, spindle speed, hysteresis, azimuth & more. And, you can use Memory Minder to actually align your disk drives! **$99** plus $4 shipping.
J & M Systems, Ltd.
15100-A Central SE, Albuquerque, NM 87123
(505) 292-4182

Inquiry 669.

MCFORMAT $50

Don't let DOS waste your disk space! Add up to 50% more hard disk capacity to your IBM PC, XT, AT or 100% compatible by selecting format parameters, including cluster & directory size. Fully DOS compatible (3.0 or 3.1). VISA/MC.

MICROCOMPUTER CONCEPTS, INC.
9715 SE 43 St., Mercer Island, WA 98040
(800) 722-8088 (206) 236-2300

Inquiry 712.

Multi-terminal DOS

GASS-General Accounting Scientific Switching system. Multitasking. Can handle 12 terminals off IBM PC. Used in mini's since 1976. Dealers wanted. List price $795.00.
For limited time $95.00.

Maxey Systems, Inc.
5910 Youree Dr. Suite D, Shreveport, LA 71105
(318) 868-5422

Inquiry 706.

LASER TYPOGRAPHY $495.

Typographic composition software to drive the Corona L300 Laser Printer as a typesetter. H & J 24 proportional space fonts, widths for 78 fonts available. Mix face & point size on any line. multicolumn capability.

Micro Print-X, Inc.
P.O. Box 581, Ballinger, TX 76821
(915) 365-2343 Dealer Inquiries Welcome

Inquiry 715.

ACT1 PROFESSIONAL FULLY INTEGRATED ACCOUNTING SYSTEM *for PC-DOS*

Proven 3½ years. Includes General Ledger; Accounts Receivables; Order Entry/Inv.; Accounts Payable; Inventory; Payroll (incl. Post Facto).
only $99.50 plus ship. & hand.
(800) 344-2540

Cougar Mountain Software
Box 6886, Boise, ID 83707

Inquiry 744.

CPM-80 LIVES on your PC

CP/Mulator puts a 4mhz 8 bit CP/M emulator in your IBM-PC for $99.
- A great 8 bit development system
- Saves expensive CPM-80 applications
- Increases PC speed 10% for 8088 programs
- Priced less than most software only products
- Uses no valuable board slots

Source Information
P.O. Box 2974, Warminster, PA 18974
Phone (215) 628-4719

Inquiry 741.

CP/M Calls from CB80

Access the full power of CP/M or MP/M direct from your CB80 progs. Execute BDOS or XDOS calls. Get such info. as user or CP/M version number, time of day, directory, etc. BDOSMASTER consists of CB80 Basic code to be "INCLUDED" in your prog. and a module for use by LK80. Complete package $75.00.

Practical Solutions, Inc.
134 S. Central Ave., Valley Stream, NY 11580
FOR INFO. CALL 1-516-561-0566
TO ORDER 1-(800)-227-3800, ext. 983

Inquiry 730.

Symbolic Debugger for Turbo Pascal™

- Set breakpoints at line numbers or procedures
- Display and modify variables symbolically
- Fully integrated into Turbo Pascal environment

Requires Turbo 2.0 or 3.0, IBM PC version.
Only **$49** plus **$2** S&H.

KYDOR COMPUTER SYSTEMS
812 S. Sherman St., Richardson, Texas 75081
(214) 669-1888

Inquiry 704.

pcSHARE MULTI-USER O/S

pcSHARE allows your IBM-XT/AT or compatible to support up to 5 users running 1-2-3, dBASE, WordStar, etc. on inexpensive serial CRTs. For software developers, pcSHARE efficiently runs compiled Basic, Pascal & C programs with full DOS 3.0 compatible record locking.

DIGITROL COMPUTERS INC.
440 Phillip Street
Waterloo, Ontario, CAN, N2L 5R9
(519) 884-4541

Inquiry 678.

STATISTICS

RATS!

RATS is a fast, accurate & complete regression package with unsurpassed POWER. Has both time-series & cross section analysis. Includes Box-Jenkins, logit & probit. Spectral analysis & graphics also available. Requires 256K RAM, IBM PC or compatible. $200. MC/Visa.

VAR Econometrics
P.O. Box 19334, Minneapolis, MN 55419
(612) 822-9690

Inquiry 747.

NUMBER CRUNCHER STAT SYS

Menu-driven. Multiple & stepwise regression, ANOVA, time series, discriminant analysis, principal components, scatter plots, histograms, t-tests, contingency tables, nonparametrics. Import export data. Sort, join, merge. Site license $79. IBM PC/Macintosh.

NCSS-B
865 East 400 North, Kaysville, UT 84037
801-546-0445

Inquiry 718.

TRANSLATIONS

ARABIC AND FRENCH TRANSLATION

If you are interested in expanding your sales base into the Arabic or French market then SCIENCE may be able to help you. Fast, accurate translation of any computer related application. Business advice for entry of your product into these markets is also available.

SCIENCE
55 rue Barbes, 94200 Ivry-Sur-Seine, France
(1) 46-71-18-55

Inquiry 737.

UTILITIES

DOS PATHING EXTENSION

Give your software the full PATHING capabilities that are missing from the 2xx and 3xx versions of MS-DOS and PC-DOS. FULLPATH object license: $19.95, source license: $399.95, (+$5 S&H + 6% in MN). VISA/MC/PO/CHK 30 day money back guarantee.

P. R. GLASSEL and ASSOCIATES, INC.
30255 Fir Trail, Stacy, MN 55079
612-462-1337

Inquiry 691.

UTILITIES

MEDIA MASTER PLUS

READ, WRITE, and FORMAT over 60 CP/M disks and run most CP/M-80 programs on your IBM PC! Two program package includes ZP/EM, a CP/M-80 emulator program that transforms your IBM PC into a 1-2 MHZ CP/M 22 computer. $59.95 + $3.00 S/H (CA 6%)

INTERSECTING CONCEPTS, INC.
4573 Heatherglen Ct. Ste. 10
Moorpark, CA 93021
(805) 529-5073

Inquiry 699.

BASIC PROGRAMMERS

Add SALT & PEPPER to your existing/new programs. Create dazzling Menus, intelligent Input Screens. Walking Strings, ASC/Desc Sort, PRT. SCR. Data processing & more. SALT & PEPPER has 28 modules. (in MS-DOS compatible BASIC). They merge with your program in minutes. S & P performs all the tricks, YOU get the applause. $59.95 plus $2.50 s&h. Demo disk $2.50 ppd. MC/VISA

COMPUTER GURU
40 Wagner Ave., Piscataway, NJ 08854
201-356-6477

Inquiry 664.

PACKED UTILITY DISK

HOT STUFF **$10** FOR IBM-PC

EXPECT A MIRACLE!

MICRO TOOLS INC.
POB 357 N. Chili, NY 14514 **(716)594-1088**
Circle the Inquiry # ... We'll do the Rest

Inquiry 714.

***** HARD DISK OWNERS *****

SIMPLIFY & PROTECT YOUR SYSTEM WITH THE MAIN MENU!

Organize your system with easy-to-create easy-to-follow menus that display when the system is turned on. Execute programs and DOS commands with the touch of a key. Password protect specific programs or entire menus. Will not detract from your systems memory. On-line help screens. Time Utility. **$19.95** VISA/MC

IBM pc/xt & compatibles with 192K and dos 2.x.

PARSONS TECHNOLOGY
6925 Surrey Dr. NE., Cedar Rapids, IA 52402
(319) 373-0197

Inquiry 725.

ZERODISK

ZeroDisk runs dozens of copyprotected business packages from your hard disk without floppies. Call for the latest list of software it handles. Needs IBM AT, XT, PC, or compatible. DOS 2.0 or higher. ZeroDisk is revised monthly and is not copy protected. $75 US. Check or Credit Cards accepted.

QUAID SOFTWARE LIMITED
45 Charles St. E. 3rd Fl.
Toronto, Ontario, Canada M4Y 1S2
(416) 961-8243

IBM – TOSHIBA PRINTER INTERFACE

- all extended capabilities of the TOSHIBAS available
- bit mapped graphics supported
- Prints all IBM extended ASCII characters
- screen dumps in text and graphics
- escape sequences supported
- popular software supported directly
- "Sideways" and "Pyxel Visuals" support
- dealers welcome $79.95 ($2.50 S&H)

Integrated Data Technologies, Inc.
4775 Bunchberry Lane, Colorado Springs, CO 80917
303-488-2583 MC/VISA

Inquiry 697.

DoKay

COMPUTER PRODUCTS, Inc.

ORDER TOLL FREE

(800) 538-8800

(CALIFORNIA RESIDENTS)

(800) 848-8008

VISA MasterCard

STATIC RAMS

101	256 x 4	450ns		1.90
102	1K x 1	450ns		.79
102L-4	1K x 1	450ns		.89
102L-2	1K x 1	250ns		1.29
111	256 x 4	450ns		2.29
112	256 x 4	450ns		2.29
114	1K x 4	450ns		.99
114-25	1K x 4	250ns		1.10
114L-4	1K x 4	450ns		1.20
114L-3	1K x 4	300ns		1.30
114L-2	1K x 4	200ns		1.40
147	4K x 1	55ns		3.95
101	256 x 4	450ns	CMOS	3.90
M84044-4	4K x 1	450ns		2.95
M84044-3	4K x 1	300ns		3.45
M84044-2	4K x 1	200ns		3.95
K4118	1K x 8	250ns		8.95
MM2016-20	2K x 8	200ns		2.49
MM2016-15	2K x 8	150nx		2.99
MM2016-10	2K x 8	100ns		4.49
M6116-4	2K x 8	200ns	CMOS	2.49
M6116-3	2K x 8	150ns	CMOS	2.99
M6116-2	2K x 8	120ns	CMOS	5.49
M6116LP-4	2K x 8	200ns	CMOS	2.99
M6116LP-3	2K x 8	150ns	CMOS	3.49
M6116LP-2	2K x 8	120ns	CMOS	8.49
-6132	4K x 8	300nx		29.95
M6264P-15	8K x 8	150ns	CMOS	5.95
M6264LP-15	8K x 8	150ns	CMOS	6.95
M6264LP-12	8K x 8	120ns	CMOS	6.95

DYNAMIC RAMS

M84027	4K x 1	250ns		1.45
PD411	4K x 1	300ns		1.95
M5280	4K x 1	300nx		1.95
K4108	8K x 1	200ns		.49
M5298	8K x 1	250ns		.49
116-20	16K x 1	200ns		.79
116-15	16K x 1	150ns		.99
116-12	16K x 1	120ns		1.49
116	16K x 1	150ns	5v	3.95
164-25	64K x 1	250ns	5v	.59
164-20	64K x 1	200ns	5v	.69
164-15	64K x 1	150ns	5v	.79
1256-20	256 x 1	200nx		2.69
1256-15	256 x 1	150ns		2.69

EPROMS

702	256 x 8	1 us		3.95
708	1K x 8	450ns		2.49
758	1K x 8	450ns		5.90
716	2K x 8	450ns	5v	2.95
716-1	2K x 8	350nx	5v	3.95
M82516	2K x 8	450ns	5v	3.95
M82716	2K x 8	450ns		6.95
M82532	4K x 8	450ns	5v	3.95
732	4K x 8	450ns	5v	2.95
732 A-4	4K x 8	450ns	21v	2.95
732 A-35	4K x 8	350ns	21v	3.95
732 A	4K x 8	250ns	21v	5.95
732 A-2	4K x 8	200nx	21v	8.95
764	8K x 8	450ns	5v	3.95
764-25	8K x 8	250ns	5v	4.95
764-20	8K x 1	200nx	5v	5.95
M82564	8K x 8	450ns	5v	9.95
CM68764	8K x 8	450ns	5v	17.95
CM68766	8K x 8	350ns	5v	19.95
7128-45	16K x 8	450nx	5v	6.00
7128-30	16K x 8	300ns	5v	5.50
7128-25	16K x 8	250ns	5v	6.00
7256-25	32K x 8	250nx	14v	9.95

74LS00

74LS00	.23	74LS125	.48	74LS260	.58
74LS01	.24	74LS126	.48	74LS266	.54
74LS02	.24	74LS132	.58	74LS273	1.45
74LS03	.24	74LS133	.58	74LS275	3.30
74LS04	.23	74LS136	.38	74LS279	.48
74LS05	.24	74LS137	.98	74LS280	1.95
74LS08	.27	74LS138	.54	74LS283	.68
74LS09	.28	74LS139	.54	74LS290	.88
74LS10	.24	74LS145	1.15	74LS293	.88
74LS11	.34	74LS147	2.45	74LS295	.98
74LS12	.34	74LS148	1.30	74LS298	.88
74LS13	.44	74LS151	.54	74LS299	1.70
74LS14	.58	74LS153	.54	74LS323	3.45
74LS15	.34	74LS154	1.85	74LS324	1.70
74LS20	.24	74LS155	.68	74LS352	1.25
74LS21	.28	74LS156	.68	74LS353	1.25
74LS22	.24	74LS157	.64	74LS363	1.30
74LS26	.28	74LS158	.58	74LS364	1.90
74LS27	.28	74LS160	.68	74LS365	.48
74LS28	.34	74LS161	.64	74LS366	.48
74LS30	.24	74LS162	.68	74LS367	.44
74LS32	.28	74LS163	.64	74LS368	.44
74LS33	.54	74LS164	.68	74LS373	1.35
74LS37	.34	74LS165	.94	74LS374	1.35
74LS38	.34	74LS166	1.90	74LS377	1.35
74LS40	.24	74LS168	1.70	74LS378	1.13
74LS42	.48	74LS169	1.70	74LS379	1.30
74LS47	.74	74LS170	1.45	74LS385	1.85
74LS48	.74	74LS173	.68	74LS386	.44
74LS49	.74	74LS174	.54	74LS390	1.15
74LS51	.24	74LS175	.54	74LS393	1.15
74LS54	.28	74LS181	2.10	74LS395	1.15
74LS55	.28	74LS189	8.90	74LS399	1.45
74LS63	1.20	74LS190	.88	74LS424	2.90
74LS73	.38	74LS191	.88	74LS447	.38
74LS74	.34	74LS192	.78	74LS490	1.90
74LS75	.38	74LS193	.78	74LS624	3.95
74LS76	.38	74LS194	.68	74LS640	2.15
74LS78	.48	74LS195	.68	74LS645	2.15
74LS83	.59	74LS196	.78	74LS668	1.65
74LS85	.68	74LS197	.78	74LS669	1.65
74LS86	.38	74LS221	.88	74LS670	1.45
74LS90	.54	74LS240	.94	74LS674	9.60
74LS91	.88	74LS241	.98	74LS682	3.15
74LS92	.54	74LS242	.98	74LS683	3.15
74LS93	.54	74LS243	.98	74LS684	3.15
74LS95	.74	74LS244	1.25	74LS685	3.15
74LS96	.88	74LS245	1.45	74LS688	2.35
74LS107	.38	74LS247	.74	74LS689	3.15
74LS109	.38	74LS248	.98	74LS783	23.95
74LS112	.38	74LS249	.98	81LS95	1.45
74LS113	.38	74LS251	.58	81LS96	1.45
74LS114	.38	74LS253	.58	81LS97	1.45
74LS122	.44	74LS257	.58	81LS98	1.45
74LS123	.78	74LS258	.58	25LS2521	2.75
74LS124	2.85	74LS259	2.70	25LS2569	4.20

We will try to BEAT All Competitor's Prices

CALL for Quote!

8000

8031	14.90	8253	6.90
8035	5.90	8253-5	7.90
8039	5.90	8255	4.45
INS-8060	19.90	8255-5	4.90
INS-8073	29.90	8257	7.90
8080A	3.90	8257-5	6.90
8085	4.90	8259	5.90
8085A-2	11.90	8259-5	6.90
8086	24.90	8271	69.90
8087-3 (5 MHz)	124.95	8272	19.90
8087-2 (8MHz)	199.95	8274	28.90
8088	19.90	8275	28.90
8089	59.90	8279	6.90
		8279-5	7.90
		8282	6.45
		8283	6.45
		8284	4.90
		8286	6.45
		8287	6.45
		8288	12.90
		8289	44.90
		8292	12.90

8100

8131	2.90
8155	6.90
8155-2	7.90
8156	6.90
8185	28.90
8185-2	38.90

8200

8202	23.90
8203	38.90
8205	2.90
8212	1.75
8214	3.75
8216	1.75
8224	2.20
8226	1.75
8228	3.45
8237	12.90
8237-5	14.90
8238	4.45
8243	4.45
8250	9.90
8251	3.90
8251A	4.45

8300

8303	2.90
8304	1.90
8307	2.90
8308	2.90
8310	3.90
8311	3.90

8700

8741	28.90
8748	19.90
8749	28.90
8755	23.90

80000

80188-8	99.90
80188	69.90

THIS IS A SAMPLING ONLY . . . CALL WITH ALL YOUR COMPONENT NEEDS

CRYSTALS

ALL STANDARD VALUES . . . 1.69

CRYSTAL CLOCK OSC.

ALL STANDARD VALUES . . . 4.89

DIP SWITCHES

4, 5, 6, 7, 8, 10 ALL . . . .79 ea.

ZIF SOCKETS

14 pin ZIF	4.69
16 pin ZIF	4.69
24 pin ZIF	5.89
28 pin ZIF	6.69
40 pin ZIF	9.69

ORBITAL SYSTEMS:

EXTENDED 80-Column Card for APPLE IIe

- 64K to 128K Upgrade
- 2-Year Warranty $69.95

Z-80 (CP/M) CARD APPLE II+, IIE†

- Compatible w/all Apple CP/M
- Lifetime Warranty 69.95

MEG-O-RAM EXPAND DESKTOP SPACE 1 MEGABYTE on APPLEWORKS† APPLE II e† . . . $259.00

APPLE ACCESSORIES

Parallel Printer Card	49.95
80-Col. card for Apple II+	149.95
80-Col. card for Apple IIe	129.95
Serial Card (communication)	69.95
Cooling Fan	38.95
Power Supply	69.95
Joystick	29.95
Joystick Adapter Apple IIc	14.95
RF Modulator	13.95
Disk Drive Full Height	169.95
Disk Drive ½ Height	169.95
Controller Card	49.95
Apple Paddles	5.95
16K Card	39.95

★ BULK DISKETTES ★

SS/DD . . . . . 25/$17.25

DS/DD . . . . . 25/$19.75

AT‡ disks . . . . 25/$50.00

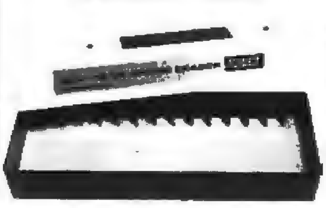
3½" disks . . . . 25/$50.00

ALL DISKETTES HAVE A FULL 1-YEAR WARRANTY

UV ERASERS

QUV-T8/1 $49.95

ECONOMY Model



- Erases 15 EPROMS in 20 minutes
- Plastic Enclosure

DOKAY carries the Full Line of LOGICAL DEVICES, Inc.

MEMORY EXPANSION KIT

41256 150ns $2.89 each!

APPLE† or IBM‡ JOYSTICK $29.95

☆ MERCURY MODEMS ☆

For APPLE† and IBM‡

HAYES COMPATIBLE MODEM 195.00

— FULL ONE YEAR WARRANTY —

✓ IBM‡ ACCESSORIES ✓

8087-3 (5 MHz)	124.95
8087-2 (8 MHz)	144.95
TEAC 55B	99.95
TANDON TM100-2	129.95
135W XT POWER SUPPLY	99.95
512K RAM MEMORY BOARD	139.95
MULTIFUNCTION BOARD with 384K RAM	179.95

MACINTOSH† UPGRADE

(Parts only)

128K to 512K 50.00

Consists of: 16 41256 150ns
1 74F253
17 16 Pin Sockets

Resistors and Capacitors ALSO INCLUDED

† A TRADEMARK OF APPLE COMPUTER
‡ A TRADEMARK OF IBM CORPORATION

CALL or WRITE for our FULL CATALOG

TERMS: Minimum order $10.00. For shipping and handling include $2.50 for UPS ground or $3.50 for UPS Blue (air). For each additional air pound, add $1.00. California residents must include 6% sales tax; L.A., S.F., S. Cruz, & S. Mateo counties include 6.5% sales tax and Santa Clara include 7% sales tax. All items subject to availability and prices subject to change. Typographical errors are not our responsibility.
No additional charge for Mastercard or Visa. We reserve the right to substitute manufacturers and to limit quantities.

CALL for VOLUME Quotes

HOURS: Mon – Fri 7:30 to 5:00
Saturdays 10:00 to 3:00

VISIT OUR RETAIL STORE

2100 De La Cruz Blvd
Santa Clara, CA 95050
(408) 988-0697

ALL MERCHANDISE IS 100% GUARANTEED

Telex: 756440

DoKay

TOLL-FREE ORDERING: 800-222-8686

FOR TECHNICAL SUPPORT/ SERVICE / IN ARIZONA: 602-282-6299

CCT® CUSTOM COMPUTER TECHNOLOGY

A PAT MARTINI COMPANY

1 CCT PLAZA — P.O. BOX 4160 — SEDONA, ARIZONA 86340

Purchase your Hardware and Software directly from an OEM / Systems Integrator. Take advantage of our buying power! We stock a full line of Board Level Components, Software and Peripherals. Call for your needs. We'll give you the Lowest Prices, and the Technical Support and Know-How we are quickly becoming well-known for. Satisfied Customers Nationwide. The Nation's Custom Systems House for Business, Education and Science. Call for a system quote. CCT implements tomorrow's technology today!™

• FOREMOST QUALITY • ADVANCED SUPPORT • REASONABLE COST •

CCT© CompuPro

80286 NOW!

☐ **CCT-286Z** is our model designation for the **MI-286** dual processor board from **Macrotech.** It features the super high speed combination of Z-80H and 80286, with provision for the 80287 math chip. Directly replaces 8085/88 and 8086 CPUs running CP/M, MP/M Concurrent DOS, and MS-DOS, at throughput increases of 3X to 5X!

SPECIAL PRICE - $795

80287 Option - Installed - **$250**

SEE THE CCT-4 SERIES USING THIS BOARD DETAILED ON THE FACING PAGE

NOW! BATTERY BACK-UP ON CCT RAM BOARDS!

VOLATILE PRICES CALL FOR QUOTE

LIBERTY TERMINALS

• Superior Reliability •

110-14" GREEN-80/132 Column	CLOSE
110-14" AMBER	OUT
200-14" GREEN-80/132 Super Deluxe	PRICES
200-14" AMBER	CALL!

OKIDATA PRINTERS - Top Quality

82 - 80 Col	CALL
83 - 132 Col	CALL
92 - 80 Col	CALL
93 - 132 Col	CALL
84 - 132 Col/200cps—Top of the Line	CALL
For Serial Interfaces	CALL

TOSHIBA P351 - 288 CPS/24 PIN - **$1499**

DIABLO — Letter Quality Series

Model 620 .. **$969** **Model 630** .. **$1799**

WE HAVE ALL SOFTWARE—CALL

$ ACROSS THE BOARD PRICE REDUCTIONS $

INDUSTRIAL GRADE SUPERIOR QUALITY **CCT DISK DRIVE SYSTEMS** ROLLS ROYCES OF THE INDUSTRY

S-100 HARD DISK SUBSYSTEMS

Professionally engineered ST-506 type systems for the business market S-100 Computer user. Includes industry top quality drives, CompuPro Disk 3 DMA controller, all cabling, A&T, formatted, burned-in. Provisions for up to two hard disks in each system. We include operating system update. CP/M 80, CP/M 86, CP/M 8-16, CCP/M 8-16, CP/M 68K. (/1 Systems are CCT innovated hard/floppy combinations, with Mitsubishi DSDD 8" drive.) 12 month warranty.

CCT-10 (11 + MEG)	$1499	CCT-10/1	$2049
CCT-20 (22 + MEG)	$2019	CCT-20/1	$2569
CCT-40 (36 + MEG)	$2499	CCT-40/1	$3049
CCT-60 (58 + MEG)	$3699	CCT-60/1	$4249
CCT-90 (87 + MEG)	$4909	CCT-90/1	$5459
CCT-125 (123 + MEG)	$6099	CCT-125/1	$6649

HOT NEW CCT BOARD **PRINTERFACER 1™** - Print buffer I/O Board. Up to 1 Meg. RAM on board. Looks as/works with Interfacer 3/4. Single or Multiuser/Interrupt driven or polled. Super-slick design handles one serial, one parallel, software switchable. Also for Zenith and Alpha. Intro Price — **$349.**

FLOPPY SYSTEMS

CCT-2.4 • Dual 8" DSDD
Mitusbishi 2.4 Megabyte in Extra Heavy horizontal enclosure, removeable filter air system, all cabling, A&T, Burned in. The fastest system available: $1229

CCT-5 • 5¼" DSDD
IBM Compatible Mitsubishi 360K. Extra Heavy Cabinet accommodates two drives, hard or floppy. All cabling, A&T, Burned-in. Perfect for our Concurrent DOS Package . $399

CCT-8/5 • FULL IBM COMPATIBILITY
One Mitsubishi 8" DSDD (1.2 Meg)/One 5-¼" DSDD (360K) IBM Drive
For Concurrent DOS and PC DOS **$1029**

★ SUPER PRICES ★ COMPUPRO COMPONENTS ★ IN STOCK ★

CPU-Z - **$229** • Disk 1A - **$399** • Disk 1A w/CP/M - **$499** • CPU 8086/10 - **$359** • SPU-Z - ?
CPU 8085/88 - **$229** • CPU 286 - **$849** • CPU 68K - 10Mhz - **$359**
Disk 3 - **$459** • RAM 22 (256K) - ? • RAM 23/64K - **$229**/128K - **$299**

SUPER SALE — M-Drive/H - 512K - **$399** / 2 Meg - **$899**

Enclosure 2 Desk - **$699**/Rack - **$749** • Interfacer 3 - **$409** • Interfacer 4 - **$289** • System Support 1 - **$299**
Concurrent DOS 8-16 (CCTCMX) - **$309** • CP/M 80 (CCTHMX) - **$125** • CP/M 86 (CCTTMX) - **$175**
CP/M 8-16 (CCTTMX) - **$199** • CP/M 68K (CCTCX) - **$279** • **Operating System Updates/Remakes - $30**

16 Bit Upgrade Kit: CP/M 86, RAM 23, System Support 1, Cable $649 ☐ CP/M 8-16 - Kit - $673

CCT-1 — ENTRY LEVEL S-100 BUSINESS SYSTEM

- Enclosure 2-Desk-21 Slot Mainframe •
- CPU-Z - 6 Mhz Z-80 CPU Board •
- Disk 1A - DMA Floppy Disk Controller •
- RAM 23 - 64K Static RAM - 12Mhz •
- Interfacer 4 - 3 Serial/2 Parallel I/O •
- CCT-2.4-Dual 8" Mitsubishi DSDD Drive System - 2.4 Megabytes •
- CP/M 80 - 2.2 HMX - CCT Modified •
- All Cabling, Complete CCT Assembly, Testing, and Minimum 20 Hour Burn-in •

SPECIAL PRICE $3,150

RUNS ALL STANDARD 8" CP/M SOFTWARE - INCLUDES OUR EXCLUSIVE 12 MONTH DIRECT WARRANTY

Prices & availability subject to change. All products new, and carry full manufacturer's warranties. Call for catalog. Free technical help to anyone. All products we sell are CCT individually tested and set up for your system - Plug-In & Go! Arizona residents add sales tax **CCT**© Trademark — Custom Computer Technology; **MS-DOS**© Trademark — Microsoft; **IBM**© Trademark — International Business Machines; **CompuPro**© Trademark — W.J. Godbout; **CP/M**© **MP/M**© Trademarks — Digital Research **HERCULES**™ Trademark — Hercules Computer Technology

SUNTRONICS CO.,INC.

12603 Crenshaw Blvd., Hawthorne, CA 90250

1-800-421-5775 (Order Only)
(213) 644-1140 (CA Order & Info.)
STORE HOURS
Mon.-Fri. 9 a.m. to 6 p.m.
Sat. 10 a.m. to 5 p.m.

TERMS: VISA, MASTERCARD, C.O.D. (Cash or Certified Check Required). Check (Allow 2-3 Weeks for Clearing). Shipping & H.C. $3.00 for 3 Lbs. plus 50c for each add'l Lb. Calif. residents add Calif. Sales Tax. $10.00 Minimum Order. IBM and Apple are registered trade marks of IBM & Apple.

SUN-XT COMPUTER
(IBM PC/XT COMPATIBLE)

- ☐ RAM EXPANDABLE TO 640 K
- ☐ USES MS & PC-DOS OPERATING SYSTEMS
- ☐ RUN LOTUS 1-2-3 FLIGHT SIMULATOR SYMPHONY DBASE II & III AUTO CAT, WORD STAR, MULTI PLAN ... ETC. (DOES NOT RUN PROG. REQUIRE ROM BASIC.)

- ☐ CPU BOARD W/256 K RAM
- ☐ COMPUTER CABINET
- ☐ FULL FUNCTION KEYBOARD
- ☐ 135 W/POWER SUPPLY
- ☐ 2 DSDD DISK DRIVES
- ☐ FDC W/CABLE
- ☐ TTL MONITOR (AMBER OR GREEN)
- ☐ MONOCHROME GRAPHICS CARD W/PARALLEL PRINTER PORT.
- ☐ FULLY A & T (MEETS FCC CLASS "A" REG., FOR IND. & BUS. USE)

ONLY $895.00

DEALER & OEM INQUIRES INVITED!!

SUN-XT CPU
- ☐ 8088 CPU (8087 OPTION)
- ☐ RAM EXPANDABLE TO 640K
- ☐ FULLY IBM COMPATIBLE
- ☐ DIMENSION SAME AS IBM PC/XT
- ☐ NO RAM INCLUDED
- ☐ 8 EXPANSION SLOTS

$175.00

FLOPPY DISK CONTROLLER
- ☐ STANDARD DOUBLE SIDE DOUBLE DENSITY
- ☐ RUN 2 INTERNAL & 2 EXTERNAL
- ☐ WITH CABLE

$59.00

IBM STYLE CABINET
- ☐ 8 SLOT BACK PANEL
- ☐ COMES WITH MOUNTING BRACKET & HARDWARE
- ☐ FITS IBM POWER SUPPLY

$59.00

COLOR GRAPHIC CARD
- ☐ RGB & COMPOSITE VIDEO
- ☐ 640 x 200 HIGH-RES
- ☐ 320 x 200 LO-RES
- ☐ 80 x 25 TEXTMODE
- ☐ LIGHT PEN INTERFACE

$99.00

HIGH RESOLUTION MONOCHROME MONITOR
- ☐ 12" AMBER OR GREEN
- ☐ 1000 LINES AT CENTER
- ☐ 20MHZ BAND WIDTH
- ☐ SEPARATE TTL SIGNAL INPUT
- ☐ DUAL INTENSITY SIGNAL LEVEL
- ☐ HIGH PERFORMANCE SHARP IMAGES

$105.00

MONOCHROME GRAPHIC CARD
- ☐ HIGH-RES CHARACTER
- ☐ 720(H) x 348(V)
- ☐ 80 x 25 TEXT MODE
- ☐ RUN LOTUS 1-2-3 ETC.
- ☐ WITH PARALLEL PRINTER PORT

$120.00

MULTI-FUNCTION BOARD
- ☐ RAM EXPANDABLE TO 384(0 K)
- ☐ SERIAL/PARALLEL PORT
- ☐ CLOCK CALENDAR W/BATTERY BACKUP
- ☐ GAME PORT
- ☐ SPOOL & RAM DISK

$129.00

MULTI-I/O BOARD
- ☐ FLOPPYDISK DRIVE CONTROLLER
- ☐ PARALLEL PRINTER PORT
- ☐ SERIAL I/O PORT (OPTION DUAL)
- ☐ CLOCK CALENDAR W/BATTERY BACKUP
- ☐ GAMEPORT

$149.00

RGB COLOR MONITOR
- ☐ 14" DISPLAY DB-9 CONNECTOR
- ☐ 640 x 240 HIGH-RES
- ☐ 2500 CHARACTERS (80 x 32)
- ☐ RGB TTL LEVEL, INTENSITY SIGNAL
- ☐ 0.38 mm DOT PITCH
- ☐ H-SCANNING 14.5K-17.8KHZ

$365.00

FULL FUNCTION KEYBOARD
- ☐ 83 KEY FULL FUNCTION
- ☐ POWER, CAPS, NUM LIGHT INDICATOR
- ☐ MECHANICAL TYPE SWITCH
- ☐ WITH CABLE

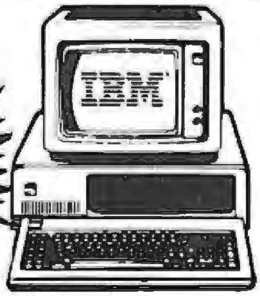
$79.00

135W POWER SUPPLY	$89.00
150W POWER SUPPLY	$109.00
6 OUTLET SURGE SUPPRESSOR [MIDLAND RDSS IND.]	$14.50
10MB HARD DISK w/CONT.	$450.00
20MB HARD DISK w/CONT.	$550.00
ASYNC RS232	$59.00
PARALLEL PRINTER CARD	$39.00
TEAC 55 BV OR TOSHIBA ND-04 DISK DRIVE	$89.00
HARD DISK DRIVE CONTROLLER (10MB OR 20MB)	$159.00
64K RAM KIT (9 EA)	$8.50/KIT
256K RAM KIT (9 EA)	$29.00/KIT
PARALLEL PRINTER CABLE	$15.00
CITIZEN MSP-10 PRINTER	$299.00
TOSHIBA 1340 PRINTER	$599.00
DSDD 5¼ DISKETTE	$12.95/per 10 ea
EPROM BLASTER FOR IBM, HIGH SPEED, BURNSIN 45 SEC. PROG. 2716, 32, 64, 128	$139.00

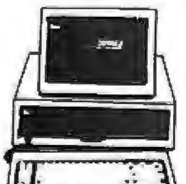
FREE*DELIVERY

CALL: 1-800-872-4727

PC-256K, 1/360K Floppy, 10 MB Hard Disk



$1,955.00 (Monitor Extra)



COMPAQ DESKPRO™ (Monitor Extra)

$2,260.00

256K, 1/360 Floppy, 10 MB Hard Disk

MONITORS

Amdek 310A	$169.00
Taxan 121, Green	$159.00
Taxan 122, Amber	$165.00
TVM MD-3 (Amber, Green, RGB)	$449.00
COMREX CR6700 (RGB)	$299.00

DISK DRIVES

INTERNAL HARD DISK (with controller)

10MB Rodime (Compaq Upgrade Kit)	$529.00
10MB ½ Height Seagate	$395.00
20MB ½ Height Seagate	$495.00
External Case	$149.00

FLOPPY DISK DRIVES

½ Height Mitsubishi	$85.00

PC*USA Has It All
- Honesty
- Price
- Service
- Delivery

COMPAQ®
Portable Hard Disk System
256K 1/360K Floppy, 10 MB Hard Disk

$2318.00

IBM®

$4359.00 (Monitor Extra)

Systems Include...
IBM AT and Keyboard, IBM 1.2 Meg Floppy, Panasonic 360K Floppy, Seagate (ST4026) 20 MB Hard Disk (40 MS Access Time)

TEAC 20MB Tape Backup **$839**

PRINTERS

EPSON LX 80	$215.00
EPSON LQ 1500	$920.00
COMREX CRII	$299.00
COMREX CRIV	$499.00
Okidata 192P	$369.00
Okidata 193P	$499.00
CANON LASER BEAM	$2495.00

PC*USA®

2003 108th St., Suite 301 Grand Prairie, TX 75050
214-641-6953 Metro 647-4008 Texas Wats 1-800-441-0975
National Wats 1-800-872-4727 Business Hours (M - F 9 - 6) CT

TELEPHONE SALES ONLY - NOT OPEN TO THE PUBLIC • MINIMUM ORDER $200.00 for free delivery • TERMS: VISA, MASTERCARD, CASHIER'S CHECK, WIRE TRANSFER, (C.O.D. call for details) • ALL ITEMS SUBJECT TO AVAILABILITY AND PRICE CHANGE • ALL PRODUCTS ARE NEW AND CARRY MFG AND/OR PC*USA WARRANTY. PLEASE CALL FOR WORK-ORDER NUMBER BEFORE RETURNING DEFECTIVE MERCHANDISE. UNAUTHORIZED RETURNS SUBJECT TO A RESTOCKING FEE • ALL SALES ARE FINAL.

¢ompu$ave

Call Toll Free: 1-800-624-8949

IN ARIZONA CALL (602) 967-3532

COMPUTERS

Altos 586-20 Multiuser System	5199
AT&T 6300-PC/1 Floppy Drive	1679
Lazer 3000/1 FDrive/Apple Comp.	425
Televideo PM-4T Multiuser System	4895
Wyse-PC/2 Floppy Drives	1159
Wyse-XT/1 FDrive/10M HDrive	1879
Zenith 158-PC/1 Floppy Drive	1549
Zenith 171-PC Port/2 FDrives	1879
Amstrad/Columbia/Corvus	CALL
Compaq/Corona/IBM/Molecular	CALL
NEC/Onyx/Olivetti/Sharp/Sperry	CALL

ZENITH 148-PC WITH 1 DRIVE
VERY IBM COMPATIBLE....995

MODEMS

AST Reach Half-Card W/Soft (Int)	325
Anchor Volksmodem (Ex)	55
Anchor Signalman Express (Ex)	235
Hayes Micromodem IIE W/Soft	128
Hayes Smartmodem 300 W/Soft (Ex)	155
Hayes Smartmodem 1200 (Ex)	361
Hayes Smartmodem 1200B (Int)	309
Novation Apple Cat II (Int)	192
Novation J-Cat 300 (Ex)	98
Novation Half-Card 2400 (Int)	439
Racal-Vadic 300 PC W/Soft (Int)	98
Racal-Vadic 1200V W/Soft (Ex)	215
Racal-Vadic 2400V W/Soft (Ex)	399
Ven-Tel PC Modem Half-Card (Int)	375
AT&T/Prometheus/U.S. Robotics	CALL

PRINTERS

Citizen MSP10	248	Abati LQ	199
C. Itoh F10-55	949	Juki 6100	345
Data Prod. 8052	1129	Juki 6200	495
Data South 220	1295	Juki 6300	665
Diablo D25	535	NEC 3550	985
Epson LX90 W/IF	269	NEC ELF	385
Panasonic 1080	205	NEC P5	965
Panasonic 1091	234	Star SG10	209
Panasonic 3131	285	Tally MT86	419
Toshiba 341	899	TI 855	549
Toshiba 1340	469	Cables 10'	19

Anadex/Brother/Canon/Okidata	CALL
Oume/Silver-Reed/Televideo	CALL
Buffers/Sheet Feeders/Tractors	CALL
Stands/Switches/Ribbons	20% OFF
Houston DMP 41/42 Plotter	2495
Roland DXY 880 Plotter	975
Houston TG8024 Digitizer	2395
Other Plotters And Digitizers	CALL

TERMINALS

Adds Viewpoint +	429	Oume 101G	289
Altos III	595	Oume 201G	525
Ampex 210	365	Oume 202G	595
Ampex 219	519	Wyse 50	418
Ampex 230	449	Wyse 75	555
Televideo 914	539	Wyse 85	575
Televideo 922	595	Wyse 350	855
Televideo 955	458	Zenith Z29	608
IBM/Liberty/LSI/Samsung/Visual	CALL		

MONITORS

BUI 14" Color	349	Amdek 300G	116
Princeton HX9	415	Amdek 310A	142
Princeton HX12	432	Amdek 500	255
Princeton MAX12	162	Amdek 700	399
Princeton SR12	579	Taxan 115	115
Tatung CM1370	499	Taxan 122	139
Thomson 31021G	139	Taxan 620	389
Thomson 36432	345	Taxan 640	499
Wyse 600 W/Card	519	Wyse 500	169
Zenith 122/123	79	Zenith 1240	169
NEC/Panasonic/Roland/Tecmar	CALL		
Corona/Magnavox/Quadram	CALL		
Cables/Interfaces/Stands	CALL		

QUALITY PRODUCTS
AT EXTREMELY LOW
DISCOUNT PRICES.

DISK DRIVES

Apple Compatible Floppy Drives	125
IBM Compatible Floppy Drives	95
Seagate 10M Subsystem/IBM Comp.	439
Seagate 20M Subsystem/IBM Comp.	539
Tape Back Up Systems	CALL

OTHER FLOPPY AND HARD DRIVES

- ALPHA OMEGA
- CONTROL DATA
- CORVUS
- IOMEGA
- MAYNARD
- MICRO SCI
- MITSUBISHI
- PRIAM
- SHUGART
- TANDON
- TEAC
- TECMAR

LOW PRICES....CALL

BOARDS

AST Advantage W/128K	375
AST Six Pack Plus W/64K	209
Cardo G-Whiz (Commodore)	55
Hercules Color Card	143
Hercules Monochrome Graphics	289
Micro Sci 80/64E (Apple)	75
Orange Grappler + (Apple)	70
Orange Hot Link (Apple)	49
Orchid Conquest/0K	265
Orchid PCturbo 186/256K	635
Paradise Modular Graphics	258
Paradise Multi-Display	189
Persyst Short-Port Color Card	159
Persyst Bob Board	335
Premier Color-Pack Card	115
Quadram Quadboard/384K	225
Quadram Silver Quadboard/0K	219
STB Graphics Plus II	235
Tecmar Captain/384K	225
Tecmar Maestro AT	379
ABM/Logicom/Microtek/PGS	CALL
Practical Peripherals/Thesys	CALL

WE ALSO CARRY

Bonus Diskettes/SS-DD (Bx)	12
Bonus Diskettes/DS-DD (Bx)	17
Verbatim/Maxell/Memorex/Others	CALL

SOFTWARE
Apple/Atari/IBM/Commodore
Keyboards/Joysticks/Power Supplies
Chips/Mice/Labels/Surge Protectors
Cables/Graphics Tablets/Light Pens

Inquiry 70

HOURS: MON - FRI 8AM - 6PM/SAT 9AM - 2PM

CompuSave 3010 S. 48th St., Suite 8, Phoenix, AZ 85040, (602) 967-3533
Purchase Orders and All Major Credit Cards Welcome
Prices Reflect Cash Discounts. Minimum Shipping Charge $4
A Division of Adlanko Corporation

BYTE CONNECTION INC.

BOTTOM LINE PRICE BUSTERS! — "Who you gonna call?"

(714) 778-6496

PERSONAL COMPUTERS:

UBM ★1 (IBM Compatible), 384K, two 360 floppies, hi-res graphics card, monitor and K.B.	$ 995
UBM ★ II, all the above, w/10MB HD	$1495
AT & T 6300, 256K, two 360 floppies, AT & T graphics card, monitor and K.B.	$2222
all the above, w/360 floppy and 20MB HD drive	$2828
AT & T 7300	CALL
COMPAQ PORTABLE, 640K, 360 floppy, 10MB HD	$2595
COMPAQ DESK PRO, 640K, two 360 floppies, hi-res graphics card, K.B.	$2020
all the above w/360 floppy, 10MB HD, 10MB tape b/u	$3131
with 30MB	$3636
COMPAQ PORTABLE MODEL 286, 512K, two 1.2 MB floppies	$3838
above with one 1.2 floppy, 20MB HD	$4444
COMPAQ DESK PRO MODEL 286, 640K, two 1.2 floppies, hi-res graphics card, monitor and K.B., S.P., C/C	$3838
above with one 1.2 MB floppy, 20MB HD, 10MB tape b/u	$4994
above w/30MB HD	$5353
above w/70MB HD and 60MB tape b/u	$6969
IBM PC, 256K, two 360 floppies, hi-res graphics card, monitor, P., S., C/C, K.B.	$2099
above w/360 floppy, 10MB HD, 10MB tape b/u	$3131
IBM PC XT, 640K, 360 floppy, 20MB HD, 10MB tape b/u	$3663
IBM PC AT, 512K, 1.2 MB floppy, 20MB HD, S., P., C/C, hi-res graphics card, monitor, K.B.	$4444
IBM PC AT, above with 70MB HD, 60MB tape b/u	$6969

We carry all name brand MFC, modems, monitors, monitor adapters and software. Call for what is not listed.
WE GUARANTEE THAT YOUR CALL WILL NOT BE A WASTE.

PRINTERS:

ANADEX 9620 - 9752	$1129 - $1350
BROTHER DM40 - DH45	$ 950 - $1050
CITIZEN MSP15 - 25	$ 439 - $ 619
COMREX CR III	$ 395
DATA PRODUCT 8070 - 8072	$1750 - $1850
DATA PRODUCT LINE PRINTERS	CALL
DIABLO P32 - 34LQ	$ 685 - $1250
DIABLO AP1 - P38	$1595 - $1550
EPSON 85 - 185	$ 399 - $ 499
HP LAZERJET	$2600
HP LAZERJET PLUS	$3550
NEC 3550 - 8850	$1050 - $1350
OKIDATA 192 - 193	$ 389 - $ 495
OKIDATA 84 - 2410	$ 665 - $1825
PANASONIC 1093	$ 499
TOSHIBA 1340	$ 550
TOSHIBA P351	$1159

PLOTTERS & DIGITIZERS:

CALCOMP 1043	CALL
HP 7475	$1659
HITACHI DIGITIZERS	CALL
H1 DMP 41 - 42	$2495
H1 DMP 51/52	$3595
H1 DMP 51MP-52MP	$4995
NICOLET DPX	CALL
ROLAND DPX	$3850
TI	CALL
10 LINE	$4095

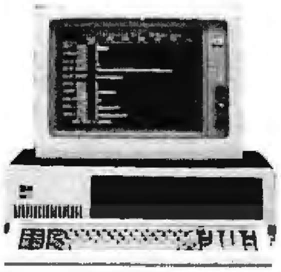
SPECIAL OF THE MONTH

20 MB HD, SUBSYSTEM	$550
30,40,70 MB	CALL

163 West Cerritos Ave., Anaheim, CA 92805
(714) 778-6496

Inquiry 45

IBM



IBM PC, 256K, One Half Height 320K Disk Drive DS/DD, Persyst Color Card With Printer Port, Taxan Green Monitor, DOS 2.1, PLUS a 10MB Hard Disk Sub System All For:

$2499.

IBM PC, 256K, Two Half Height Drives DS/DD, Persyst Color Card With Printer Port, Taxan Green Monitor, DOS 2.1, 130 Watt Power Supply PLUS a 10MB Hard Disk Sub System All For:

$2799.

IBM PC, 256K, Two Half Height Drives DS/DD, Persyst Color Card With Printer Port, Taxan Green Monitor, DOS 2.1, 130 Watt Power Supply, 10MB Hard Disk Sub System, PLUS 10MB Tape Back Up System All For:

$3299.

IBM PC, 256K, Two Half Height Drives DS/DD, Persyst Color Card With Printer Port, Taxan Green Monitor, DOS 2.1, 130 Watt Power Supply, 20MB Hard Disk Sub System All For:

$3099.

IBM PC, 256K, Two Half Height Drives DS/DD, Persyst Color Card With Printer Port, Taxan Green Monitor, DOS 2.1, 130 Watt Power Supply, 20MB Hard Disk Sub System, PLUS 10MB Tape Back Up System All For:

$3699.

MONITORS	
AMDEK 300 Green	$135.00
AMDEK 300 Amber	$149.00
AMDEK 310 Amber W/TTL Plug	$165.00
PGS HX-12	$465.00
PGS MAX-12	$185.00
PGS SR-12	$625.00
TAXAN #115 Green Composit	$125.00
TAXAN #116 Amber Composit	$135.00
TAXAN #121 Green W/TTL Plug	$149.00
TAXAN #122 Amber W/TTL Plug	$159.00
TAXAN #620 COLOR MONITOR	$449.00
TAXAN #640 COLOR MONITOR	$569.00
IBM MONOCHROME DISPLAY	$260.00
IBM COLOR DISPLAY	$590.00

COMPAQ®

COMPAQ® DESKPRO™

CALL FOR DIFFERENT CONFIGURATIONS

PRINTERS	
NEC PINWRITER 80 COL.	$599.00
NEC PINWRITER 136 COL.	$799.00
EPSON LX 80	$239.00
EPSON FX 85	$359.00
EPSON FX 185	$499.00
EPSON RX 100	$399.00
EPSON JX 80	$499.00
EPSON LQ 1500	$895.00
COMREX CR 420	$1895.00
TOSHIBA 351	$1199.00
STAR MICRONICS SG 10	$259.00
STAR MICRONICS SG 15	$395.00
CITIZEN PRINTER MSP-10	$325.00
CITIZEN PRINTER MSP-15	$450.00
CITIZEN PRINTER MSP-20	$435.00
CITIZEN PRINTER MSP-25	$599.00
JUKI LQ 6100	$385.00
JUKI LQ 6300	$725.00
BROTHER HR-25	$499.00
BROTHER HR-35	$775.00
DYNAX DX 15XL	$365.00
OKIDATA	CALL

SPECIAL
13" RGB MONITOR
FORTIS FC10
$299.00

MODEMS	
HAYES SMART MODEM 1200	$395.00
HAYES SMART MODEM 300	$209.00
HAYES 1200B PLUG IN CARD	$365.00
HAYES 2400 BAUD MODEM	$699.00
POP COM 1200 EXTERNAL	$375.00
AST REACH MODEM	$380.00
QIC MODEM INTERNAL	$275.00

DRIVES	
TANDON TM-100-2 DS/DD	$139.00
TOSHIBA SLIMLINE DS/DD	$120.00
TEAC SLIMLINE DS/DD	$120.00

HARD DISKS	
10MB SUB SYSTEM INTERNAL	$595.00
EXTERNAL	$795.00
20MB SUB SYSTEM INTERNAL	$875.00
EXTERNAL	$1050.00
40MB SUB SYSTEM INTERNAL	$1150.00
EXTERNAL	$1325.00

HARD DISKS & TAPE BACK-UP UNITS (EXTERNAL)	
10MB HARD DISK W/10MB TAPE BACK UP	$1250.00
20MB HARD DISK W/10MB TAPE BACK UP	$1475.00
40MB HARD DISK W/10MB TAPE BACK UP	$1795.00

CONQUEST PC TURBO

CONQUEST PC TURBO 640K Two Half Height Drives, Floppy Disk Controller 135 Watt Power Supply, Serial Port, Parallel Port (IBM Standard) and Enhanced Keyboard:

$1225.

Above System With 10MB Internal Hard Disk:

$1970.

With 20MB Internal Hard Disk:

$2195.

With 40MB Internal Hard Disk:

$2515.

Tape Back Up Systems Are Also Available for the Conquest PC Turbo at a reasonable price.

MULTIFUNCTION BOARDS	
AST I/O MINI CARD, 1-SER.	$145.00
AST SIX PACK 64K, 1-SER., 1-PAR	$249.00
AST PREVIEW	$299.00
AST ADVANTAGE CARD 128K FOR AT	$425.00
ALR CHALLENGER CARD 128K FOR AT	$395.00
PERSYST COLOR PRINTER ADAPTER	$179.00
PERSYST MONOCHROME PRINTER ADAPTER	$189.00
PERSYST BOB CARD	$395.00
HERCULES COLOR PRINTER ADAPTER	$179.00
HERCULES GRAPHIC PRINTER ADAPTER	$299.00
STB GRAPHIC PLUS II	$325.00
IBM COLOR GRAPHIC ADAPTER	$225.00
IBM MONO PRINTER ADAPTER	$230.00
GENOA SPECTRUM GRAPHIC CARD	$349.00

GENERAL	
MAXELL DISKETTES MD2	$35.00/box
MAXELL MD2-HDM FOR AT	$60.00/box
CONTROL DATA DISKETTES	$24.00
KEYTRONIC KEYBOARD KB 5151	$169.00

IBM PC-XT AND PC-AT

Different configurations available.

CALL FOR PRICES.

Microshop COMPUTER PRODUCTS

(714) 838-7530
2630 Walnut Avenue, Unit C, Tustin, California 92680

The Zipper™ 1200 bps & 2400 bps Modems

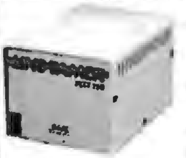
Fully Hayes Compatible
2 Year Warranty

Supports all 20 Hayes Commands
and all 6 responses

- Tone & Pulse dialing • Built-in speaker
- Auto dial/auto answer • 8 status lights
- Auto speed selection • Self-test

1200 bps Standalone	2400 bps Standalone	1200 bps IBM PC
Bell 103 and Bell 212A Compatible	CCITT V22, V22BIS, Bell 212A, and Bell 103 Compatible	Compatible Card w/MITE Communications Software
$199	**$399**	**$199**
BAPRIZIP12 (4 lbs.) Retail $299.00	BAPRIZIP24 (5 lbs.) Retail $599.00	BAPRIZIP12B (4 lbs.) Retail $299.00

PC LINE CONDITIONER



- Constant Voltage Output with up to 15% DIPs in Line Voltage
- Spike & surge suppression
- Noise suppression
- Prolongs computer life

150 WATT	300 WATT
$59	**$99**
BASHP150 (Sh. wt. 20 lbs.)	BASHP300 (Sh. wt. 30 lbs.)

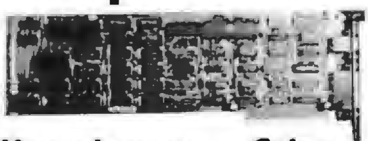
DATAGARD SURGE & NOISE SUPPRESSOR

- 600V spike max.
- 6500A spike current max.
- 6' line cord • 15A circuit breaker

$29.95 ea. **$27.50** 50-99 **$25** 100 or more

BAWBRDG115S (Sh. wt. 2 lbs. each)

HERCULES Graphics Cards



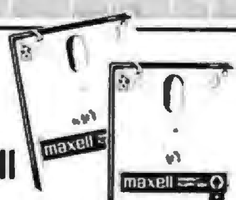
Monochrome	Color
$339	**$179**
BAHECGC	BAHECCOLOR

QUADRAM Quadchrome II

- Large 14" high-res. RGB display
- 640 x 240 res. • PC cable included

BAQDRQC2
Retail: $599.00 **$299**
(Shipping weight 30 lbs.)

maxell



3½" Diskettes

Single Sided	Double Sided
$31	**$46**
BAMXLMF1	BAMXLMF2

EPSON LX90

Dot Matrix Printer with NLQ with FREE Tractor and Interface

with IBM-PC Interface	Standard Parallel (Inc. Apple IIe)
BAEPNLX901	BAEPNLX902

YOUR CHOICE: **$249**
(Shipping weight 18 lbs.)

PRIORITY ONE ELECTRONICS

Inquiry 289

IRVINE
18241 Mc Durmott,
Irvine, CA 92714
(714)660-1411

Mail Your Order To:
21622 Plummer St., Chatsworth, CA 91311-9970
RETAIL: (818)709-5464 INDUSTRIAL: (818)709-5111

SAN JOSE
452 W. Trimble Rd.,
San Jose, CA 95131
(408)946-7010

MINIMUM PREPAID ORDER $25.00. Terms U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds ONLY. CA residents add 6%, 6½%, or 7% Sales Tax, depending on your local rates. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs., plus 50¢ for each additional pound (25¢ if within Calif.) Plus 25¢ per $100.00 value of your order for insurance. Orders over 70 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through January 1986. Credit card orders will be charged appropriate freight. We are not responsible for typographical errors.

PRIORITY ONE ELECTRONICS and PRIORITY 1 ELECTRONICS are registered service marks of the Heath Group, Ltd. Zipper 212A, Zipper 2400, Zipper 1200B and Zipper Modem are trademarks of the Heath Group, Ltd.

ORDER TOLL FREE (800)423-5922 (NOW IN CALIF. TOO!!)

Inquiry 146

Inquiry 191

Inquiry 35

Inquiry 174

Inquiry 64

Inquiry 225

Inquiry 285

Inquiry 166

COMPUTERBANC™

FREE SHIPPING ON ALL SOFTWARE

HARD DRIVE KITS
20 MB Internal w/Controller **$495**
30 MB Internal for AT **$799**
10 MB Internal w/Controller **$425**
*External Models Add **$150**

TAPE DRIVES

20 MB	45 MB	60 MB
$699	$999	$1,099

*File by File
*Mirror Image *Software Included

IBM PC AT 20 MB
(Seagate Model 225)
512 K, Serial, Parallel
$4,299

MODEMS
Volksmodem 1200 **$169.95**
Prometheus 1200 **$269.00**

IBM PC XT
10 MB, 256K
CALL
CALL
256K, 2 Drive
IBM PC

AT COMPATIBLES
Sperry IT 44 MB
$4,399
CALL
COMPAQ 286 30 MB

KEYBOARD
$119
*Keytronics 5151 Compatible

IBM PC COMPATIBLES
ITT XTRA 2 Drive, 256K **$1,495**
Leading Edge PC CALL
16 Bit PC Clone System **$899**

*** All systems include monochrome monitor, DOS, and parallel part**

IBM SOFTWARE

LOTUS 123	CALL
Symphony	CALL
ENABLE	389.00
GEM COLLECTION	129.00
ASHTON TATE Framework	379.00
dBASE II	289.00
dBASE III	389.00
CLIPPER dBASE III Compiler	379.00
MULTIMATE	239.00
SORCIM Supercalc III	210.00
Super Project	210.00
MICROSOFT Multiplan	125.00
Word	229.00
Project	159.00
FOX & GELLER Quickcode	139.00
NORTON UTILITIES	52.00
TURBO PASCAL ver 3.0	49.00
SUPERKEY	37.00
SIDEKICK (unprotected)	46.00
ASCII PRO Comm Software	69.00
CROSSTALK XVI	105.00
PEACHTREE Back To Basics	101.00
IN-HOUSE ACCOUNTANT	89.00
WORD PERFECT	249.00
MICROPRO WordStar Pro	259.00
WordStar 2000	316.00
SAMNA Plus	345.00
WORD III	279.00
RBASE 5000	389.00
PRINTMASTER	35.00
ENERGRAPHICS	169.00
BPI General Accounting	316.00

IBM HARDWARE

AST 6 Pack Plus w/384K	249.00
Advantage w/128K	399.00
HERCULES Mono Graphic	319.00
Color Card	159.00
HERCULES like Color Card	129.00
Monochrome Graphics Card	149.00
ORCHID Turbo w/256K	669.00
QUADRAM Quadboard O-K	198.00
QuadPort for AT ser & par	115.00
TECHMAR Graphics Master	469.00
STB Rio plus 64K 5 Functions	189.00
Rio Grande 3 function for AT	289.00
Graphix II	210.00
High Res 400	369.00
Chaffeur monographics NEW	234.00
PARADISE Modular GraphicsCard	CALL
SIGMA High Res Color 400	CALL
IBM COMPATIBLES	
Color card	129.00
Multifunction Card 384K s.p.clck.	169.00
Multifunction Card Ok-1.2mb	179.00
Compatible Mono Card w/par.	129.00
5151 Compatible Keyboard	119.00
TTL Monitor Amb or Grn IBM	100.00
Expansion Chasis	CALL
TALLGRASS w/Tape	CALL
IRWIN TAPE DRIVE	499.00
EVEREX TAPE Pc/Xt/AT	CALL
Graphics Edge Card	CALL
Edge Card	CALL
RODIME 20MB Drive	CALL
TEAC 55BV	95.00
1.2MB FLOPPY for AT	189.00
360K FLOPPY for AT	115.00
MOUSE SYSTEMS Mouse	135.00
FIELDMOUSE	113.00
MICROSOFT Mouse (bus) w/sftwr.	117.00
Mouse (serial) w/PC Paintbrush	125.00
KOALA KAT	149.00
DISKETTES 2S DD	15.00

MODEMS

ANCHOR Express 300/1200	229.00
Volksmodem 12 (5 wrnty)	169.95
Lightning 2400 Baud	CALL
HAYES 1200	379.00
1200B	349.00
2400	CALL
Micromodem//e	CALL
Transet 1000	CALL
PROMETHEUS 1200	269.00
Promodem 1200B	219.00
Promodem 1200A	259.00
Promodem Mac Pac Kit	299.00
Promodem 300 IIc	139.00

MONITORS

AMDEK 300A	139.00
310A Hi-Res Ambr	155.00
Color 600 Hi-Res RGB	433.00
Color 710	474.00
PRINCETON GRAPHICS HX-12	469.00
HX-9	449.00
SR-12	625.00
MAX-12	179.00
TAXAN 121/122	149.00
620 (RGB) 640x200 NEW	CALL
640 (RGB) 720x400 NEW	CALL
PANASONIC DT-S101 Color	179.00
DT-H103 10" High Res RGB	369.00
IBM COMPATIBLE Monocrome	99.00
Color RGB Monitor (640x200)	349.00

PRINTERS

BROTHER 1509 DOT MATRIX	369.00
HR-15XL	345.00
HR-25XL	469.00
HR-35XL	699.00
Twinwriter	822.00
EPSON LX-80	225.00
FX-85	345.00
FX-185	485.00
OKIDATA ML-192	373.00
ML-193	522.00
PANASONIC KX-P1091	229.00
KX-P1092	299.00
KX-P3131/17cps Daisey	269.00
KX-P3151/22cps Daisey Wheel	379.00
TOSHIBA P351 w/tractor	1279.00
STAR MIRONICS SG-10	219.00
SG-15	399.00
CITIZEN MSP-10	266.00
MSP-15	335.00
MSP-25	489.00
CANNON Laser Printer	CALL
HOUSTON INSTRUMENTS Plotters	CALL
Digitizers	CALL
HEWLETT PACKARD PRINTERS	CALL

APPLE PRODUCTS

APPLIED ENGINEERING	
Ramworks 64K	149.00
AST Multi I/O	CALL
MICRO SCI A2 Drive IIe	169.00
IIc Compatible Drive	139.00
APPLE Compatible Drive	129.00
HABA Mac Drive	CALL
MAC Compatible 3 1/2 drive	249.00
BERNOULLI 5MB MAC Drive	CALL
MACINTOSH Harddrive	CALL
MICROSOFT Macenhancer	CALL
Softcard II	259.00
Multi-plan //e & Mac	129.00
Basic (Mac)	109.00
ASCII XPRESS (Communications)	69.00
THE DESK ORGANIZER (Mac)	133.00
APPLE MOUSE II	129.00
APPLEWORKS	215.00
SPELLWORKS	CALL
PRINTSHOP	30.00
HAYES Mach III Joystick	39.00
SYSTEMS SAVERF an	69.00
VIDEO 7 IIc Enhancer	CALL
V-color IIc (RGB)	CALL
TITAN Accelerator	229.00
VIDEX Ultraterm	169.00
APRICORN (Lifetime Warranty)	
Super Serial Imager	69.00
Graphics Interface	59.00
80 Column/64K	59.00
EXTEND IT 64K	39.00
KOALA SpeedKey	99.00
Muppet Learning Keys	39.00
DISKETTES Apple/Mac	12.00/24.00
APPLE IIe 64k w/80 column	775.00

Call for complete pricing. Thousands of products available.

COMPUTERBANC™

16783 Beach Blvd., Huntington Beach, CA 92647
TELEX #550757 ANSWER BACK—COMPUTER UD
714/841-6160

VISA

No Charge for Credit Cards
Orders Only

800/332-BANC
OUTSIDE CALIFORNIA

Cash prices indicated. All products are in factory sealed packages. We guarantee all items for 30 days. Within this period, defective merchandise returns must be accompanied by RMA number. All other returns will be subject to a 10% restocking fee. For prepaid orders, there will be a 3% shipping charge; 5% for UPS Blue Label; $5.00 minimum; all orders outside U.S.A. at 15% shipping. California residents add 6% sales tax. Prices subject to change without notice.

TERMINAL EMULATION

Softerm PC emulates over 30 popular terminals including the:

- DEC VT102, VT220
- Data General D200, D410
- IBM 3101-20 (block mode)
- Hewlett-Packard 2622A
- Honeywell VIP7801, VIP7803

Guaranteed Compatibility
Call for free product brief
$195 MC-VISA-COD
For the IBM PC/XT/AT, DG1, NEC, Wang PC, TI Pro, Gridcase, Tandy

SOFTRONICS
3639 New Getwell, Suite 10
Memphis, TN 38118
901-683-6850

Inquiry 328

M•A•G•I•C

INLAB 28 LOGIC/MEMORY PROGRAMMER

It *must* be magic! How else could INLAB load all these features into such a small package:

- Capable of programming hundreds of logic and memory devices!
- Small and portable-less than 26 ounces!
- Inexpensive firmware updating!
- Available with CUPL™ design software!
- Standard RS232 interface!
- EPROM emulation, from 2716 up to 27256 (including CMOS)!

It's no illusion! For only $1995. we can make a Model 28 appear before your very eyes! Just give us a call at 303/460-0103.

We'd like to do some *magic* for you!

CUPL is a trademark of Assured Technology; some elements of the Model 28 are manufactured and marketed under license from Digital Media, Inc

INLAB INC
A Hathaway Company
2150-I West 6th Avenue
Broomfield, CO 80020

Inquiry 168

WEDGE-PC OEM PRODUCTS

PC-AT Compatible $1659/one
512k RAM, 1.2M disk drive, hard disk & floppy disk controller, monochrome card. 200W power, keyboard, enclosure.

PC-XT compatible $550/one
256k RAM, one 340 disk drive, monochrome card, keyboard, 130W power, enclosure.

AT mother board $895 AT Enclosure $79
AT 200W power $135 Monochrome monitor $99
Dealer call for qty price

WEDGE TECHNOLOGY INC.
1190 Mt. View-Alviso Rd., Suite R
Sunnyvale, CA 94089 (408) 734-9866
Telex 3719075 EDGE UB

Inquiry 379

I/O Bus for Data Acquisition & Control

now available for IBM PC & Apple II series computers

In photo are 'LAB40-PC' generator & 'LAB40-1' signal acquisition module.

- **Modular approach to data acquisition and control.** A 40 conductor ribbon cable bus is generated by a card in the host computer. Up to 8 low cost modules can be located anywhere on a cable up to 100 ft. long. Our LAB 40 generator cards for the IBM PC or Apple II are priced at $185.
- **Signal Acquisition and Control Module, model 'LAB 40-1'.** Features: 8 bit resolution, 4 channels, differential inputs, sampling rate up to 650KHz, software programmable gains and offset, digital output port, low price of $220. Twelve bit module available.
- **Full featured 'digital oscilloscope' software.** Documented and user modify-able. PC version $175. Apple II version $100. Complete data acquisition packages (hardware and software) start at $450.
- **Development tool.** Unique to LAB 40 is its ability to interface directly to microprocessor compatible integrated circuits and hybrids. We encourage users to develop projects and products. LAB 40 is an ideal educational tool.
- **New low cost modules.** Twelve bit A/D. Port/Relay Driver. Real Time Clock.

Computer Continuum
75 Southgate Ave., Suite 6 • Daly City, CA 94015
(415) 755-4978

ROSE ELECTRONICS — DATA SWITCHES

SHARE computers, printers, any parallel or serial device
ELIMINATE cable swapping
INEXPENSIVE way to network
COMPATIBLE with all computers.
Businesses, Schools, Homes

WE ALSO OFFER:
Data Buffers, Line Drivers, Modems, Protocol Converters, Parallel - Serial Converters, Cables, Computers, Printers, Disk Drives, and more.

AUTOMATIC - **CARETAKER** is ideal for a **business** or school to share a printer or modem among many computers. Operation is fully automatic with no software required.
Parallel or Serial 4 channels - $295 8 channels - $395

MANUAL - **HARDSWITCH** is operated **with** the flip of a switch. 2:2 and 2:4 models allow simultaneous communication.

Serial	1:2 - $59	1:4 - $ 99	2:2 - $109	2:4 - $169
Parallel	1:2 - $79	1:4 - $139	2:2 - $119	2:4 - $199

LED and spike protection on serial models add $20.

CODE ACTIVATED - **PORTER** connects one computer to multiple peripherals. A software code selects the peripheral.
Parallel or Serial 4 channels - $295 8 channels - $395
Buffer option 64K - $100 256K - $250

REMOTE - **TELEPATH** connects multiple computers to multiple peripherals. A selector at each computer or terminal chooses up to 4 peripherals and displays busy status.
4:4 - $495 4:8 - $795 selector - $39.

Give a Rose to your computer

ROSE ELECTRONICS (713) 933-7673
P.O. BOX 742571
HOUSTON, TX 77274
MC & VISA Accepted
Dealer Inquiries Invited
CALL US FOR ALL YOUR INTERFACE NEEDS

Inquiry 310

The **GRANDSTAND**
PRINTER STAND AND TRAY

- Folds & Stacks Automatically
- Fits ALL Popular Micro Printers
- Space Saving Operation
- Routes Cables Neatly

Grand Union
Micro Systems
P.O. Box 1880
Fallbrook, CA 92028
(619) 723-0882

Inquiry 148

NEC PRINTERS

Pinwriter P-2 . . . . $ 485
(w/Interface & Tractor)
Pinwriter P-3 . . . . $ 685
(w/Interface & Tractor)
Pinwriter P-5 . . . . $ 925
(w/Interface & Cut Sheet Guide)
ELF 360, 350 . . . . $ 380
2010/15/30/50 . . . . $ 605
3510/15/30/50 . . . . $ 960
8810/15/30/50 . . . . $1365
Optional Forms Handling Devices . . . . CALL

QUALITY PRINTERS
8415 Cement City Rd.
Brooklyn, Michigan 49230
Phone: 517-592-3749

Inquiry 299

Still Waiting?

ATTENTION BERNOULLI BOOSTERS

Go Either Way!

BOOT
from the Bernoulli Box!
from the AT Hard Disk!

FORMAT WITH DOS
PARTITION WITH FDISK
NO SLOWING
We've been shipping Bernoulli Boots that work for over a year — still waiting?

Golden Bow Systems
$95-$110
Add $3 for shipping/handling
California residents add 6% sales tax
PO Box 3039
San Diego, CA 92103
(619) 298-9349

Inquiry 147

RS-232 to RS-422A CONVERTER

For Under **$50!**

- **Allows your RS-232 Equipment to communicate with devices using RS-422A**
- **Two converters can extend RS-232 signals up to 4,000 ft.**
- **Bi-directional, uses 12 volts**

ORDER NOW! Model 422 COV $49.95
Optional power supply $14.95. Cash orders shipped postpaid. IL Res. add 6% sales tax. Visa and MasterCard accepted. Satisfaction Guaranteed. FREE fully illustrated newly revised catalog of interface & testing equipment. Phone: **815-434-0846**

B&B electronics
MANUFACTURING COMPANY
P.O. Box 1008B, OTTAWA, IL 61350

Inquiry 30

Super Disk™ Diskettes

Now...Diskettes you can swear by, not swear at.

Lucky for you, the diskette buyer, there are many diskette brands to choose from. Some brands are good, some not as good, and some you wouldn't think of trusting with even one byte of your valuable data. Sadly, some manufacturers have put their profit motive ahead of creating quality products. This has resulted in an abundance of low quality but rather expensive diskettes in the marketplace.

A NEW COMPANY WAS NEEDED AND STARTED
Fortunately, other people in the diskette industry recognized that making ultra-high quality diskettes required the *best* and newest manufacturing equipment as well as the best people to operate this equipment. Since most manufacturers seemed satisfied to give you only the everyday quality now available, an assemblage of quality conscious individuals decided to start a new company to give you a new and better diskette. They called this product the *Super Disk* diskette, and you're going to love them. Now you have a product you can swear by, not swear at.

HOW THEY MADE THE BEST DISKETTES EVEN BETTER
The management of *Super Disk* diskettes then hired all the top brains in the diskette industry to make the *Super Disk* product. Then these top bananas (sometimes called floppy freaks) created a new standard of diskette quality and reliability. To learn the "manufacturing secrets" of the top diskette makers, they've also hired the remaining "magnetic media moguls" from competitors around the world. Then all these world class, top-dollar engineers, physicists, research scientists and production experts (if they've missed you, send in your resume to *Super Disk*) were given one directive...to pool all their manufacturing know-how and create a new, better diskette.

HOW SUPER DISK DISKETTES ARE MANUFACTURED
The *Super Disk* crew then assembled the newest, totally quality monitored, automated production line in the industry. Since the manufacturing equipment at *Super Disk* is new, it's easy for *Super Disk* to consistently make better diskettes. You can always be assured of ultra-tight tolerances and superb dependability when you use *Super Disk* diskettes. If all this manufacturing mumbo-jumbo doesn't impress you, we're sure that at least one of these other benefits from using *Super Disk* diskettes will:

1. **TOTAL SURFACE TESTING** - For maximum reliability, and to lessen the likelihood of disk errors, all diskettes must be totally surface tested. At *Super Disk*, each diskette is 100% surface tested. *Super Disk* is so picky in their testing, they even test the tracks that are in between the regular tracks.
2. **COMPLETE LINE OF PRODUCTS** - For a diskette to be useful to you and your computer, it must be compatable physically. *Super Disk* has an entire line of 5¼-inch diskettes for your computer.
3. **SPECIALLY LUBRICATED DISK** - *Super Disk* uses a special oxide lubricant which is added to the base media in the production of their diskettes. This gives you a better disk drive head to media contact and longer head and disk life.
4. **HIGH TEMPERATURE/LOW-MARRING JACKET** - A unique high temperature and low-marring vinyl jacket allows use of their product where other diskettes won't work. This special jacket is more rigid than other diskettes and helps eliminate dust on the jacket.
5. **REINFORCED HUB RINGS** - Standard on all *Super Disk* mini-disks, to strengthen the center hub hole. This increases the life of the disk to save you money and increase overall diskette reliability.
6. **DISK DURABILITY** - *Super Disk* diskettes will beat all industry standards for reliability since they will give you more than 75% of the original signal amplitude remaining even after an average (Weibul B-50) of 30 million passes. They are compatible with all industry specifications as established by ANSI, ECMA, ISO, IBM and JIS.
7. **CUSTOMER ORIENTED PACKAGING** - All *Super Disk* disks are packaged 10 disks to a carton and 10 cartons to a case. The economy bulk pack is packaged 100 disks to a case without envelopes or labels.
8. **LIFETIME WARRANTY** - If all else fails, remember, all disks made by *Super Disk* Inc., have a lifetime warranty. If any *Super Disk* diskette fails to meet factory specifications, *Super Disk* Inc. will replace them under the terms of the *Super Disk* warranty.
9. **SUPERB VALUE** - With Super Disk's automated production line, high-quality, error-free disks are yours without the high cost.

Order toll free 800-USA-DISK

Inquiry 65

NOW...NAME BRAND QUALITY AT SUPER CE PRICES
Now, you can buy Super Disk brand diskettes directly from Communications Electronics at prices less than "unbranded" generic diskettes. Your data is valuable, so why take chances using a diskette that could be so unreliable that the manufacturer refuses to put their name on it. To save you even more, we also offer Super Disk bulk product where 100 diskettes are packed in the same box without envelopes or labels. Since we save packaging costs, these savings are passed on to you. Diskette envelopes are also available from us. These super strong and tear resistant envelopes are only 8¢ each. Use order # EV-5 and specify the quantity of 5¼" diskette envelopes that you want.

39¢ per disk Quantity One

Our diskettes are packed 10 disks to a carton and 10 cartons to a case. The economy bulk pack is packaged 100 disks to a case without envelopes or labels. For best value, you should order in increments of 100 diskettes. Almost all diskettes are immediately available from Super Disk. With our efficient warehouse facilities, your order is normally shipped in less than a day.

SAVE ON SUPER DISK™ DISKETTES Product Description	Part #	Super Disk price per disc ($)
5¼" SSSD Soft Sector w/Hub Ring	6431-BA	0.54
5¼" Same as above, but bulk pack w/o envelope	6437-BA	0.39
5¼" SSDD Soft Sector w/Hub Ring	6481-BA	0.58
5¼" Same as above, but bulk pack w/o envelope	6487-BA	0.43
5¼" DSDD Soft Sector w/Hub Ring	6491-BA	0.64
5¼" Same as above, but bulk pack w/o envelope	6497-BA	0.49
5¼" DSQD Soft Sector w/Hub Ring (96 TPI)	6501-BA	1.49

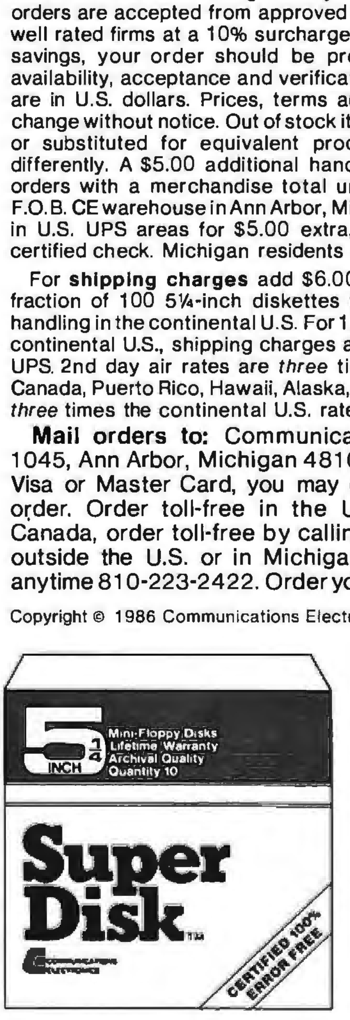
SSSD = Single Sided Single Density; SSDD = Single Sided Double Density; DSDD = Double Sided Double Density; DSQD = Double Sided Quad Density. TPI = Tracks per inch.

BUY YOUR DISKETTES FROM CE WITH CONFIDENCE
To get the fastest delivery of your diskettes, phone your order directly to our order desk and charge it to your credit card. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. For maximum savings, your order should be prepaid. All sales are subject to availability, acceptance and verification. All sales are final. All prices are in U.S. dollars. Prices, terms and specifications are subject to change without notice. Out of stock items may be placed on backorder or substituted for equivalent product unless we are instructed differently. A $5.00 additional handling fee will be charged for all orders with a merchandise total under $50.00. All shipments are F.O.B. CE warehouse in Ann Arbor, Michigan. COD terms are available, in U.S. UPS areas for $5.00 extra, and are payable with cash or certified check. Michigan residents add 4% sales tax.

For **shipping charges** add $6.00 per 100 diskettes and/or any fraction of 100 5¼-inch diskettes for U.P.S. ground shipping and handling in the continental U.S. For 1,000 or more disks shipped to the continental U.S., shipping charges are $3.00 per hundred diskettes. UPS 2nd day air rates are *three* times continental U.S. rates. For Canada, Puerto Rico, Hawaii, Alaska, or APO/FPO delivery, shipping is *three* times the continental U.S. rate.

Mail orders to: Communications Electronics Inc., Box 1045, Ann Arbor, Michigan 48106-1045 U.S.A. If you have a Visa or Master Card, you may call and place a credit card order. Order toll-free in the U.S. Dial 800-USA-DISK. In Canada, order toll-free by calling 800-CA1-DISK. If you are outside the U.S. or in Michigan dial 313-973-8888. Telex anytime 810-223-2422. Order your Super Disk diskettes now.

 Ad #102585-BA



Now 39¢ a disk

Inquiry 52

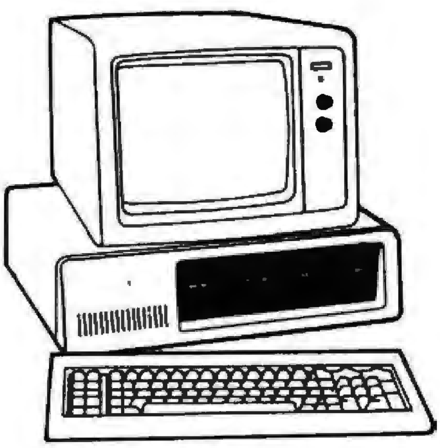
THE DIVERSIFIED GROUP

The DG PC Series computers offers the maximum alternatives in the PC XT compatible market. Alternatives which exceed current PC XT configurations.

Standard features on all DG PC Series computers include:

- Full compatibility with IBM PC XT® machines
- 640K bytes of parity checked memory, 8 slots
- 135 watt power supply
- Keytronics 5151 compatible keyboard
- 1 Full Year Warranty on Parts and Labor.

SYSTEMS



DG-PC

BASE UNIT	SYSTEM	XT
System Unit	System Unit	System Unit
640K on Board	640K on Board	640K on Board
Two 360K Drives	Two 360K Drives	One 360K Drive
w/Controller	135 watt pwr sply	10Meg w/135 watt
135 Watt	Hi-Res Green Mon	Monochrome Mon
Power Supply	w/Interface Card	Monochrome Card
$699.95	$847.95	$1195.95

All DG Systems are fully IBM Compatible w/1 Year Warranty

COMPAQ

DESKPRO		*286*	
Model I	$1724.95	Deskpro 286	$3295.95
Model II	2049.95	Portable 286	3295.95
Model III	3549.95		

PORTABLE
Two 360K Drives,
256K
$1987.95

PORTABLE + DG
One 360K Drive, 256K
10 Meg Hard Disk
$2389.95

Some Compaqs have been Enhanced by The Diversified Group
All Come with 1 Year Warranty through The Diversified Group

IBM

IBM PC

One 360K Dr, 256K	$1489.95
Two 360K Dr, 256K	1592.95

IBM XT
One 360K Drive & 10 Meg Drive
$2231.95

IBM AT

Unenhanced	$3395.95
Enhanced DG	3995.95

IBM SYSTEM
PC-XT
with 10 Meg
One 360K Drive,
Hercules Color
Compatible Card
Hi-Res Green Monitor
Dos 2.1

$2492.95

TOLL FREE ORDER LINE
(800) 523-1041
INSIDE CALIFORNIA
(213) 675-0717

MAIL ORDERS TO:
8726 S. Sepulveda, Suite A132, Los Angeles, CA 90045
WAREHOUSE: 4732 Rosecrans, Hawthorne, CA 90250

IBM PC-XT is a registered Trademark of International Business Machines

VISA MasterCard

TERMS:
Visa, MC, Co. Check, Cashiers Check
Wire Transfer, P.O.'s Accepted
Minimum Shipping $4.50. All Orders Insured
No Surcharge on Credit Cards

They Say It — WE DO IT!
BEAT ALL COMPETITOR'S PRICES
Call 523-1041

DISK DRIVES

SIEMANS 5¼"
• Tandon Compatible • 360K
Double Side/Double Density
2 for **$137.00**

HARD DISK DRIVES
All Hard Disks Come With: 1 Yr. Warranty, Cables, Controller and are Formatted

	QTY. 1	QTY. 5
10 Megabyte w/Controller	$389.95	$379.95
20 Megabyte w/Controller	489.95	469.95
] Megabyte w/Controller	789.95	779.95

For 1/2 Height Drives add $50
Most Hard Disks are Shugart, Microsci, CMI, Rodine
Call for Others

TAPE BACK-UP BY IRWIN

10 Meg Internal ½ Height, Low Power	$495.95	$485.95
10 Meg External Back-up	635.95	615.95

5¼" DISK DRIVES
For IBM COMPATIBLES

Teac 55B	$ 84.95	$ 81.95
Epson	89.95	86.95
IBM "Logo" Drives	119.95	109.95
Tandon TM100-2	89.95	87.95
Siemans (Tandon Compatible)	69.95	69.95

DISK DRIVE CONTROLLERS

IBM (Original) Controller	$ 99.95	—
IBM Compatible Controler	59.95	—
Western Digital Hard Disk Cont.	179.95	—
Adaptec Hard Disk Cont.	199.95	—
DG Hard Disk Cont.	139.95	—

EXPANSION CARDS

AST ADVANTAGE
• Comes with 1.5 Meg
• Parallel Port • Serial Port
$497.95

AST SixPac+ w/0K 2 Yr War	$219.95
MF-100 SixPac Compatible plus Gameport Par., Ser., Game, 0K-384K, Software Clock Calendar, 2 Year Warranty	$119.95
AST Advantage w/1.5 Megabyte of Memory Parallel & Serial Ports	$529.95

MODEMS

HAYES
1200B w/Smartcom II $356.95
1200 External $385.95 2400 External $599.95

PROMETHEUS
Pro 1200 Ex. $289.95 Pro 1200B Int. $309.95

PRINTERS

OKIDATA ML193P
• 160 cps • 15" Carriage
• w/Correspondence Quality • Similar to Epson FX100
$539.95

LETTER QUALITY — DOT MATRIX

OKIDATA

ML182P, 120 cps, Parallel	$229.95
ML182S, 120 cps, Serial	309.95
ML192P, 160 cps, w/NLQ	339.95
ML192S, 160 cps, Serial	439.95
ML193P, 15" Carriage, 160 cps, w/NLQ	539.95
ML193S, 15" Carriage, 160 cps, Serial	639.95
ML84P, 15" Carriage, 200 cps	749.95
ML84S, 15" Carriage, 200 cps, Serial	859.95

EPSON — Call for Availability

We also carry Juki, Dynax, Toshiba, Star, Panasonic, NEC, Brother
We Will Also Beat All Competitors Prices on These Too.

VIDEO CARDS

HERCULES COMPATIBLE

Color Graphics w/Parallel Port 2 Yr. War.	$104.95
Monochrome Graphics w/Par Port	119.95

EVEREX

The Edge Color/Mono	$289.95
Graphics Edge	289.95

IBM

IBM Monochrome w/Parallel Port	$219.95
IBM Color Card w/Parallel Port	214.95

PARADISE
Modular Graphics Card $259.95

SIGMA
Color 400 Board $539.95

MEMORY

64K SETS*
All Upgrades Carry a 2 Year Warranty
Nine 4164, 200ns $7.95
50 Sets $6.54 ea. 150ns Sets $8.00
*Due to Semi Conductor Market Call for Current Prices

128K SETS
Nine, 4128 $39.95
25 Sets 32.95 ea.

256K SETS
9, 41256, 200ns $28.95
25 Sets 27.95 ea.

80287
5MHZ for AT & Deskpro $189.95

8087-3
5MHZ Math Co-Processor for IBMPC
$109.95

8087-2
8MHZ Math Co-Processor for AT&T, Compaq, Deskpro
$124.95

MONITORS

AMDEK COLOR COMPOSITE
• Works w/IBM
Apple and Commodore
$159.95

AMDEK

300G Composite Green	$124.95
300A Composite Amber	134.95
310A Monochrome Amber	159.95

TAXAN
Call For Lowest Prices

SAKATA

SC-100 Color Composite 13" 280x300	$179.95
SC-150 Color Composite or RGB 640 x 200 w/Text Switch	379.95
SC-200, 640x240 Dot Pitch .39	399.95
SC-300P, 800x400 Dot Pitch .31	599.95

PRINCETON GRAPHICS

HX12, 640x200 Dot Pitch .31	$442.95
HX12E, 640x350 Dot Pitch .28	517.95
SR12, 640x400 Dot Pitch .31	573.95
SR12P, 640x480 Dot Pitch .26	787.95
HX-9, 640x350 Dot Pitch .28	432.95
MAX12E, 720x350	169.95

DIVERSIFIED GROUP

100 Hi-Res Green 18MHZ Composit 80 col.	$ 79.95
100 Hi-Res Amber 18MHZ Compos. 80 col.	89.95
200 Hi-Res Green 20MHZ Mono. 80 col.	89.95
200 Hi-Res Amber 20MHZ Mono. 80 col.	99.95

DG Monitors come with 1 Year Warranty

IBM ACCESSORIES

5¼" POLAROID DISKS
• 10 Diskettes
• Reinforced Hub • w/Free Library Case
$12.95

A-B SWITCH BOXES
Parallel 2 pos. $54.95 Serial 2 pos. $64.95

DISKETTES
Polaroid Dbl/Dbl 5 Year Warranty
1 bx. $12.95 10 bxs. $11.95 100 bxs. $9.95

KEYTRONICS KEYBOARDS
5153 Touch Pad $289.95
5150 Standard $169.95 5151 Deluxe $179.95

BELKIN CABLES
6 foot Shielded
IBMPC to Par. $14.95 IBMPC to Modem $16.95

THE DIVERSIFIED GROUP

TOLL FREE ORDER LINE
(800) 523-1041
INSIDE CALIFORNIA
(213) 675-0717

Uniforth™

ANNOUNCING OUR

NEW PRODUCTS

Sampler ($35) and/or

Professional Systems (from $175) for..

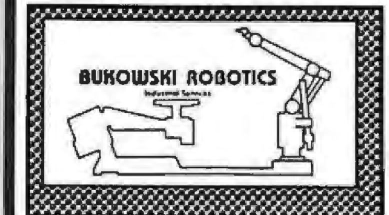
Apple ProDos
Amiga
Micro VAX
Macintosh
IBM PC/AT
DEC Falcon

UNIFORTH is a *full-featured, floating-point,* FORTH-83 Standard language available for most micro and mini computers

Call or write for our *free catalog* or use Bulletin Board (614-459-7736, 300/1200 Baud) formoredetailed information.

UNIFIED SOFTWARE SYSTEMS
P O Box 21294, Columbus, OH 43221-0294
(614) 459-7735

Inquiry 367



APPLE II™ I/O

ROBOTIC CONTROLLER

WE KNEW THE TRUE ENTHUSIAST WOULD FIND THIS ARTICLE WAY BACK HERE IN THE BACK OF BYTE
THE BUKOWSKI ROBOTICS VIP CARD IS A LOW COST APPLE COMPATIBLE ROBOTICS CONTROLLER CARD THAT MAY BE USED STAND ALONE, OR IN AN APPLE SLOT AS AN INTELLIGENT PERIPHERAL CARD THE CARD FEATURES AN ONBOARD 65C02 MICROPROCESSOR, UP TO 48 I/O LINES, 2 TIMERS, AND 8K NON VOLATILE RAM SHIPPED WITH TONS OF SOFTWARE AND SUPPORT $129 00
BUKOWSKI ROBOTICS
1555 W UNIVERSITY #105
TEMPE AZ 85281 (602) 966-6230

Inquiry 426

Software for **Engineers**

Electronic Circuit Analysis

- Nonlinear transient, DC, AC analysis
- Worst Case, Monte-Carlo
- Frequency, time dependent parts

$450.

Logic Simulation System

- Full delay analysis (min, max, typical, load dependent)
- Ability to save simulation results

$395.

Both have:

- Built in editor, fully interactive
- Macros (unlimited)
- Large circuits

For MS-DOS, 192k minimum

Tatum Labs
33 Main Street
Newtown, CT 06470
(203) 426-2184

Inquiry 427

VT100 $150*

*** plus your**
PC, jr, XT, AT or compatible

ZSTEMpc-VT100 Smart Terminal Emulator
132-col. by windowing - no addit. hardware
Double High Double Wide Characters
Full VT100 line graphics. Smooth scrolling
2-way file transfers incl. XMODEM and KERMIT
Full keyboard softkeys/MACROS
Speeds to 38.4KB. High Throughput
Color/graphics, monochrome & EGA support
International Font Support • DOS Access
ZSTEMpc-VT100 $150. ZSTEMpc-D200 $125.
4010/4014 Option $99
30 day money back guarantee. MC/VISA.

KEA SYSTEMS LTD.
#412 - 2150 W. Broadway
Vancouver, B.C. CANADA V6K 4L9
Support (604) 732-7411
TELEX 04-352858 VCR
Order Toll Free (800) 663-8702

Zstem by KEA SYSTEMS

Inquiry 393

PC EXPANSIONS

AST SixPakPlus (64k)	$229
SixPakPlus (384k)	$259
MegaPlus (64k)	$269
Advantage (128k)	$409
Advantage (1.5M)	$569
I/O Plus	$129
PCnet - starter kit	$809
Quadboard (64k)	$193
Quadboard (384k)	$229
Quadmeg-AT (128k	$319
Quadmeg-AT (2M)	$529
Quadport-AT	$105
HERCULES graphics board	$319
Color Cardwith PP	$159
HAYES Modems: 2400	$call
Smartmodem 1200	$409
Smartmodem 1200B	$379
Set of 9 chips (64k	$6
256k chips (each)	$3
8087 chip	$119
Maynard Disk Controller	$100
Sandstar Series	$call
Internal Hard Disks from	$609
MaynStream tape backup from	$979
Qume 142A	$99
Teac FD55B	$99
Tandon TM100-2	$109
CDC 9409	$119
Verbatim Datalife disks (10)	$20

VLM Computer Electronics
10 Park Place • Morristown, NJ 07960
(201) 267-3268 Visa. MC. Check or COD.

Serial ◀▮▮▮▮▮▮▮▮▶ ***Parallel***

Convert What You Have To What You Want!

- RS232 Serial
- 8 Baud Rates
- Latched Outputs
- Centronics Parallel
- Handshake Signals
- Compact 3¼ × 4⅞ × 1½

No longer will your peripheral choices be limited by the type of port you have available! Our new High Performance 700 Series Converters provide the missing link. Based on the latest in CMOS technology, these units feature full baud rate selection to 19.2K, with handshake signals to maximize transfer efficiency. Detailed documentation allows simplified installation. Order the Model 770 (SerPar) or Model 775 (ParSer) Today!

Buffer Products Coming Soon!

Tigertronics
2734-C Johnson Dr.
Post Office Box 3717
Ventura, California 93006

only $89.95

CALL (805) 658-7466 or 658-7467
For FAST Delivery

Inquiry 353

DATA ACQUISITION
and control for ANY computer

The Model 1232 communicates via RS-232, and has 8 analog inputs (±4 VDC; 12 bits), 8 digital inputs and outputs, and a 2000 point buffer. Suitable for field data logging or lab use, the 1232 costs only $690. The 8-bit system (0–5 VDC) is $490. Detailed manual, $6. Phone our applications engineer at 617-237-5514 or write:

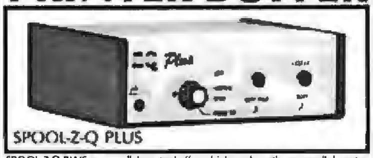
★★ STARBUCK DATA COMPANY ★★

2 Mica Lane, Wellesley, MA 02181

Inquiry 337

TIME SAVING — MONEY SAVING

PRINTER BUFFER



SPOOL-Z-Q PLUS

SPOOL-Z-Q PLUS is a parallel printer buffer which works with any parallel printer and frees up your computer for productive use while printing. Very high capacity (128K to 512K) and full time space and null character compression means that Spool-Z-Q Plus is ready to take on the really big jobs. A special Pause-on-Formfeed feature allows printing single sheets from the buffer. Spool-Z-Q Plus also has Copy, Clear, and Self-Test functions built in. Supplied complete with UL/CSA listed power supply, the Spool-Z-Q Plus buffer is easy to install and use. All models are user expandable to 512K at any time by just plugging in standard 256K RAM chips. Spool-Z-Q Plus is the professional's choice, for size, features, and price.

(Without Cable)	**128K-$279**	**256K-$309**	**512K-$369**
(Including Cable)	**128K-$309**	**256K-$339**	**512K-$399**

SPOOL-Z-Q BLUE PLUG IN PRINTER BUFFER FOR THE IBM PC and compatible computers IS A GENUINE HARDWARE PRINTER BUFFER, NOT A SPOOLER. Parallel only and Serial/Parallel models available. Works with any software and does not use any of the computer's memory. Sizes from 256K to 1,024K are available. Spool-Z-Q Blue replaces the parallel printer card in the PC (May be LPT1, 2, or 3). Many, many advanced features. Call or write for full details. Prices start at $319 (Parallel only) and $399 (Serial capable).

Available from dealers or direct from us. We accept M/C, VISA, AMEX or COD orders. No charge for shipping or COD. 15 day trial period (no-hassle refund policy) on all products. CA residents — 6% tax.

DEALER INQUIRIES INVITED.
O.E.M.s — We can modify our buffers to meet your special requirements.

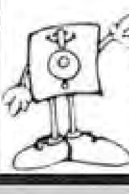
jwb Electronics
1601 Fulton Ave.,Suite 10A
Sacramento, CA 95825
(916) 483-0709

Inquiry 189

Maxell Floppy Disks

The Mini-Disks with maximum quality.

Dealer inquiries invited. C.O.D's accepted. Call FREE (800) 235-4137.



PACIFIC EXCHANGES
100 Foothill Blvd.. San Luis
San Luis Obispo. CA 93401.
In Cal. call (800) 592-5935 or (805)543-1037.

Inquiry 272

TAKE THE D & D CHALLENGE! CAN YOU FIND A BETTER PRICE?

SPECIAL #1
CORONA PORTABLE
• 256K • 2 Drives
• Monitor • Keyboard • DOS
$1195

All Sales Are Warranteed for 90 Days, Parts & Labor
WE SERVICE WHAT WE SELL!
MAIL ORDER AND SAVE
ORDER TOLL FREE (800) 621-0849 ext. 446

SPECIAL #2
IBM XT 256K
• One 360K Drive • One 20 MG Hard Disk • Keyboard • Controllers
$2295

SYSTEMS

IBM
PC 256K, 1 Drive	$1495
PC 256K, 2 Drives	1529
XT 256K, 1 Drive	1879
XT 256K, 1 Drive 1-10 MG	2229

AT & T
Call for best price

COMPAQ
Portable, 2 Drives, 256K	$1875

Call on Desk Pro's

CORONA
Portable	$1195
Desk Top, 2 Drives, 256K w/monitor	1399

ZENITH
Call for best price

MODEMS

HAYES
Micromodem IIE	$149
300	149
1200	389
1200B IBM Internal	359
2400 External	639

PROMETHEUS
Promodem 1200	$279
Promodem 1200A	289
Promodem 1200B	269
Promodem 1200MAC	Call

ANCHOR
Express	$219

PRINTERS

EPSON
Call for Best Pricing

OKIDATA
182, 120 cps	$218
183, 120 cps	418
192, 160 cps, IBM	348
193, 160 cps, IBM	498
84, 200 cps, IBM	658
OKI-MATE 20, Color	118

TOSHIBA
P1351	Call
P1340	$ 519
P351	1029

STARMICRONICS
SG10/15	$219/389
SD10/15	355/469
SR10/15	Call

CITIZEN
MSP-10	$249
MSP-15	369
MSP-20	399
MSP-25	539

DISKETTES
Call for quantity discounts

PRECISION COPY
SS 100 (Box of 10)	$12
DS 100 (Box of 10	15

DYSAN
SS 100 (Box of 10	$30
DS 100 (Box of 10)	34

MAJOR BRAND DS/DD
Bulk Disks as low as ....69¢ ea.

IBM EXTRAS
We carry almost everything for PC, AT or XT
Name Brands or Generic

AST RESEARCH
PC Net II	$519
SixPak+, 64K w/Side Kick	209
Reach wCrosstalk	329
Preview Mono Card	239
Advantage w128K	399

D & D MEMORY CARD
MF-100+, 64K same as SixPak+	$119

HERCULES
Color Card w/Printer Port	$149
Mono Graphics Card	305

GOODIES
IBM Printer Cable	$15
64K Ram Set of Nine Chips	8
256K Ram Set of Nine Chips	29
Power Supply 135 Watts	79
8087 CoProcessor	Call for Best Price
DOS 2.1	55
DOS 3.1	64

MONITORS

PRINCETON GRAPHICS
Max 12E	$159
HX-9	Call
HX-12	429
SR-12	569
Doubler Card	179

THOMSON
Color Monitor	$329
Monochrome Monitor	169

AMDEK
310A	$148
600	419
722	525

DRIVES

IBM COMPATIBLE
Teac 55B	$90
Mitsubishi 4851	89
Tandon TM 100-2	89

In quantities of 2 or more

TEAC
55B, 360K	$ 94
55GF, 1.2MG for AT	149

WELTEC
AT Compatible 360K	$109

IRWIN
10 MG Tape Backup	$479

100% APPLE COMPATIBLE 5¼"
525A for IIe and II+	$109
525C for IIc	119
350M for Mac	Call

BUILD YOUR OWN P.C.
640K Mother Board w/8 Slots	$179
Flip Top Case w/speaker	59
Disk Controller	49
Color Card	99
Monochrome Card	129
5151 Keyboard	99
Dual Drive Kit	189
135 Watt Power Supply	79

WE OFFER VOLUME DISCOUNTS! MAKE THAT CALL (800) 621-0849 ext. 446

SPECIAL #3
IBM PC
• Two ½ Ht 360K Drives
• 256K • 10 MG Hard Disk Drive
• 120 Day Warranty
$1929

SPECIAL #4
MULTIFUNC. CARD FOR IBM
• Serial and Parallel Ports
• Clock/Gameport • Ram disk/ Printer spool, Software • 1 yr. War.
w/384K only **$139**

SPECIAL #5
INTERNAL HARD DISK FOR IBM
• Seagate w/IBM Controller
10 Meg **$419** 20 Meg **$519**

SPECIAL #6
IBM PC/XT COMPATIBLE
• Two 360K ½ Ht Drives
• 256K • 8 Slots • 135 Watts
• 120 Day Warranty
$569

d&d Discount Computers
SELLING TO YOU SINCE 1978

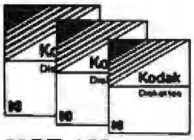
MAIL ORDER:
13324 HAWTHORNE BLVD., SUITE 201
HAWTHORNE, CA 90250
ORDER DESK:
Inside California **(213) 970-0206**
Outside California **(800) 621-0849 x446**
Hours: Monday—Friday 8 am to 6 pm
Open Saturdays

WE CARRY TOO MANY ITEMS TO LIST, PLEASE CALL FOR A QUOTE ON ANY ITEM.

VISA MasterCard

No Surcharge for Credit Cards
Terms: All merchandise new. We accept MC, Visa, Wire Transfer, C.O.D. (call), Certified Check, P.O.'s from qualified firms. Shipping: minimum $4.00 first 5 pounds. Tax: California residents only add 6½% salestax. All returns subject to 15% restock fee. Prices Subject to Change.

[redacted]



KODAK.
THE NAME
SAYS IT ALL.

Take a Century of experience in coatin(products like photo film, add two brand new state-of-the-art plants for manufactur ing diskettes and you have something new KODAK diskettes, a taste of the future.

Kodak spends more than three millior dollars a day in research and development They have more than 120,000 employee: and manufacture and market more thai 30,000 products.

But George Eastman said it best:

George Eastman, the founder of Eastmai Kodak and the man who made it possibl(for everyone to have a family album ex pressed Kodak's philosophy almost a cen tury ago: make "good goods!"

That's why we're so pleased to ad(KODAK diskettes to our line.

Great quality, great value!

For those of you who want a "brand name" diskette with top-of-the-line quality...without paying through the nose, the choice is simple: KODAK.

Of course, there's a LIFETIME WARRANTY!

Except as noted, all KODAK diskettes are packed in boxes of ten with Tyvec sleeves, user ID labels and write-protect tabs. Bulk packed diskettes are labelled as KODAK diskettes and are packed in 4 bundles of 25 diskettes with Tyvec sleeves, user ID labels and write-protect tabs.

	Qty. 20-40	Qty. 60+	Qty. 100
5.25" SSDD	$1.11 ea.	$1.01 ea.	
5.25" DSDD	$1.46 ea.	$1.33 ea.	
5.25" DSDD-HD	$3.47 ea.	$3.15 ea.	

3.5" KODAK DISKETTES

3.50" SSDD	$2.06 ea.	$1.87 ea.
3.50" DSDD	$2.73 ea.	$2.48 ea.

KODAK LABELLED BULK DISKETTES

5.25" SSDD in package of 100	$ .93
5.25" DSDD in package of 100	$1.24

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-714C
HOURS: 8AM-5PM Central Time, Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICI ON THE SAME PRODUCTS AND QUANTITIES!
DISK WORLD!, Inc.
629 Green Bay Road • Wilmette, Illinois 60091

[redacted]

FANTASTIC LOW PRICES ON BASF QUALIMETRIC DISKETTES!
LIFETIME WARRANTY!

ɔuy in bulk and save. 150 to the carton with envelopes, write-protect tabs and user ID labels. Boxed product is the same, excepi in cardboard boxes of 10.

	Qty. 50	Qty. 150
5.25" SSDD	.83 ea.	.80 ε
5.25" DSDD	.94 ea.	.92 ea.
5.25" DSDD-HD	2.13 ea.	N/A
5.25" SSDD-96TPI	.94 ea.	N/A
5.25" DSDD-96TPI	1.06 ea.	N/A
3.50 SSDD-135TPI	1.84 ea.	1.68 ea.
3.50 DSDD-135TPI	2.40 ea.	2.28 ea.

NOTE: 3.50" diskettes in Quantity 50 are packed in plastic library cases. That's why they seem to be a better buy. But there are only 5 diskettes to a case...so the bulk diskettes are really a better deal, unless you like expensive little library cases.

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-7140
HOURS: 8AM-6PM Central Time, Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES!

[redacted]

[redacted]

Shipping: 5¼" & 3.5" DISKETTES—Add $3.00 per each 100 or fewer diskettes. **Other Items:** Add shipping charges as shown in addition to other shipping charges. **Payment:** VISA and MASTERCARD accepted. **COD Orders:** Add additional $5.00Special Handling charge. **APO, FPO, AK, HI & PR Orders:** Include shipping charges as shown and additional 5% of total order amount to cover PAL and insurance. **Taxes:** Illinois residents only, add 7% sales tax.

Prices subject to change without notice.
This ad supercedes all other ads.
Not responsible for typographical errors.
MINIMUM TOTAL ORDER: $35.00

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-7140
HOURS: 8AM-6PM Central Time Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES!
DISK WORLD!, Inc.
629 Green Bay Road • Wilmette, Illinois 6009

[redacted]

[redacted]

60¢ ea. ← 5¼" SSDD Qty. 50 — 5¼" DSDD → 74¢ ea. Qty. 50

You've used these diskettes hundreds of times...as copy-protected originals on some of the most popular software packages. They're packed in poly-bags of 25 with Tyvek sleeves, reinforced hubs, user identification labels and write-protect tabs.

[redacted]

SOFT SECTOR ONLY! Sold in multiples of 50 only.

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-7140
HOURS: 8 AM-6PM Central Time, Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES!
DISK WORLD!, Inc.
629 Green Bay Road • Wilmette, Illinois 60091

[redacted]

Now, the lowest prices ever on 3M diskettes.
LIFETIME WARRANTY!

All 3M diskettes are factory packed in boxes of 10 and come with Tyvec sleeves, user ID labels and write-protect tabs.

		Qty. 20-40	Qty. 50+
5.25"	SSDD	$1.20 ea.	$1.09 ea.
5.25"	DSDD	$1.70 ea.	$1.54 ea.
5.25"	SSDD-96TPI	$2.18 ea.	$1.98 ea.
5.25"	DSDD	$2.73 ea.	$2.48 ea.
5.25"	DSDD-HD	$3.45 ea.	$3.14 ea.
3.50"	SSDD	$2.18 ea.	$1.98 ea.
3.50"	DSDD	$3.09 ea.	$2.81 ea.

3M DATA CARTRIDGES
(Sold 10 to a carton only.)
(Add $5.00 shipping charges for cartridges!)

DC1000	$12.43 ea
DC300XLP	$19.09 ea
DC600A	$20.30 ea

[redacted]

[redacted]

at extraordinary prices!

Brand new ribbons, manufactured to Original Equipment Manufacturer's specifications, in housings. (Not re-inked or spools only.)

LIFETIME WARRANTY!

Epson MX-70/80 .. $2.70 ea. + 25¢ Shpng.
Epson MX-100 .... $4.08 ea. + 25¢ Shpng.
Okidata Micro83 .. $1.37 ea. + 25¢ Shpng.
Okidata Micro84 .. $2.98 ea. + 25¢ Shpng.

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-7140
HOURS: 8AM-6PM Central Time, Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES!
DISK WORLD!, Inc.
ɔ29 Green Bay Road • Wilmette, Illinois 6009¹

[redacted]

[redacted]

IN DISKETTE STORAGE

Every once in a while, someone takes th simple and makes it elegant! This unit hold: 50 5¼" diskettes, has grooves for eas stacking, inside nipples to keep diskettes from slipping and severa other features. W like it! **$9.69** ea. + $2.0C Shpng

DISKETTE 70 STORAGE: STILL A GREAT BUY
Dust-free storage for 70 5¼" diskettes S x dividers included. An excellent value. **$9.95** + $3.0C Shpng

ISK CADDIES
The original flip-up holder for 10 5¼ skettes. Beige or grey only. **$1.65** e + 20¢ Shpng

FOR ORDERS ONLY: 1-800-621-6827 (In Illinois: 1-312-256-7140)
INFORMATION & INQUIRIES: 1-312-256-7140
HOURS: 8AM-6PM Central Time, Monday-Friday
WE WILL BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES!
DISK WORLD!, Inc.
ɔ29 Green Bay Road • Wilmette, Illinois 60091

[redacted]

What the world really needs is a 69 cent Double Sided, Double Density Diskette with a LIFETIME WARRANTY!

And DISK WORLD! has it.

Introducing Super Star Diskettes: the high quality diskette with the lowest price and the best LIFETIME WARRANTY!

In the course of selling more than a million diskettes every month, we've learned something: higher prices don't necessarily mean higher quality.

In fact, we've found that a good diskette manufacturer simply manufactures a good diskette...no matter what they charge for it. (By way of example, consider that none of the brands that we carry has a return rate of greater than 1/1,000th of 1 percent!)

In other words, when people buy a more expensive diskette, they aren't necessarily buying higher quality.

The extra money might be going toward flashier advertising, snazzier packaging or simply higher profits.

But the extra money in a higher price isn't buying better quality.

All of the good manufacturers put out a good diskette. Period.

How to cut diskette prices ...without cutting quality.

Now this discovery posed a dilemma: how to cut the price of diskettes without lowering the quality.

There are about 85 companies claiming to be "diskette" manufacturers.

Trouble is, most of them aren't manufacturers.

Rather they are fabricators or marketers, taking other company's components, possibly doing one or more steps of the processing themselves and pasting their labels on the finished product.

The new IBM diskettes, for example, are one of these. So are IBM 5¼" diskettes. Same for DYSAN, Polaroid and many, many other familiar diskette brand names. Each of these diskettes is manufactured in whole or in part by another company!

So, we decided to act just like the big guys. That's how we would cut diskette prices...without lowering the quality.

We would go out and find smaller companies to manufacture a diskette to our specifications...specifications which are higher than most...and simply create our own "name brand" diskette.

Name brand diskettes that offered high quality at low prices.

Super Star diskettes are sold in multiples of 50 only. Diskettes are shipped with white Tyvec sleeves, reinforced hubs, user ID labels and write-protect tabs.

Boy, did we get lucky. Our Super Star Diskettes are the same ones you've been using for years...without knowing it.

In our search for the low priced, high quality diskette of our dreams, we found something even more interesting.

We found that there are several manufacturers who don't give a hoot about the consumer market for their diskettes. They don't spend millions of dollars in advertising trying to get you, the computer user, to use their diskettes.

Instead, they concentrate their efforts on turning out the highest quality diskettes they can...because they sell them to the software publishers, computer manufacturers and other folks who (in turn) put their name on them...and sell them for much higher prices to you!

After all, when a software publisher or computer manufacturer or diskette marketer puts their name on a diskette they want it to work time after time, everytime. (Especially software publishers who have the nasty habit of copy-protecting their originals!)

Super Star Diskettes. You already know how good they are. Now you can buy them...cheap.

Well, that's the story.

Super Star diskettes don't roll off the boat from Pago-Pago or emerge from a basement plant just east of Nowhere.

Super Star diskettes have been around for years...and you've used them for years as copy-protected software originals, unprotected originals. Sometimes, depending on which computer you own, the system master may have been on a Super Star diskette. And maybe more than once, you've bought a box or two or more of Super Star diskettes without knowing it. They just had some "big" company's name on them.

Super Star Diskettes are good. So good that a lot of major software publishers, computer manufacturers and other diskette marketers buy them in the tens or hundreds of thousands.

We buy them in the millions.

And than we sell them to you.

Cheap.

When every little bit counts, it's Super Star Diskettes.

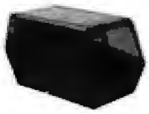
You've used them a hundred times...under different names.

Now, you can buy the real McCoy, the same diskette that major software publishers, computer manufacturers and diskette marketers buy...and call their own.

We simply charge less.

Store 75 diskettes for

Yep, that's right: order 50 Super Star diskettes, add $5.95 and we'll include a Media Products DISK MINDER II...a well made unit that we're impressed with.



It holds 75 diskettes

Please be careful!

A lot of the "no-name" diskettes flooding the market at prices of less than $1.00 are what we in the industry call "floor sweepings."

In other words, they're garbage...stuff that six months ago, no self-respecting manufacturer would have sold.

But times got tough and some people's scruples got a little lost in desperation...and so a lot of computer users are getting some really bad disks...and that isn't bargain at all.

So, when the price seems too good to be ue...like 39 cents, be ca

HOURS:
Human: 8AM-6PM Central Time, Monday through Friday

ORDERS ONLY:
1-800-621-6827
(In Illinois: 1-312-256-7140)

INQUIRIES:
1-312-256-7140

FOR FASTEST SERVICE, USE NO-COST MCI MAIL: Our address is DISKORDER. It's a FREE MCI MAIL letter. No charge to you. (Situation permitting, we'll ship these orders in 24 hours or less.)

SHIPPING: 5¼" & 3½" DISKETTES—Add $3.00 per each 100 or fewer diskettes. **OTHER ITEMS:** Add shipping charges as shown in addition to other shipping charges. **PAYMENT:** VISA, MASTERCARD and Prepaid orders accepted. **COD ORDERS:** Add additional $5.00 special handling charge. **APO, FPO, AK, HI & PR ORDERS:** Include shipping charges as shown and additional 5% of total order amount to cover PAL and insurance. We ship only to United States addresses, except for those listed above. **TAXES:** Illinois residents, add 7% sales tax.

MINIMUM ORDER: $35.00.

Super Star Diskettes are unconditionally warrantec ıgainst defects in original material and workmanshiṛ ;o long as owned by the original purchaser. Returns ıre simple: just send the defective diskettes with proo ɔf purchase, postage-paid by you with a short expla ıation of the problem, and we'll send you the replace nents. (Incidentally, coffee stained diskettes anc diskettes with staples driven through them don' qualify as "defective".)

WE WILL MEET OR BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES SUBJECT TO THE SAME TERMS AND CONDITIONS.

S-100™ ESTABLISHED 1977

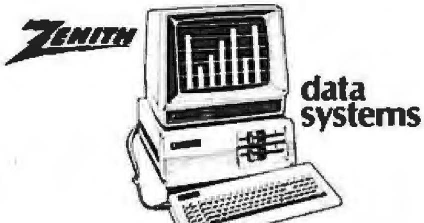
ORDERS 800-528-3138
TECH. SALES/CUST. SERVICE 602-991-7870
TELEX 165025 FTCC SEC PHX

PLEASE NOTE: We Now Accept AMERICAN EXPRESS...Add 5% To The Cash Prepaid Price

Computer Systems

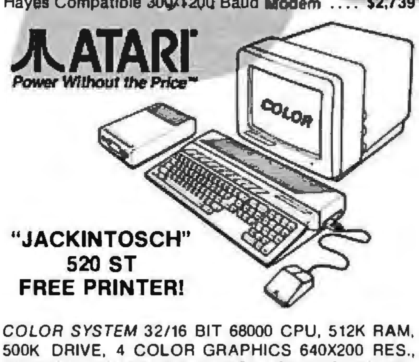
VIASYN *816/286-H40* **w/256K SPUZ & .5MDrv/H. $$SPECIAL... TOO LOW TO ADVERTISE!!!**

VIASYN *816/C2* w/80286, 512K RAM, SPUZ-256, 40Mb H.D., 10Mb Tape, 5¼" 96TPI FLPY. CDOS 816/286, NewWord & Supercalc II .... **REDUCED!! $6,779**
VIASYN *CORE SYSTEM* w/256K RAM, I/F-4, Syst. Supp. 1, ENCL. 2D, Disk 1A, Disk 3, 5¼" FLPY, & 10Mb H.D. Add Your Choice of CPU & Oper. Sys.... $3,949
VIASYN *816/10-H40* w/Tape & 1Mb MDrv $6,377
CALL FOR OTHER SYSTEM CONFIGURATIONS
MORROW *PIVOT II* Portable .... CALL



PC COMPATIBLE & FASTER TOO!

ZENITH *Z-158 PC-DESK TOP SYSTEM:* 256K RAM, 2 DSDD FLPY DRIVES, Serial, Paral, Monochrome & Color Composite & RGB Color Ports & MS-DOS w/4.77 & 8 MHZ CPU Clock Rates. G or A Monitor ... $1,895
Z158 *W/ 2 FLPY & 20Mb H.D. DRVS.* $2,459
Z158 *W/ 2 FLPY & 40Mb H.D. DRVS.* $2,798
½ HT 10Mb TAPE OPTION $425
Z-148 PC w/256K, 2 FLPYS, MS-DOS, 4.77 & 8MHz, Serial & Parallel Ports, Amber Monitor $1,219
Z-138 PCTRANSPORTABLE 24 Lbs. 320K. Dual FLPYS, 7" Amber Screen, MS-DOS, 4.77 & 8MHz. Serial & Parallel Ports $1,499
Z-171 *Lap-Top Portable.* Dual Drvs., 640K, MS-DOS Battery, Padded Carrying Case, Video RGB & CMPST., Hayes Compatible 300/1200 Baud Modem $2,739



"JACKINTOSCH"
520 ST
FREE PRINTER!

COLOR SYSTEM 32/16 BIT 68000 CPU, 512K RAM, 500K DRIVE, 4 COLOR GRAPHICS 640X200 RES., MENU DU MOUSE, TOS, BASIC & LOGO SOFTWARE, MUSIC GENERATOR, PARA., SERIAL & JOYSTICK PORTS, CLOCK & TERMINAL EMULATOR $999.95
JACKINTOSCH 520ST Monochrome 640x400 $799.95

ATARI COMMUNICATIONS PACKAGE BY S-100: *PROMETHEUS 1200 MODEM, CABLE, & CHAT SOFTWARE* .... **RETAILS FOR $545, NOW $329**

Diagnostic-Keyboards-Voice

DATACOM *TRI-STATE RS232* V.24 Break-out Box $189
DYSAN *DISK DRIVE INTERROGATOR* $115
DYSAN *DDD Digital Diagnostic Disk* . SS $30, DS $40
DYSAN *AAD Analog Alignment Disk* .. SS $25, DS $50
RID DYMEK *FLPY DRV. DIAGNOSTIC DISKETTE* $29
FLUKE *77 DVM* with Holster $129
KEYTRONICS *5150/5151/5153* .... $169/$179/$299
VOTRAX *PERSONAL SPEECH SYSTEM* $295

Floppy Disk Drives

MITSUBISHI *2894* STD / *2896* ½ HT 8" .... $395/$369
MITSUBISHI *4853* / **TEAC** *FD55F* 96TPI .... $119/$99
TANDON *TM 100-2A* $115
TEAC *FD55B* & **MITSUBISHI** *4851* 48 TPI $88

Computer Accessories

CA *P15* Expandable 5 Circuit Monitor Base with Modem Protection & Surge/Noise $99
CA *P150,P151,P152,P15* with ABC Data Switch .. $209
CA *C1-6* 6' IBM-Paral. CBL ...(1-9) $9.50, (10+) $8.80
CA *C1-9* 9' IBM-Paral. CBL (1-9) $11.95, (10+) $11.00
CA *C200 SERIES* Premium Molded RS232 Cables ....(1-9) $18.98 TO $28.47, (10+) $11.86 TO $27.05
CA *C300 SERIES* Premium Molded Parallel Cables ... .(1-9) $19.98 TO $45.57, (10+) $18.98 TO $43.29
CA *C400* VIDEO CABLES .... (1-9) $2.48 TO $21.29, (10+) $2.36 TO $18.10
CA *C500 SERIES* Cable Extender Packs w/ MON. PWR, VIDEO & KEYBD. CBLS ... (1-9) $29.98, (10+) $28.48
CA *S4* 4 Circuit Surge Supp.(1-9) $26.47, (10+) $25.15
CA *S6* 6 Circuits Surge & Cable Storage .... (1-9) $31.77, (10+) $30.18
Monitor Tilt & Swivel Stand...(1-9) $12.95, (10+) $10.95

Hard Disk/Tape Subsystems

AT-INSIDER, PC-INSIDER, PC-OUTSIDER HARD DISK SERIES FOR IBM, BOOTS FROM HARD DISK, FORMATTED W/ CONTROLLER & ALL NECESSARY CABLES, HARDWARE & P/S or PC STYLE CABINET.
PC-INSIDER-33 33Mb Formatted $929
PC-OUTSIDER-33 W/T 33Mb & 10Mb Tape ... $1,599
PC-INSIDER-72 72Mb Formatted $2,385
PC-OUTSIDER-72 W/T 72Mb & 60Mb Tape ... $3,166
PC-INSIDER-116 116Mb Formatted $4,175
PC-OUTSIDER-116 W/T 116Mb & 60Mb Tape . $5,415
AT-INSIDER-33 33Mb Formatted $995
AT-INSIDER-66 66Mb Formatted $1,649
AT-INSIDER-120 120Mb Formatted $3,895
TECMAR *QIC60* TAPE For PC'S............ $1,299
TECMAR *QIC60* HOST I/F Board $109
WANGTEK *PC-36* 60Mb TAPE Internal Same As **TECMAR** $1,199
CALL For DLR &/or QTY. PRICES on HARD DISKS:
QUANTUM *Q540* 40Mb........ **REDUCED!! $1,138**

MITSUBISHI Maxtor Seagate
MICROPOLIS Amcodyne

S-100 *BUS SYBSYSTEMS* Supporting Turbodos, Cadcur. Dos. CP/M 80 & 816 Operating Systems CALL

DRIVE SYBSYSTEMS FOR COMPUPRO:
w/ DISK 3, CABINET P/S, FAN CABLES, ETC. ......
•*20Mb* EPSON, SEAGATE, ETC. $1,139
•*37Mb* QUANTUM Q540 .... $1,825
•*45Mb* MICROPOLIS 1304 .... $2,179
•*72Mb* XT-1085 or 1325 .... $2,295
•*89Mb* MAXTOR XT-1105 .... $3,695
•*116Mb* MAXTOR XT-1140 .... $4,395
10Mb TAPE *(CompuPro or PC)* INT/EXT... $498/$598
ALLOY *PC-BACKUP* 17.7Mb TAPE $1,729
ALLOY *PC-QICTAPE* Up to 69Mb $1,799
ALLOY *PC-9TRACK* 42Mb $4,995
ALLOY *ITS-100+* 9TRACK 42Mb/S-100 .... $4,995
ALLOY *IDXCS-100T* 17.7Mb Tape Subsystem . $1,719

Mainframe & Drive Enclosures

ECT *RM-10* Rack Card Cage 10 Slot-15A $250
ECT *TT-10* Desk 10 Slot - 15 AMP................. $365
FULCRUM *880* with Front Panel & 20 Slots $565
INTEGRAND *2200A* w/4 Slots & 2 X 8" ½HT FLPY $349
INTEGRAND *2210* w/4 Slots & 5¼" FLPY + H.D.. $315
INTEGRAND *Laser Turbo* 10 Slots, 2 H.D. 5¼" .. $498
PARA DYNAMICS *3020D* 20 Slot Desk........... $639
INTEGRAND *2909* 2X8" ½ HT Horiz. Stack...... $189
JMR *1H5* 5¼" H.D. PC Style Cabinet............ $189
JMR *2SV8* Dual Vertical ½ HT. 8" $175
JMR *2H5* Dual 5¼" Horizontal H.D. $225
MPS *8462* Dual Horizontal 8" Slimline $215
MPS *8465* Dual 5" & 8" Horizontal Slimline...... $225
MPS *5500* 5¼" STD. HT. H.D. & ½ HT. Drive $225
MPS *5505* 5¼" H.D. & ½ HT Flpy or Tape $209
MPS *5401* 5¼" STD HT H.D. or Dual ½ HT $215
MICROWARE *SINGLE STD.* 5¼" Flpy Horizontal . $59
MICROWARE *DUAL HORIZ.* 5¼" ½ HT. Floppy .. $79
MICROWARE *920004* Dual STD. 5¼, PC-Style... $149
PARA DYNAMICS *2300-G3* 2X8" Flpy & 5 H.D... $395

Chips

We Have Some of the LOWEST PRICES in the Nation!!
64K, 256K, 8087 & 80287 .... CALL

Power Solutions

PC/XT *REPLACEMENT P/S* 130/150 WATT .. $89/$99
SAFT *SPS 400VA* 400 WATT & SINE WAVE $475
SAFT *SPS1000VA* 1000 WATT/SINE WAVE ... $1,099
SOLA *750/4500* WATT *HI-INRUSH UPS* $1,899
TRIPPLITE *ISOBAR* Line Suppressor-Filters from $35
TRIPPLITE *BC-425-FC* 425 Watts 15-20 Minutes. $398
TRIPPLITE *BC-1000* Watts 20-30 Minutes $925
TRIPPLITE *LC-1800* Conditioner/Stabilizer...... $215
TRIPPLITE *COMMAND CONSOLE* CCI 8-12.... $110

PC & AT Multifunction/Slave Bds.

We Have a Good Selection of Multifunction and Memory Boards for PC, XT, AT, JR, AT & T. and PC Portables
INTEL *ABOVE BOARD AT* 128K-4Mb w/Expanded Mem. SW to allow CPU to Address all Avail. Mem.$459
LASER *DISK I/O* FLPY CTRL, S.P & G Ports. CLK-CAL, Ram-Disk & Print Spool, MS-DOS $195
MACROTECH *MSR-AT* 3Mb PC/AT. 120nSEC .. $929
STB *BIG BYTE* 64K.............................. $122
STB *GRANDE BYTE* 128K $225
STB *RIO PLUS II* 64K-512K, S.P, Clock $216
STB *RIO GRANDE PC-AT* 128K.-1.5Mb, 2S,P&G $319
TECMAR *CAPTAIN* UNPOP w/Treasure Chest .. $157
TECMAR *EXPANSION CHASSIS* With 8 Slots... $675
TECMAR *MAESTRO* Unpopulated for IBM-AT .. $325
TECMAR *MAESTRO* For PC/AT 2.5Mb $775
TECMAR *WAVE* 64K to 256K Fits XT Short Slot . $179
ADVANCED DIGITAL *PC-SLAVE* w/256K, 8MHz 8088 CPU.2 S Ports. RTNX S/W-For Multi-User P.C. .. $695
ADVANCED DIGITAL *PC-SLAVE PACKAGE* with Link 125 Terminal $999
ALLOY *PC-SLAVE 16* 256K to 768K RAM $759

PC Scientific/Industrial Boards

IND. COMP. DESIGNS *1000* w/96TTL I/O Ports . $379
TECMAR *BASE BOARD* 96 Digital I/O Lines ... CALL
TECMAR *DADIO* D to A Up to 24 Devices ..... CALL
TECMAR IEEE-488 Board .... CALL
TECMAR *LABMASTER* .... CALL
TECMAR *EXPANSION CHASSIS* 12AMP P/S, Dual AC Outlets. 7 Useable Slots. Space for Hard Disk ... $675

Video/Graphics & Cad

STB *MONO PLUS II* $16
STB *CHAUFFEUR* RGB Port/16 Grey Shades Produced on Monochrome TTL Monitor Without Video Drivers $279
STB *GRAPHICS PLUS II* w/ Paral. PRT Port $249
STB *SUPER RES 400* Color Hi-Res w/ 32K...... $325
TECMAR *GRAPHICS MASTER* 16 Color Hi-Res. $439
TECMAR *GRAPHICS TENDER* RGB/PRT Port .. $195
CSD-PC *AUTOCAD 2 PACKAGE:* 1024X1024 Monochrome Graphics • 15" 1100X1250 Res. . $3,14
ILLUMINATED TECHNOLOGIES *AUTOCAD PACKAGE:* 8 Color 1024X1024 S-100 Board • Insid Autocad Handbook • Autocad 2 • Mitsubishi 19 1024X874 RGB Analog Color Monitor • Hitachi Tige 11"X11" Tablet with 12 Button Cursor......... $4,995
STB *SUPER-RES PKG:* Board & 13" CM-1370 Monitor w/ 16 Colors, 720X400 @ 31.5KHz Scan Rate.... $749
TECMAR *SUPER-RES PKG:* Board & 13" ZVM-136 Monitor with 16 Colors @ 640X400 .... $925
VECTRIX *VXPCA* 4096 Colors .... Close-Out $1,899
VECTRIX *VX/PC* Video Cable $79

Monitors & Terminals

AMDEK *300G* $125
PRINCETON GRAPHICS *SR-12* 690X480 RGB .. $595
TATUNG *CM-1322* 640X200 RGB Same as IBM . $37
TATUNG *CM-1360* LIKE 1322 with G-A Switch .. $419
TATUNG *CM-1370* 720X480 RGB w/GRN Switch, Long Persist Phos. Works w/ STB's *SUPER RES 400*.. $469
TATUNG *DM-12VL* A&G 12" Monochrome . $125/$119
TATUNG *MM-1222G/A* Hi-Res 12" TTL (IBM)$119/$129
TAXAN *MONITORS* .... Call for Low Price
TECMAR *ZVM-136* 640X480 RGB 13", Grn Switch $49
ZENITH *ZVM122A* AMB or *ZVM123A* GRN....... $7
ZENITH *ZVM123A* (Green)/*122A* (Amber).... $85/$8
ZENITH *ZVM135* Hi-RES RGB w/ Green Switch . $45
KIMTRON *KT-7* 14" Green $49
LIBERTY *FREEDOM TERMINALS* .... CALL
LINK *125* Wyse 50 Compat. 14" GRN or AMB w/Higher RES., More Emul'S, Selectric K.B., 6 Scroll Rates $42
LINK *125 PC* w/PC Emulating Video & Keybd .. CAL

S-100 DIV./696 CORP.
14455 NORTH 79th ST.
SCOTTSDALE, AZ 85260

FULL DEALER SUPPORT
VISIT OUR SHOWROOM
HRS: 8:00AM — 5:00PM M-F

Inquiry 313 for End-Users. Inquiry 314 for DEALERS ONLY.

WORLD'S LARGEST SELECTION OF *PC* & S-100 PRODUCTS

S-100 Bus BDS & Accessories

If you purchased before calling us, you probably paid too much! We stock **ACKERMAN DIGITAL, ADVANCED DIGITAL, CCS, VIASYN, CROMEMCO, DUAL, ELECTROLOGICS, INTERCONTINENTAL MICRO, KONAN, MULLEN, PICKLES & TROUT, INDUSTRIAL COMPUTER DESIGNS, TARBELL, TECMAR, TRANSEND, VECTOR ELECTRONICS.**

A Few Of This Month's SPECIALS Are:

- **ACKERMAN** *MEMORIZER* 64K RAM & EPROM . $211
- **ACKERMAN** *KLUGE CARD A&T* $175
- **ACKERMAN** *PROMBLASTER II* Up to 27256K'S . $306
- **ACKERMAN** *PROMBLASTER EXTENDER* $79.95
- **SPECTRONICS** *PE24T/9 EPROM ERASER/TIMER* 146
- **ADV. DIGITAL** *SUPER 186/256K MASTER* $1,495
- **CCS** *2422* Dual Floppy CTRL With CP/M $350
- **CCS** *2710* 4 Port Serial Board $275
- **CCS** *2720* 4 Port Parallel Board $215
- **CCS** *2810* Z80 CPU with Serial Port $235
- **COMPUPRO/VIASYN** *RAM 16* 64K STATIC $175
- **COMPUPRO/VIASYN** *RAM 22* 256K STATIC $446
- **COMPUPRO/VIASYN** *RAM 23* 128K STATIC $219
- **COMPUPRO** *MDRIVE/H-10-1Mb* for 816/10 ..... $595
- **COMPUPRO** *PC-VIDEO BOARD* $369
- **COMPUPRO** *DISK 1A* 5" & 8" Floppy CTRL. $369
- **COMPUPRO** *Disk 3* ST506 5" H.D.C. $445
- **COMPUPRO** *SYSTEM SUPPORT 1* w/ CLK-CAL $263
- **COMPUPRO** *MOTHER BOARD* 21 Slot $222
- **COMPUPRO** *CPU 8085/88* 6 & 10 MHz $263
- **COMPUPRO** *CPU 8086* - 10MHz $297
- **COMPUPRO** *CPU 68K* - 10MHz $319
- **COMPUPRO** *CPU 286* - 8MHz $672
- **CROMEMCO** *XPU* 10MHz 68000 CPU $1,270
- **CROMEMCO** *DPU* 68000/Z-80 Dual CPU $675
- **CROMEMCO** *SCC Z-80* Single BD. Computer ... $420
- **CROMEMCO** *8PIO* 8 Port Parallel $293
- **CROMEMCO** *D+7A* 8 Channel 8 Bit D/A $293
- **CROMEMCO** *BIART* Dual Sync/Async........ $675
- **CROMEMCO** *64FDC* 5"&8" Floppy CTRL $505
- **DUAL** *AIM-12* A/D Input 12 Bit/32 Channel $629
- **DUAL** *AOM-12* D/A Output 12 Bit/4 Channel.... $540
- **DUAL** *WDC* Winchester DMA 2 BD. Set SA-4000 $840
- **ICM** *MASTER & SLAVE BOARDS* .... CALL

INDUSTRIAL COMPUTER DESIGNS:

- •*D/A 64-100* 64 Analog Outputs $298
- •*A/D 64-100* 64 Analog Inputs........ $225
- •*CCT-100* Highly Accurate Time & Date Controller with Battery Back-Up $249
- **KONAN** *DGC-100* ST 506 5¼ H.D. Controller.... $325
- **KONAN** *SMC-200* SMD 8" Controller $450
- **MACROTECH** *VRAM* 512K Static with Battery Back-Up and MDrive/H Capability $789
- **MACROTECH** *MI-286* 80286/Z80H Dual Proc. $699
- **MACROTECH** *MSR-II* 1Mb Dynamic Ram $825
- **MACROTECH** *MSR-II* 2Mb Dynamic Ram $999
- **MULLEN** *TB4A EXTENDER BD.* w/Logic Probe .. $69
- **MULLEN** *ICB10* 8 Channel Low Voltage Controller $165
- **PICKLES & TROUT** *P&T488* IEEE 488 BD & S.W. $429
- **VECTOR** *RAM 17* 64K Static Ram (VIASYN) Excellent with Z80 CPU'S........ $299
- **VECTOR** *INTERFACER I* Dual Serial (VIASYN).. $199
- **VECTOR** *INTERFACER II* 3 Para., 1 Serial $219

S.D. SYSTEMS CLOSE-OUT!!!!!!

- •*RAMDISK* 256K $495
- •*EXPANDORAM-4* 256K with Parity $595
- •*VFW-3* Floppy & H.D.C. $475
- •*CP/M 3.0* UNBANKED $95

TRANSEND CLOSE-OUT!!!!!!

- •*I/O 5* 2 Serial, 3 Parallel........ $195
- •*EP128* 128K Eprom Reader........ $169
- •*PB1* 2708, 2716 Eprom Programmer $99
- •*VB2 Kit* I/O Mapped Video Board........ $99
- •*MB64* 64K Static Ram Board $449

Diskettes & Cartridges

- **3M TAPES** *300XL&600A/1000A* In Stock .$29.95/19.95
- **DYSAN** *3.5" SSDD* $29.39
- **DYSAN** *3.5" DSDD* $35.00
- **DYSAN** *5¼" DSDD* $24.95
- **DYSAN** *5¼" SSDD* $22.95
- **DYSAN** *3740/20 8" DSDD* $31
- **DYSAN** *HARD DISK CARTRIDGES 8"* $150
- **DYSAN** *5¼" DSDD / UHI-96TPI IBM-AT* ..... $28/$59
- **FUJI** *5¼" SSDD / 5¼" DSDD* .... $15/$19
- **FUJI** *FD2D-1024 8" DSDD* $29.95

Printers, Plotters & Buffers

- **BROTHER** *HR-15-XL* 17CPS Daisywheel S or P . $377
- **BROTHER** *HR-10* 12CPS Daisy w/ TRAC., S&P . $249
- **BROTHER** *TwinRiter* 5 Dot Matrix & Daisywheel $659
- **BROTHER** *2024L* 24 Pin Hi-Res Print&Graphics . $869
- **BROTHER** *M-1509* 180/45 NLQ, P&S I/F $295
- **BROTHER** *M1009* EPSON Compatible Plug & Play $149
- **BROTHER** *HR-5* Plain-Paper Thermal Portable .. $159
- **CITIZEN** *MSP-10* 160/40 NLQ 80/132 .... $275
- **CITIZEN** *MSP-15* 160/40 CPS 15" Low Profile ... $409
- **CITIZEN** *MSP-20* 200/50 NLQ 80/132 .... $349
- **CITIZEN** *MSP-25* 200/50 CPS 15" ULTRA QUIET $569
- **EPSON** *LQ-1500* Cut-Sheet Feeder, Single Bin .. $309
- **SIEMENS** *PT-88* 80 Column Ink Jet........ $595
- **STAR** *SG10/15* 120 DATA/30 NLQ .... $239/$409
- **STAR** *SD10/15* 160 DATA/40 NLQ........ $369/$495
- **STAR** *SR10/15* 200 DATA/50 NLQ........ $535/$659
- **TEXAS INSTRUMENTS** *800 SERIES* .... CALL
- **HOUSTON INST.** *PLOTTERS & DIGITIZERS* .. CALL
- **DITRON** *64K PC/XT CARD BUFFER* w/PRT Port(LPT 1 or 2 or 3) 100% PC&AT Resident S/W Utilities.... $135
- **HANZON** *12315* 64K-256K INTELLIGENT BUFFER SER.-SER., SER.-PAR., PAR.-SER., PAR.-PAR. Computer to Printer Combinations Possible. So easy to use - instructions printed on bottom of cabinet.. $259
- **HANZON** *ADD-IN MODULE* 64K RAM........ $49
- **JOHNATHAN FREEMAN DESIGNS** *UNIVERSAL PRT BUFFER* S&P In & S&P Out, 64K/256K..... $189/$249
- **OKIDATA** *182* 80 Column 120 DATA/ 60 NLQ... $222
- **PRACT. PERIPH.** *APPLE GRAPHICARD & CBL.* . $70
- **PRACTICAL PERIPH.** *APPLE SERIAL BOARD* .. $112
- **PRACTICAL PERIPH** *APPLE PRINTERFACE*..... $55
- **VIA WEST** *VSP-32* Paral-Serial Converter $62

Networking & Switch Boxes

- **INTERCONT. MICRO SYS.** *LAN-PC* w/o RAM... $469
- **INTERCONT. MICRO SYSTEMS** *LANS-100* $359
- **COMPUPRO/VIASYN** *NET 11* For 816/10 Sys.... $425
- **COMPUPRO/VIASYN** *NET 101-96* For S-100 Bus $425

GILTRONIX *MANUAL and AUTOMATIC SWITCHING UNITS* to Fit all of your SHARED PRINTER, TERMINAL, MODEM & other Peripheral Needs. These Units In Stock:

- **5100** 8 Wire A-B Serial .... CALL
- **5110** 8 Wire A-B-C Serial........ CALL
- **5200** 24 Wire A-B Serial .... CALL
- **5210** 24 Wire A-B-C Serial........ CALL
- **5211** 24 Wire A-B-C W/ LED'S .... CALL
- **5220** 24 Wire A-B-C-D Serial .... CALL
- **5230** 24 Wire A-B-C-D-E Serial .... CALL
- **5240** 24 Wire A-B-C-D-E-F Serial .... CALL
- **5400** CENTRONICS A-B .... CALL
- **5410** CENTRONICS A-B-C........ CALL
- **5500** IBM - PARALLEL A-B........ CALL
- **5530** IBM - PARALLEL A-B-C-D-E........ CALL
- **5540** IBM - PARALLEL A-B-C-D-E-F........ CALL
- **8005** *5 Port Peripheral Shared Device* to Connect 5 Terminals/Computers to Printer .... CALL
- **9301** *3-Way Distributed Control Unit* - RS232 For Use with Multiple Baud Rate Devices........ CALL

Call For Prices & Configurations On Other Units

Software • Software • Software

We have Access to all Well Known Brands - **ORDER CORRECTLY -- SOFTWARE IS NOT RETURNABLE!**

Word Proc./Screen Formatter

- **MICROPRO** *CORRECT STAR / PC-DOS*........ $95
- **MICROPRO** *MAIL MERGE / CP/M-86 8"*........ $75
- **MICROPRO** *PROPAK*........ $317

NEW STAR *NEWWORD* 16 Bit with MERGE PRINT, THE WORD PLUS Spelling Checker - Easier than Word Star but File Compatible........ $99.95

NEW STAR *NEWWORD* 8 BIT with MERGE PRINT $79.95

- **PFS** *WRITE* $97
- **OASIS** *THE WORD PLUS* Spelling Checker $95
- **OASIS** *PUNCTUATION & STYLE*........ $79
- **MARK OF THE UNICORN** *THE FINAL WORD*... $189
- **COMPUVIEW** *VEDIT/VEDIT PLUS*........ $115/$169
- **COMPUVIEW** *VEDIT PLUS, V-PRINT & SPELL*.. $298
- **COMPUVIEW** *V-SPELL* CP/M 80 8" & PC DOS... $95

Language And Tools

- **BD SOFTWARE** *"C" Compiler 8"* SS SD 8 BIT ... $95
- **BORLAND** *PC TURBO PASCAL* 3.0 .... $44
- **BORLAND** *PC TURBO PASCAL* 3.0 W/ 8087 ..... $70
- **COMPUTER INNOVATIONS** *C-86 "C" Compiler.* $299
- **DIGITAL RESEARCH** Most Products .... 36% OFF
- **ITHACA** *PASCAL Z* CP/M80 8"........ $285
- **LATTICE** *"C" Compiler* $299
- **MICROSOFT** Complete Line .... 32% OFF
- **SUPERSOFT** *FORTRAN* PC/MSDOS $199
- **DIGITAL RESEARCH** *COMPLETE LINE* ___ 36% OFF
- **AMERICAN TRAINING INT'L** *TUTORIALS* .. 36% OFF
- **BORLAND** *PC SIDEKICK* (Unprotected) $54
- **BORLAND** *PC SUPERKEY* (Unprotected) $41
- **BORLAND** *PC TURBO GRAPHIX TOOLBOX*..... $35
- **BORLAND** *PC TURBO TOOLBOX*........ $35
- **BORLAND** *PC TURBO TUTOR*........ $22
- **FOX & GELLER** *QUICKCODE* For dBASE 2..... $187
- **FOX & GELLER** *dGRAPH* For dBASE 2 .... $187
- **FOX & GELLER** *dUTIL* For dBASE 2........ $63
- **FOX & GELLER** *QUICK SCREEN* For dBASE 2... $94
- **FOX & GELLER** *PC GRAFOX* BUS. GRAPHICS . $159
- **FOX & GELLER** *PC QUICKREPORT III* $187

Data Bases & Spreadsheets

- **ASHTON-TATE** *ALL PRODUCTS* .... 32% OFF
- **DATAFLEX** *FILE/RECORD* Locking Multi-User . CALL
- **MDBS** *Knowledgeman* CP/M86 8" $295
- **MICROPRO** *REPORT STAR*........ $119
- **MICROPRO** *INFO STAR*/16 Bit........ $239
- **MICRORIM** *R: BASE 5000*........ $439
- **PFS** *FILE / REPORT* .... CALL
- **SORCIM** *Supercalc-3* Better Than 1-2-3!!! $195

Communications Programs

- **MICROSTUF** *CROSS TALK XVI*........ $125
- **MYCROFT LABS** *MITE / MITE PLUS* ...... $135/$150
- **WOOLF** *MOVE-IT* PC-PC Communications $95

Modems

- **PROMETHEUS** *PROMODEM 1200* Hayes Compatible w/ Built-In PWR Supply-RS232 Stand Alone Unit $289

OPTIONS FOR PROMODEM 1200 ARE:

- *COMMUNICATIONS PROC. BUFFER* 2K-512K... $99
- *512K RAM* for Communications Buffer........ $49
- *ALPHA NUMERIC DISPLAY*........ $75
- **PROMETHEUS** *1200A* Apple II, II+, IIe Card w/Terminal Software in ROM $279
- **PROMETHEUS** *300C* Apple IIC Piggy Back $139
- **PROMETHEUS** *1200B* For PC'S with Procom ... $249
- **PROMETHEUS** *1200M* Stand Alone MAC Modem with Cable and Communications Software $348
- **HAYES** *SMART MODEM 1200* RS-232 .... $439
- **HAYES** *SMART MODEM 2400* Universal $659
- **U.S. ROBOTICS** *PASSWORD 1200* $209
- **U.S. ROBOTICS** *AUTO DIAL 212A* $309
- **U.S. ROBOTICS** *PC/XT MODEM* with TELPAC.. $199
- **U.S. ROBOTICS** *PC MULTI-MODEM* with Clk-Cal., Batt. Back-up, PRT Port, 256K RAM Telpac $386
- **U.S. ROBOTICS** *MULTILINK/COURIER* 2400 $435

Hobby Corner

SOLD "AS IS" WITH NO RETURNS ....

- **AMPRO** *"LITTLE BOARD"* (The Original) $259
- **APPLE II** *INTEGER BASIC CARD* $59
- **CROMEMCO** *ZPU* $149
- **DRI** *GSX-80*........ $39
- **DRI** *PASCAL/MT+*........ $175
- **ELECTROLOGICS** *QUASI-DISK* 2/4Mb CP/M80 RAM DISK with Battery Back-Up .... $1,695/$3,095
- **HEURISTICS** *SPEECH LAB* For Speech Recognition95
- **IMSAI** *PIO6-6 Kit* 2 Sets of 24 PROG. I/O Lines . $149
- **IMSAI** *MIO KIT* (Assembled) 2 PAR & 1 SER $69
- **MICROPRO** *CalcStar* 1.20 8" CP/M $79
- **MICROPRO** *SuperSort* 1.60 8" CP/M $140
- **MORROW** *DJDMA-3A* with Software........ $195
- **MORROW** *HDCA-3* 8 or 14" SA4008 H.D.C. $195
- **MORROW** *MPZ80* REV. 2 w/ Documentation $195
- **NORTH STAR** *FLOATING POINT BOARD* $169
- **NOVATION** *SMART CAT 212* $239
- **PARA DYNAMICS** *2508D* Like 3510 w/ 8 Slots .. $395
- **PRAGMATIC DESIGNS** *PD20MS* 8" FUJITSU 20Mb H.D. Subsystem For CompuPro System........ $2,495
- **PROTEUS ENGINEERING** *"WRITE"* W.P. *CP/M 8"* $50
- **S.D.S.** *MPU 100* Z80 CPU Kit........ $89
- **S.D.S.** *E-PROM BOARD #27007* Kit $49
- **SMS** *STATIC RAM* 64K For N.S. Horiz., Etc. $149
- **TEI** *TFD-O* Cabinet For 3 STD 5¼" FLY DRVS. .. $195

PLEASE NOTE: We Now Accept ***AMERICAN EXPRESS...*** Add 5% To The Cash Prepaid Price

All merchandise new. Advertised prices are cash prepaid only. MC, Visa & P.O's from qualified firms - add 3% Wires, COD's ($5 min. fee) with Cashiers Check/MO & APO's accepted. Shipping: minimum $4 first 3 lbs Tax: AZ RES ONLY add 6% sales tax. All returns subject to 20% restocking fee or credit towards future purchases. Retail prices slightly higher. All prices subject to change without notice.

TOLL FREE
800-854-8230
CA Residents **714-558-8813**

OUR POLICY
- Surcharge for VISA or Mastercard.
- Volume purchasing agreements available.
- Orders subject to availablity. •Supply limited on certain items.
- Pricing subject to change without notice.
- ACP Retail Store pricing may vary. Not responsible for typos.

MAJOR BRAND PRICE BREAKTHRU

(Photo of System 8)

At these prices you would expect a Taiwan clone. We are offering the best IBM PC/XT® compatible available in the market today. Compare the features and you won't believe the price!

ADVANCED PC/XT

NEW LOW PRICE! **$750.00** BASE PRICE

ACP has sold over 2,000 of this system to major customers including Rockwell Int'l, Hughes Aircraft and Emulex Corp. See for yourself why these customers prefer the Advanced XT over the IBM XT.

BASE PRICE INCLUDES:
- (1) 360K DS/DD Floppy Disk
- 256K RAM Expandable to 640K on the Motherboard (256K chips)
- On Board Serial Port - **FREE**
- On Board Parallel Port - **FREE**
- On Board LCD Display Port - **FREE**
- On Board RGB Output - **FREE**
- On Board Video Comp. Out - **FREE**
- Keyboard Output Port
- (3) Expansion Slots
- Quiet 100 Watt Power Supply
- Ergonomic Design & Packaging
- VLSI Circuit Design
- 90 Day Warranty
- UL Approved/FCC Approved

SYSTEM 1	CPU w/(2) Floppys, Keyboard, Mouse, Mouse Software & Gm Mon w/Tlt Swiv Base.	$1150.00
SYSTEM 2	Same as System 1 with RGB Color Monitor and Tilt Swivel Base	$1399.00
SYSTEM 3	CPU w/(1) Floppy, 10Mb Hard Disk, Controller, Keyboard, Mouse and Mouse Software	$1399.00
SYSTEM 4	Same as System 3 with 20Mb	$1699.00
SYSTEM 5	CPU w/(1) Floppy, 10Mb HD, Contr'l, Keyboard, Mouse w/Software & Grn Mon. w/Tlt/Swiv Base	$1549.00
SYSTEM 6	Same as System 5 with RGB Color Monitor and Tilt & Swivel base	$1799.00
SYSTEM 7	CPU w/(1) Floppy, 20Mb HD, Contr'l, Keyboard Mouse w/Software & Gm Mon w/Tlt & Swiv Base	$1849.00
SYSTEM 8	Same as System 7 with RGB Color Monitor and Tilt and Swivel Base	$2099.00

UNBUNDLED ADVANCED PC/XT COMPONENT PRICING (ACP recommends using all Advanced Components in upgrading your PC)

- CPU Base Unit.................$750.00
- Keyboard w/Mouse & Software.... 149.95
- RGB Color Mon w/Tlt Swiv Base... 395.00
- Gm Comp. Mon w/Tlt Swiv Base.. 199.00
- LCD 80 x 25 Display............ 299.00
- Green Monochrome Monitor...... 149.00
- Hi-res Text Mono Card........... 149.00
- 256K Upgrade (Installed).......... 59.95
- 8087-2 Co-processor............ 129.95
- 1200 Baud Modem Short Card, Hayes Compatible w/Software.....$179.95
- 6 Slot Expansion Chassis......... 399.00
- 10Mb (gray) Upgrade w/Contr'l.... 399.00
- 20Mb (gray) Upgrade w/Contr'l.... 599.00
- 360K (gray) DS/DD Floppy Disk... 129.00
- PC DOS 2.1..................... 65.00
- PC Works 1.15 (Touchstone) Regular $195.................. 49.95
- GW Basic......................$75.00
- GEM by Digital Research.......... 29.95
- Maintenance Manual.............. 50.00
- Technical Reference Manual 50.00

SYSTEM SPECIALS
- Sys 5 w/Diablo 620 Serial.......$1849.00
- Sys 6 w/Diablo 620 Serial....... 2099.00

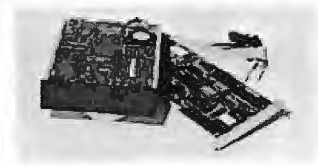
DIABLO 620 DAISYWHEEL PRINTER

The Finest Letter Quality Printer at a Spectacular Price. We have sold 1000's. You can have a spare at this price.

620 Serial........	List 1495	ACP	$395.00
620 API.........	List 1695	ACP	445.00
620 D36.........	List 1695	ACP	495.00
F-21 Sheet Feeder.	List 895	ACP	249.00
620 Tractor......	List 395	ACP	99.00
Cable.....................		ACP	29.00
Serial to Par. 16K Buffer....		ACP	125.00

IBM PC/XT® of IBM

CORPORATE BUYERS CALL BARRY



10 Mb Upgrade **$399** 20 Mb Upgrade **$599**
(1 Year Warranty)

	Qty. 1	Qty. 6
SA712 10 Mb	$229	$219
ST225 20 Mb	$369	$349
Western Digital Cont	$195	$175

PC UPGRADE SPECIAL

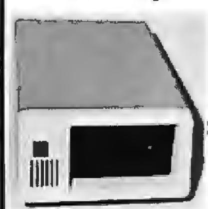
$7.95 SET OF (9) 64K RAMS

$26.95 SET OF (9) 256K RAMS

$5.95 4128 PIGGYBACK RAM

1200 Baud Hayes™ Comp. Modem
Shor Card by U.S. Robotics with Telpac I Software.
List $499 ACP.. **$179.00**
Buy (6)......... **$159.00**

20Mb Tape Back-up



Archive, #1 in tape back-up technology.
High speed 20Mb back-up for only
$899.00

External Box w/Power Supply
Great for adding Hard Disk to your PC.
Same as photo.......... **$179.00**

DOT-MATRIX BLOW OUT

DIABLO/HONEYWELL

P-11 100cps, parallel	$129.95
S-11 100cps, serial	139.95
P-31 100cps, par, wide	249.95
S-31 100cps, ser, wide	269.95
P-32 150cps, par, NLQ	299.95

CANNON/USA

PW-1080A 165cps, parallel	$169.95
PW-1156A 165cps, par, wide	199.95

Advanced Computer

DID YOU GET OUR FLYER?

IF NOT . . . CALL & GET ON OUR MAIL LIST

UPS POWER SUPPLY

Back Up Power for your IBM, Apple or Compatible

UPS-PC 200 Watts	$277.00
UPS-XT300 Watts	419.00
UPS-AT 800 Watts	739.00

A-B PRINTER SWITCH

An AB Switch allows use of two printers with your computer system. We stockover 15 different configurations.

AB Switch (Centronics)	$59.00
AB Switch (DB25)	59.00

COLOR VIDEO CARDS

Plantronics Color Plus	$375.00
IBM Color Card	227.00
IBM Mono Card w/parallel	219.00
STB Graphics Plus	369.00
Paradise Multidisplay Card	345.00
Everex Graphics Edge	345.00

DRIVE CABINETS

IBM Style Hard Disk with power supply and fan	$179.00
Dual Hard Disk w/power sup & fan	295.00
Dual 5¼" Full Height vertical mount	65.00
Dual 5¼" Full Height horizontal mount	99.00
Dual 5¼" Thinline w/power sup & fan	60.00
Single 5¼" Full Height w/power sup & fan	56.00
Single 5¼" Thinline w/power sup & fan	60.00

PERSYST CARDS

Persyst MonoCombo — NEW!	$335.00
Persyst Color Combo — NEW!	335.00
Persyst Bob Board	445.00
Persyst Shortport Color	Call
Persyst Mini Mono	Call
Persyst +I Time Spectrum w/64K	179.95
Persyst 192K Rainbow DEC Card	149.95

SPECIAL BUY
Sharp 12" Color RGB Monitor
List $499.00 ACP $249.95

MODEM SPECIAL
Hayes Smartmodem Compatible
1200 B. External. Sold for $399
$199.00

INTERSIL STD-BUS BOARDS

	LIST	ACP
ISB3100 Z80CPU	$200	$69.95
ISB3101 Z80 Univ. CPU	200	69.95
ISB3110 8065 CPU	200	79.95
ISB3216 16K CMOS RAM	810	99.95
ISB3218 16K Static RAM	200	39.95
ISB3220 16K CMOS RAM	750	119.95
ISB3330 Z80 PIO (D mating)	210	49.95
ISB3331 Universal PIO	210	49.95
ISB3340 Opto Para. Input	300	119.95
ISB3400 Floppy Controller	215	79.95
ISB3410 SASI (DMA) WINI Inter.	255	99.95
ISB3500 Triac	215	99.95
ISB3510 Opto-Iso Input	270	119.95
ISB3520 SPST Relay	150	69.95
ISB3521 DPDT Relay	190	89.95
ISB3600 Arithmetic	375	149.95
ISB3610 EPROM Programer	260	79.95
ISB3700 Sync/Async	245	89.95
ISB3711 Univ. Sync/Async	245	69.95
ISB3720 REMDACS	315	149.95
ISB3830 12 Bit A/D	720	269.95

CAPACITORS

.01uF DISC BYPASS CAPACITOR	100/$5.50
.1 uF DISC BYPASS CAPACITOR	100/6.50
.01uF MONOLITHIC CAPACITOR	100/11.25
.1 uF MONOLITHIC CAPACITOR	100/14.25

CORCOM EMI FILTER

STD CORCOM 3 Conductor Filter	$4.50
Line Cord for above — 6 foot	1.49
Line Cord 2 Conductor — 6 foot	.35
Line Cord 3 Conductor — 6 foot	.95

MUFFIN FANS

Over 10,000 In Stock

Torin 3" TA-300 Fan	NEW!	$9.95
Torin 4.66" Muffin Fan	NEW!	12.95
12VDC Fan	NEW!	14.95
Finger Guards add		1.49
Power Cords add		1.49

IC SOCKETS

SOLDERTAIL	1-99	100
8 Pin ST/LP	$ .13	$ .10
14 Pin ST/LP	.15	.11
16 Pin ST/LP	.17	.12
18 Pin ST/LP	.20	.17
20 Pin ST/LP	.28	.26
22 Pin ST/LP	.29	.27
24 Pin ST/LP	.29	.27
28 Pin ST/LP	.39	.32
36 Pin ST/LP	.45	.36
40 Pin ST/LP	.48	.42
64 Pin ST/LP	3.95	3.25
WIREWRAP (GOLD)	1-99	100
8 Pin WW/3L	$ .48	$ .40
14 Pin WW/3L	.82	.49
16 Pin WW/3L	.65	.55
18 Pin WW/3L	.88	.77
20 Pin WW/3L	.99	.89
22 Pin WW/3L	1.19	1.13
24 Pin WW/3L	1.25	1.17
28 Pin WW/3L	[illegible]	1.36
40 Pin WW/3L	1.89	1.75

TEXTOOL/ZIF ZERO INSERTION
16 Pin $6.75 24 Pin $7.85 28 Pin $8.95
(We Stock All Types of Sockets)

TRANSISTORS/DIODES

PN2222A	7/$1.00	2N3904	11/$1.00
PN2369A	5/1.00	2N3906	11/1.00
PN918	3/1.00	TIP29A	2/1.00
2N2218A	.45	TIP30A	2/1.00
2N2219A	.45	TIP31A	2/1.25
2N2905	.45	TIP32A	2/1.25
2N2907	.25	1N4148	25/1.00
2N3055	.69	1N751	5/1.00
2N3565	4/1.00	1N4002	12/1.00
2N3638	4/1.00	1N4004	10/1.00
2N3772	1.89	MPQ2232	1.49

OPTO ISOLATORS

MCT-2	$ .59	4N33	$ .89
MCT-6	1.39	4N35	1.25
MCT-66	.55	4N37	1.25
MCA-255	1.69	4N38	.96
4N26	.65	TIL117	.79
4N27	.65	SPX33	.29
4N28	.69	4N25	5/1.00

LED LAMPS

	1-99	100
Jumbo Red	$ .09	$ .08
Jumbo Green	.17	.15
Jumbo Yellow	.17	.15
Mini Size Red	.10	.09
Mini Size Green	.19	.16
Mini Size Yellow	.19	.16

SPECIAL VALUES!

MCM68705 EPROM	$9.95
6116/2016-150mS	10/19.95
DB-25P Male	10/17.50
DB-25S Female	10/19.95
2732A-2	10/29.95
2716DC-450mS	10/24.50
2764-450mS	10/29.95

CALL ACP FOR ALL YOUR VOLUME IC REQUIREMENTS

EDGE CONNECTORS

	1-99	100
S-100ST	$3.95	$3.25
S-100 WW	4.75	4.10
44 Pin ST	2.75	2.60
44 Pin WW	4.75	4.25
72PinST	6.50	6.10
72PinWW	7.25	6.95

D-SUBMINIATURE

	1-24	25
DB25S (Female)	$3.10	$2.90
DB25P (Male)	2.40	2.29
Hood $1.25	Mtg H/W $ .99	
DE37S (Female)	$5.95	$5.75
DE37P (Male)	5.25	5.10
Hood $1.75	Mtg H/W $ .99	
DD50S (Female)	$8.95	$8.65
DD50P (Male)	6.00	5.75
Hood $3.25	Mtg H/W $ .99	

(OTHER STYLES IN CATALOG)

CENTRONICS

IDC 36 Pin Male	$8.95
IDC 36 Pin Female	9.49
Solder 36 Pin Male	7.49
Solder 36Pin Female	8.95

(CALL TOLL FREE FOR IDC's)

6800

68000	$19.95	6810	$ 2.85	6850	$ 3.25
68000L10	39.95	6820	3.75	6852	5.65
6800	2.90	6821	2.90	6860	7.90
6802	7.75	6826	14.50	6875	6.75
6803	16.95	6840	12.75	6880	2.20
6809E	9.50	6845	11.95	68047	22.95

6500

6502	$4.50	6504	$8.75	6522	$5.25
6502A	6.90	6507	9.75	6532	9.50
6502B	9.50	6520	4.25	6551	11.50

8000

8035	$ 5.75	8214	$ 3.75	8259	$ 6.75
8039	5.75	8216	1.95	8271	69.95
8080A	2.95	8224	2.20	8275	26.95
8085A	4.90	8226	1.95	8279	6.75
80C85A	9.95	8228	3.40	8282	6.25
8086	24.50	8237	13.75	8283	6.25
8087-2	129.95	8237-5	15.95	8284	5.50
8088	17.50	8238	4.25	8286	6.45
8089	88.95	8243	3.95	8287	6.45
8155	8.75	8250	10.50	8288	11.95
8156	8.75	8251	4.25	8289	44.95
8185	26.95	8251A	5.95	8292	12.95
8202	23.95	8253	6.75	8741	27.95
8203	37.95	8255	4.25	8748	24.50
8205	3.25	8255A	5.95	8749	24.50
[illegible]	[illegible]	8257	5.75	[illegible]	34.95

Z-80

	2.5MHz	"A" 4.0MHz	"B" 6.0MHz
Z80-CPU	2.25	[illegible]	[illegible]
Z80-CTC	2.50	3.75	9.25
Z80-DART	7.50	8.50	17.95
Z80-DMA	8.00	8.95	17.95
Z80-PIO	2.95	3.50	9.50
Z80-SIO/0	8.50	9.50	22.95
Z80-SIO/1	8.50	9.50	—
Z80-SIO/2	8.50	9.50	22.95
Z80-SIO/9	8.50	9.50	—

Z8030	$34.95	[illegible]	[illegible]	[illegible]	[illegible]
Z8530	34.95	[illegible]	[illegible]	[illegible]	[illegible]

DISK CONTROLLERS

uPD765	$9.95	1797	$21.95	6843	$28.95
1771	15.95	2791	32.95	8272	19.95
1791	22.75	2793	32.95	1691	6.95
1793	21.50	2795	32.95	2143	6.95
1795	21.50	2797	27.95	9216	[illegible]

CRT CONTROLLERS

6845	$11.95	8275	$28.50	TMS9918	$39.50
68B45	17.85	7220	34.95	6350	39.95
6847	11.50	5027	17.95	6545	14.95
46505	14.75	5037	21.95	8002	19.95
68047	19.50	NEC7220Graphics			34.95

UARTS/USARTS

1602B	$3.95	2350	$ 8.95	IM6403	$ 8.75
1013A	3.95	8250	10.50	TMS5501	14.95
1015A	6.75	IM6402	7.75	2651	8.95

EPROMS

1702 (1mS)	$ 3.90	2732A-4 (450nS)	$ 4.50
2708 (450nS)	3.65	2732A (250nS)	6.95
2758 (5V)	5.50	2732A-2 (200nS)	8.95
2716 (450nS)	1.95	2764 (450nS)	1.95
2716 (350nS)	3.95	2764 (250nS)	2.95
2516 (5V)	2.95	2764 (200nS)	4.95
TMS2716	7.50	TMS2564 (450nS)	6.95
TMS2532	5.60	MCM68764 (450nS)	19.95
2732 (450nS)	1.95	MCM68766 (350nS)	21.95
2732 (250nS)	2.95	27128-3 (300nS)	9.50
2732 (200nS)	4.95	27128 (250nS)	15.95
CMOS EPROMS		27C32	$5.95
27C16	[illegible]	27C64	6.95

STATIC RAMS

2101 (450nS)	$1.89	MK4118	$4.95
21L02 (450nS)	.99	TMM2016-2 (200nS)	3.10
2102-1 (450nS)	.79	TMM2016-15 (150n)	3.25
21L02-2 (250nS)	1.39	TMM2016-1 (100nS)	3.00
2111 (450nS)	2.75	HM6116P-4 (200nS)	4.75
2112 (450nS)	2.75	HM6116P-3 (150nS)	3.25
2114 (450nS)	1.45 8/9.50	HM6116P-2 (120nS)	5.75
2114L-4 (450n)	1.69 8/12.50	HM6116LP-4 (LP)	3.60
2114L-3 (300n)	1.79 8/13.30	HM6116LP-3 (LP)	3.95
2114L-2 (200n)	1.89 8/13.90	HM6116LP-2 (LP)	3.95
2147 (55nS)	4.50	Z6132 (300nS)	32.95
4044-4 (450nS)	3.25	HM6264P-15 (150)	14.95
4044-3 (300nS)	3.75	HM6264LP-15 (LP)	16.95
4044-2 (200nS)	4.35	74S189 (35nS)	1.85
UPD410 (100nS)	3.75	93415 (50nS)	3.95
5101 (CMOS)	3.50	93425 (50nS)	3.95

DYNAMIC RAMS

4027 (250nS)	$ .99	TMS4416 (200nS)	$6.95
1103 (300nS)	.79	TMS4416 (150nS)	7.75
4116N-2 (150nS)	.85	41256-150 (150n)	2.75
4116N-3 (200nS)	.65	41256-200 (200n)	2.75
4116N-4 (250nS)	.49	TMS4050 (300nS)	1.85
4164N-150 (150nS)	9/7.95	TMS4060 (300nS)	1.85
4164N-200 (200n)	9/7.50	MM5260 (300nS)	1.85
4164N-120 (120nS)	2.95	UPD411 (300nS)	1.85
TMS4164 (150nS)	2.95	MM5298 (250nS)	1.85

DISK SPECIAL (IBM PC DSDD)
79¢ ea. PACKAGE OF 100
"IBM PC" DS/DD Hub Rings Tyvac Cover Major Mfgr
WOW! Supply Limited

5¼" DISKETTES	1 Box	10 Box
VERBATIM 525-01 SS/DD	$22.95	$19.95
VERBATIM 550-01 DS/DD (IBM)	27.95	24.95
MAXELL MD-1 SS/DD (All)	19.95	17.95
MAXELL MD-2 DS/DD (IBM)	24.95	22.95
MAXELL DISKS for AT (96tpi)	46.95	43.95
DYSAN 104/1D SS/DD (All)	27.95	25.95
DYSAN 104/2D DS/DD (IBM)	34.95	31.95
ACP SS/DD (All)	14.95	12.95
ACP DS/DD (IBM)	17.95	[illegible]
3½" DISKETTES		
VERBATIM 3½" MF350 (MAC)	32.00	29.00
MAXELL 3½" MICRODISK (MAC)	33.00	31.00
8" DISKETTES		
VERBATIM 8" SS/DD	28.95	26.95
VERBATIM 8" DS/DD	38.95	35.95
DYSAN 8" SS/DD	32.95	30.95
DYSAN 8" DS/DD	[illegible]	47.95

5¼" DISK TUB $8.95 | 3½" DISK TUB $14.95 | HEAD CLEANING KIT—5¼" or 8" $9.95

CMOS

4000	$ .26	4028	$ .65	4059	$7.90	4505	8.95
4001	.22	4029	.75	4060	.85	4506	1.10
4002	.22	4030	.39	4066	.39	4507	1.10
4006	.79	4031	3.25	4069	.28	4508	1.90
4007	.22	4032	2.15	4070	.35	4510	.79
4008	.95	4034	1.91	4071	.28	4511	.79
4009	.39	4036	.79	4072	.28	4512	.79
4010	.39	4037	1.95	4073	.28	4514	1.18
4011	.24	4040	.75	4075	.28	4515	1.79
4012	.24	4041	.75	4076	.75	4516	1.19
4013	.35	4042	.65	4077	.35	4518	.85
4014	.75	4043	.85	4078	.35	4520	.75
4015	.39	4044	.69	4081	.29	4555	.95
4016	.35	4046	.60	4082	.29	4556	.95
4017	.65	4047	.89	4085	.95	4566	1.35
4018	.79	4048	.99	4086	.95	80C95	1.50
4019	.39	4049	.35	4093	.45	80C97	.49
4020	.69	4050	.34	4094	2.95	MC14408	12.95
4021	.69	4051	.75	4098	1.90	MC14409	12.95
4022	.69	4052	.75	4099	1.65	MC14410	9.95
4023	.25	4053	.78	4501	.69	MC14411	11.95
4024	.59	4055	3.95	4502	.95	MC14412	12.95
4025	.25	4056	2.95	4503	.49	MC14419	4.95
4027	.45	CALL FOR 74HC					

74C00

74C00	$.29	74C74	$.65	74C161	$1.15	74C373	$2.35
74C02	.29	74C85	1.89	74C175	1.15	74C374	2.35
74C04	.29	74C90	1.15	74C240	1.89	74C901	.59
74C08	.35	74C93	1.15	74C244	1.69	74C922	4.45
74C10	.35	MORE 74C IN STOCK — ALSO IN CATALOG					

LINEAR

LM108AH	$3.95	NE590	$2.45	LM3909	.98
LM300H	.99	NE592	2.70	LM3914	$2.95
LM301N	.35	LM709N	.55	LM3915	2.95
LM304H	1.89	LM709H	1.90	LM3916	2.95
LM305H	.95	LM710	.68	MC4024	3.75
LM306H	4.75	LM711	.75	MC4044	4.35
LM307N	.40	LM715	3.95	RC4131	3.75
LM308CN	.65	LM723N	.55	RC4136	1.19
LM310CN	1.65	LM723H	.75	RC4151	3.75
LM311CN	.62	LM733	.98	CA3023	2.75
LM312H	1.75	LM739	1.85	CA3039	1.25
LM318CN	1.45	LM741CN	.33	CA3046	1.25
LM318H	1.55	LM741H	.40	CA3059	2.85
LM319N	1.19	LM741N	.29	CA3060	2.85
LM320 (see VRs)		LM747	.66	CA3065	1.69
LM324N	.55	LM748	.55	CA3080	1.10
LM339N	.95	LM1014	1.15	CA3081	1.60
LM340 (see VRs)		LM1303	1.90	CA3082	1.60
LM348N	.95	LM1310	1.45	CA3083	1.55
LM358CN	.65	MC1330	1.65	CA3086	.80
LM359	1.75	MC1349	1.85	CA3089	2.95
LM360N	2.95	MC1350	1.15	CA3096	3.45
LM370N	4.95	MC1358	1.65	CA3130	1.29
LM373N	3.95	MC1372	6.75	CA3140	1.15
LM376N	3.75	LM1414	1.55	CA3146	1.79
LM377N	1.90	LM1558H	2.99	CA3160	1.49
LM380CN	.85	LM1800	2.35	LM13080	1.25
LM380N	1.05	LM1812	8.10	LM13600	1.45
LM381N	1.59	LM1830	3.40	LM13700	1.45
LM382N	1.35	LM1871	5.45	LF347	2.19
LM383N	1.95	LM1872	5.45	LF351	.60
LM384N	1.75	LM1877	3.20	LF353	.99
LM386N	.89	LM1889	1.90	LF355	1.10
LM387N	1.29	LM1896	1.70	LF356	1.10
LM389N	1.15	ULN2001	1.25	LF357	1.39
LM392N	.69	ULN2003	1.49	TL071CP	.79
LM723N	.48	XR2206	3.75	TL072CP	1.35
LM723H	.55	XR2207	2.90	TL074CN	1.90
NE531	2.85	XR2208	2.40	TL081CP	.59
NE555	.65	XR2211	3.75	TL084CN	1.90
NE556	.65	LM2877P	2.00	TL494	4.10
NE558	1.49	LM2878P	2.25	TL496	1.65
NE561	23.50	LM2900	.83	TL497	3.20
NE564	2.85	LM2901	.99	MC3423	1.49
LM565	.95	LM2903	.69	MC3453	4.95
LM566	1.45	LM2907	2.45	MC3456	1.29
LM567	.85	LM2917	2.85	MC3459	3.75
NE570	3.85	LM3900	.55	MC3469	5.25
NE571	2.90	LM3905	1.15	MC3470	7.95

VOLTAGE REGULATORS

7805T Also 8, 12, 15, 24V	.69	7905K Also 12, 15, 24V	1.39
78L05, 12, 15V	.65	79L05, 12, 15V	.75
78M06C	.89	LM309K	1.25
78MG/79MG	1.49	LM317H/K	1.25/3.85
78H05KC	8.75	LM323K	4.85
7805K Also 12, 15, 24V	1.29	LM337K	3.75
7905T Also 8, 12, 15, 24V	.79	LM338K	8.75
		LM350T	4.55
		LM350K	[illegible]

SPECIAL PURPOSE CHIPS

MC14411	$11.50	58174	$11.25	95H90	$ 9.25
BR1941	11.50	5832	3.75	76477	3.75
34702	12.50	AY52376	11.50	76488	5.75
5016	14.95	AY53600	11.50	76489	8.75
8116	10.50	2513-001U	9.50	AY38910	7.95
5307	10.50	2513-002L	9.50	AY38912	7.95
MC4024	3.75	UPD7201	27.95	SSI-263	38.95
8038	3.75	3341	4.50	Votrax	39.95
5369	3.50	11C90	13.25	Digitalker	34.95
58167	12.25	MC15906	2.95	LM13800N	1.95
SP1000 Speech	$9.95	TR1863 5V UART			$4.25

DATA AQUISITION

ADC0800	$14.95	ADC0817	$9.75	1408L6	$1.95
ADC0804	3.45	DAC0800	4.75	1408L8	2.65
DAC0806	1.90	DAC0806	2.85	DAC100	7.95
ADC0809	4.45	DAC1020	7.95	DAC08	7.95
ADC0816	14.25	DAC1022	5.65	DAC01	8.95
AD7523JN	1.99	LF353N	1.99	LF13201N	1.99

EXPANSION MEMORY

64K UPGRADE (Set of 9) **$7.95**
256K RAMS (Set of 9) **$26.95**

CABLES/ACCESSORIES

IBM PARALLEL (Shielded)	$19.95
IBM SERIAL (Shielded)	[illegible]
KEYBOARD EXTENSION	[illegible]
RS232 GENDER CHANGER Male-Male	[illegible]
RS232 GENDER CHANGER Female-Female	9.95
NULL MODEM ADAPTOR	9.95

DISK DRIVE SPECIALS
Toshiba ND04D DS/DD IBM......$89.50
Toshiba ND04E-G for "AT"......99.50
Toshiba ND08DE-G 1.2Mb for "AT" 149.50
ALL WITH MOUNTING KIT

JANUARY SPECIALS

(SUPPLY LIMITED)

From AMPEX ALL NEW FACTORY BOX with 1 Year Warranty!

MODEL 127 20Mb HARD DISK

External Unit with Controller Built-in. Available with Host Adaptor for IBM-PC, IBM-XT or Apple II (Add $149.95 for Host Adaptor).

Reg Retail $1495 **ACP $499.00**

MODEL 227 20Mb w/TAPE

Complete Subsystem with 20Mb Hard Disk and High Speed Tape Back-up. Requires Host Adaptor at $149.95.

Reg Retail $2995 **ACP $1399.00**

For PC Jr.

SUPER NUMERIC KEYPAD

Manufactured by Keytronics. We have sold 1000's of these.

Reg Retail $99 **ACP $29.95** or 6 for **24.95** ea

7400

7400	$ .18	7446	$ .66	74123	$ .45	74176	$ .89
7401	.18	7447	.65	74125	.42	74177	.89
7402	.18	7448	.66	74126	.44	74178	1.34
7403	.18	7450	.19	74128	.49	74180	.75
7404	.18	7451	.19	74132	.45	74181	1.75
7405	.23	7453	.19	74136	.75	74182	1.15
7406	.49	7454	.19	74141	.65	74184	2.25
7407	.49	7459	.25	74142	2.95	74185	2.25
7408	.24	7460	.37	74143	3.70	74190	.87
7409	.19	7470	.29	74144	2.95	74191	.87
7410	.19	7472	.29	74145	.59	74192	.87
7411	.24	7473	.33	74147	1.49	74193	.87
7412	.38	7474	.34	74148	1.19	74194	.87
7413	.34	7475	.38	74150	1.09	74195	.87
7414	.49	7476	.34	74151	.55	74196	.75
7416	.49	7479	4.60	74152	.67	74197	.86
7417	.49	7480	.69	74153	.63	74198	1.15
7420	.19	7482	.95	74154	1.19	74199	1.15
7421	.35	7483	.45	74155	.69	74221	1.19
7422	.45	7485	.55	74156	.59	74251	.75
7423	.58	7486	.35	74157	.58	74273	1.85
7425	.29	7489	1.85	74158	1.65	74276	1.88
7426	.29	7490	.35	74159	1.58	74279	.75
7427	.25	7491	.85	74160	.79	74283	1.40
7428	.55	7492	.45	74161	.89	74284	2.90
7430	.18	7493	.35	74162	.69	74285	2.90
7432	.29	7494	.85	74163	.69	74290	1.49
7437	.25	7495	.50	74164	.69	74298	1.49
7438	.29	7496	.69	74165	.69	74365	.55
7439	.58	7497	2.70	74166	.85	74366	.55
7440	.19	74100	1.50	74167	2.75	74367	.55
7441	.79	74107	.24	74170	1.25	74368	.55
7442	.45	74109	.37	74172	4.75	74390	1.45
7443	1.15	74116	1.45	74173	.69	74393	1.33
7444	1.15	74121	.29	74174	.89	74490	2.25
7445	.68	74122	.44	74175	.69		

74LS00

74LS00	$ .15	74LS113	$ .38	74LS247	$ .74
74LS01	.15	74LS114	.39	74LS248	.98
74LS02	.15	74LS122	.45	74LS249	.98
74LS03	.16	74LS123	.95	74LS251	.59
74LS04	.24	74LS124	2.75	74LS253	.59
74LS05	.25	74LS125	.49	74LS257	.59
74LS08	.27	74LS126	.49	74LS258	.59
74LS09	.28	74LS132	.59	74LS259	2.95
74LS10	.25	74LS136	.39	74LS260	.59
74LS11	.33	74LS139	.59	74LS261	2.49
74LS12	.33	74LS135	.59	74LS266	.55
74LS13	.39	74LS145	1.19	74LS273	1.45
74LS14	.59	74LS148	1.38	74LS275	3.29
74LS15	.33	74LS151	.56	74LS279	.58
74LS20	.28	74LS153	.55	74LS283	.68
74LS21	.29	74LS154	1.49	74LS290	.88
74LS22	.29	74LS155	.69	74LS293	.78
74LS25	.29	74LS156	.69	74LS295	.98
74LS27	.28	74LS157	.69	74LS298	.88
74LS28	.29	74LS158	.69	74LS324	1.75
74LS30	.25	74LS160	.69	74LS347	1.96
74LS32	.33	74LS161	.69	74LS348	1.95
74LS33	.53	74LS162	.69	74LS352	1.25
74LS37	.35	74LS163	.69	74LS353	1.29
74LS38	.39	74LS164	.69	74LS363	1.29
74LS40	.25	74LS165	.90	74LS365	.48
74LS42	.44	74LS166	1.90	74LS366	.48
74LS47	.74	74LS168	1.15	74LS367	.45
74LS48	.74	74LS169	1.15	74LS368	.45
74LS51	.25	74LS170	1.40	74LS373	1.33
74LS54	.29	74LS173	.87	74LS374	1.33
74LS55	.29	74LS174	.87	74LS375	.69
74LS73	.39	74LS175	.87	74LS377	1.38
74LS74	.34	74LS181	1.95	74LS385	1.95
74LS75	.39	74LS190	.85	74LS386	.45
74LS76	.39	74LS191	.85	74LS390	1.15
74LS78	.39	74LS192	.78	74LS393	1.15
74LS83	.59	74LS193	.78	74LS395	1.15
74LS85	.69	74LS194	.69	74LS399	1.47
74LS86	.39	74LS195	.69	74LS424	2.95
74LS90	.54	74LS196	.79	74LS668	1.75
74LS92	.54	74LS197	.79	74LS670	2.29
74LS93	.54	74LS221	.89	81LS95	1.45
74LS95	.75	74LS240	.95	81LS96	1.45
74LS96	.89	74LS242	.95	81LS97	1.45
74LS107	.39	74LS243	.95	81LS98	1.45
74LS109	.39	74LS244	1.25	25LS2521	2.69
74LS112	.39	74LS245	1.46	29LS2569	3.60

74S00/PROMS*

74S00	$.25	74S74	$.55	74S159	$.99	74S260	$1.19
74S02	.29	74S85	1.89	74S160	2.49	74S280	1.95
74S03	.29	74S86	.55	74S161	1.89	74S287*	1.95
74S04	.45	74S112	.55	74S174	1.19	74S288*	1.95
74S05	.45	74S113	.55	74S175	1.19	74S373	2.09
74S08	.38	74S114	.55	74S188*	1.49	74S374	2.09
74S09	.39	74S124	2.68	74S194	1.49	74S387*	1.95
74S10	.35	74S132	1.39	74S195	1.48	74S471*	5.95
74S11	.38	74S133	.45	74S196	1.49	74S472*	4.95
74S15	.35	74S134	.50	74S240	1.99	74S473*	4.95
74S20	.39	74S135	.69	74S241	1.99	74S474*	4.95
74S22	.35	74S136	1.39	74S242	1.99	74S475*	4.95
74S30	.35	74S139	.89	74S243	1.99	74S570*	2.95
74S32	.45	74S135	.89	74S244	1.99	74S571*	2.95
74S38	.89	74S140	.55	74S251	1.19	74S572*	4.95
74S40	.39	74S151	.99	74S253	1.19	74S573*	4.95
74S51	.35	74S153	.99	74S257	1.19	74S940	2.49
74S64	.39	74S157	.99	74S258	1.19	74S941	2.49
74S65	.39	CALL FOR 74HC					

IDC CONNECTORS

IDC TYPE	ACP NO	10	20	26	34	40	50
		NUMBER OF CONTACTS					
Solder Header	IDHxxS	.79	1.20	1.65	2.10	2.40	3.00
Rt Angle Solder Header	IDHxxSR	.79	1.20	1.65	2.10	2.40	3.00
Ribbon Header Socket	IDSxx	.75	.95	1.35	1.50	1.85	2.10
Ribbon Header	IDMxx	—	5.25	5.95	6.75	7.25	8.25
Ribbon Edgecard	IDExx	1.70	2.15	2.50	2.60	3.70	3.95
Wirewrap Header	IDHxxW	1.80	2.90	3.75	4.25	4.95	6.50
Rt Angle W/W Header	IDHxxWR	1.99	3.10	4.10	4.20	4.60	7.15

NOTE: To order insert number of contacts in place of xx in ACP part number.
ORDER QUANTITY OF 50pcs (mixed) AND TAKE AN ADDITIONAL 10% OFF.

EPSON PRINTERS

FX-85 (160cps)	$369.00
FX-185 (160cps)	515.00
LX-80 (100 cps)	245.00
LQ-1500 (NLQ)	899.00
FX-80+	339.00

PRINTER SPECIALS

Toshiba 1340	$399.00
Toshiba 341	949.00
Toshiba 351	1099.00
Star SG-10	239.00
Brother 1509	399.00

Inquiry 12

Products Inc.

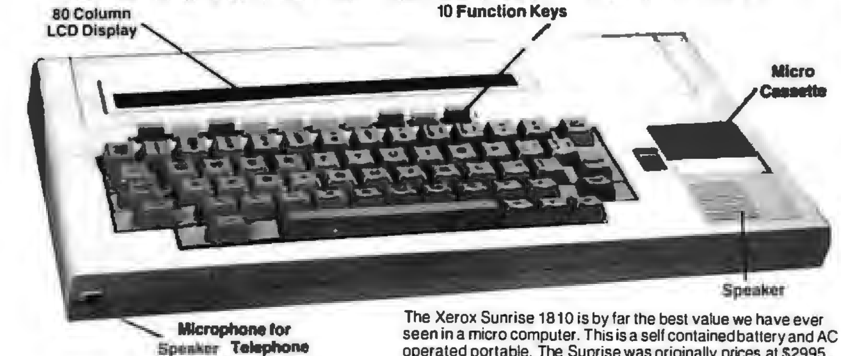
Mail Order:
P.O. Box 17329 Irvine, CA 92713
Retail:
1310 B E. Edinger, Santa Ana, CA 92705

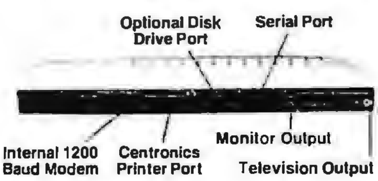
California Digital

17700 Figueroa Street • Carson, California 90248

XEROX ~~$2995~~ $299

SUNRISE COMPUTER



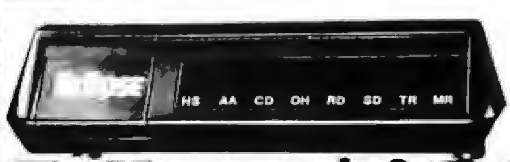


The Xerox Sunrise 1810 is by far the best value we have ever seen in a micro computer. This is a self contained battery and AC operated portable. The Sunrise was originally prices at $2995. Xerox has since elected to drop the computer from their product list. California Digital has purchased all the remaining inventory and is making the unit available at a fraction of its original cost.

This portable features a built in 80 column liquid crystal display, 64K of memory along with both RF monitor and television outputs. The internal 300/1200 baud modem includes an auto dial telephone assembly. The units has both centronics parallel and a serial port programmable to 19,200 baud. The self contained micro cassette is capable of capturing data from the keyboard as well as doubling as an recorder for dictating messages.

An optional dual floppy disk drive module, pictured above, is available for only $219. Also available, for $59 is an 80 column printer that mounts in the drive module. The Sunrise features a CP/M operating system which allows the operator to use any CP/M program in Xerox 5¼" disk format and over 5000 CP/M programs available in public domain.

We have avalable a 15 minute tape on the Sunrise Computer. The tape is in VHS format and was produced by Xerox to promote the computer. California Digital is offerthe promotional tape at $15. This will be applied towards purchase price of the Sunrise 1810.



Eclipse $179

DATA PRODUCTS

1200 Baud • Hayes Compatible

The Eclipse 1200 is the best value we have ever offered in a fully Hayes Compatible modem. The unit incorporates status lamps, speaker; auto dial and many more features into this compact package.

California Digital is so comfident of your complete satisfaction that we will allow the return of the Eclipse 1200 and apply the full credit towards the purchase price of any other modem.

IBM SUPPORT PRODUCTS

MEMORY & SPECIALTY BOARDS

Twix-Winchester, floppy and streamer tape	299
AST Six Pack64K, serial, par'l, clock/cal.	229
AST Six Pack as above but384k/Byte of mem.	239
AST Advantage 128K	419
ASTI/O plus clock/cal., serial & game port	129
Quadram Quadboard II, 64K memory	279
Quadram QuadLink/Apple files	379
Persyst Time Spectrum card, 64K	239
DigiGraphics Multifuncition	219
Titan Tech. PC/Accellertor	499
Hexace RAM card 576K/byte	199
Hexace multifunction	119

GRAPHIC CARDS

Hercules Color Card	179
Hercules Graphic Card	319
Persyst BoB Board super hi-res color.	329
Hexace half slot video card	119
Peacock Color Card, composit/RGB, printer	139
California Comp. SuperVision graphics	379

INTERNAL MODEMS

Modtech UltraLink 1200, 202 half duplex	99
Anchor Auto. Signalman Mk6. 300 baud.	49
Promethus 1200B internal	279

HARDWARE

Tallgrass 60 meg. tape back-up	1459
Kraft IBM JoyStick	35
Microsoft Mouse, serial & paintbrush	145
Mouse Systems PC Mouse	149
8087 co-processor	119
Keytronics 5151 IBM keyboard	199
Belkin A/B switch. par'l or serial	59

SOFTWARE

MicroPro WordStar word processing	179
Ashton Tate Framework, spreadsheet+	395
Ashton Tate D/Base III, DataBase Manager	395
Lotus 1-2-3 spreadsheet & more	299
Symphony by Lotus development	419
Redwood Dev. Jr. CAD, plotter	59

1200 BAUD MODEMS

$159

The Universal Data 212A is manufactured for the mini-computer market. This modem is both 300 and 1200 baud auto answer. An industrial quality modem originally priced at $595. NOT Hayes compatible.

SMARTEAM 1200

$199

The Team 212A offers all the features of the Hayes Smart Modem 1200 for a fraction of the price. Now is your opportunity to purchase a 1200 baud modem at the price of a 300 baud modem.

SIGNALMAN 300 BAUD MARK VI

$49

The Anchor Automation Mark VI is a 300 baud direct connect modem that plugs into any slot of your IBM/PC. This modem supports auto answer and auto dial capabilities. Other features include telephone number storage, send / receive text files, single key-stroke dialing along with many other functions provided on disk. The Mark VI was originally priced at over $300.

UltraLink 1200

$99

The UltraLink is a 1200 baud HALF DUPLEX bell 202 compatible internal modem card for the IBM/PC. This unit operates full duplex at 300 baud.

The UltraLink adds a voice/data demension to your PC. Manufacturers original suggested price on this modem is $795. California Digitals price is only $99.

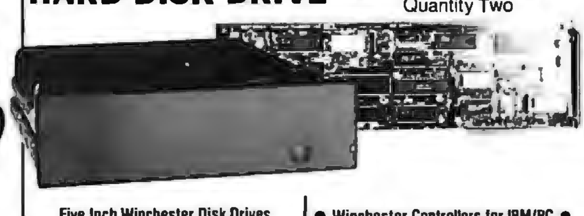
MODEMS

Eclipse 1200 100% Hayes, with status lamps	ECP-1200	179.00
Universal Data 212LP, 1200 duplex, line powered	UDS-212LP	139.00
Universal Data 212A, 300/1200 baud, industrial	UDS-212A	159.00
Universal Data 103JLP, line powered, auto answer	UDS-103LP	29.00
Hayes Smartmodem 2400 baud modem	HYS-2400	599.00
Fujitsu 2400/1200 baud auto everything	FUJ-1935D	459.00
Team 1200 Hayes Compatible, 300/1200 baud	TEM-SM1200	199.00
UltraLink 1200 data and voice on same line	UTL-1200A	99.00
CTS 212AH 1200 baud, auto dial	CTS-212AH	219.00
Terminal software for CTS 212AH	CTS-212SFT	35.00
Prometheus 1200 super features	PRM-P1200	319.00
Prometheus 1200B internal PC	PRM-P1200B	279.00
Signalman Mark 12, 1200 baud, Hayes compatible	SGL-MK12	239.00
Signalman Mark VI, 300 baud internal PC	SGL-MK6	49.00
Hayes Smart Modem 1200 baud, auto dial	HYS-212AD	389.00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	369.00
Hayes Smartmodem, 300 baud only, auto dial	HYS-103AD	199.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
Penril 300/1200 industrial quality	PEN-12AD	395.00

Shugart $239

10 MEGABYTE WINCHESTER HARD DISK DRIVE

Quantity Two



Five Inch Winchester Disk Drives

	each	two+
SHUGART SA712 10 M. Ht.	259	239
SEAGATE ST506 6.7 Meg.	139	129
SEAGATE 225 20 Meg. ½ Ht.	389	359
SEAGATE 4026 26 M. 35mS.	859	829
SEAGATE 4051 51 M. 35mS.	1095	1059
FUJITSU 2242 55 M. 35mS.	1799	1729
FUJITSU 2243 86 M. 35mS.	2295	2219
RODIME RO-202E 27 Meg.	759	729
RODIME RO-203E 40 Meg.	995	959
RODIME RO-204E 53 Meg.	1259	1195
CONTROL DATA 94155-86 M.	1829	1779
MAXTOR XT1140 140 Meg.	3379	3295
HONEYWELL 85M. 27 mS.	1795	1695
TOSHIBA MK56 70 M. 30mS.	1789	1729
TANDON 502 10 Meg.	419	379

• Winchester Controllers for IBM/PC •

FALCON FT-HDC half card	189
XEBEC 1220 with floppy controller	269
NATIONAL COMPUTER 5004	159
OTC 5150BX	159
OMTI 5510 half card	189
ADAPTEC 2010A software install	189
WESTERN DIGITAL WD/1002	189

• SCSI/SASI Winchester Controllers •

XEBEC 1410A 5¼" foot print	239
OMTI 20L	119

• Winchester Accessories •

Installation Kit with manual	10
Winchester enclosure and supply	139
Dual 20/34 cable set	25
Switching power supply	49

TOLL FREE ORDER LINE
(800) 421-5041

TECHNICAL & CALIFORNIA
(213) 217-0500

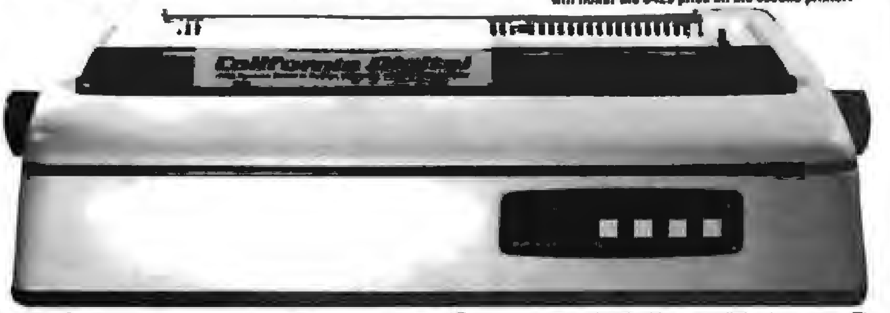
California Digital

17700 Figueroa Street ● Carson, California 90248

LETTER QUALITY F-10 DAISY WHEEL PRINTER

$429 Quantity Two

Single piece price $499. But if you have already purchased an F-10 printer from California Digital, we will honor the $429 price on the second printer.



The TEC F-10 Daisy Wheel printer is the perfect answer to a reasonablly priced 40 character word processing printer. While this printer is " extremely" similar to C.Itoh's F-10/40 Starwriter printer. Legal counsel for the C.Itoh Company have advised us that we should refrain from referring to the TEC printer as a Starwriter.

This 40 character per second printer auto installs with Wordstar and Perfect Writer. Features extensive built-in word processing functions that allow easy adaptability and reduced softwar complexity ndustry provides instant compalibility with all computers equiped with a parallel printer port. The TEC F-10 accepts paper up to 15 inches in width.

These printers were originally priced to sell at over $1400. Through a special arrangment California Digital has purchase these units from a major computer manufacturer and is offering these printers at a fraction of their original cost.

Options available include sheetfeeder, tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

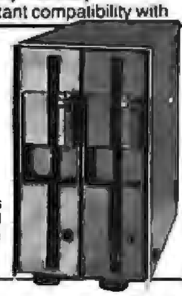
5¼" DISK DRIVE SALE $89

Quantity Two

Your Choice any 48 or 96 TPI drive SHUGART ● TEAC ● QUME ITSUBISHI ● MATSUSHITA

	One	Two	Ten
TEAC FD55B half height	99	89	89
TEAC FD55F 96 TPI, half ht.	119	89	89
TEAC FD55FG for IBM AT	189	179	175
SHUGART SA455 Half Height	99	89	89
SHUGART SA465 ½ Ht. 96TPI	99	89	89
TANDON 100-2 full height	129	125	119
MITSUBISHI 4851 half height	99	89	89
MITSUBISHI 4853 96/TPI ½ Ht.	99	89	89
MITSUBISHI 4854 8" elec.	295	285	275
QUME 142 half height	99	89	89
Switching power supply			49
Installation Kit with manual			10
Dual enclosure for 5¼" drives			59
34 pin edge connectors			5
Scotch head cleaning kit			19
Flip Storage tubs			15

DUAL SHUGART SUBSYSTEM $239



The dual Shugart subsystem features two SA465 (96 tpi) 5¼" double sided disk drives. Also supplied within the power shielded signal cable

Uninterruptable Power Supply $239

free from RFI and EMI monitor upto 12 miniu program and come to hours by connecting to a 12 volt car battery. This is an inexpensive solution to a very costly problem.

QUME $149

Eight Inch Single Sided Drives

QUME 841 single side	159	149	call
SHUGART 801R	359	359	354
SIEMENS FDD 100-8	119	115	109

Eight Inch Double Sided Drives

QUME 842 "QUME TRACK 8"	189	179	call
SHUGART SA851R	495	485	475
OLIVETTI double sided	189	179	159
REMEX RFD-4000	179	169	159
MITSUBISHI M2896-63 ½ Ht.	459	449	409
Dual 8" enclosure with power and fan			259
Switching power supply			89
Installation kit with manual			10

PLOTTER $219

The Comrex Comscriber I is the ideal solution to make short work of translating financial and numeric data into a graphic presentation Many ready to run programs such as Lotus 1-2-3. Visi-on and Apple business graphics already support this plotter

The Comscriber I features programmable paper sizes up to 8½ by 120 inches. 6 inch per second plot speed and 0.004 step size Easy to implement Centronics interface allows the Comscriber I immediate use with the printer port of most personal computers

The Comscriber I is manufactured for Comrex by the Enter Computer Corporation The plotter is marketed by Heath Kit and also sold under Enters own Sweet P Label This is your opportunity to purchase a plotter which was originally priced ; $795 for only $219

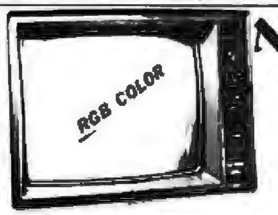
Also available is a support package which includes demonstration oftware, interface cable, a multicolor pen assortment and a vario y of paper and transparen material

Quick-Link 300 $59

The Quick-Link 300 gives you an instant link to any dial up data base. Such as Dow Jones, Western Union or the Source. The Quick-Link has four user programmable log-on keys, allowing the operator, with only one key stroke, to dial the data base, log-in and give the password. All this information is permanently stored in non-volatile RAM.

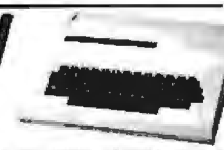
Features include video output to television or monitor, auto dial, auto-log, full sized keyboard, 300 baud modem and 1200 baud auxillary printer port. All this is available for only $59.

NEC RGB COLOR MONITOR $219



The NEC JC-1401D is a 13 medium/high resolution RGB monitor suitable for use with the Sanyo MBC-550/555 or the IBM/PC The monitor features a resolution of 400 dots by 240 lines Colors available are Red, Green, Blue, Yellow, Cyan, Magenta, Black and White The NEC monitor carries the Lilton-Monroe label and was originally scheduled for use in their Office of the Future equipment A change in Monroe's markoting strategy has made ia Digital We are offering these Sanyo compatible NEC-1401/S;

DRAGON $99



Compatible with most Radio Shack Color Computer software. The world famous Dragon computer is now available in the United States. Manufactured by the Tano Corp. under license of the British Broadcasting Company.

The Dragon comes complete with 64K Byte of memory, serial modem port along with a Centronics printer interface. This unique microcomputer features Motorola's advanced 6809E microprocessor and comes standard with Microsoft Color Basic, data base manager, and a complete word processing package. The computer outputs color composite video along with R.F. video that allows the unit to be used in conjunction with any color television.

This is the Ideal low cost computer to be used with any dial up information system such as the Source, EasyLink or any other time share service.

PRINTERS

MATRIX PRINTERS

Star Gemini-SG10 120 char/sec.	STR-SG10	239.00
Star Gemini-SG15, 100 char/sec. 15" paper.	STR-SG15	389.00
Star Gemini Delta 10, 160 Char/sec	STR-D10	359.00
Citizen MSP/10FT 160 char/sec.	CIT-MSP10	289.00
Toshiba P1351, 192 char/sec. letterquality	TOS-1351	1495.00
Okidata 182A serial & parallel 9½" paper	OKI-182A	257.00
Okidata 192A parallel interface, 160 char/sec.	OKI-192A	345.00
Okidata 84P parallel 15" paper	OKI-84P	789.00
Epson LX-80 10" 120 Char/sec.	EPS-LX80	239.00
Epson FX80FT, 10" 160 char./sec. with graphtrax	EPS-FX80	369.00
Epson RX100+ 15" withGraphtrax	EPS-RX100	389.00
Epson FX100FT 15" 160 char./sec with graphtrax	EPS-FX100	489.00
Epson LQ1500, 15" corespondence quality	EPS-LQ1500	895.00
Epson JX80 Color printer	EPS-JX80	519.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	329.00
Dataproducts B-600-3, band printer 600 LPM.	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	3995.00
Printronix P600 ultra high speed 600 lines per minute.	PTX-P600	5795.00

WORD PROCESSING PRINTERS

Starwriter F10 parallel, 40char/sec.	PRO-F10P	499.00
NEC8810 55 char/second, serial interface	NEC-8810	1659.00
NEC8830 55 char/sec. par'l interface	NEC-8830	1659.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599.00
NEC2050 designed for IBM/PC 20 char/sec par'l	NEC-2050	689.00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	319.00
Silver Reed EXP550 17 Char/sec par'l interface.	SRD-EXP550	429.00
Diablo 630 40 char/sec. serial	DBL-630	1569.00
Diablo 620, proportional spacing, horz.& vert. tab. 20 cps.	DBL-620	769.00
Juki 6100, 18 char./sec	JUK-6100	399.00
Juki 6300 40 char./sec	JUK-6300	699.00
proportional spacing par'l		395.00

VISA

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. ● COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.

master charge

HARD DISK DRIVE SALE!

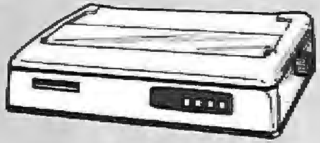
JADE COMPUTER PRODUCTS
1975 - 1985
10 YEARS
SATISFACTION GUARANTEED!

Why pay $1149 for a C.Itoh STARWRITER™ F-10

When our 40 cps letter quality daisywheel from the same manufacturer is only

AS LOW AS **$399.95**

EACH	$499
2-5	$429
5 or more	$399



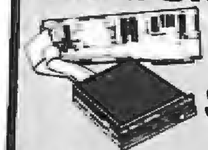
Bi-directional deluxe tractor	$249	$149.95
Automatic cut sheet feeder	$449	$249.95

™StarWriter is a Trademark of C. Itoh Digital Products, Inc.

135/150 WATT Drop-in replacement POWER SUPPLY For your IBM PC

	LIST	JADE
135 Watt	$199	$95.95
150 Watt	$249	$115.95

10 MEGABYTE Hard Disk System FOR YOUR IBM PC



$389.95

Complete with controller card, data cable, and mounting hardware, totally PC/XT compatible. For external model (cabinet & power supply)—add $199.

	LIST	JADE
10 MB Internal ½ High	$990	$389.95
20 MB Internal ½ High	$1550	$489.95
20 MB for AT, 60-80 ms	$999	$399.95
20 MB Hi-Speed for AT	$1250	$699.95
30 MB Hi-Speed for AT	$1550	$899.95
10 MB Tape Back-up	$699	$399.95

JADE 1200 External Baud Modem $179.95

	LIST	JADE
JADE 1200 Baud External	$349	179.95
JADE 2400 Baud External	$699	$499.95
JADE 1200B Internal	$349	$179.95
HAYES Smartmodem 2400	$899	$629.95
HAYES Smartmodem 1200	$699	$389.95
HAYES 1200B w/o Smartcom II	$539	$339.95
HAYES 1200B for IBM PC	$599	$359.95
HAYES Smartmodem 300	$289	$169.95
HAYES Micromodem IIe	$299	$169.95
HAYES Smartmodem IIc	$399	$169.95
Modem Cable	$35	$24.95
ProModem 300c for Apple IIc	$199	$149.95
ProModem 1200B for IBM PC	$399	$289.95
ProModem 1200 RS-232	$495	$299.95
ProModem 1200A for Apple	$449	$349.95
ProModem 1200 for Macintosh	$495	$349.95
Alpha/num Display Option	$99	$79.95
Options Processor	$99	$79.95
64K Mem Expansion for Above	$99	$19.95
Modem Cable	$35	$24.95

Expand Your IBM PC, IBM PC-XT, IBM PC-AT

AST BOARDS ON SALE!

	LIST	JADE
AST Six Pak Plus 64K	$395	$249.95
AST Six Pak Plus 384K	$945	$299.95
AST Rampage 256K	$495	$379.95
AST Rampage 2 MB	$1995	$679.95
AST Advantage-AT 128K	$595	$399.95
AST Advantage-AT 3 MB	$4145	$999.95
IRMA 3270 Board	$1195	$988.95

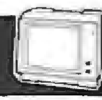
TALLTREE JRAM-2/JRAM-3

0K JRAM-2	$179.95
1 MB JRAM-2	$399.95
2 MB JRAM-2	$599.95
256K JRAM-3	$329.95
1 MB JRAM-3	$499.95
2 MB JRAM-3	$629.95

INTEL/LOTUS ABOVE BOARD

For Your IBM PC		For IBM PC-AT	
64K	$349.95	128K	$529.95
256K	$399.95	512K	$629.95
512K	$449.95	1 MB	$729.95
1 MB	$549.95	2 MB	$929.95
2 MB	$749.95	4 MB	$1599.95

High Resolution Video Monitors



	LIST	JADE
Amdek 300G	$179	$139.95
Amdek 300A	$199	$149.95
Amdek 310A	$230	$179.95
PGS MAX-12 E 720 x 350	$269	$179.95
PGS HX-12 640 x 240	$699	$449.95
PGS HX-12E 690 x 350	$785	$549.95
Taxan 640 Ultra Hi-Res RGB	$799	$599.95
JADE Hi-Res TTL Monochrome 750 x 350 w/free tilt & swirl; green/amber	$229	$149.95

HIGH RESOLUTION 640 x 260, .38 Dot Pitch TAXAN 415 RGB COLOR MONITOR

Originally manufactured for Acorn Computer.

$289

LIST PRICE $699
IBM cable—$14.95

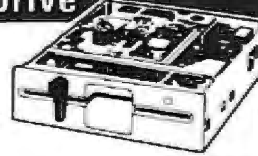
64K RAM Chip Upgrade Kits $9.99

High speed RAM upgrade kit with FREE parity (error detection) and one year warranty. We ship thousands of these kits to satisfied customers every week.

	LIST	JADE
128K RAM Chip Kit for AT	$395	$99.95
256K RAM Chip Kit	$99	$39.95

360K Disk Drive

IBM PC, XT or Compatibles.



$69.95

	LIST	JADE
TANDON 100-2, DS, DD	$299	$119.95
TEAC 55B, DS, DD	$249	$99.95
TEAC 55F, DS, QD 720K	$299	$99.95

High Speed APU Chips

8087-3	$119.95	80287	$199.95
8087-2	$129.95		

KEYTRONICS

	LIST	JADE
KB5150 Improved IBM Keyboard	$209	$159.95
KB5151 Deluxe IBM Keyboard	$299	$199.95
KB5153T Touch Pad	$399	$299.95

Inquiry 178

5¼" BASF FLEXYDISKS

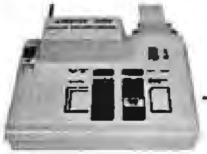
	10-90	100 +
SS / DD Soft	$ .92 ea.	$ .89 ea.
DS / DD Soft	$1.02 ea.	$ .99 ea.
High Density (IBM - AT)	$2.59 ea	$2.49 ea
3.5 / SS Micro	$2.10 ea.	$2.05 ea.

In Stock — Immediate Shipment.
Mastercard, VISA, Check or Money Order.
Add $3.00 shipping charges per each 100 or part.
Add $2.50 additional for C.O.D. shipments.
N.J. residents add 6% sales tax.

Data Exchange
Dept. B, P.O. Box 993
178 Route 206 South
Somerville, N.J. 08876
(201) 874-5050

Inquiry 394

EPROM PROGRAMMER



APROTEK 1000
ONLY
$265.00
COMPLETE WITH PERSONALITY MODULE

117 VOLT AC POWER-RS232
-6 BAUD RATES - HANDSHAKE TO HOST
ALLOWS READ, WRITE, VERIFY & COPY

Comes complete with a CPM, IBM-PC or Apple Driver Program on Disc.

Programs the following 5 Volt 24 or 28 pin devices: 2716 series through 27256, 25xx series, 68764 plus others. Please Specify Personality Module desired with order. Additional Personality Modules only $15.00 ea. **Full 1 year warranty.**

TO ORDER: CALL 1 800 962-5800 OR WRITE
APROTEK
1071 A AVENIDA ACASO
CAMARILLO, CA 93010
Info: (805) 987 2454
Add $4.00 Shipping USA
VISA or MC Add 3%

Inquiry 24

AMX

8080 Z80 6809 — 8086 8088 — Now 68000

Real-Time Multitasking Executive

- No royalties
- Source code included
- Fault free operation
- Ideal for process control
- Timing control provided
- Low interrupt overhead
- Inter-task messages

- Language interfaces: C, Pascal, PL/M, Fortran
- DOS File Access: CP/M-80, IBM PC DOS

Options:

- Resource Manager
- Buffer Manager
- Integer Math Library

AMX for 8080	$ 800 US	
8086	950	
6809	950	
68000	1600	
Manual (specify processor)	75	

KADAK Products Ltd. (604) 734-2796 Telex 04-55670
206-1847 W. Broadway, Vancouver, B.C., Canada V6J 1Y5

Inquiry 190

ChinaStar© II CHINESE WORD PROCESSOR

中文文書處理

$99.

- IBM PC, XT, AT, portable or compatible with 256 K RAM
- Multilingual
- 21,000 Traditional or 11,000 Simplified Chinese characters
- Traditional/Simplified file translation program
- Multiple input methods

JHL RESEARCH, INC.
2552 W. Woodland Dr., Anaheim, CA 92801
(714) 827-7420 Telex: 350481 IBC

Inquiry 186

M68000 SINGLE BOARD COMPUTER

On board 6-10 MHz CPU, 20K RAM, 32K EPROM, two RS-232, 16-bit port, 5-counter/timers expandable via Memory/FDC Board.

M68K CPU (bare board)	$ 89.95
M68K CPU A&T (6MHz)	$495.00
MD512K Memory/FDC (bare board)	$ 89.95
MD512K Memory/FDC (128K)	$495.00
FDC/Hard Disk interface option	$150.00
M68KE Enclosure w/power supply	$249.00
M68K Monitor EPROM's	$ 95.00
M68K MacroCross Assembler	$195.00
4XFORTH OS w/assembler, editor	$295.00
CP/M 68K OS w/"C" compiler	$395.00

EMS Educational Microcomputer Systems
P.O. Box 16115
Irvine, CA 92713
(714) 854-8545

Inquiry 119

15-BIT A/D CONVERTER FOR IBM® PC

+/-5 VOLT INPUT RANGE, FULLY DIFFERENTIAL
0.025% ACCURACY, 4 CHANNELS
7 SAMPLES/SECOND $265
6-CHANNEL THERMOCOUPLE THERMOMETER
FULLY DIFFERENTIAL $175
64-CHANNEL DATA LOGGING SOFTWARE
VOLTAGE, CURRENT OR THERMOCOUPLES
16-CHANNEL STRIP CHART INCLUDED
POWERFUL AND EASY TO USE $150

* * * * * *

FOR APPLE II®

BROAD LINE OF DATA ACQUISITION AND CONTROL PRODUCTS INCLUDING:
8-, 12-, AND 13-BIT A/D CONVERTERS
SAMPLING RATES UP TO 111,000/SECOND
THERMOMETRY, DIGITAL I/O
DATA LOGGING SOFTWARE
CUSTOM HARDWARE AND SOFTWARE
REASONABLE PRICES

LAWSON LABS, INC.
5700 RAIBE ROAD
COLUMBIA FALLS, MT 59912 406-387-5355

Inquiry 204

PC/XT USERS!

COGTREE Utilities by Cogitate	$129.95
LYNC by Norton-Lamber	$199.95
DATAFLEX by Data Access	Varies
RM/COBOL by Ryan/McFarland	Varies
Universe by Omnitrend	$ 98.50
Blue Mac! by Cogitate	$599.00
CadPower + by Trilex	$995.00
Softext Teaching Aids	$ 95.00
PrintSet by Cogitate	$ 79.95
CogiTAPE by Cogitate	CALL!!
Anti-Static Products	Varies
Uninterruptible Power Backups	Varies
TeleVideo Software	CALL!!

COGITATE
"A Higher Form of Software"
24000 Telegraph Road
Southfield, MI 48034
(313) 352-2345/Telex 386581
VISA/MASTERCARD ACCEPTED
Dealer Inquiries Welcomed

Inquiry 63

ICs and Disk Drives

- **64K / 128K / 256K** D-RAMs at LOW PRICES
- **TEAC FD-55BV** DSDD Disk Drives
  $89.00 each or
  $82.00 each for box of 10
  [w/one year factory warranty!]
- **V-20/V-30 TURBO CHARGER**
  - HIGH SPEED—Up to 40% increase!
  - CMOS—Uses 85% less power!
  - REPLACES slow 8088 CPU
  - LOW COST!
- **MEMORY BOARDS**

*ABM SUPERBOARD w/0K	$125.00
*ABM MEM512 w/0K	$ 95.00
*URAM-2 w/0K	$149.00
Expandable 2MB w/0K	$149.00

- **E-PROM, S-RAM, 8087, and 80287s are IN STOCK**
  CALL US FOR DETAILS!

WARRANTY: All ICs are guaranteed for 180 days from the invoice date on defective items. We will replace them free of charge.

ExcelTec Industries, Inc.
P.O. Box 2205 Silver Spring, MD 20902
1015 Gayley Ave. #422, Los Angeles, CA 90024

	West Coast	East Coast
Phone:	(213) 208-6942	(301) 933-3523
FAX:	(213) 208-6846	(301) 933-3643

OEMs and DEALERS are Invited
CALL US FOR THE LATEST PRICES

Inquiry 128

9-TRACK MAG. TAPE SUBSYSTEM FOR THE IBM PC/XT/AT

For information interchange, backup and archival storage, IBEX offers a 9-track, IBM format-compatible ½" magnetic tape subsystem for the IBM PC, featuring:

- **42 M-Bytes on a single reel.**
- **IBM format 1600 cpi.**
- **Software for PC-DOS, MS-DOS.**

Write, phone or TWX for information

I B E X
IBEX COMPUTER CORP.
20741 Marilla St.
Chatsworth, CA 91311
(818) 709-8100
TWX 910-493-2071

Inquiry 162

4164 200ns 69¢ 41256 150ns $2.95

STATIC RAMS

2101	256x4	(450ns)	1.95
5101	256x4	(450ns)(CMOS)	3.95
2102L-4	1024x1	(450ns)(LP)	.99
2102L-2	1024x1	(250ns)(LP)	1.45
2112	256x4	(450ns)	2.99
2114	1024x4	(450ns)	.99
2114L-4	1024x4	(450ns)(LP)	1.09
2114L-2	1024x4	(200ns)(LP)	1.49
2114L-15	1024x4	(150ns)(LP)	1.95
TMS4044-4	4096x1	(450ns)	1.95
TMM2016-150	2048x8	(150ns)	1.49
TMM2016-100	2048x8	(100ns)	1.95
HM6116-4	2048x8	(200ns)(CMOS)	1.39
HM6116-3	2048x8	(150ns)(CMOS)	1.49
HM6116LP-4	2048x8	(200ns)(CMOS)(LP)	1.49
HM6116LP-3	2048x8	(150ns)(CMOS)(LP)	1.59
HM6116LP-2	2048x8	(120ns)(CMOS)(LP)	2.95
HM6264P-15	8192x8	(150ns)(CMOS)	3.89
HM6264LP-15	8192x8	(150ns)(CMOS)(LP)	3.95
HM6264LP-12	8192x8	(120ns)(CMOS)(LP)	4.49

LP=Low power

DYNAMIC RAMS

4116-250	16384x1	(250ns)	.49
4116-200	16384x1	(200ns)	.69
4116-150	16384x1	(150ns)	.89
4116-120	16384x1	(120ns)	1.49
MK4332	32768x1	(200ns)	6.95
4164-200	65536x1	(200ns)(5V)	.69
4164-150	65536x1	(150ns)(5V)	.79
4164-120	65536x1	(120ns)(5V)	1.95
MCM6665	65536x1	(200ns)(5V)	1.95
TMS4164	65536x1	(150ns)(5V)	1.95
4164-REFRESH	65536x1	(150ns)(5V)(REFRESH)	2.95
TMS4416	16384x4	(150ns)(5V)	4.95
41128-150	131072x1	(150ns)(5V)	5.95
41256-200	262144x1	(200ns)(5V)	2.95
41256-150	262144x1	(150ns)(5V)	2.95

5V=Single 5 Volt Supply REFRESH=Pin 1 Refresh

★★★★HIGH-TECH★★★★

NEC V20 UPD70108 $20.95

REPLACES 8088 TO SPEED UP IBM PC 10-40%

- HIGH-SPEED ADDRESS CALCULATION IN HARDWARE
- PIN COMPATIBLE WITH 8088
- SUPERSET OF 8086/8088 INSTRUCTION SET
- LOW POWER CMOS

8 MHz	V20	UPD70108-8	$24.95
8 MHz	V30	UPD70116-8	$26.95

★★★★SPOTLIGHT★★★★

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

MasterCard VISA

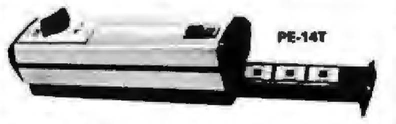
EPROMS

2708	1024x8	(450ns)	3.95
2716-6	2048x8	(650ns)	2.29
2716	2048x8	(450ns)(5V)	1.95
2716-1	2048x8	(350ns)(5V)	2.49
TMS2532	4096x8	(450ns)(5V)	3.95
2732	4096x8	(450ns)(5V)	2.29
2732A	4096x8	(250ns)(5V)(21V PGM)	2.69
2732A-2	4096x8	(200ns)(5V)(21V PGM)	3.95
27C64	8192x8	(250ns)(5V)(CMOS)	5.95
2764	8192x8	(450ns)(5V)	1.95
2764-250	8192x8	(250ns)(5V)	2.49
2764-200	8192x8	(200ns)(5V)	3.49
TMS2564	8192x8	(450ns)(5V)	8.95
MCM68766	8192x8	(350ns)(5V)(24 PIN)	17.95
27128	16384x8	(250ns)(5V)	2.79
27C256	32768x8	(250ns)(5V)(CMOS)	12.95
27256	32768x8	(250ns)(5V)	7.49

5V=Single 5 Volt Supply 21V PGM=Program at 21 Volts

SPECTRONICS CORPORATION

EPROM ERASERS



Model	Timer	Capacity Chip	Intensity (uW/Cm²)	Unit Price
PE-14	NO	9	8,000	$83.00
PE-14T	YES	9	8,000	$119.00
PE-24T	YES	12	9,600	$175.00

8000

8035	1.49
8039	1.95
8080	2.95
8085	2.49
8087-2	139.95
8087	109.00
8088	6.95
8088-2	9.95
8155	2.49
8155-2	3.95
8748	7.95
8755	19.95
80286	129.95
80287	185.00

8200

8203	29.95
8205	3.29
8212	1.49
8216	1.49
8224	2.25
8237	4.95
8237-5	5.49
8250	6.95
8251	1.69
8251A	1.89
8253	1.89
8253-5	1.95
8255	1.69
8255-5	1.89
8259	1.95
8259-5	2.29
8272	4.95
8279	2.49
8279-5	2.95
8282	3.95
8284	2.95
8286	3.95
8288	4.95

Z-80

Z80-CPU 2.5 MHz	1.79

4.0 MHz

Z80A-CPU	1.89
Z80A-CTC	1.95
Z80A-DART	5.95
Z80A-DMA	5.95
Z80A-PIO	1.95
Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95

6.0 MHz

Z80B-CPU	4.95
Z80B-CTC	8.95
Z80B-PIO	8.95
Z80B-DART	14.95
Z80B-SIO/0	12.95
Z80B-SIO/2	12.95
Z8671 ZILOG	19.95

6500

1.0 MHz

6502	2.79
65C02(CMOS)	12.95
6507	9.95
6520	1.95
6522	4.95
6526	26.95
6532	6.95
6545	6.95
6551	5.95
6561	19.95
6581	34.95

2.0 MHz

6502A	2.95
6520A	2.95
6522A	5.95
6532A	11.95
6545A	7.95
6551A	6.95

3.0 MHz

6502B	6.95

6800

1.0 MHz

6800	1.95
6802	4.95
6803	9.95
6809	5.95
6809E	5.95
6810	1.95
6820	2.95
6821	1.95
6840	6.95
6843	19.95
6844	12.95
6845	4.95
6847	11.95
6850	1.95
6883	22.95

2.0 MHz

68B00	4.95
68B02	5.95
68B09E	7.95
68B09	7.95
68B21	4.95
68B45	8.95
68B50	3.95
68B54	7.95

CLOCK CIRCUITS

MM5369	1.95
MM5369-EST	1.95
MM58167	12.95
MM58174	11.95
MSM5832	2.95

CRT CONTROLLERS

6845	4.95
68B45	8.95
6847	11.95
HD46505SP	6.95
MC1372	2.95
8275	26.95
7220	19.95
CRT5027	12.95
CRT5037	9.95
TMS9918A	19.95

DISK CONTROLLERS

1771	4.95
1791	9.95
1793	9.95
1795	12.95
1797	12.95
2791	19.95
2793	19.95
2797	29.95
6843	19.95
8272	4.95
UPD765	4.95
MB8876	12.95
MB8877	12.95
1691	6.95
2143	6.95

BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM8116	8.95
MM5307	4.95

UARTS

AY5-1013	3.95
AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	6.95
IM6403	9.95
INS8250	6.95

SOUND CHIPS

76477	3.95
76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
SP1000	39.00

CRYSTALS

32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.097152	1.95
2.4576	1.95
3.2768	1.95
3.579545	1.95
4.0	1.95
4.032	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
6.5536	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
15.0	1.95
16.0	1.95
17.430	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95
24.0	1.95
32.0	1.95

CRYSTAL OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	4.95
4.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
12.480	4.95
15.0	4.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

MISC.

TMS99531	9.95
TMS99532	19.95
ULN2003	.79
3242	7.95
3341	4.95
MC3470	1.95
MC3480	8.95
MC3487	2.95
11C90	13.95
2513-001 UP	6.95
AY5-2376	11.95
AY5-3600 PRO	11.95

74LS00

74LS00	.16	74LS165	.65
74LS01	.18	74LS166	.95
74LS02	.17	74LS169	.95
74LS03	.18	74LS173	.49
74LS04	.16	74LS174	.39
74LS05	.18	74LS175	.39
74LS08	.18	74LS191	.49
74LS09	.18	74LS192	.69
74LS10	.16	74LS193	.69
74LS11	.22	74LS194	.69
74LS12	.22	74LS195	.69
74LS13	.26	74LS196	.59
74LS14	.39	74LS197	.59
74LS15	.26	74LS221	.59
74LS20	.17	74LS240	.69
74LS21	.22	74LS241	.69
74LS22	.22	74LS242	.69
74LS27	.23	74LS243	.69
74LS28	.26	74LS244	.69
74LS30	.17	74LS245	.79
74LS32	.18	74LS251	.49
74LS33	.28	74LS253	.49
74LS37	.26	74LS256	1.79
74LS38	.26	74LS257	.39
74LS42	.39	74LS258	.49
74LS47	.59	74LS259	1.29
74LS48	.69	74LS260	.49
74LS51	.17	74LS266	.39
74LS73	.29	74LS273	.79
74LS74	.24	74LS279	.39
74LS75	.29	74LS280	1.98
74LS76	.29	74LS283	.59
74LS83	.49	74LS290	.89
74LS85	.49	74LS293	.89
74LS86	.22	74LS299	1.49
74LS90	.39	74LS322	3.95
74LS92	.49	74LS323	2.49
74LS93	.39	74LS364	1.95
74LS95	.49	74LS365	.39
74LS107	.34	74LS367	.39
74LS109	.36	74LS368	.39
74LS112	.29	74LS373	.79
74LS122	.45	74LS374	.79
74LS123	.49	74LS375	.95
74LS124	2.75	74LS377	.79
74LS125	.39	74LS378	1.18
74LS126	.39	74LS390	1.19
74LS132	.39	74LS393	.79
74LS133	.49	74LS541	1.49
74LS136	.39	74LS624	1.95
74LS138	.39	74LS640	.99
74LS139	.39	74LS645	.99
74LS145	.99	74LS669	1.29
74LS147	.99	74LS670	.89
74LS148	.99	74LS682	3.20
74LS151	.39	74LS683	3.20
74LS153	.39	74LS684	3.20
74LS154	1.49	74LS688	2.40
74LS155	.59	74LS783	22.95
74LS156	.49	81LS95	1.49
74LS157	.35	81LS96	1.49
74LS158	.29	81LS97	1.49
74LS160	.29	81LS98	1.49
74LS161	.39	25LS2521	2.80
74LS162	.49	25LS2569	2.80
74LS163	.39	26LS31	1.95
74LS164	.49	26LS32	1.95

HIGH SPEED CMOS

A new family of high speed CMOS logic featuring the speed of low power Schottky (8ns typical gate propagation delay), combined with the advantages of CMOS: very low power consumption, superior noise immunity, and improved output drive.

74HC00

74HC: Operate at CMOS logic levels and are ideal for new, all-CMOS designs.

74HC00	.59	74HC148	1.19
74HC02	.59	74HC151	.89
74HC04	.59	74HC154	2.49
74HC08	.59	74HC157	.89
74HC10	.59	74HC158	.95
74HC14	.79	74HC163	1.15
74HC20	.59	74HC175	.99
74HC27	.59	74HC240	1.89
74HC30	.59	74HC244	1.89
74HC32	.69	74HC245	1.89
74HC51	.59	74HC257	.85
74HC74	.75	74HC259	1.39
74HC85	1.35	74HC273	1.89
74HC86	.69	74HC299	4.99
74HC93	1.19	74HC368	.99
74HC107	.79	74HC373	2.29
74HC109	.79	74HC374	2.29
74HC112	.79	74HC390	1.39
74HC125	1.19	74HC393	1.39
74HC132	1.19	74HC4017	1.99
74HC133	.69	74HC4020	1.39
74HC138	.99	74HC4049	.89
74HC139	.99	74HC4050	.89

74HCT00

74HCT: Direct, drop-in replacements for LS TTL and can be intermixed with 74LS in the same circuit.

74HCT00	.69	74HCT166	3.05
74HCT02	.69	74HCT174	1.09
74HCT04	.69	74HCT193	1.39
74HCT08	.69	74HCT194	1.19
74HCT10	.69	74HCT240	2.19
74HCT11	.69	74HCT241	2.19
74HCT27	.69	74HCT244	2.19
74HCT30	.69	74HCT245	2.19
74HCT32	.79	74HCT257	.99
74HCT74	.85	74HCT259	1.59
74HCT75	.95	74HCT273	2.09
74HCT138	1.15	74HCT367	1.09
74HCT139	1.15	74HCT373	2.49
74HCT154	2.99	74HCT374	2.49
74HCT157	.99	74HCT393	1.69
74HCT158	.99	74HCT4017	2.19
74HCT161	1.29	74HCT4040	1.59
74HCT164	1.39	74HCT4060	1.49

74F00

74F00	.69	74F74	.79	74F251	1.69
74F02	.69	74F86	.99	74F253	1.69
74F04	.79	74F138	1.69	74F257	1.69
74F08	.69	74F139	1.69	74F280	1.79
74F10	.69	74F157	1.69	74F283	3.96
74F32	.89	74F240	3.29	74F373	4.29
74F64	.89	74F244	3.29	74F374	4.29

VISIT OUR RETAIL STORE LOCATED AT 1256 SOUTH BASCOM AVENUE IN SAN JOSE

JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA) • (408) 995-5430
FAX (408) 275-8415 • Telex 171-110

HOURS: M-W-F, 9-5 TU-TH, 9-9 SAT, 10-3

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: Minimum order $10.00. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges - please contact our sales department for the amount. CA. residents must include applicable sales tax. All merchandise is warranted for 90 days unless otherwise stated. Prices are subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

Inquiry 183

PARTIAL LISTING ONLY — CALL FOR A FREE CATALOG

CMOS

4001	.19	14419	4.95
4011	.19	14433	14.95
4012	.25	4503	.49
4013	.35	4511	.69
4015	.29	4516	.79
4016	.29	4518	.85
4017	.49	4522	.79
4018	.69	4526	.79
4020	.59	4527	1.95
4021	.69	4528	.79
4024	.49	4529	2.95
4025	.25	4532	1.95
4027	.39	4538	.95
4028	.65	4541	1.29
4035	.69	4553	5.79
4040	.69	4585	.75
4041	.75	4702	12.95
4042	.59	74C00	.29
4043	.85	74C14	.59
4044	.69	74C74	.59
4045	1.98	74C83	1.95
4046	.69	74C85	1.49
4047	.69	74C95	.99
4049	.29	74C150	5.75
4050	.29	74C151	2.25
4051	.69	74C161	.99
4052	.69	74C163	.99
4053	.69	74C164	1.39
4056	2.19	74C192	1.49
4060	.69	74C193	1.49
4066	.29	74C221	1.75
4069	.19	74C240	1.89
4076	.59	74C244	1.89
4077	.29	74C374	1.99
4081	.22	74C905	10.95
4085	.79	74C911	8.95
4086	.89	74C917	8.95
4093	.49	74C922	4.49
4094	2.49	74C923	4.95
14411	9.95	74C926	7.95
14412	6.95	80C97	.95

7400/9000

7400	.19	74147	2.49
7402	.19	74148	1.20
7404	.19	74150	1.35
7406	.29	74151	.55
7407	.29	74153	.55
7408	.24	74154	1.49
7410	.19	74155	.75
7411	.25	74157	.55
7414	.49	74159	1.65
7416	.25	74161	.69
7417	.25	74163	.69
7420	.19	74164	.85
7423	.29	74165	.85
7430	.19	74166	1.00
7432	.29	74175	.89
7438	.29	74177	.75
7442	.49	74178	1.15
7445	.69	74181	2.25
7447	.89	74182	.75
7470	.35	74184	2.00
7473	.34	74191	1.15
7474	.33	74192	.79
7475	.45	74194	.85
7476	.35	74196	.79
7483	.50	74197	.75
7485	.59	74199	1.35
7486	.35	74221	1.35
7489	2.15	74246	1.35
7490	.39	74247	1.25
7492	.50	74248	1.85
7493	.35	74249	1.95
7495	.55	74251	.75
7497	2.75	74265	1.35
74100	2.29	74273	1.95
74121	.29	74278	3.11
74123	.49	74367	.65
74125	.45	74368	.65
74141	.65	9368	3.95
74143	5.95	9602	1.50
74144	2.95	9637	2.95
74145	.60	96S02	1.95

74S00

74S00	.29	74S163	1.29
74S02	.29	74S168	3.95
74S03	.29	74S174	.79
74S04	.29	74S175	.79
74S05	.29	74S188	1.95
74S08	.35	74S189	1.95
74S10	.29	74S195	1.49
74S15	.35	74S196	1.49
74S30	.29	74S197	1.49
74S32	.35	74S226	3.99
74S37	.69	74S240	1.49
74S38	.69	74S241	1.49
74S74	.49	74S244	1.49
74S85	.95	74S257	.79
74S86	.35	74S253	.79
74S112	.50	74S258	.95
74S124	2.75	74S280	1.95
74S138	.79	74S287	1.69
74S140	.55	74S288	1.69
74S151	.79	74S299	2.95
74S153	.79	74S373	1.69
74S157	.79	74S374	1.69
74S158	.95	74S471	4.95
74S161	1.29	74S571	2.95

VOLTAGE REGULATORS

TO-220 CASE

7805T	.49	7905T	.59
7808T	.49	7908T	.59
7812T	.49	7912T	.59
7815T	.49	7915T	.59

TO-3 CASE

7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49

TO-92 CASE

78L05	.49	79L05	.69
78L12	.49	79L12	.69

OTHER VOLTAGE REGS

LM323K	5V 3A	TO-3	4.79
LM338K	Adj.5A	TO-3	3.95
78H05K	5V 5A	TO-3	7.95
78H12K	12V 5A	TO-3	8.95
78P05K	5V 10A	TO-3	14.95

IC SOCKETS

	1-99	100
8 PIN ST	.11	.10
14 PIN ST	.11	.09
16 PIN ST	.12	.10
18 PIN ST	.15	.13
20 PIN ST	.18	.15
22 PIN ST	.15	.12
24 PIN ST	.20	.15
28 PIN ST	.22	.16
40 PIN ST	.30	.22
64 PIN ST	1.95	1.49
ST=SOLDERTAIL		
8 PIN WW	.59	.49
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80
WW=WIREWRAP		
16 PIN ZIF	4.95	CALL
24 PIN ZIF	5.95	CALL
28 PIN ZIF	6.95	CALL
40 PIN ZIF	9.95	CALL
ZIF=TEXTOOL (ZERO INSERTION FORCE)		

LINEAR

TL066	.99	LM733	.98
TL071	.69	LM741	.29
TL072	1.09	LM747	.69
TL074	1.95	LM748	.59
TL081	.59	MC1330	1.69
TL082	.99	MC1350	1.19
TL084	1.49	MC1372	6.95
LM301	.34	LM1414	1.59
LM309K	1.25	LM1458	.49
LM311	.59	LM1488	.49
LM311H	.89	LM1489	.49
LM317K	3.49	LM1496	.85
LM317T	.95	LM1812	8.25
LM318	1.49	LM1889	1.95
LM319	1.25	ULN2003	.79
LM320	see7900	XR2206	3.75
LM322	1.65	XR2211	2.95
LM323K	4.79	XR2240	1.95
LM324	.49	MPQ2907	1.95
LM331	3.95	LM2917	1.95
LM334	1.19	CA3046	.89
LM335	1.40	CA3081	.99
LM336	1.75	CA3082	.99
LM337K	3.95	CA3086	.80
LM338K	3.95	CA3089	1.95
LM339	.59	CA3130E	.99
LM340	see7800	CA3146	1.29
LM350T	4.60	CA3160	1.19
LF353	.59	MC3470	1.95
LF356	.99	MC3480	8.95
LF357	.99	MC3487	2.95
LM358	.59	LM3900	.49
LM380	.89	LM3909	.98
LM383	1.95	LM3911	2.25
LM386	.89	LM3914	2.39
LM393	.45	MC4024	3.49
LM394H	4.60	MC4044	3.99
TL494	4.20	RC4136	1.25
TL497	3.25	RC4558	.69
NE555	.29	LM13600	1.49
NE556	.49	75107	1.49
NE558	1.29	75110	1.95
NE564	1.95	75150	1.95
LM565	.95	75154	1.95
LM566	1.49	75188	1.25
LM567	.79	75189	1.25
NE570	2.95	75451	.39
NE590	2.50	75452	.39
NE592	.98	75453	.39
LM710	.75	75477	1.29
LM723	.49	75492	.79

H=TO-5 CAN, K=TO-3, T=TO-220

DATA ACQ

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0816	14.95
ADC0817	9.95
ADC0831	8.95
DAC0800	4.49
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1022	5.95
MC1408L8	2.95

INTERFACE

8T26	1.29
8T28	1.29
8T95	.89
8T96	.89
8T97	.59
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65

EDGECARD CONNECTORS

100 PIN ST	S-100	.125	3.95
100 PIN WW	S-100	.125	4.95
62 PIN ST	IBM PC	.100	1.95
50 PIN ST	APPLE	.100	2.95
44 PIN ST	STD	.156	1.95
44 PIN WW	STD	.156	4.95

36 PIN CENTRONICS

MALE

IDCEN36	RIBBON CABLE	6.95
CEN36	SOLDER CUP	4.95
CEN36PC	RT ANGLE PC MOUNT	4.95

FEMALE

IDCEN36/F	RIBBON CABLE	7.95

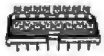
INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	4.95
ICM7207A	5.95
ICM7208	15.95

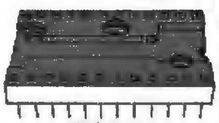
DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	---	.95	.95	---	---	---	1.75	---	2.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE BELOW


ICC18


IDP14


AUGAT 24ST

DIODES/OPTO/TRANSISTORS

1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
1N5402	.25	4N37	1.19
KBP04	.55	MCT-2	.59
KBU8A	.95	MCT-6	1.29
MDA990-2	.35	TIL-111	.99
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

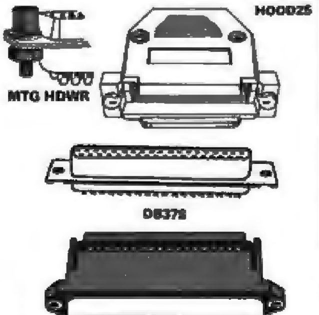
D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.82	.90	1.25	1.25	1.80	3.48
	FEMALE	DBxxS	.95	1.15	1.50	1.50	2.35	4.32
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.20	1.49	---	1.95	2.65	---
	FEMALE	DBxxSR	1.25	1.55	---	2.00	2.79	---
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	---	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	2.70	2.95	---	3.98	5.70	---
	FEMALE	IDBxxS	2.92	3.20	---	4.33	6.76	---
HOODS	METAL	MHOODxx	1.25	1.25	1.30	1.30	---	---
	GREY	HOODxx	.65	.65	---	.65	.75	.95

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED.

EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE $1.00


MTG HDWR

HOOD25

DB37S

IDB37S

LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM CATHODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
MAN-8940	COM CATHODE	.8"	1.99
TIL-313	COM CATHODE	.3"	.45
HP5082-7760	COM CATHODE	.43"	1.29
TIL-311	4x7 HEX W/LOGIC	.270"	9.95
HP5082-7340	4x7 HEX W/LOGIC	.290"	7.95

DIFFUSED LEDS

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

SWITCHES

SPST	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
SPST	TOGGLE ON-OFF	.49
BCD OUTPUT 10 POSITION 6 PIN DIP		1.95

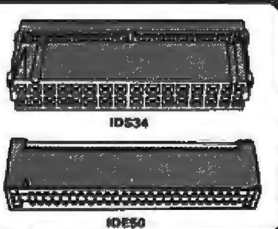
DIP SWITCHES

4 POSITION	.85	7 POSITION	.95
5 POSITION	.90	8 POSITION	.95
6 POSITION	.90	10 POSITION	1.29

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	—	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE ABOVE


IDS34

IDE50

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.18	1.60	.30	2.75
16	.28	2.50	.48	4.40
20	.36	3.20	.60	5.50
25	.45	4.00	.75	6.85
26	.46	4.10	.78	7.15
34	.61	5.40	1.07	9.35
40	.72	6.40	1.20	11.00
50	.89	7.50	1.50	13.25

HARD TO FIND "SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE	1.49
2x40	STRAIGHT LEAD	2.49
2x40	RIGHT ANGLE	2.99

SHORTING BLOCKS

GOLD CONTACTS SPACED AT .1" CENTERS

5/$1.00

Let me tell you how much I appreciate your Sales & Customer Service staffs. My recent order was filled in a most courteous & prompt manner & I will deal with you in the future to the exclusion of other similar firms who obviously don't need customers bothering them. Thank you,

F.K.
Chapel Hill, NC.

CALL FOR VOLUME QUOTES

IN ASSORTED COLORS $27.50
100ea: 5.5", 6.0", 6.5", 7.0"
250ea: 2.5", 4.5", 5.0"
500ea: 3.0", 3.5", 4.0"

$85.00

SPOOLS

100 feet	$4.30	250 feet	$7.25
500 feet	$13.25	1000 feet	$21.95

$69.95

Please specify color:
Blue, Black, Yellow or Red

FR-4 EPOXY GLASS LAMINATE
WITH GOLD-PLATED EDGE-CARD FINGERS

EMI FILTER

- MANUFACTURED BY CORCOM
- LOW COST
- FITS LC-HP BELOW
- 6 AMP 120/240 VOLT

6 FOOT LINE CORDS

LC-2	2 CONDUCTOR	.39
LC-3	2 CONDUCTOR	.99
LC-HP	3 CONDUCTOR W/STD FEMALE SOCKET	1.49

MUFFIN FANS

3.15" SQ	ROTRON	14.95
3.63" SQ	ETRI	14.95
3.18" SQ	MASUSHITA	16.95

IBM-PR2

IBM

BOTH CARDS HAVE SILK SCREENED LEGENDS AND INCLUDES MOUNTING BRACKET

IBM-PR1	WITH +5V AND GROUND PLANE	$27.95
IBM-PR2	AS ABOVE WITH DECODING LAYOUT	$29.95

S-100

P100-1	BARE - NO FOIL PADS	$15.15
P100-2	HORIZONTAL BUS	$21.80
P100-3	VERTICAL BUS	$21.80
P100-4	SINGLE FOIL PADS PER HOLE	$22.75

APPLE

P500-1	BARE - NO FOIL PADS	$15.15
P500-3	HORIZONTAL BUS	$22.75
P500-4	SINGLE FOIL PADS PER HOLE	$21.80
7060-45	FOR APPLE IIe AUX SLOT	$30.00

TS-806
ONE TEAC FD
HEIGHT HA
MAJOR
PERFECT FOR T

LY $99.95
A FULL OR ½
ECIAL FROM A
SAY WHO).

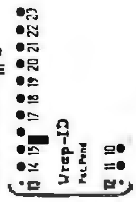
HURRY — QUANTIT ES ARE LIMITED!
SPECIALS END 2/28/86

SOCKET-WRAP I.D.™

- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON PLASTIC; SUCH AS IC #

PINS	PART#	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)



IDWRAP 24

FRAME STYLE TRANSFORMERS

12.6V AC CT	2 AMP	5.95
12.6V AC CT	4 AMP	7.95
12.6V AC CT	8 AMP	10.95
25.2V AC CT	2 AMP	7.95

SWITCHING POWER SUPPLIES

PS-IBM $99.95

- FOR IBM PC-XT COMPATIBLE
- 130 WATTS
- +5V @ 15A, +12V @ 4.2A -5V @ .5A, -12V @ .5A
- ONE YEAR WARRANTY

PS-IBM

PS-130 $99.95

- 130 WATTS
- SWITCH ON REAR
- FOR USE IN OTHER IBM TYPE MACHINES
- 90 DAY WARRANTY

PS-130

PS-A $49.95

- USE TO POWER APPLE TYPE SYSTEMS
- +5V @ 4A, +12V @ 2.5A -5V @ .5A, -12V @ .5A
- APPLE POWER CONNECTOR

PS-SPL200 $49.95

PS-A

- +5V @ 25A, +12V @ 3.5A -5V @ 1A, -12V @ 1A
- UL APPROVED
- ALUMINUM ENCLOSURE

PS-TDK

- +5V @ 4A, +12V @ 2A +12V @ 2.8A, -12V @ .30A
- 6.2" x 7.4" x 1.7", 1.6 LBS.

PS-11951

- MANUFACTURED BY ASTEC
- +5V @ 6A, +12V @ 2A +12V @ 1.5A, -12V @ 2A,
- 5.0" x 8.0" x 2.0", 1.6 LBS.

CAPACITORS

TANTALUM

15V	.35	.47µf	35V	.45
15V	.70	1.0	35V	.45
15V	.80	2.2	35V	.65
15V	1.35	4.7	35V	.85
35V	.40	10	35V	1.00

DISC

50V	.05	680	50V	.05
50V	.05	.001µf	50V	.05
50V	.05	.0022	50V	.05
50V	.05	.005	50V	.05
50V	.05	.01	50V	.07
50V	.05	.02	50V	.07
50V	.05	.05	50V	.07
50V	.05	.1	12V	.10
50V	.05	.1	50V	.12

MONOLITHIC

50V	.14	.1µf	50V	.18
50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL	
25V	.14	1µf	50V	.14
35V	.15	10	50V	.16
50V	.15	22	16V	.14
50V	.15	47	50V	.20
35V	.18	100	35V	.25
16V	.18	220	25V	.30
35V	.20	470	50V	.50
25V	.30	1000	16V	.60
16V	.70	2200	16V	.70
25V	1.45	4700	16V	1.25
		44,000µf	30V	3.95

- ERASES TWO EPROMS IN 10
- COMPACT-NO DRAWER
- THIN METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

5% CARBON FILM ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG. OHM

10 PCS	same value .05	100 PCS	same value .02
50 PCS	same value .025	1000 PCS	same value .015

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR
SIP	8 PIN	7 RESISTOR
DIP	16 PIN	8 RESISTOR
DIP	16 PIN	15 RESISTOR
DIP	14 PIN	7 RESISTOR
DIP	14 PIN	13 RESISTOR

MICROCOMPUTER HARDWARE HANDBOOK

FROM ELCOMP $14.95

OVER 800 PAGES OF DATA SHEETS ON THE MOST COMMONLY USED ICs. INCLUDES TTL, CMOS, 74LS00, MEMORY, CPUs, MPU SUPPORT. AND MUCH MORE!

JDR Microdevices

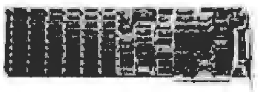
1224 South Bascom Avenue, San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA) • (408) 995-5430 • FAX (408) 275-8415 • Telex 171-110

IBM COMPATIBLE INTERFACE CARDS

ALL WITH A ONE YEAR WARRANTY

MULTIFUNCTION CARD $129.95

ALL THE FEATURES OF AST'S 6 PACK PLUS AT HALF THE PRICE

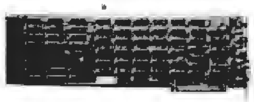


- CLOCK/CALENDAR
- 0-384K RAM
- SERIAL PORT
- PARALLEL PORT
- GAME PORT
- SOFTWARE INCLUDED

PRINTER CABLE $9.95 64K RAM UPGRADE 9/$6.21

COLOR GRAPHICS ADAPTOR $99.95

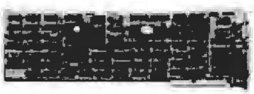
FULLY COMPATIBLE WITH IBM COLOR CARD



- 4 VIDEO INTERFACES: RGB, COMPOSITE COLOR, HI-RES COMPOSITE MONOCHROME, CONNECTOR FOR RF MODULATOR
- COLOR GRAPHICS MODE: 320 x 200
- MONO GRAPHICS MODE: 640 x 200
- LIGHT PEN INTERFACE

MONOCHROME GRAPHICS CARD $129.95

FULLY COMPATIBLE WITH IBM MONOCHROME ADAPTOR AND HERCULES GRAPHICS CARD



- LOTUS COMPATIBLE
- TEXT MODE: 80 x 25
- GRAPHICS MODE: 720 x 348
- PARALLEL PRINTER INTERFACE
- OPTIONAL SERIAL PORT $19.95

FLOPPY DISK DRIVE ADAPTOR $59.95

- INTERFACES UP TO FOUR STANDARD FDDs TO IBM PC OR COMPATIBLES
- INCLUDES CABLE FOR TWO INTERNAL DRIVES

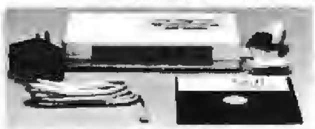
1200 BAUD INTERNAL MODEM FOR IBM

INCLUDES PC TALK III COMMUNICATIONS SOFTWARE

- HAYES COMPATIBLE
- AUTO DIAL/AUTO ANSWER
- AUTO RE-DIAL ON BUSY
- INCLUDES SERIAL PORT!
- ONE YEAR WARRANTY

EASYDATA-12B $195

300 BAUD MODEM FOR APPLE OR IBM



CLOSE-OUT SPECIAL NOW ONLY

WHILE SUPPLY LASTS

$49.95

INCLUDES ASCII PRO-EZ SOFTWARE (A $100 VALUE IN ITSELF)

- FCC APPROVED
- BELL SYSTEMS 103 COMPATIBLE
- INCLUDES AC ADAPTOR
- AUTO DIAL/AUTO ANSWER
- DIRECT CONNECT

CABLE FOR APPLE IIc $14.95

Canon

160 CPS PRINTER

MODEL PW-1080A

$199.95 Printed in Draft mode or Proportional and NLQ

- VERY HIGH SPEED PRINTING (160 CPS)
- EPSON/IBM COMPATIBLE CONTROL
- 11 x 9 DOT DRAFT MODE CHARACTERS
- 23 x 18 DOTS IN NEAR LFTTER QUALITY
- 2K PRINT BUFFER
- DOWNLOADING FONT BUFFER
- FAN FOLD, CUTSHEET OR ROLL PAPER
- SOLID "BUSINESS" MACHINE

UNBELIEVABLE MONITOR DEALS

TAXAN RGB VISION III

MODEL 415

MADE FOR TAXAN BY ACORN
- 640 x 262 PIXEL RESOLUTION
- 16 COLORS
- 18 MHz BANDWIDTH
- 12" BLACK MATRIX
- IBM AND LOTUS COMPATIBLE

CABLE FOR IBM $15.95

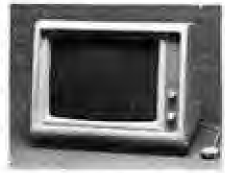
$289.95

SAKATA COMPOSITE COLOR

MODEL SC-100

- TOP RATED FOR APPLE
- 13" COMPOSITE VIDEO
- RESOLUTION: 280H x 300V
- INTERNAL AUDIO AMPLIFIER
- ONE YEAR WARRANTY

$169.95



SAMWOO MONOCHROME

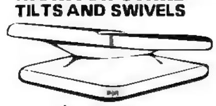
MODEL DM-216B

- PERFECT COSMETIC MATCH FOR IBM PC
- IBM COMPATIBLE TTL INPUT
- 12" NON-GLARE SCREEN
- P39 GREEN PHOSPHOR
- HI-RES 22 MHz BAND WIDTH

$99.95

MONITOR STAND

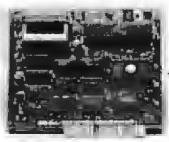
TILTS AND SWIVELS



$12.95

APPLE COMPATIBLE INTERFACE CARDS

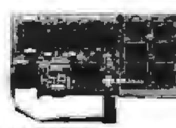
EPROM PROGRAMMER $59.95



PRICE REDUCED!

MODEL RP525

- DUPLICATE OR BURN ANY STANDARD 27xx SERIES EPROM
- EASY TO USE MENU-DRIVEN SOFTWARE INCLUDED
- MENU SELECTION FOR 2716, 2732, 2732A, 2764 & 27128
- HIGH SPEED WRITE ALGORITHM
- LED INDICATORS FOR ACTIVITY
- NO EXTERNAL POWER SUPPLY REQUIRED
- ONE YEAR WARRANTY



16K RAMCARD $39.95

- FULL TWO YEAR WARRANTY
- EXPAND YOUR 48K APPLE TO 64K
- USE IN PLACE OF APPLE LANGUAGE CARD

BARE PC CARD W/ INSTRUCTIONS $9.95

IC TEST CARD $99.95

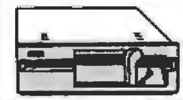
- QUICKLY TESTS MANY COMMON ICs
- DISPLAYS PASS OR FAIL
- ONE YEAR WARRANTY
- TESTS: 4000 SERIES CMOS 74HC SERIES CMOS 7400; 74LS, 74L, 74H, 74S, SOME PROMS AND RAMS

DISK DRIVES

FOR APPLE COMPUTERS

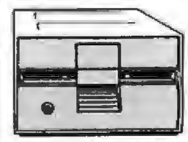
BAL-525 $99.95

- ½ HEIGHT-ALPS MECHANISM
- 100% APPLE COMPATIBLE
- FULL 1 YEAR WARRANTY



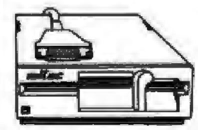
BAL-500 $129.95

- TEAC MECHANISM- DIRECT DRIVE
- 100% APPLE COMPATIBLE
- FULL 1 YEAR WARRANTY



AP-135 $129.95

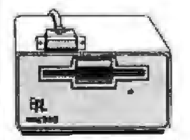
- FULL HT. SHUGART MECHANISM
- DIRECT REPLACEMENT FOR APPLE DISK II
- SIX MONTH WARRANTY



FOR APPLE IIc

AD-3C $139.95

- 100% APPLE IIc COMPATIBLE, READY TO PLUG IN W/ SHIELDED CABLE & MOLDED 19 PIN CONNECTOR
- FAST, RELIABLE SLIMLINE DIRECT DRIVE
- SIX MONTH WARRANTY



FOR MACINTOSH

MAC 535 $249.95

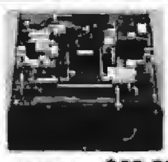
- 3.5" ADD-ON DISK DRIVE
- 100% MACINTOSH COMPATIBLE
- SINGLE SIDED 400K BYTE STORAGE
- HIGH RELIABILITY DRIVE FEATURES AUTO-EJECT MECHANISM
- FULL ONE YEAR WARRANTY

DISK DRIVE ACCESSORIES

DISK CONTROLLER CARD $49.95
APPLE IIc ADAPTOR CABLE $19.95
ADAPTS STANDARD APPLE DRIVES FOR USE WITH APPLE IIc

PS-IBM 130 WATTS $99.95

TEAC DISK DRIVES FOR IBM PCs



FD-55B	DS/DD	$89.95
FD-55F	DS/QUAD	$99.95

COMREX CR-1000 DUAL SLIMLINE DISK DRIVE $199.95

FOR APPLE COMPUTERS

- SPACE SAVING DESIGN STACK BETWEEN COMPUTER AND MONITOR
- QUIET, RELIABLE ½ HEIGHT DRIVES
- TOTAL STORAGE CAPACITY: 286K BYTES
- AUTO-EJECT MECHANISM
- SHIELDED CABLE INCLUDED

INCLUDES CONTROLLER AND DOS 3.3 WITH DISK UTILITIES

ALL MERCHANDISE 100% GUARANTEED

U·N·C·L·A·S·S·I·F·I·E·D A·D·S

NEEDED: Nonprofit organization needs donation of IBM compatibles, monitors, printers, and Hayes-compatible modems for conflict resolution and mediation training and education project in Costa Rica, Central America. Peaceworkers, 3149 Plymouth Rd., Lafayette, CA 94549, (415) 935-3565.

TRADE: Two white-water rafting tickets in exchange for an IBM PC XT or compatible for our training adventure teaching people with severe cerebral palsy to use micros and obtain employment. Tax-deductible. Kathleen Martin, Computer Access Project, 1904 Franklin St., Oakland, CA 94612, (415) 832-7430.

NEEDED: Nonprofit school for emotionally disturbed children seeks tax-deductible donation of Apple computers, peripherals, literature, supplies, etc. Will provide receipts. Dean Esmay, SMA Independence High School, 22700 Richton Square Rd., Richton Park, IL 60471, (312) 481-6091.

WANTED: Volunteer programmer seeks contribution of IBM, Apple, or compatible, peripherals, and literature for Institution of Social Work and Community Development projects and development of public-domain educational programs for literacy training in underdeveloped areas. Jeffrey Y. Balanag, 3536 Road Ten, Altura St., Sta. Mesa, Metro-Manila 2806, Republic of the Philippines.

NEEDED: UNIX system, IBM or compatible micros, terminals, monitors, printers, and other equipment for training and user's group sponsored at Maine State Prison. Tax-deductible. George Fernald, Maine State Prison Jaycees, Box A, Thomaston, ME 04861, or call David Macmillan or Bruce Wentworth at (207) 354-2535, ext. 293.

WANTED: Tax-deductible IBM PC-compatibles, monitors, printers, and copying machines for U.S. professors helping revive scientific psychology in China through graduate program at Liaoning Teachers University. Macintosh with printer also welcome. Shipping paid. Dr. J. S. Phillips, Child Study Center, University of Denver, Denver, CO 80208.

WANTED: Nonprofit educational institution seeks tax-deductible contribution of an Apple IIe or IIc with printer for class use. Sherrill Jones, Northside Elementary School, Milledgeville, GA 31061, (912) 452-8502.

WANTED: Nonprofit youth-benefitting organization seeks 256K IBM PC, daisy-wheel printer, and public-domain software and/or 256K Apple IIe for business and training use. Will pay shipping and send receipt. John Donohue, San Francisco Youth Sports Travel Fund Inc., POB 31488, San Francisco, CA 94131, (415) 661-5002.

WANTED: Nonprofit after-school day-care center seeks tax-deductible donation of public-domain word-processing and database software for Apple II+. Karen Schiller, Havurah Youth Center, San Francisco Jewish Community Center, 3200 California St., San Francisco, CA 94118, (415) 346-6040, ext. 224.

WANTED: Tax-deductible contributions welcomed by nonprofit organization acting as equipment clearinghouse for many nonprofit organizations needing hardware donations in Montana, Idaho, and Wyoming. Northern Rockies Action Group, 9 Placer, Helena, MT 59601, (406) 442-6615.

WANTED: Nonprofit organization specializing in promoting family life seeks tax-deductible donations of computer equipment to expand services. Marian Redinger, Beginning Family, 14260 Lake Hills Blvd., Bellevue, WA 98007, (206) 644-2207.

WANTED: Tax-deductible donation of TRS-80 computer and peripherals or Kaypro and compatible CP/M machines to support orthodox church group community project. Monastery of St. Justin Martyr, POB 844, El Dorado, CA 95623, (916) 644-6652.

NEEDED: Small church seeks computer system (IBM, Apple, or Commodore) for bookkeeping and word processing. Donations are tax-deductible. Templo El Olivar, POB 729, Sunland Park, NM 88063, (915) 778-8605.

NEEDED: Word-processing and computer equipment to assist nonprofit ministry to preach in all parts of the world. Charles and Yvonne Svitlik, Cornerstone Ministries, POB 845, Waterbury, CT 06720.

WANTED: Nonprofit tax-exempt organization needs donation of IBM PC, Apple, TRS-80, or compatible for general accounting and stock-control applications. Mrs. Z. Elizondo, Confraternity of Christian Doctrine, 276 Pitt St., Sydney, New South Wales 2000, Australia.

WANTED: Nonprofit community service organization seeks tax-deductible donation of Apple or compatible with printer. New Life Foundation, Box 2000, Ojai, CA 93023.

WANTED: Swedish student would like to correspond with others who have an interest in artificial intelligence in general and LISP in particular. Fredrik Nyman, Pilvägen 1, S-616 00 Åby, Sweden.

WANTED: I need to convert my Apple II to a II+, but I can't find the autostart ROMs. Can anyone help? Richard Ashby, M.D., 9713 Old Creek Rd., Ventura, CA 93003, (805) 649-2725 or 652-6153.

WANTED: Information on punch-card readers, including interface for connection to an Apple II+ or CompuPro (S-100) running a Z80 processor. Walter F. George, M.D., 1345 East 14th St., San Leandro, CA 94578, (415) 483-6367.

WANTED: A copy of BYTE document #112 (LISP interpreter for the 6800 or similar document for the 6809). Mark Wilson, POB 14, Huntingdon, PA 16652.

WANTED: Documentation on OEM (parallel) interface Diablo Hi-Type II daisy-wheel printer including pin assignments, voltage levels, etc. Maintenance information also appreciated. Will refund postage costs. Dick Dixon, Ilmarin, Vale View Dr., Beech Hill, Reading RG7 2BD, England.

WANTED: Working Intel 4004 and 8008 microprocessor chips for science museum exhibit. Send price. Ray Albrektson, 900 Edgehill Court, Covington, KY 41011.

WANTED: BYTE, issues 1 through 10. Will pay reasonable price for good condition. Dave Jenson, 7200 Marilyn NE, Albuquerque, NM 87109, (505) 821-0109.

WANTED: Information about sales places of literature for Casio FP-200 notebook computer, particularly on how to create an assembly program and to redefine the character set. Javier Argandoña Lazo, Dr. Johow No. 385, Ñuñoa, Santiago, Chile.

FOR SALE: TI-99/4A, cassette-recorder cable, and books: $130, Timex Sinclair 1000: $20, ColecoVision: $140. Atari 5200: $170. I will pay postage. Heriberto Suarez, Buzon 3034, Trujillo Alto, Puerto Rico 00760.

FOR SALE: DEC PDP-11/05 system with 32K, includes restart/LDR, CRC/LRC arithmetic element, Unibus CTL RK06-EA 120/60, single-access RK06 120/60 Hz, 10½-inch expander box 120 V. DEC maintained. Best offer. Mary Ann Atkins, Fountaindale Public Library District, 300 West Briarcliff Rd., Bolingbrook, IL 60439, (312) 759-2103.

FOR SALE: Radio Shack information distribution network. Five TRS-80 Model II terminals, four disk drives, one MUX. Sue, Data Support Service, 7711 Carondelet 504, Clayton, MO 63015.

FOR SALE: PDP-11/10, two RK05s, Laboratory Peripheral System, VT-52, and manuals. $800. Science Unlimited Research Foundation, 311-D Spencer Lane, San Antonio, TX 78201.

FOR SALE: Complete system board for Columbia 1600-1, 8088 processor, one parallel and two serial ports, power supply, and documentation. $400. Paul Bookbinder, 150 West 87th St., New York, NY 10024, (212) 840-1327.

UNCLASSIFIED ADS MUST *be noncommercial, from readers who have computer equipment to buy, sell, or trade on a onetime basis. All requests for donated computer equipment must be from nonprofit organizations. Programs to be exchanged must be written by the individual or be in the public domain. Ads must be typed double-spaced, contain 50 words or less, and include full name and address. This is a free service; ads are printed as space permits.* BYTE *reserves the right to reject any unclassified ad that does not meet these criteria. When you submit your ad* (BYTE, *Unclassified Ads,* POB 372, *Hancock,* NH 03449), *allow at least four months for it to appear.*

FOR SALE: Apple II+ (64K) with two Apple drives, Zenith monitor, Epson MX-80 F/T with graphics chips, RS-232 interface, RF modulator, manuals, and accessories. Excellent condition. $1100. John Lipa, 165 Harcross Rd., Woodside, CA 94062, (415) 366-0547.

WANTED: Commodore 64 and 128 users in U.S. and Canada for public-domain software club. Jonathan Harte, 138 Birch-Hill Dr., Ottawa, Ontario K1K 3Y5, Canada, (613) 746-7392.

FOR SALE: NEC PC-8001A computer, 8031 dual 150K disk drives, Renaissance Technology Wedge, NEC JB1201 monitor, extra RS-232C port, sound synthesizer board, A/D/A ports, Centronics parallel port, and 300-bps modem. $1700. James Bucan, 278 Sisson St., Romeo, MI 48065, (313) 752-2660.

FOR SALE: Dimension 68000, 1-megabyte RAM, four floppy-disk drives, and IBM, Z80, and Apple emulation boards. Asking $6000. Stan Miley, 2812 Hillside Dr., Bryan, TX 77802, (409) 846-1664.

FOR SALE: S-100 system 6-slot Integrand mainframe, Teletek FDC-I CPU/disk controller 5¼-inch and 8-inch formats, two RS-232C ports, parallel ports, CompuPro RAM 16, two 8-inch 1.2-megabyte drives, two monitors, two printers, 300/1200-bps modem, and documentation. $2500 or best offer. Art Morton, 2513 Dawes St., Rancho Cordova, CA 95670, (916) 363-8144.

FOR SALE: Hazeltine Executive 80 Model 20 terminal, 80/132 columns, up to 19,200 bps, character graphics, eight programmable function keys, detachable keyboard. Paul Wick, 10503 Jimenez St., Lake View Terrace, CA 91342, (818) 896-3502.

FOR SALE: Tektronix 60-MHz oscilloscope, Model 2215, dual trace, dual time base, delayed sweep, with manuals, probes, and cover. $1200 or best offer. Richard Gorton, DVI-C68544, POB 600, Tracy, CA 95376.

FOR SALE: Sol-20 48K computer with Micropolis 630K dual drive Model 1053 MOD II, manuals, and more. All in good condition. $750 plus postage. John L. Gorman Sr., 210 Sprague Ave., South Plainfield, NJ 07080.

WANTED: ALSPA ACI-2 CP/M computer. Duncan Moyer, 13418 Garden Bar, Grass Valley, CA 95945, (916) 268-0115.

FOR SALE: BYTE: January 1982, 23 copies will be sold individually by lottery for $5 each. Send SASE for drawing. Selene Pappas, 23644 North 84th St., Scottsdale, AZ 85255.

WANTED: Hewlett-Packard 86/87, 128K memory module, serial (RS-232C) interface, I/O ROM, modem, and plotter ROM. D. Bran, 12335 Santa Monica Blvd. #192, Los Angeles, CA 90025.

FOR SALE: Intersystems S-100 system, 64K, Z80, two serial and two parallel ports, two Shugart 850 DS/DD, C. Itoh 101 terminal, PROM burner, modem, and more. $1400 or best offer. Martin Unger, 1415 Northwest 62nd St., Ft. Lauderdale, FL 33309, (305) 772-3070.

FOR SALE: BYTE: June through December 1976: $20; 1977 through 1983: $30 per year. David Baldwin, 22 Fox Den Rd., Hollis, NH 03049, (603) 465-7857.

FOR SALE: Mannesmann Tally MT-160 printer. Epson-compatible, 160 cps, has near-letter-quality mode. In fine working condition. Asking $200. Also, Apple 80-column card: $25. Dave Schultz, 12801 Countryview Court, Burnsville, MN 55337.

WANTED: EPROM copy, disk copy, source code, or hex dump of operating system for TLC Problem Solver Intelligent Terminal (TOS version 1.011 or later). Also schematics or other documentation. (PSS Inc. out of business in 1979.) Will provide TOS in 2732 for your terminal. Tim Vest, 4 Cambridge Rd., Convent Station, NJ 07961, (201) 993-8541.

WANTED: Correspondence about computers for solar and greenhouse applications. John Wilson, 29001 Harvey Lane, Corvallis, OR 97330.

FOR SALE: Hewlett-Packard 9816 personal computer, 9121 two-drive unit, 82906A dot-matrix printer, and all manuals. Mint condition. W. M. Davidson, 4405 West Pyracantha, Tucson, AZ 85741, (602) 742-3982.

FOR SALE: Cromemco Trace System simulator Model TSS-S, $15. N. Conroy, 177 Tosca Dr., Stoughton, MA 02072, (617) 344-1352. ■

B·O·M·B

BYTE's Ongoing Monitor Box

BOMB *Results*

SIMULATION TABULATION

Lawrence Cone wins $100 for his article "Skycam: An Aerial Robotic Camera System," which placed first in the results of October's issue. In second place is the theme "Why Models Go Wrong" by Tom R. Houston, who wins $50. Part 2 of Clifford Kelley's "EGO: A Homebuilt CPU" covering "The Hardware" came in third. Steve Ciarcia, Bruce Webster, and Jerry Pournelle remain popular with readers. Hats off to all.

R·E·A·D·E·R S·E·R·V·I·C·E

TO GET FURTHER information on the products advertised in BYTE, either pick up your touch-tone telephone and use TIPS (if you are a subscriber), or fill out the reader service card. Either way full instructions are provided following this reader service index which is provided as an additional service by the publisher, who assumes no liability for errors or omissions. *Correspond directly with company.

* *Correspond directly with company.*

INTERNATIONAL ADVERTISING SECTION

No domestic inquiries, please.

TIPS

SUBSCRIBERS ONLY! *

Use BYTE's Telephone Inquiry Processing System

Using TIPS can bring product information as much as 10 days earlier.

SEND FOR YOUR SUBSCRIBER I.D. CARD

1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label.** We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: (413) 442-2668 and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter □ □ □ □ □ □ □ □ □ □ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 1 6 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. □ □ □ # # 6. □ □ □ # # 10. □ □ □ # # 14. □ □ □ # #
2. □ □ □ # # 7. □ □ □ # # 11. □ □ □ # # 15. □ □ □ # #
3. □ □ □ # # 8. □ □ □ # # 12. □ □ □ # # 16. □ □ □ # #
4. □ □ □ # # 9. □ □ □ # # 13. □ □ □ # # 17. □ □ □ # #
5. □ □ □ # #

END SESSION

8) End session by entering * * 9 1 # #

9) Hang up after hearing final message
If you are a subscriber and need assistance, call (603) 924-9281.

Available 24 Hours, 7 Days a Week

If you are not a subscriber fill out the subscription card found in this issue or, call BYTE Circulation 800-258-5485.

*Domestic and Canadian Subscribers Only!

BYTE READER SERVICE

Fill out this coupon carefully. PLEASE PRINT. Requests cannot be honored unless the zip code is included. This card is valid for 6 months from cover date.

JANUARY 1986
4116

Name ____________________

(Title) ____________________ (Company) ____________________

Address ____________________ Telephone ____________________

City ____________________ State ______ Zip ____________

I purchased this copy by ☐ Subscription ☐ Newsstand, computer store, or bookstore

1 23 45 67 89	111 133 155 177 199	221 243 265 287 309	331 353 375 397 419	441 463 485 507 529	551 573 595 617 639	661 683 705 727 749	771 793
2 24 46 68 90	112 134 156 178 200	222 244 266 288 310	332 354 376 398 420	442 464 486 508 530	552 574 596 618 640	662 684 706 728 750	772 794
3 25 47 69 91	113 135 157 179 201	223 245 267 289 311	333 355 377 399 421	443 465 487 509 531	553 575 597 619 641	663 685 707 729 751	773 795
4 26 48 70 92	114 136 158 180 202	224 246 268 290 312	334 356 378 400 422	444 466 488 510 532	554 576 598 620 642	664 686 708 730 752	774 796
5 27 49 71 93	115 137 159 181 203	225 247 269 291 313	335 357 379 401 423	445 467 489 511 533	555 577 599 621 643	665 687 709 731 753	775 797
6 28 50 72 94	116 138 160 182 204	226 248 270 292 314	336 358 380 402 424	446 468 490 512 534	556 578 600 622 644	666 688 710 732 754	776 798
7 29 51 73 95	117 139 161 183 205	227 249 271 293 315	337 359 381 403 425	447 469 491 513 535	557 579 601 623 645	667 689 711 733 755	777 799
8 30 52 74 96	118 140 162 184 206	228 250 272 294 316	338 360 382 404 426	448 470 492 514 536	558 580 602 624 646	668 690 712 734 756	778 800
9 31 53 75 97	119 141 163 185 207	229 251 273 295 317	339 361 383 405 427	449 471 493 515 537	559 581 603 625 647	669 691 713 735 757	779 801
10 32 54 76 98	120 142 164 186 208	230 252 274 296 318	340 362 384 406 428	450 472 494 516 538	560 582 604 626 648	670 692 714 736 758	780 802
11 33 55 77 99	121 143 165 187 209	231 253 275 297 319	341 363 385 407 429	451 473 495 517 539	561 583 605 627 649	671 693 715 737 759	781 803
12 34 56 78 100	122 144 166 188 210	232 254 276 298 330	342 364 386 408 430	452 474 496 518 540	562 584 606 628 650	672 694 716 738 760	782 804
13 35 57 79 101	123 145 167 189 211	233 255 277 299 321	343 365 387 409 431	453 475 497 519 541	563 585 607 629 651	673 695 717 739 761	783 805
14 36 58 80 102	124 146 168 190 212	234 256 278 300 322	344 366 388 410 432	454 476 498 520 542	564 586 608 630 652	674 696 718 740 762	784 806
15 37 59 81 103	125 147 169 191 213	235 257 279 301 323	345 367 389 411 433	455 477 499 521 543	565 587 609 631 653	675 697 719 741 763	785 807
16 38 60 82 104	126 148 170 192 214	236 258 280 302 324	346 368 390 412 434	456 478 500 522 544	566 588 610 632 654	676 698 720 742 764	786 808
17 39 61 83 105	127 149 171 193 215	237 259 281 303 325	347 369 391 413 435	457 479 501 523 545	567 589 611 633 655	677 699 721 743 765	787 809
18 40 62 84 106	128 150 172 194 216	238 260 282 304 326	348 370 392 414	458 480 502 524 546	568 590 612 634 656	678 700 722 744 766	788 810
19 41 63 85 107	129 151 173 195 217	239 261 283 305 327	349 371 393 415	459 481 503 525 547	569 591 613 635 657	679 701 723 745 767	789 811
20 42 64 86 108	130 152 174 196 218	240 262 284 306 328	350 372 394 416	460 482 504 526 548	570 592 614 636 658	680 702 724 746 768	790 812
21 43 65 87 109	131 153 175 197 219	241 263 285 307 329	351 373 395 417	461 483 505 527 549	571 593 615 637 659	681 703 725 747 769	791 813
22 44 66 88 110	132 154 176 198 220	242 264 286 308 330	352 374 396 418	462 484 506 528 550	572 594 616 638 660	682 704 726 748 770	792 814

BYTE's BOMB is your direct line to the editor's desk. Each month, the two top-rated authors receive bonuses based on your evaluation. First look at the list of this month's articles and corresponding article numbers (located on the page preceding the Reader Service list), then rate each article you've read as Excellent, Good, Fair, or Poor, based on your overall impression of the article, by circling the appropriate number in each column below. Your feedback helps us produce the best possible magazine each month.

Article No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Excellent	1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	61	65	69	73	77	81	85	89	93	97
Good	2	6	10	14	18	22	26	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98
Fair	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99
Poor	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100

Article No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Excellent	101	105	109	113	117	121	125	129	133	137	141	145	149	153	157	161	165	169	173	177	181	185	189	193	197
Good	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170	174	178	182	186	190	194	198
Fair	103	107	111	115	119	123	127	131	135	139	143	147	151	155	159	163	167	171	175	179	183	187	191	195	199
Poor	104	108	112	116	120	124	128	132	136	140	144	148	152	156	160	164	168	172	176	180	184	188	192	196	200

BYTE READER SERVICE

Fill out this coupon carefully. PLEASE PRINT. Requests cannot be honored unless the zip code is included. This card is valid for 6 months from cover date.

JANUARY 1986
4116

Name ____________________

(Title) ____________________ (Company) ____________________

Address ____________________ Telephone ____________________

City ____________________ State ______ Zip ____________

I purchased this copy by ☐ Subscription ☐ Newsstand, computer store, or bookstore

1 23 45 67 89	111 133 155 177 199	221 243 265 287 309	331 353 375 397 419	441 463 485 507 529	551 573 595 617 639	661 683 705 727 749	771 793
2 24 46 68 90	112 134 156 178 200	222 244 266 288 310	332 354 376 398 420	442 464 486 508 530	552 574 596 618 640	662 684 706 728 750	772 794
3 25 47 69 91	113 135 157 179 201	223 245 267 289 311	333 355 377 399 421	443 465 487 509 531	553 575 597 619 641	663 685 707 729 751	773 795
4 26 48 70 92	114 136 158 180 202	224 246 268 290 312	334 356 378 400 422	444 466 488 510 532	554 576 598 620 642	664 686 708 730 752	774 796
5 27 49 71 93	115 137 159 181 203	225 247 269 291 313	335 357 379 401 423	445 467 489 511 533	555 577 599 621 643	665 687 709 731 753	775 797
6 28 50 72 94	116 138 160 182 204	226 248 270 292 314	336 358 380 402 424	446 468 490 512 534	556 578 600 622 644	666 688 710 732 754	776 798
7 29 51 73 95	117 139 161 183 205	227 249 271 293 315	337 359 381 403 425	447 469 491 513 535	557 579 601 623 645	667 689 711 733 755	777 799
8 30 52 74 96	118 140 162 184 206	228 250 272 294 316	338 360 382 404 426	448 470 492 514 536	558 580 602 624 646	668 690 712 734 756	778 800
9 31 53 75 97	119 141 163 185 207	229 251 273 295 317	339 361 383 405 427	449 471 493 515 537	559 581 603 625 647	669 691 713 735 757	779 801
10 32 54 76 98	120 142 164 186 208	230 252 274 296 318	340 362 384 406 428	450 472 494 516 538	560 582 604 626 648	670 692 714 736 758	780 802
11 33 55 77 99	121 143 165 187 209	231 253 275 297 319	341 363 385 407 429	451 473 495 517 539	561 583 605 627 649	671 693 715 737 759	781 803
12 34 56 78 100	122 144 166 188 210	232 254 276 298 330	342 364 386 408 430	452 474 496 518 540	562 584 606 628 650	672 694 716 738 760	782 804
13 35 57 79 101	123 145 167 189 211	233 255 277 299 321	343 365 387 409 431	453 475 497 519 541	563 585 607 629 651	673 695 717 739 761	783 805
14 36 58 80 102	124 146 168 190 212	234 256 278 300 322	344 366 388 410 432	454 476 498 520 542	564 586 608 630 652	674 696 718 740 762	784 806
15 37 59 81 103	125 147 169 191 213	235 257 279 301 323	345 367 389 411 433	455 477 499 521 543	565 587 609 631 653	675 697 719 741 763	785 807
16 38 60 82 104	126 148 170 192 214	236 258 280 302 324	346 368 390 412 434	456 478 500 522 544	566 588 610 632 654	676 698 720 742 764	786 808
17 39 61 83 105	127 149 171 193 215	237 259 281 303 325	347 369 391 413 435	457 479 501 523 545	567 589 611 633 655	677 699 721 743 765	787 809
18 40 62 84 106	128 150 172 194 216	238 260 282 304 326	348 370 392 414 436	458 480 502 524 546	568 590 612 634 656	678 700 722 744 766	788 810
19 41 63 85 107	129 151 173 195 217	239 261 283 305 327	349 371 393 415 437	459 481 503 525 547	569 591 613 635 657	679 701 723 745 767	789 811
20 42 64 86 108	130 152 174 196 218	240 262 284 306 328	350 372 394 416 438	460 482 504 526 548	570 592 614 636 658	680 702 724 746 768	790 812
21 43 65 87 109	131 153 175 197 219	241 263 285 307 329	351 373 395 417 439	461 483 505 527 549	571 593 615 637 659	681 703 725 747 769	791 813
22 44 66 88 110	132 154 176 198 220	242 264 286 308 330	352 374 396 418 440	462 484 506 528 550	572 594 616 638 660	682 704 726 748 770	792 814

To get further information on the products advertised in BYTE, fill out the reader service card with your name and address. Then circle the appropriate numbers for the advertisers you select from the list. Add a first-class stamp to the card, then drop it in the mail. Not only do you gain information, but our advertisers are encouraged to use the marketplace provided by BYTE. This helps us bring you a bigger BYTE. The index is provided as an additional service by the publisher, who assumes no liability for errors or omissions.

PLACE
POSTAGE
HERE

BYTE

READER SERVICE
PO BOX 298
DALTON, MA 01227-0298
USA

PLACE
POSTAGE
HERE

BYTE

READER SERVICE
PO BOX 298
DALTON, MA 01227-0298
USA

BYTE

SUBSCRIPTIONS

4116

For a subscription to BYTE, please complete this card.

	USA	Canada Mexico
☐ 1 year	☐ $21	☐ $23
☐ 2 years	☐ $38	☐ $42
☐ 3 years	☐ $55	☐ $61

Name ______________________

Address ______________________

City ______________________

State ________ Zip ______ Country ________

Card No. ______________________

Expiration date ______________________

Four digits above name—Master Charge only ________

Signature ______________ Date ________

Please allow eight weeks for processing. Thank you.

☐ $69. Europe (air delivery) payment enclosed
☐ $37 Worldwide (surface mail) payment enclosed
(Air mail rates available upon request)

Please remit in US funds drawn on a US bank. Thank you.

☐ Check enclosed (Bonus: [North American only] one EXTRA issue—receive 13 issues for the price of 12)

☐ VISA ☐ Master Charge

☐ Bill me (North America only)

BYTE

SUBSCRIPTIONS

4116

For a subscription to BYTE, please complete this card.

	USA	Canada Mexico
☐ 1 year	☐ $21	☐ $23
☐ 2 years	☐ $38	☐ $42
☐ 3 years	☐ $55	☐ $61

Name ______________________

Address ______________________

City ______________________

State ________ Zip ______ Country ________

Card No. ______________________

Expiration date ______________________

Four digits above name—Master Charge only ________

Signature ______________ Date ________

Please allow eight weeks for processing. Thank you.

☐ $69. Europe (air delivery) payment enclosed
☐ $37 Worldwide (surface mail) payment enclosed
(Air mail rates available upon request)

Please remit in US funds drawn on a US bank. Thank you.

☐ Check enclosed (Bonus: [North American only] one EXTRA issue—receive 13 issues for the price of 12)

☐ VISA ☐ Master Charge

☐ Bill me (North America only)

Note our special offer! Send cash with your order and receive 13 issues for the price of 12 for each year you subscribe. (North America only, please)

Don't Miss An Issue!

Have BYTE delivered to your door.

Each month BYTE will bring you the latest in microcomputer technology.

DISCOVER and IMPLEMENT new ideas. Don't miss the original information presented in the pages of BYTE.

With BYTE you'll always be among the first to know about the important breakthroughs, worthwhile new equipment, and innovative projects in the world of computing.

CHALLENGE US to deliver the very best idea in microcomputers and advanced technology to you. Return the attached card today!

Subscribe to BYTE—the world's leading computer magazine.

PLACE
POSTAGE
HERE

BYTE SUBSCRIPTIONS
PO Box 597
Martinsville, NJ 08836-0597
USA

PLACE
POSTAGE
HERE

BYTE SUBSCRIPTIONS
PO Box 597
Martinsville, NJ 08836-0597
USA

THIS NEC PRINTER CAN MANUFACTURE 2 MILLION CARS WITHOUT A REPAIR.

Color Pinwriter CP5 dot matrix printer.

To build 2 million of these cars requires printing more than 25 billion dots. And that's how many our new Pinwriter™ P5 printer can print before you have to think about a repair.

This NEC printer is not an exception. In fact, any NEC printer can run an average of 5 years in normal use before it needs a repair.

Such reliability doesn't come easy. Every NEC printer is built on a highly automated assembly line. From the most advanced components in the industry. Then it's subjected to some of the most demanding tests ever devised for printers.

Reliability is not the only thing this NEC printer has going. It's also the quietest dot matrix printer in its class. And it has the finest graphics resolution, plus more built-in true fonts. And it's the fastest multi-speed 24-pin dot matrix printer available.

Now don't you wish NEC also made cars?

Check out a new Pinwriter P5 at your nearest NEC dealer. Or for more information, call 1-800-343-4418 (in MA 617-264-8635). Or write: NEC Information Systems, Dept. 1610, 1414 Massachusetts Ave., Boxborough, MA 01719.

NEC PRINTERS. THEY ONLY STOP WHEN YOU WANT THEM TO.

NEC

NEC Information Systems, Inc.

C&C Computers and Communications

Inquiry 265

Next to your computer,

nothing beats a Tandy® printer.

Tandy printers make fine print quality, graphics and high performance affordable.

For the best value and selection in printers, shop Radio Shack Computer Centers. Match any of these top-quality printers with your Tandy, IBM® PC or PC-compatible computer*.

Low-Cost Business Printer

The DMP 430 (26-1277, $899) is a dot-matrix printer with an 18-wire print head that delivers superior correspondence characters. Choose from micro, italic and double-high fonts, as well as bit-image graphics. In the draft mode, DMP 430 prints 180 characters per second.

Triple-Mode Personal Printer

The low-cost, versatile DMP 130 (26-1280, $349.95) lets you choose from word processing or data processing modes, as well as dot-addressable graphics. Prints in four character styles: standard or italic cursive in draft or correspondence modes.

Budget-Priced High Performer

The DMP 105 (26-1276, $199.95) is the low-cost solution for data processing and general-purpose use. Features a bit-image graphics mode, too. Prints 80 characters per second in the draft mode.

Dot-Matrix Power for Business

Get high speed and high performance with the DMP 2200 (26-1279, $1695). The draft font prints at an outstanding 380 characters per second. For correspondence, the near letter-quality mode delivers 90 characters per second. That's faster than most daisy-wheel printers.

Available at over 1500 Radio Shack Computer Centers and at participating Radio Shack stores and dealers.

Radio Shack®
COMPUTER CENTERS
A DIVISION OF TANDY CORPORATION

Inquiry 303

*DMP 105 requires optional-extra IBM Printer Emulator (700-2118, $29.95) for IBM compatibility. Prices apply at Radio Shack Computer Centers and at participating stores and dealers. IBM/Registered TM International Business Machines Corp.