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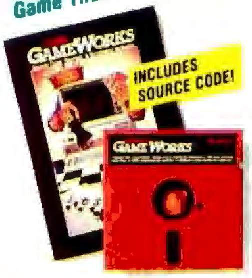
Graphics Algorithms

Turbo Pascal Programming

Learn Secrets, Strategies, Game Theory!



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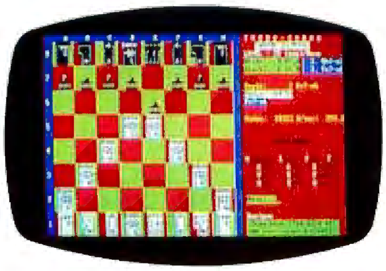

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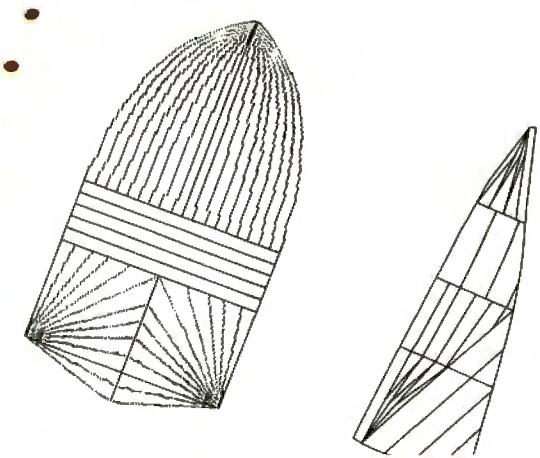
America's Cup. Coming Soon!

How to use Scratch 'n Win Rebates

It's really simple. You purchase the product between 9/5/86 and 3/31/87, and return the license agreement along with dated proof of purchase and your rebate card. We'll mail you a check for $10.00 on single product purchases or a check for $15.00 when you buy an advertised "bundle"—which means our Turbo Pascal Jumbo Pack, or Turbo Lightning and Lightning Word Wizard, or Reflex: The Analyst and Reflex Workshop, or SideKick and Traveling SideKick. (Restrictions do apply. See Official Rules on back of Instant Winner card).

Sail designs generated from Shore Sails' Turbo Pascal programs



Turbo Pascal Programming

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5th-Generation Language!

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Bruce Webster, BYTE

"Borland International, Inc. is gunning onto the fast track in the artificial intelligence and engineering-language-software race, riding aboard a new $99 Turbo Prolog," says Tom Schwartz in *Electronic Engineering Times.* And so we are. Our new Turbo Prolog has drawn rave reviews—which we think are well deserved—because Turbo Prolog brings 5th-generation language and supercomputer power to your IBM PC and compatibles. Turbo Prolog is a high-speed compiler for the artificial intelligence language, Prolog, which is probably one of the most powerful programming languages ever conceived. We made a worldwide impact with Turbo Pascal and you can expect the same results and revolution from Turbo Prolog, the natural language of artificial intelligence. Darryl Rubin, writing in *AI Expert* said, *"Turbo Prolog offers generally the fastest and most approachable implementation of Prolog."* Suggested retail, $99.95. Use a $10.00 Scratch 'n Win Rebate and that goes down to only *$89.95!* Minimum memory: 384K.

Technical Specifications:

TURBO PASCAL 3.0 Minimum memory 128K, includes 8087 and BCD features for 16-bit MS-DOS and CP M-86 systems CP/M-80 version minimum memory 48K, 8087 and BCD features not available ***TURBO DATABASE TOOLBOX*** Minimum memory 128K CP M-80 minimum memory 48K Requires Turbo Pascal 2.0 or later ***TURBO GRAPHIX TOOLBOX**** Minimum memory 192K Requires PC/MS-DOS 2.0 or later, Turbo Pascal 3.0, and IBM CGA, Hercules Monochrome Card or equivalent ***TURBO TUTOR 2.0*** Minimum memory 192K CP/M-80 version minimum memory 48K Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0 ***TURBO EDITOR TOOLBOX**** Minimum memory 192K Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0 ***TURBO GAMEWORKS**** Minimum memory 192K Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0 ***TURBO PROLOG**** Minimum memory 384K ***REFLEX: THE ANALYST**** Minimum memory 384K Requires IBM CGA Hercules Monochrome Card or equivalent Works with Intel's AboveBoard-PC and -AT AST's RAMpage! and RAMpage! AT Quadram's Liberty-PC and -AT, Tecmar's 640 Plus, IBM's EGA and 3270/PC, AT&T's 6300 and many others ***REFLEX WORKSHOP**** Minimum memory 384K Requires Reflex The Analyst ***TURBO LIGHTNING**** Minimum memory 256K Two disk drives required Hard disk recommended ***LIGHTNING WORD WIZARD**** Minimum memory 256K Requires Turbo Lightning Turbo Pascal 3.0 required to edit source code ***SIDEKICK**** Minimum memory 128K ***TRAVELING SIDEKICK**** Minimum memory 256K ***SUPERKEY**** Minimum memory 128K *For IBM PC, AT XT, PCjr and true compatibles only, running PC/MS-DOS 2.0 or later

Build Your Own Word Processor!

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Turbo Editor Toolbox™

Recently released, we called our new Turbo Editor Toolbox a "construction set to write your own word processor." Peter Feldmann of *PC Magazine* covered it pretty well with, *"A 'write your own word processor' program for intermediate level programmers, with lots of help in the form of prewritten procedures covering everything from word wrap to pull-down windows."* Source code is included, and we also include MicroStar, a full-blown text editor with pull-down menus and windowing. It interfaces directly with Turbo Lightning to let you spell-check your MicroStar files. Jerry Pournelle of *BYTE* magazine said, *"The new Turbo Editor Toolbox is the Turbo Pascal source code to just about anything you ever wanted a PC-compatible text editor to do."* Suggested retail: $69.95. Use a $10.00 Scratch 'n Win Rebate and you'll get all this for *only $59.95!* Minimum memory: 192K.

MicroStar file directory accessed by pull-down menu

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Turbo Lightning wins the 1986 World Class PC Award for "Most Promising Newcomer"!

Solve your gift-giving and spelling problems now with Turbo Lightning

While you use SideKick, Reflex, Lotus 1-2-3® and most popular programs, Turbo Lightning proofreads *as you write*! If you misspell a word, Turbo Lightning will beep at you instantly, and suggest a correction for the word you just misspelled. Press one key, and the misspelled word is immediately replaced by the correct word. And if you're ever stuck for a word, Turbo Lightning's thesaurus is there with instant alternatives. Perfect gift for everyone who reads and writes!

Attention SideKick users! Your SideKick now has a sidekick!

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It's the electronic organizer for this electronic age—a professional binder, a software program and a report generator—a modern business tool that prints your ever-changing appointments in daily/weekly/monthly/yearly form. Your appointments, phone list, address list, meeting schedule, travel itinerary—even your mailing list—can be kept up-to-the-minute correct *and with you*! (SideKick Owners: All your files translate instantly to Traveling SideKick.) Traveling SideKick is electronic, so it's good for this year, next year and all the next years after that—it's not a dusty old diary that dies Dec. 31!

BI-1075C

OFFICIAL RULES - BORLAND INSTANT WINNER GAME

1. NO PURCHASE NECESSARY: To participate, you may obtain a game card inserted into the October, November, December, or January issue of the following magazines: PC World; Byte; PC Tech Journal; PC Magazine. You may also obtain a game card by mailing a self-addressed, stamped envelope to: Borland International Game Card, P.O. Box 870, Wilton, CT 06897. (Washington State residents send self-addressed envelope.) Limit one game card per stamped request. All requests must be received by January 15, 1987.

2. TO PLAY: Remove the rub-off area on the game card to reveal what prize or rebate offer you have obtained.

3. PRIZES/ REBATES: Beneath the rub-off area one of the following prizes may be revealed: Trip for Two to America's Cup Races or $10,000; 1986 Suzuki 4W Samurai Convertible or $6,895; AST Turbo Laser; Toshiba 1100 Portable Computer; Toshiba 3100 Portable Computer; AST Sixpakpremium; AST Advantagepremium; AST 3G Pak; AST Rampage; AST Rampage AT; Free Borland Product, or you may obtain the following rebate offer: $10 rebate offer on any individual product or $15 rebate offer on any single advertised Borland bundle (See rule # 11 for prize details.).

4. PRIZE CLAIMS: If you obtain one of the prizes stated in Rule # 3, sign your full legal signature on the game card and send via certified mail (copy should be made for your records) along with your name and address to: Borland International Prize Claim, 196 Danbury Road, Wilton, CT 06897. All prize claims must be received or postmarked by February 15, 1987. (See Rule # 12 for Trip for Two to America's Cup exception.)

5. REBATE CLAIMS: Rebates are good for products purchased from September 5, 1986 through March 31, 1987. The $10 rebate is good for any individual Borland product and the $15 rebate is good for any advertised Borland software bundle. To receive your rebate you must return your completed license agreement from the manual, this game card and dated proof of purchase to: Borland International, Game Card Rebate, 4585 Scotts Valley Drive, Scotts Valley, CA 95066. Upon receipt of the license agreement, game card and proof of purchase, Borland will send your check. Rebate is not valid with any other rebate or promotion offered directly from Borland.

6. VERIFICATION: All game materials are subject to verification. Game materials are void and will be rejected if not obtained through authorized, legitimate channels, and may be rejected if any part is reproduced, counterfeited, torn or altered in any way, or if materials contain printing, typographical, or mechanical errors. Decisions of the Redemption Center are final. Game pieces from any game other than the Borland Instant Winner Game may not be used in this game.

7. CONDITIONS OF PARTICIPATION: Material submitted becomes the property of Borland International. The submission of game pieces is the sole responsibility of the individual seeking verification, who is solely responsible for lost, late, or misdirected mail. All taxes, registration and inspection fees are the sole responsibility of the verified winner. Winners may be required to execute an affidavit of eligibility and name and likeness publicity release. By participating in the game you accept and agree to be bound by these rules and the decision of the Official Redemption Center which will be final.

8. ELIGIBILITY: Participation is open solely to residents of the United States 18 years of age and over, except employees and agents of Borland International, service agencies, and individuals engaged in the development, production, or distribution of game materials, The Merritt Group, Inc. and their immediate family or members of their households. Void in Vermont and where prohibited by law.

9. GAME SCHEDULE AND AWARD OF PRIZES: The Borland Instant Winner Game will commence on or about September 5, 1986 and end on January 30, 1987. It will officially end, however, when all game pieces are distributed. Verified game prizes will be awarded within thirty (30) days from the date of their receipt for verification at the Official Redemption Center. A major prize winners' list can be obtained by sending a stamped, self-addressed envelope to: Borland Instant Winner Game Winners' List, P.O. Box 7089, Wilton, CT 06897.

10. ODDS CHART: The odds of winning prizes are based upon obtaining the one rare game piece among the applicable number of game pieces.

PRIZE	Qty.	Total Value	Odds of Winning
Trip for Two to America's Cup or $10,000	1	$ 10,000.00	1 in 6,458,000
Suzuki 4W Samurai Convertible JA or $6,895	2	$ 13,790.00	1 in 3,229,000
AST Turbo Laser	1	$ 4,995.00	1 in 6,458,000
Toshiba Portable Computer	2	$ 8,898.00	1 in 3,229,000
AST Memory Boards	25	$ 15,025.00	1 in 258,320
Borland Products	1,000	$149,000.00	1 in 6,458
OVERALL TOTAL	**1,031**	**$199,708.00**	**1 in 6,264**

All remaining game cards will contain a $10 rebate good on any individual Borland product or a $15 rebate good toward any advertised Borland software bundle.

11. PRIZE DETAILS: Trip for two to America's Cup Races (or $10,000) will include coach seating round trip airfare on regularly scheduled commercial airline from San Francisco, California to Perth, Australia and up to two weeks hotel accommodations in Perth, Australia plus $4,500 spending cash. Winners will be responsible for obtaining visa, passport, and all other travel documents. Trip does not include meals, taxes, excess baggage charges and other hotel charges. Minor must be accompanied by parent or legal guardian.

Suzuki 4W Samurai Convertible JA Standard Equipment Package (or $6,895), verified winner will be responsible for all registration, insurance, and licensing fees. AST Turbo Laser; Toshiba Portable Computer Model # T1100; Toshiba Portable Computer Model # T3100; AST Memory Boards and Free Borland Products are non-substitutional except by sponsor due to product availability and all warranties and guarantees are subject to manufacturers terms. All prizes are non-transferrable. Winning consumer is responsible for all local, state and federal taxes.

12. SECOND CHANCE SWEEPSTAKES: There are two Second Chance Sweepstakes drawings scheduled to be conducted on December 31, 1986 and February 28, 1987. Random drawing from all entries received by December 30, 1986 will award trip for two to America's Cup Races (or $10,000). Random drawing from all entries received by February 26, 1987 will award two (2) Suzuki 4W Samurai (or $6,895). All remaining prizes that are unclaimed after February 15, 1987 will remain unclaimed. Send entry to: Second Chance Entry P.O. Box 870 Wilton, CT 06897.

If you have any questions concerning the Borland Instant Winner Game, call: 1-800-451-4471.

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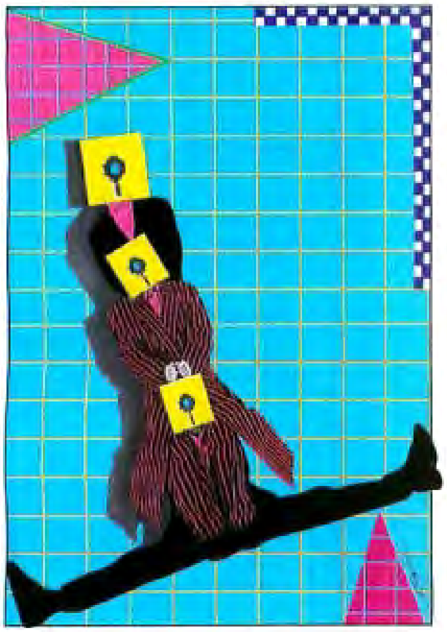

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FEATURES

THEME: GRAPHICS ALGORITHMS

REVIEWS

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KERNEL

BEST OF BIX

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BYTE Gets Faster

Through the years, BYTE has been justly criticized for its long lead time. We have now corrected this problem in four ways.

First, BYTE has purchased and installed an Atex editorial and production system. Atex is the system used by most of the major national weeklies, including *BusinessWeek*, *Newsweek*, and *Time*. BYTE will remain a monthly, but Atex will enable us to bring much fresher editorial material to you than ever before.

Atex permits electronic makeup and copy-fitting and saves countless cycles of revision between the editorial and typesetting departments. Our highest priorities in applying Atex will be to cut lead time in news sections and reviews. Microbytes, What's New, and the entire Reviews section will benefit most as we move onto Atex.

BYTE's second effort to improve timeliness has been to reexamine our internal scheduling to make sure that none of our human processes prevents us from taking advantage of Atex's speed. We have adjusted deadlines and priorities to maximize our gain in timeliness.

Third, we now put many of BYTE's articles on-line in BIX for readers who would rather have their information in electronic form. We can post material about new products in BIX on the very day of a product announcement. We put most of our major columns on-line before they appear in BYTE. Although we have just started putting reviews on-line in BIX, users have already logged significant connect time in the BYTE reviews conference.

Our fourth means of improving timeliness is the news service available on-line in BIX. Since I have previously described this service, I will be brief in describing it here. It has three main components now: microbytes, microbytes.hw, and microbytes.sw. The latter two sections consist of hardware and software product announcements, respectively. The "microbytes" section contains news of technological developments as well as preannouncement and other very early product news.

Our new editorial and production system will let us make BYTE as timely as any monthly. Our on-line publications make us more timely than any weekly. But this new emphasis on timeliness will in no way diminish BYTE's efforts to cover computers and related topics comprehensively and in depth. We will continue to publish our traditional generous selection of in-depth technical articles in our Theme and Features sections. By adding timeliness to comprehensiveness and depth, we hope to do a better job of meeting your needs.

—Phil Lemmons
Editor in Chief

BIX Happenings for December

The end of the year is becoming a busy time for the BYTE Information Exchange, with a number of special events and conferences underway or soon to begin.

Conferences concerning the Intel 80386 are ongoing. Visiting experts from Phoenix, AT&T, Softguard, Phar Lap, and other software vendors are joining the BIX regulars in the sytems software conference (os386), and early users of 80386 systems are sharing their experiences in the user386 conference.

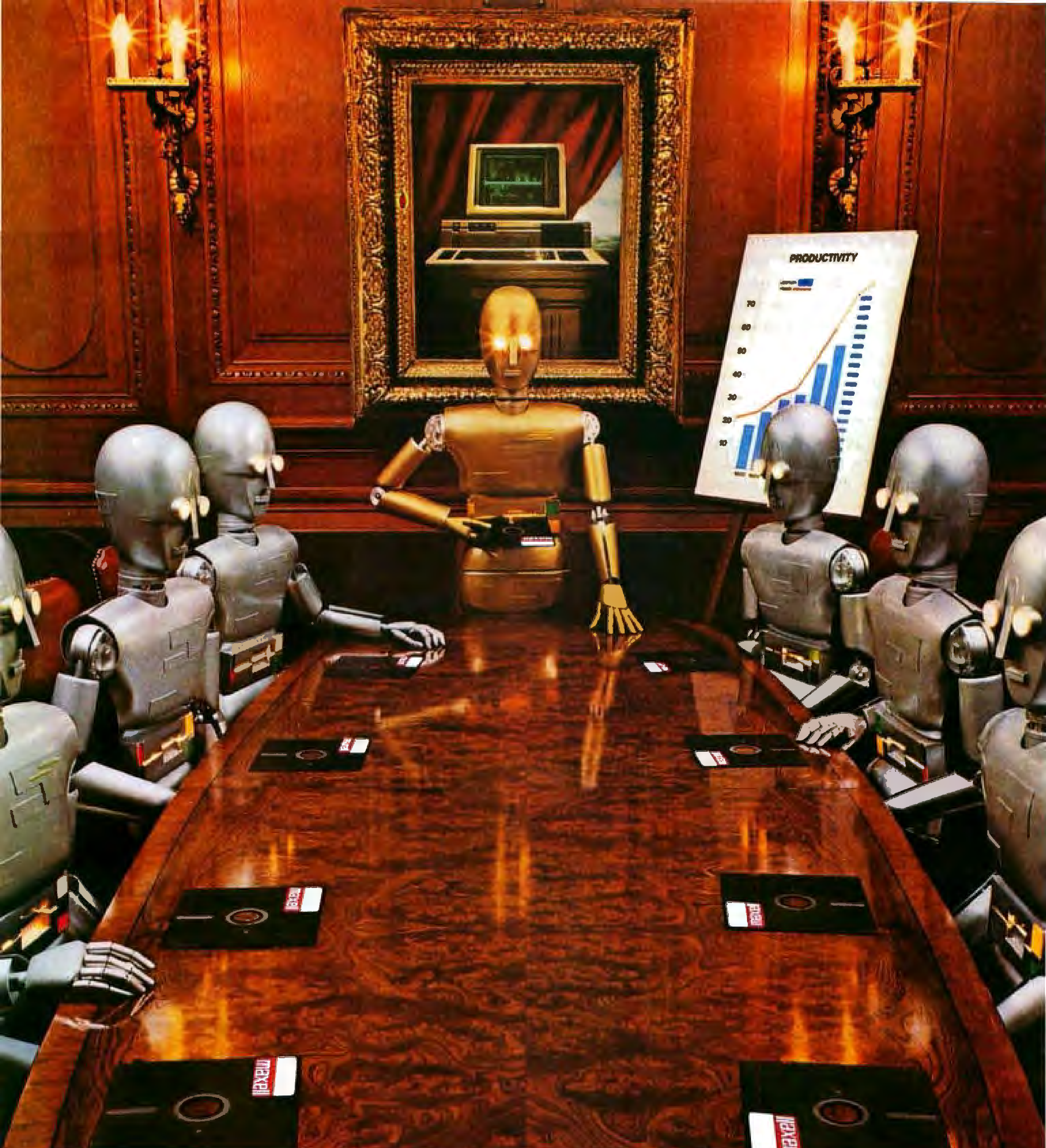
The issue of benchmarks for graphics boards and processors is being addressed with a conference event in the grafic.pgms conference. Visiting experts from chip and board manufacturers, together with programmers and users on BIX, are trying to reach a consensus on two issues: important criteria for graphics benchmarks and nonpreferential methods of testing.

A new conference on software publishing has begun, focusing on the marketing, financial, and legal aspects of the computer software business. BIX subscribers who write and/or publish their own software are sharing expertise and addressing questions of common interest in this new forum.

Conference events scheduled to begin in December include an event for owners and users of Hewlett-Packard computers, from the Integral to the HP 3000, focusing on successful integrated systems implementations; a discussion of the ISO seven-layer OSI communications protocol, with an emphasis on its practical implications for those working in microcomputer data communications; a special event on UNIX as a microcomputer operating system; and a look at central file servers and remote file systems in local area networking.

Finally, selected BYTE reviews of hardware and software are available on-line in the byte.reviews conference on BIX. These include the earliest possible looks at reviews to be published in BYTE as well as special reviews selected for publication only on BIX.

Check the system.news conference for exact starting dates and details of these events and information on other upcoming specials.



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SmarTerm Terminal Emulation Software . . . The Natural Selection

Staff-written highlights of developments in technology and the microcomputer industry.

GTE Develops High-Speed GaAs Multiplexer Combining Four Data Channels

In an effort to achieve data communication rates of several gigabits per second, GTE Labs (Waltham, MA) is combining the high capacity of fiber optics with the high speed of gallium arsenide circuits. The research arm of GTE has designed a GaAs multiplexer that can combine four data channels, each with a communication rate of 1 gigabit per second, into one channel. GTE has also recently developed a technique called MOVPE (metal-organic vapor-phase epitaxy) for efficiently growing thin-film GaAs crystals.

The new devices should play an important role in future communication systems, which will involve high-capacity fiber-optic cables connecting houses and offices through telephone switching centers. Data rates on these cables could be as high as 20 gigabits per second. In addition to standard computer data, numerous video channels could be supported, each with a data rate of almost 100 megabits per second. The GaAs multiplexers will probably be the only devices fast enough to interface houses and offices with this fiber-optic grid.

In future supercomputers, these multiplexers will also be used for high-speed fiber-optic transmissions between various boards in the computer, replacing copper wires. Because of the high-speed nature of the fiber-optic link, such techniques may even be used for chip-to-chip communication.

GTE said it has completed a prototype of the GaAs multiplexer and a final version should be ready in less than a year.

Use of Surface-Mounted Technology Growing: Expected to Be Seen in Half of All Components Soon

If any single theme was repeated at the IEEE International Electronic Manufacturing Technology Symposium, it was expressed succinctly by a speaker who said that "surface-mounted technology is going to be the way of doing business in the U.S."

Surface-mounted technology (SMT), or the attachment of electronic components and circuits to the face of a circuit board instead of connecting circuitry layers and components via holes drilled through the board, is one of the strongest trends in electronic packaging. SMT offers manufacturers two distinct advantages over conventional through-hole (TH) technology: Circuits can be built on both sides of the board, and SMT is ideal for automated assembly, thereby reducing costs and improving efficiency and quality.

Virtually every manufacturer at the symposium, including Intel, Texas Instruments, Hewlett-Packard, IBM (which uses SMT in its PC Convertible), Fujitsu, NEC, and Motorola, indicated that they are currently manufacturing products using high-density SMT processes. Estimates are that 20 percent of all electronic components now being made are surface-mounted and that within two years it will be 50 percent.

Many manufacturing engineers still express concern about some problems, particularly those that deal with thermal expansion and inspection.

"Charge Ratio" Could Be Alternative to Electromagnetic Technology in Graphics Tablets

Summagraphics (Fairfield, CT) has developed a graphics tablet technology that uses ratios of sensed areas to generate the coordinates of the stylus or cursor position. The company says that because its technique uses ratios instead of absolute signal values, variations caused by distance or dielectric constant changes between the electrode surface and the stylus don't affect tablet operation.

(continued)

The "charge ratio" tablet has three main elements: an electrode, or digitizing surface; an anode, or transducer (the stylus or cursor); and the processing electronics. The digitizing surface consists of a pattern of three differently shaped electrodes: wedges, stripes, and the area not covered by those electrodes. Summagraphics says its three-electrode approach results in stable and accurate coordinate output over the tablet's active area and eliminates problems caused by environmental noise.

The 12- by 12-inch tablet is currently undergoing tests by "major OEMs" in the CAD/CAM and workstation markets, according to a spokesperson. Look for a final product next year.

Perpendicular Technique Puts 100 Megabytes on 5¼-inch Disk

Maxell (Moonachie, NJ) has developed a disk it says can handle 100 megabytes of storage using a perpendicular recording technique. The new disk provides more magnetic surface than conventional media by standing the magnetic particles so they're perpendicular to the substrate plane instead of putting them flat on the surface. The disks have a recording density of 100 kilobits per inch, the company said.

The 5¼-inch disks won't work in current drives but, according to a spokesperson for the company, current drives can be retrofitted to handle the 100-megabyte disks. Hitachi Ltd. has designed drives for the new disks; those drives are now in prototype form. The drives will show up in machines next year, the spokesperson said.

Researchers Claim Working Part-Time at a VDT Poses No Threat to Pregnancy

Two researchers have concluded that pregnant women who work at VDTs less than 20 hours a week don't appear to be at higher-than-normal risk of having a miscarriage. However, they cautioned that more study is needed to determine if women who work at VDTs more than 20 hours a week run a higher risk.

According to William Butler at the University of Michigan, who teamed with colleague Kelley Ann Brix to study the 817 pregnancies of 728 women, "Pregnant women who worked 1 to 20 hours a week at VDTs had the same miscarriage rates as women who did not work at the machines." Of 697 pregnancies among women working 1 to 20 hours a week at a VDT, there were 145 miscarriages, which Butler and Brix said were about as many as expected. But of the 120 pregnancies reported by a group working more than 20 hours a week, 26 ended in miscarriage, "about four more" than expected.

The study was funded by the March of Dimes, which is still examining possible effects of VDTs on birth defects. Brix said more work is needed to find out if using a VDT full-time is hazardous to pregnant women. The National Institute for Occupational Safety and Health is conducting a study that will focus only on full-time VDT workers.

At "32-Bit Shootout," Speakers Take Shots at DOS, Benchmarks

Besides Motorola's new 68030, NEC's new V60/V70 chips, and everyone picking on Intel's 80386, three topics dominated the one-day symposium billed as "The 32-Bit Shootout": the future of MS-DOS in the 32-bit world, the value of benchmark results, and compilers.

From Intel's perspective, compatibility with existing 8086-family software will be the driving force in establishing the 386 as the leading 32-bit CPU in the microcomputer market. As one speaker said, "Six million PCs are the lowest common denominator and software will continue to be written for them." Motorola's Jeff Nutt countered by stating that the influence of MS-DOS will lessen and UNIX will gain prominence. However, he also said that the 68020 will eventually run DOS 5.0.

Of the six chip makers participating, only Motorola refused to release benchmark statistics. "We'll run whatever applications our customer base wants and give them the results," Nutt explained. Manufacturers and panelists agreed that benchmarks aren't meaningful to the user unless they are uniform and repeatable; instead, what is really needed is a series of market-specific evaluations, and the buyer had better run those tests. Just about everyone agreed that "benchmarks don't lie, but liars do benchmarking." George Morrow, former chairman of Morrow Designs, concluded that "magazines that support the industry should act as watchdogs" and do benchmarking for their readers.

(continued)

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Inquiry 372

Panelists agreed that compiler portability is more important in the micro market, while compiler performance is more important in the workstation and minicomputer markets.

Hardness Tester Helps Build Better Integrated Circuits

Electrical engineers know that the thin-film, multilayered structures that make up integrated circuits are subject to high degrees of failure, particularly at interconnection points. Researchers at Stanford University (Palo Alto, CA) are using new techniques to understand why relatively straightforward interconnections that appear to be solid when made, inexplicably break later on. One technique devised by William Nix, a professor at the Stanford School of Engineering, uses a new submicron hardness tester (nicknamed the "nano indenter") to determine the hardness of thin-film material by indenting the metal to a minimum depth of 500 angstroms.

"The nano indenter allows us for the first time to probe mechanically on a very small scale," Nix explained. The degree of hardness as determined by the indentation is then compared to the known microstructure of the material being studied, which helps determine why the material might fail.

Hewlett-Packard Defends Its Choice of DDL

After taking its licks at the Seybold Desktop Publishing Seminar for picking Imagen's DDL as a document-description language, Hewlett-Packard held its own symposium on desktop publishing and defended its choice. Apparently the company was still smarting somewhat from Steve Jobs's comment at the Seybold seminar that HP must have been "brain-damaged" when it decided to support DDL instead of Adobe Systems' PostScript. In her talk, Jan Bell of HP's Peripherals Group (Boise, ID) specifically compared DDL to PostScript and Interpress, a document language from Xerox. HP chose DDL over PostScript, she said, because DDL supports both binary and ASCII representation (PostScript supports only ASCII, she said), intelligent scaling of bit-map characters (PostScript does not), composite objects (again, she said, PostScript does not), full object caching (PostScript supports font object caching only), and document layout (PostScript does not). Interpress, she pointed out, supports only limited programmability, binary representation, font-only object caching, and limited document layout. She also said Interpress doesn't support intelligent scaling of bit-map characters and composite objects.

NANOBYTES

VLSI Technology (San Jose, CA) brought out a series of 1.5-micron CMOS gate arrays based on its Continuous Gate technology. Arrays in the VGT100 series contain from 10,000 to 50,000 usable gates. The series gives designers a choice between gate array or cell-based implementations. . . . The **IEEE** has formed a group to address the work of the **Personal Computer Extended Technology Standards Committee**, which has released a technical spec for its proposal for a 16-bit PC AT–compatible bus with a 32-bit bus extension. According to Gary Lyons of the IEEE's microprocessor standards committee, the society's involvement with PCET will lead to an AT-compatible bus specification that's officially recognized by the IEEE. The final document could be used by manufacturers basing systems on 32-bit processors, including Motorola's 680x0 series, National Semiconductor's 32xxx series, and Intel's 80386 . . . . **Symbolics Inc.** (Concord, MA) is selling the source code for its New Flavors object-oriented programming system, written in Symbolics Common LISP. Full source code on a DOS-compatible disk costs $25; documentation costs $50 . . . . **Corvus Systems Inc.** (San Jose, CA) has acquired the laser printer technology developed by BDS Computer Corp. (Mountain View, CA) . . . . **OEM Marketing** (Canoga Park, CA) is selling a device that monitors a computer's temperature. Heat Alarm bleats a high-pitched warning when the temperature hits 123 degrees. It costs $49.95 and, according to the company, it's easily installed between the speaker and the motherboard. The firm's next product? The Cool Card.

TECHNOLOGY NEWS WANTED. *The news staff at BYTE is always interested in hearing about new technological and scientific developments that might have an impact on microcomputers and the people who use them. We also want to keep track of innovative uses of that technology. If you know of advances or projects that involve research relevant to microcomputing and want to share that information, please contact us. Call the Microbytes staff at (603) 924-9281, send mail on BIX to Microbytes, or write to us at One Phoenix Mill Lane, Peterborough,* NH 03458.

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Dept. of Chemical & Nuclear Engineering
Mail Location #171
Cincinnati, OH 45221

Thomas A. Edison State College
101 West State St.
CN 545
Trenton, NJ 08625

Connected Education Inc.
92 Van Cortlandt Park South, #6F
Bronx, NY 10463

Nova University
Information Sciences
Center for Computer-Based Learning
3301 College Ave.
Fort Lauderdale, FL 33314

CORRECTION

I wish to point out an error in your September editorial, which urges the use of computer conferencing as a medium for educational instruction and college credits. When mentioning the EIES conferencing system, you give credit to the correct person (Murray Turoff), but to the wrong school. EIES was in fact developed at New *Jersey* Institute of Technology, not in New York as you claimed.

MARK SAVASTANO
Bloomfield, NJ

SORT RUN TIMES

In every generation there is someone who has trisected the angle with compass and straightedge, squared the circle, repealed the second law of thermodynamics, or written a sort with run time linear in the number of records. Alas, they are always mistaken! The letter from John W. Ward (September, page 373) is in this category and illustrates the danger of generalizing from a single datum.

Mr. Ward claims to have found a sort that runs in $O(n)$ time. In fact, the sort he presents runs in $O(n^{1.5})$, that is, $O(n\sqrt{n})$, considerably worse than the $O(n \log n)$ that the better sorts offer.

The timing for Mr. Ward's algorithm has a component that is $O(n)$ and I/O-bound, and a second component that is $O(n^{1.5})$ and CPU-bound. Since his memory was too small to handle more than 90,000 records, his timing was dominated by the slow disk drives he was using. Had he tried the same algorithm with 9,000,000 records, the CPU time would have been more noticeable. Had he tried it with semiconductor auxiliary memory instead of disks, that is, with "RAM disks," the I/O time would have been less noticeable. In either case, his error would have been obvious.

The description of algorithm timing as $O(f(n))$ is only meaningful when n is allowed to grow arbitrarily large. In Mr. Ward's case, he restricted the evaluation to the small memory of his DEC PDP-11/73.

Whether Mr. Ward meant $O(n)$ or $o(n)$, his example fails to justify his claim that "I know it's theoretically impossible, but it can sometimes be done in practice." In fact, what he did is theoretically possible, trivial, and irrelevant to the real world. In a "Mom and Pop" grocery store, 90,000 records may be a large file. In a world of multinational corporations, 9,000,000 records is ridiculously small.

SEYMOUR J. METZ
Annandale, VA

CD-ROM SOFTWARE DEVELOPMENT

Editor's note: Hein ten Bosch of Kluwer Technical Publishing in Deventer, The Netherlands, called to say he had spotted a bug in our May article "CD-ROM Software Development." Says he, "The author compares the number of bytes but forgets to calculate inner sectors," so that the final counts represented in table 2 (page 184) are off. Author Bill Zoellick's response:

The reader is correct; table 2 is in error. I do not understand what the reader means by "inner sectors," but he is right about my not adding up the maximums in the table. The figures in the columns for two levels and three levels are in fact the number of records just at that level, rather than in the whole tree. An entire three-level tree, of course, contains records at the first and second levels as well as those at the third level. So we need to accumulate the records as we move from left to right, resulting in the following, corrected table:

Block size	*One level*	*Two levels*	*Three levels*
2K	*64*	*4,224*	*274,624*
4K	*128*	*16,640*	*2,146,688*
8K	*256*	*66,048*	*16,974,592*

I am sorry about this error and am pleased that someone read the article closely enough to notice it. I also notice that we left out the "K" in the field that should read "Block size = 2K" in table 2.

BILL ZOELLICK
Stillwater, OK

FOOLING THE SYSTEM

Structural analysis programs developed in a mainframe environment frequently use a large array that is partitioned for various purposes. Appropriate subelements are then passed to subroutines. The Microsoft requirement that dimensions of an array be fixed can create problems when these programs are converted for use on a microcomputer. At first glance, the technique proposed in "Structural Analysis" by Robert W. Johnson and Fernando G. Loygorri for "Fooling the [operating] System" (July, page 210) appears to provide a useful technique to alleviate some of these problems. However, there are

(continued)

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First, many mainframe programs will mix double-precision numbers, integers, and characters in the same array. If so, the programmer must assure that no scalar crosses a segment boundary. Otherwise, incorrect results are likely when that item is passed to a subroutine (since only one segment and offset will be associated with that item when it is passed).

In addition, the proposed approach relies on the fact that the array spans more than one segment to create code that deals with both segment and offset. However, a subelement of a large array passed to a subroutine often does not itself span more than one segment. The fact that proper code for an actual argument is generated in the calling routine does not assure that proper code is generated in the called routine for the formal argument. Consequently, the formal argument should be explicitly declared as $LARGE or $HUGE to assure that both segment and offset are used within the subroutine. (The $LARGE metacommand could be applied to all code in a program.)

Finally, and most importantly, the memory model was changed for version 3.3 of the Microsoft FORTRAN compiler and linker. At run time, common blocks and large variables are now loaded below segments such as the stack and heap. We compiled and linked a short program, first using MS-FORTRAN 3.2 and then MS-FORTRAN 3.31. The result: Memory organization is substantially changed and a number of segments now occur above the common blocks. Using the recommended "tricks" will now result in "clobbering" the program unmercifully.

Ten years ago the prevalent view seemed to be that good programming meant getting the most out of a specific machine. That notion is outdated because it ignores issues such as code maintenance, portability, and assurance that the results are accurate. In our view, a "very sloppy approach" is writing code using shortcuts that significantly increase the probability of incorrect results, as opposed to writing code that "will not use all the memory available in computers that have plenty of it."

This is not strictly a philosophical exercise. Recognize that the standard of care required of a programmer or an engineer using an analysis program is still developing. Many lawyers would argue that "strict liability" is appropriate for areas, such as structural analysis, that are "inherently dangerous." In other words, if analysis results are incorrect because of some

(continued)

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Inquiry 18

obscure bug, and the incorrect results cause damage, the responsible programmer and/or engineer may be liable for that damage, regardless of the care taken to ensure accuracy. If there is any question about the degree of care, the case will be even stronger.

KENNETH S. HERRING
VICKI R. HARDING
Rockville, MD

The authors' reply:
We fail to see how it is possible to "mix double-precision numbers, integers, and characters in the same array" in FORTRAN 77. Perhaps the writers meant to say "in the same common block," in which case Microsoft FORTRAN's inability to cope with segment boundaries is already well documented in the manuals. Anybody using MS-FORTRAN should be aware of it by now.

We also fail to see why a subroutine should have code to handle common-block variables that is different from the equivalent main program code when the compiler has the explicit definition of the common block in both cases. Of course, there could be an error in the compiler itself, but our experience tells us that this is not the case. Furthermore, since the article was written we have finished the graphics module for the 3-D models and, as before, memory expansion gave us no trouble.

Now, if a subarray is passed and it crosses a segment boundary, then you have a problem, but again, it is a more general problem not due to the memory expansion method presented in the article.

We found that the declaration of $LARGE *for big arrays was not as good as using common blocks because it had the nasty side effect of including the entire array in the .EXE file! As a result, the program submitted by the writers compiles into an executable file 260K bytes long, instead of 20K.*

After MS-FORTRAN 3.3 was released we became aware of the memory model change, but it was too late. As you can imagine, we cannot predict what Microsoft will do next. If they want to make their FORTRAN more C-like, it is their privilege, but because of this and other problems we stay clear of the latest releases and just use the 3.2 version, as was stated in our article.

As for the philosophical arguments about what should and should not be done, we are not after anybody's "Good Programming Seal of Approval," but we try to get the job done instead. And when there is only one way of accomplishing a task with the available tools, the "programming style" is a moot point anyway.

Regarding maintenance, it is our opinion that it would be much more complex to maintain, update, and keep track of multiple versions of the programs for different computer memory sizes. Portability is a nonissue for us, as we are dedicated to designing software for the IBM PC family.

From the writers' comments about reliability, it seems that they think we dreamt up the memory expansion mechanism one afternoon, then implemented it hastily and never tested it. Nothing could be further from reality.

We know that the mechanism works well because we have used it extensively in different types of models with total success. Of course, it is always possible to make errors, so the results should always be checked out, not only in the case of tricky code but also with run-of-the-mill programs.

Their letter implies that if only standard methods are used, then different compilers may be employed with no fear of incorrect results. We wish such a naive notion would hold true. In the real world you must thoroughly check out programs every time any change is made to your code, or when a different compiler or a different computer is used. The existence of nonstandard techniques neither increases nor decreases this responsibility.

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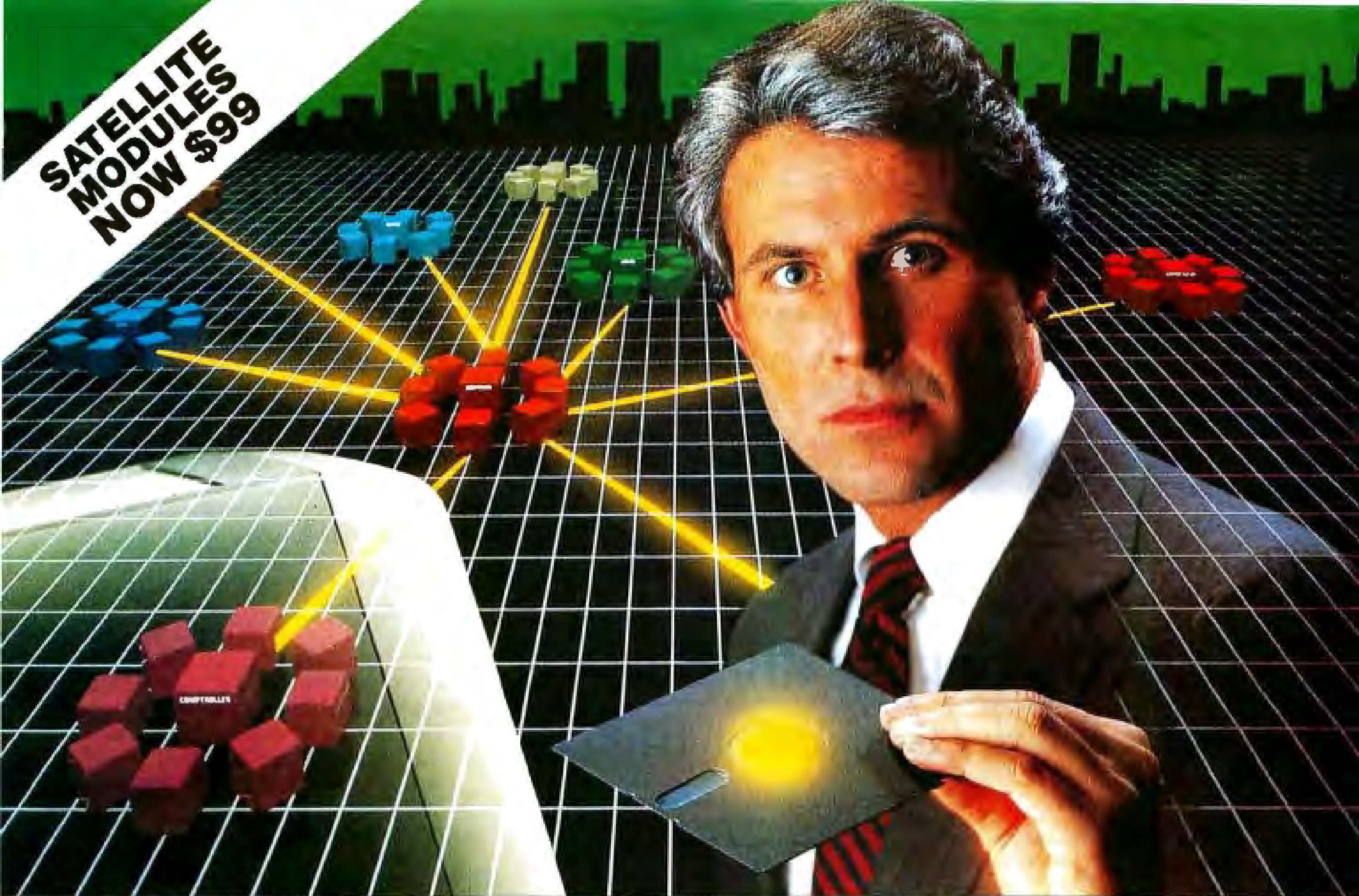
The use of software, as well as the rest of the activities conducted by engineers, requires the use of checks and balances, together with methods that are sound and proven by experience, to provide a defense that reasonable and appropriate

(continued)



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care was used in the design process. It is not a justification to allow bad solutions to be used because of the "It's not my fault" philosophy.

ROBERT W. JOHNSON
FERNANDO G. LOYGORRI
Microstress Corp.
Seattle, WA

EASY C

The company I work for was in a situation very similar to what Pete Orlin and John Heath described ("Easy C," May): converting to C from other languages with no experience in C. We also used the #define macro features of C to make a version of Easy C. I was very relieved to read the May article and learn that we were not alone in the world. Having worked in the meantime with two C "expert" consultants, I was not surprised at the letter from John A. Rupley in the September issue (page 22). I can understand Mr. Rupley's dislike of Easy C; beauty *is* in the eye of the beholder. But some of his other comments are, well, staggering.

Mr. Rupley's first objection relates to communication by accepted rules of style. There is certainly a great deal of merit in writing books and magazine articles in a commonly accepted standard form of C. Articles written for law magazines need to be written in legalese, medical journals have their own style, and so on. I find it hard to believe, however, that learning local variations of C will freeze the brain and make programmers illiterate. I don't have any trouble converting an article in any FORTRAN/ALGOL-style language to standard C, and Easy C to standard C is no exception.

There is a comment in the letter that asks "...should not the ANSI Standardization Committee, rather than individual dissenters, be enjoined to wrestle with the problem [of confusing operator characters]?" Is that a joke? Or should I make a comment about how that hooligan Galileo should leave the motion of heavenly bodies to the experts? Naw, he can't be serious.

Mr. Rupley's "moral" of hiding one's light under a barrel (preferably with the barrel in the dumpster out back) is puzzling. What is the point of suppressing new ideas and innovation? Whether the idea is good or bad is beside the point in the case of the Easy C article. You are not being asked to like Easy C; you are not being asked to use it. If you encounter it and find it intolerable then by all means remove the irritation, but please, no more calls for the Thought Police.

If you work in an environment that requires programmers to move from one language to another rather frequently, there are advantages to having the source code as similar as is practical and Easy C is worth looking at. I am not trying to belittle Mr. Rupley's opinion. If I were forced to work only with C all day long, year after year, I would think Easy C is a waste of time. I have just gotten very tired in the last year of "experts" telling me that God speaks in The One True C.

NEAL S. PENDLETON
San Dimas, CA

The September BYTE contained a letter from John A. Rupley that was quite critical, to the point of being sarcastic, of "Easy C" by Pete Orlin and John Heath. He claimed that Easy C would lead to C illiteracy and that it masks the clarity and beauty of C programs. As a consequence, he asserts, an ANSI Standardization Committee is the proper forum for considering "new species" and that individual

(continued)

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dissenters should keep such "mutants" to themselves.

Personally, I take issue with virtually every point Mr. Rupley made. First, he suggested that Orlin and Heath have made "changes in an established language." Exactly how they changed it evades me, since they followed not only the rules but also the intent of the #define construction (see Kernighan and Ritchie, page 12) precisely! Moreover, they have conformed to the C convention of writing symbolic names in uppercase (Ibid., page 13)—a practice Mr. Rupley condemns in a cleverly written, intentionally confusing paragraph in which he transformed all punctuation to uppercase words. (For those of you who have heard it, there is a close and very interesting parallel between that paragraph and Victor Borge's comic monologue, "Phonetic Punctuation." I see little parallel, however, between that paragraph and Orlin and Heath's work.) Why would an ANSI committee want to become involved in someone's following the rules, except, perhaps, to applaud it? Perhaps Mr. Rupley's complaints should really be pointed at Kernighan and Ritchie, not Orlin and Heath!

I think Mr. Rupley's real concern is that, if Easy C is used, it alters the appearance of C source code from its pristine state, which he seems to prefer. From my perspective, the alteration is for the better, too, for the Easy C coding example in figure 6 of Orlin and Heath's article is (Mr. Rupley's claim to the contrary) much more readable than its straight C equivalent in figure 5. It even incorporates Kernighan and Ritchie's own suggestion on improving the appearance of C code (Ibid., page 87)! Is this an alteration of the language? I think not. If it is, then vive la mutant!

The truth is that *all* languages are living things, the use of which changes with time. I abhor the inclusion of the word "ain't" in the English language, but it is certainly found in my dictionary. George Bernard Shaw correctly claimed that "Americans haven't spoken English for years!" In this sense, I can understand Mr. Rupley's objection, but I hope we see a lot of Easy C.

D. MARTIN HARRELL
Severna Park, MD

CALCULATING CRCS

I don't have a 6809 reference manual handy and Greg Morse ("Programming Project: Calculating CRCs by Bits and Bytes," September) did not include any listings of his byte-wise CRC generator, but 86 cycles seems too high. When I implemented it a couple of years ago, the operation was about 8 instructions: two 1-byte table lookups and two XORs (no shifting at all). The contents of the two 256-byte tables depended on the polynomial, but I used a macro assembler to generate them from a couple of formula lines. The algorithm in Modula-2 is

```
(* Variable declarations, just so you can see
   what is involved . . . *)

VAR T0T7, R0R7, R8R15, D0D7: BYTE;
  Table1, Table2: ARRAY BYTE OF BYTE;

(* Temporary T0–T7: XOR of Data and high
   byte of R *)

T0T7 := R8R15 / D0D7;

(* Index into Table 1 and XOR to low byte of
   R to form new high byte *)

R8R15 := R0R7 / Table1 [T0T7];

(* Index into Table 2 for new low byte *)

R0R7 := Table2 [T0T7];
```

TOM PITTMAN
Manhattan, KS ■

 Inquiry 392

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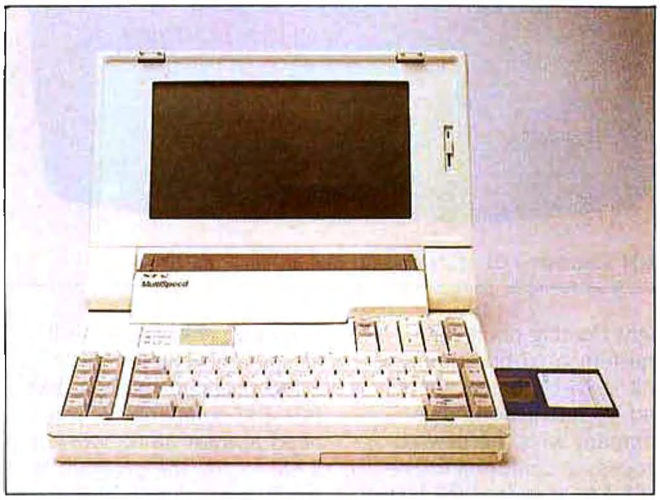
NEC Introduces Fast IBM-compatible Portable

NEC Home Electronics has released the MultiSpeed, its first IBM-compatible laptop computer. The computer has a 16-bit NEC V30 (8088-compatible) microprocessor running at either of two clock speeds: 4.77 MHz or 9.54 MHz.

The MultiSpeed features two 3½-inch 720K-byte floppy disk drives, a detachable LCD screen, and a built-in keyboard with a separate numeric keypad. The computer's memory is composed of 640K bytes of RAM and 512K of ROM. Included in the ROM are a number of desktop utility programs with windowing capabilities.

The MultiSpeed also includes a parallel port, serial port, and RGB display connector. The 80-character by 25-line LCD uses high-contrast "super-twisted pair" technology and features a resolution of 640 by 200 pixels. Battery life is said to be 6 to 10 hours.

The 11-pound laptop computer, which supports MS-DOS 3.2, has a retail price of $1995. Options include an internal 300/1200-bps Hayes-compatible modem, two external 5¼-inch floppy disk drives, and a PC-compatible file transfer package. For more information, contact NEC Home Electronics (U.S.A.) Inc., Computer Products Division, 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500.
Inquiry 550.



NEC's *MultiSpeed runs at* 4.77 *and* 9.54 MHz.

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Handprints runs on IBM PCs and compatibles and costs $1200. Contact Skylight Software Inc., 2 Charles St., Bedford, MA 01730, (617) 275-2999.
Inquiry 551.

Convergent's S/50 Workstation

Convergent Technologies introduced several 68000-based workstations, including the S/50, a 68010 machine that has an optional IBM PC XT–compatible coprocessor.

The S/50, which has a base price of $5500, supports five users under AT&T's UNIX System V release 5.2. Its system board, which operates at 10 MHz, is available with 1 or 2 megabytes of RAM, and its memory management system supports demand paging with 4 megabytes of virtual address space. Also included on the main processor board is a 300/1200-bps modem and circuitry to control two data lines and a voice line. Two tip/ring line jacks and one telephone jack are standard, as well as one RS-232C serial port and one parallel port. The board provides controllers for the machine's 5¼-inch floppy disk and hard disks, available in capacities from 24 to 85 megabytes.

An additional 2 megabytes of RAM, for a system total of 4 megabytes, can be added via the expansion slots. The three available slots can accommodate a variety of options, including a coprocessor board ($1000) that runs standard IBM PC XT software, a two-port RS-232C board, a combination RS-232C board with 1 megabyte of RAM, an Ethernet interface, and a controller for an external ¼-inch streaming tape drive.

The S/50 workstation comes with a keyboard, mouse, and 12-inch diagonal monitor that displays 80 columns by 29 rows and offers a resolution of 720 by 348 pixels. The system's software costs $795, which includes UNIX and the firm's WGS/Office software, an integrated package that provides access to UNIX-based applications. The package includes a word processor, spreadsheet, calendar, and electronic mail system.

Among the other workstations in the series are the 68020-based S/120 and S/220, which support 12 and 22 users, respectively, at 12.5 MHz; the S/320 and S/640, which handle 32 and 64 users; and the S/1280, which can support up to 128 users at 8.8-MIPS performance levels. Contact Convergent Technologies, 2700 North First St., San Jose, CA 95150, (408) 434-2848.
Inquiry 552.

Accounting on the Atari ST

The PayDay payroll program for the Atari ST is the first in a set of account-

(continued)

ing software announced by Crystal Software. According to Crystal, the program can handle a $21 million payroll with up to 255 employees and is capable of printing monthly, quarterly, or yearly tax information. You can also print W-2 tax forms, employee lists, personnel information, mailing labels, and continuous checks.

A configuration utility enables you to adapt the program according to your state's tax and small-business laws. The program is menu-driven and offers context-sensitive help.

PayDay sells for $69.95 and runs on the Atari 520ST and 1040ST with at least one 360K floppy disk drive. For more information, contact Crystal Software, P.O. Box 803, Merlin, OR 97532, (503) 479-9516.
Inquiry 553.

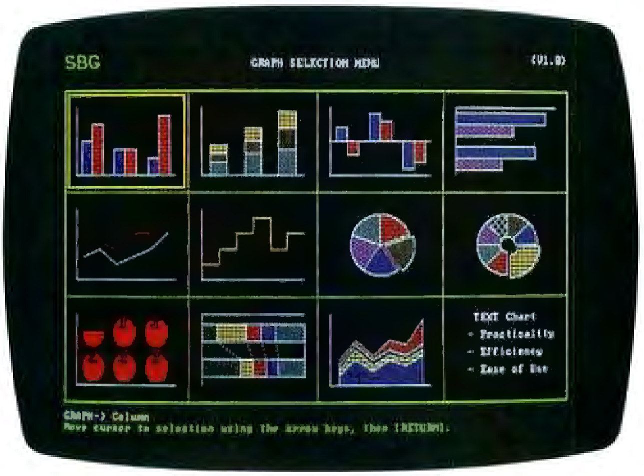
Motorola Develops Successor to 68020

Motorola's Microprocessor Group announced the MC68030, a 32-bit processor that the company claims is twice as fast as the 68020 and is fully code-compatible with its existing 16-/32-bit chips.

The chip, about ⅜-inch square, uses 300,000 transistors. According to Motorola, the 68030 is the first single-chip microprocessor to use the "Harvard-style" parallel architecture incorporated in some mainframes and supercomputers. The company claims the new device is the first 32-bit microprocessor to have on-chip instruction and data caches. The chip supports a synchronous bus interface with two-clock-cycle access and an asynchronous interface with one-clock-cycle burst access.

At the same time, the firm announced the MC68882, a 32-bit floating-point coprocessor. This chip features eight floating-point data registers, a 67-bit arithmetic unit, a 67-bit barrel shifter, and 46 instructions. The company says the new coprocessor conforms to the IEEE-754 standard for binary floating-point math.

Sampling and production for both chips are scheduled to begin in 1987. Final prices were not yet set at press time; the company estimates the chips will cost $150 to $200 in lots of 5000. For more information, contact Motorola Inc., Microprocessor Products Group, P.O. Box 52073, Phoenix, AZ 85072, (512) 440-2839 (in Austin, TX).
Inquiry 554.



VCN *Concorde* 1.01 *offers graphics and an image database.*

Business Graphics with Image Database

VCN Concorde version 1.01 offers business graphics, freehand painting, slide show and animation capabilities, and text generation. The package includes 16 fonts, 15 of which are proportionally spaced. Also included is Image Database, which contains over 2000 bit-mapped pictures. VCN Concorde works with word-processing and graphics packages, as well as spreadsheets.

The program runs on IBM PCs and compatibles. You need at least 384K bytes of RAM to run the program in medium resolution and 640K for high resolution. VCN Concorde sells for $695. For more information, contact Visual Communications Network Inc., 238 Main St., Cambridge, MA 02142, (617) 497-4000.
Inquiry 555.

Software Library for Series 151 Image Processor

ITEX 151 is a subroutine library of over 200 image-processing and graphics routines designed for use with Imaging Technology's Series 151 Image Processor. The program includes board-level access and control routines, look-up table operations, image filtering and convolutions, graphics, image geometry, and statistical analysis.

The program is distributed as object code for MS-DOS systems and costs $995. Contact Imaging Technology Inc., 600 West Cummings Park, Woburn, MA 01801, (617) 938-8444.
Inquiry 556.

Paradise EGA Chip Has Higher Resolution

Paradise Systems has developed a single-chip Enhanced Graphics Adapter compatible with IBM's EGA that provides an extended EGA mode when used with continuous frequency monitors, like NEC's MultiSync. The chip, called the PEGA 2, offers a resolution of 640 by 480 pixels, in contrast to the maximum 640 by 350 resolution provided by IBM's EGA.

The 84-pin chip enables EGA software to run on standard monochrome and color monitors and enhanced monitors. It also permits EGA software to be emulated on monitors with 640 by 480 resolution (the same as that supported by the IBM Professional Graphics Controller) or 640 by 400 resolution (compatible with the AT&T PC 6300). The chip also supports the IBM CGA, MDA, and Hercules monochrome graphics standards.

The firm will provide software developers with drivers for Microsoft Windows, GEM, and a variety of applications programs, including CAD, graphics, and desktop publishing packages.

Production quantities are slated to be available this year; the price is set at $55 each in OEM quantities. For more information, contact Paradise Systems Inc., 217 East Grand Ave., South San Francisco, CA 94080, (415) 588-6000.
Inquiry 557.

IBM Adds RAM, Storage to RT PC

IBM has introduced a new desktop model of its 32-bit RISC-based RT PC, called the RT PC 6151

(continued)

Orchid's TurboEGA™

The world's *fastest* EGA

Introducing the only Enhanced Graphics Adapter with PCturbo™ speed.

The experts agree: the EGA is the breathtaking new graphics standard, but the sophisticated software written for it places a big burden on the PC's processing speed. Beautiful graphics, crisp text, but t o o s l o w .

Everyone else rushed their EGAs to the market, but Orchid Technology took the time to do it right. Orchid's TurboEGA™, from the *inventors* of PC TurboProcessing, packs a high-speed Turbo and an EGA into one slot, for the world's fastest EGA.

Graphics with Speed

TurboEGA makes IBM PCs and XTs run faster than an AT. It brings dazzling speed to sluggish graphics programs. *All* types of software run faster, so you finish more quickly. Transparent to the user, you won't know it's there *until you see its speed.*

We are so confident that our TurboEGA is the ultimate graphics card that we decided to give away a *free* copy of Microsoft's Windows™ with each TurboEGA*. Even Microsoft recommends that you run Windows on an AT. Now Orchid's TurboEGA gives you AT speed so XT users can use this number one windowing software at the speed they demand.

The Complete Solution

Only Orchid puts this much performance into one slot *and* comes fully loaded with 256K of RAM, so there's no hidden cost. TurboEGA is the *complete* graphics solution.

Pick up the phone and find out how you can have the EGA the competition wishes *they* had: Orchid's TurboEGA, the world's fastest.

If you have an AT or a system with 80286 speed, ask about the Orchid EGA™—four graphic-card compatibility in one slot.

Features:

- Powered by 7.2MHz 80286
- Optional 5 or 8MHz 80287
- 256K of on-board RAM
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  - Framework
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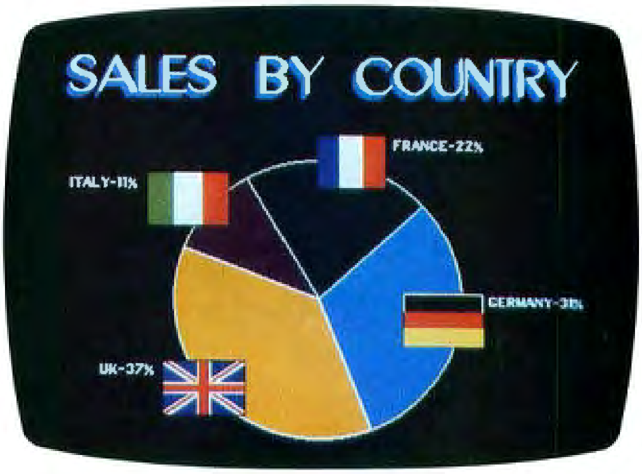
Inquiry 427 for End-Users. Inquiry 428 for DEALERS ONLY.

model 15. Priced at $10,050, the unit comes with 2 megabytes of internal memory and a disk capacity of 70 megabytes. The firm also introduced a 4-megabyte memory expansion card ($4300) that can bring the RT's memory to a total of 8 megabytes, double the computer's previous maximum.

IBM said it will release a revised version of the RT's UNIX-based operating system next year. AIX 2.1 will handle 16 users concurrently (double the capacity of the original version) and provide the RT with Systems Network Architecture capabilities. Also sometime next year, IBM will bring out an SCSI adapter card ($1080), a System/370 host interface adapter ($1795), and a plug-in board called the Advanced Floating-Point Accelerator ($1995) that the company claims will nearly triple the speed of floating-point calculations. For more information, contact IBM Corp., Information Systems Group, 900 King St., Rye Brook, NY 10573.

Inquiry **558.**



Stella Business Graphics for IBM PCs *and compatibles.*

Presentation Charts and Graphs on the IBM PC

With Stella Business Graphics, you can produce graphs and charts by supplying data and labels through the Stella Data Spreadsheet. Stella also works with your spreadsheet, word-processing, and numerical database programs to create graphic presentations. Stella offers you a choice of 12 graphic formats, and you can import data from ASCII or DIF files to create pie, donut, area, column, deviation, bar, pictograph, and text charts.

Stella Business Graphics costs $199 and runs on IBM PCs, XTs, ATs, or compatibles with 320K bytes of RAM and an Enhanced Graphics Adapter, Color Graphics Adapter, or a Hercules-compatible graphics board. Stella Systems recommends using a hard disk drive. The program works with dot-matrix and laser printers, plotters, and film recorders.

For more information, contact Stella Systems Inc., 10430 South De Anza Blvd., Cupertino, CA 95014, (408) 257-6644.

Inquiry **559.**

Chip Replaces Seven in PC AT

Chips and Technologies introduced an IBM PC AT-compatible chip that replaces seven VLSI chips on the AT system board. The 82C206 Integrated Peripheral Controller (IPC) performs the functions of two 8237 DMA controllers, two 8259 interrupt controllers, an 8254 timer/counter, a 146818 real-time clock, and a 74LS612 memory mapper.

The 84-pin CMOS chip consumes one-tenth the power of and operates 60 percent faster (8-MHz versus 5-MHz DMA clock) than the seven chips it replaces, the company claims. The IPC is designed to be used with the firm's AT-compatible CS8220 CHIPSet, five chips on a board that replace 63 logic devices on the AT board; the current CHIPSet system board has a socket to accept the 82C206. The CHIPSet board is about half the size of the AT board, operates 25 percent faster (10 MHz versus 8 MHz), and consumes one-third the power (15 W versus 42 W).

Chips and Technologies will sell the DK8220 development kit for the 82C206; it includes data sheets, schematics, and an evaluation board to be used in design environments. The DK8220 board has a diagnostic LED display, test points, programmable wait states, AT BIOS, and sockets for expansion.

The 82C206 costs $49 each in quantities of 100; the CHIPSet remains $51 each in the same quantities. The development kits are $1495 each. For more information, contact Chips and Technologies, 521 Cottonwood Dr., Milpitas, CA 95035, (408) 434-0600.

Inquiry **560.**

32-bit Floating-Point Processing for PCs

Data Translation's MACH Series for the IBM PC, XT, and AT is designed to provide floating-point capabilities for the company's data-acquisition and image-processing boards.

The series includes the DT7010 Floating-Point Array Processor, a plug-in board based on Advanced Micro Devices' Am29325. The chip incorporates a 32-bit floating-point ALU and multiplier with a 32-bit data path. The $4995 board, the company reports, performs floating-point operations in a single clock cycle at a rate of 6.5 MFLOPS, using the IEEE-754 standard. The board's microcode memory (2K by 56 bits) provides storage for microcoded routines that can be called from the accompanying software and for user-written microcoded routines. Its data memory (8K by 32 bits) is mapped into the host computer's memory space.

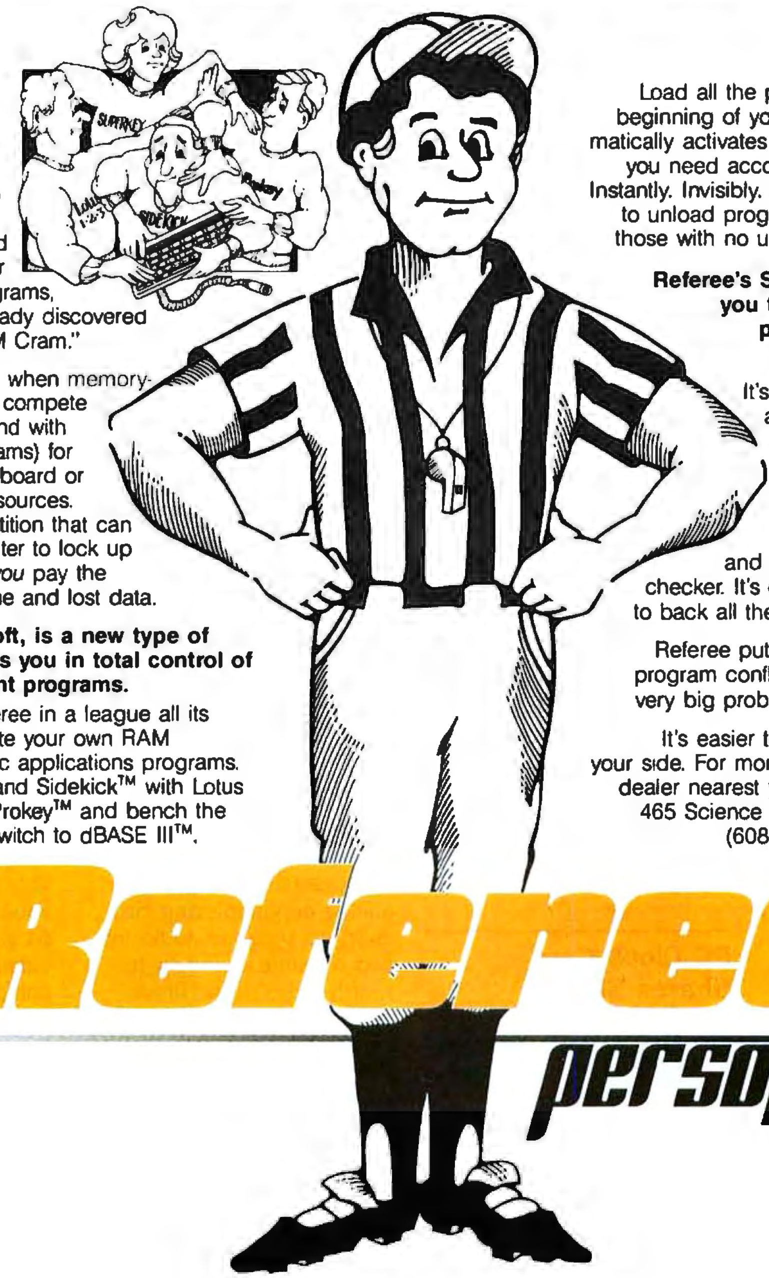
The series' software consists of three modules. The Vector Subroutine Library, which is priced at $1495, incorporates 115 subroutines that can be called from user-written programs in C or FORTRAN. The Microcode Assembler, designed for developing microcoded algorithms, provides access to the individual systems on the processor board and lets you write routines for specific applications. The Simulator enables you to write, run, and analyze custom-written microcoded routines without using a DT7010 board. The Assembler and Simulator sell for $1495; all three programs cost $2495 when purchased together. Contact Data Translation Inc., 100 Locke Dr., Marlborough, MA 01752, (617) 481-3700.

Inquiry **561.**

(continued)

RAM-Resident Program Users...

IT'S EASY TO WIN WHEN YOU BUY THE REFEREE™



With Referee, you make the rules.

If you use desktop organizers, spell checkers, keyboard enhancers or other RAM-resident programs, you may have already discovered the horror of "RAM Cram."

RAM Cram occurs when memory-resident programs compete with each other (and with applications programs) for control of your keyboard or other computer resources. It's a fierce competition that can cause your computer to lock up completely. Then *you* pay the penalty—in lost time and lost data.

Referee, by Persoft, is a new type of software that puts you in total control of your RAM-resident programs.

And that puts Referee in a league all its own. You can create your own RAM Teams™ for specific applications programs. Team Superkey™ and Sidekick™ with Lotus 1-2-3™. Or call in Prokey™ and bench the others when you switch to dBASE III™.

Load all the programs you need at the beginning of your workday. Referee automatically activates and deactivates the ones you need according to *your* set of rules. Instantly. Invisibly. You can also use Referee to unload programs from memory—even those with no unload option of their own.

Referee's Sideline™ menu enables you to control RAM-resident programs from within an applications program!

It's ideal for integrated packages like Symphony™. You can use a keyboard enhancer with the spreadsheet module. Or deactivate it, enter the word processing module and activate your favorite spell checker. It's easy. And you never have to back all the way out of the program!

Referee puts an end to RAM-resident program conflicts. At $69.95, it solves a very big problem for a very small price.

It's easier to win with the Referee on your side. For more information, and for the dealer nearest you, contact: Persoft, Inc., 465 Science Drive, Madison, WI 53711, (608) 273-6000—Telex 759491.

Referee™

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Perspective in 3-D

Three D Graphics announced a three-dimensional business graphics program. Perspective enables you to choose from 33 three-dimensional and 16 two-dimensional preprogrammed graph types. You can customize the graph by modifying the viewing angle, picture size and placement, primary and background shades and patterns, and title designs. Also included are a data manager and a label manager.

Perspective runs on IBM PCs and compatibles with a medium- or high-resolution display, a graphics card, a monochrome graphics controller, and MS-DOS or PC-DOS 2.0 or higher. The program costs $295. For information, contact Three D Graphics, 860 Via de la Paz, Pacific Palisades, CA 90272, (213) 459-7949.
Inquiry 562.

Slide Maker Based on PC

General Parametrics, manufacturer of presentation graphics products including VideoShow, has come out with a film recorder that connects to an IBM PC or compatible for the production of 35mm slides. Slides produced with the device can use up to 1000 colors with 2048 by 2048 resolution.

The PhotoMetric 200 PC system includes a desktop box containing a 35mm camera, an interface board that's inserted in the computer, and menu-driven software. Images produced with any PC graphics program (Lotus 1-2-3, ChartMaster, Microsoft Chart, Harvard Presentation Graphics, Freelance, PictureIt, and so forth) can be previewed in full color and at high resolution before the slide is made. No adjustments need to be made before the slide is produced; the unit incorporates automatic exposure calibration, which adjusts brightness and exposure times.

The PhotoMetric 200 PC, a slide-making system.

The 200 PC contains an on-board 8086 microprocessor and 1 megabyte of RAM. The high resolution and large number of available colors are generated by video circuitry, called MacroVision, developed by General Parametrics. The system, which includes the film recorder, board, 35mm camera, and software, has a retail price of $5995. For more information, contact General Parametrics Corp., 1250 Ninth St., Berkeley, CA 94710, (415) 524-3950.
Inquiry 563.

PC Clock Card Shares Slot

The SideClock, designed for IBM PCs, XTs, and compatibles, is able to share an expansion slot with any other expansion card. Measuring about 1 inch by 4 inches, the card has a rectangular hole in its center and is horizontally mounted on any of the expansion slots in the computer's motherboard. A second expansion card can be inserted through the SideClock's center hole into the same slot.

The SideClock costs $59.95 and includes clock/calendar functions, a 5-year lithium battery, and control software. For more information, contact Innoventions Inc., 1669 South Voss, Suite 880, Houston, TX 77057, (713) 728-0938.
Inquiry 564.

Stereo Sound for Apple's IIGS

MDIdeas' SuperSonic board enables the Apple IIGS to produce stereo sound. The board incorporates high-speed analog demultiplexing circuitry to separate audio into two separate channels. Its fourth-order digital filters allow only selected frequencies to pass through, and its buffer amplifiers isolate the audio for clean line-level output.

The board comes with two 0.5-watt amplifiers that can drive 8-ohm speakers and has an edge connector for future enhancements, such as a sound digitizer. You can also select power output levels for speakers or headphones. According to the company, the SuperSonic supports Apple's routines for the IIGS's Ensoniq sound chip and is compatible with software that can address the chip, like Electronic Arts' Music Construction Set.

Suggested retail price is $59.95. For more information, contact MDIdeas Inc., 1111 Triton Dr., Suite 205, Foster City, CA 94404, (415) 573-0580.
Inquiry 565.

Tektronix 4115 Graphics Terminal Emulator

TGRAF-15 emulates a Tektronix 4115 graphics terminal. It enables you to run minicomputer and mainframe graphics programs using your personal computer as a terminal. TGRAF-15 can display images of up to 1280- by 1024-bit resolution with 256 colors out of a palette of up to 16 million colors.

The program supports applications that require 32-bit coordinates, which enables you to store detailed graphics data and examine it by zooming in on the screen image. There are functions for generating circles, arcs, rectangles, points, vectors, and filled panels. You can use the extended graphics input mode, which includes user-definable and multiple cursors. You can also establish up to 64 graphics windows, providing multiple views of a complex graphical model.

TGRAF-15 runs on IBM PCs, XTs, ATs, and compatibles. It costs $1995. For more information, contact Grafpoint, 4340 Stevens Creek Blvd., San Jose, CA 95129-1102, (408) 249-7951.
Inquiry 566.

(continued)

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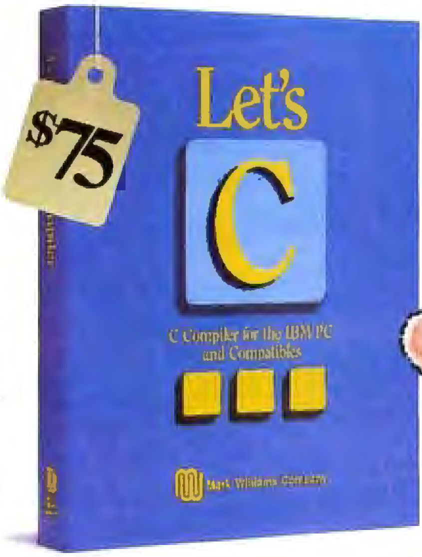

Admit it. You're intrigued with the idea of C programming. You may be working in BASIC, Pascal or Assembler now. But you're drawn to the power, portability and flexibility of C. And if money is what motivates you, imagine having it all for just $75 with Mark Williams Let's C.*

EVERYTHING YOU COULD ASK FOR IN A C COMPILER.

Let's C is no mere training tool. It's a complete, high quality C compiler. With the speed and code density to run your programs fast and lean. It won't get you sidetracked on some quirky aberration of C; Let's C supports the complete Kernighan & Ritchie C language–to the letter. And it comes from the family of Mark Williams C compilers, the name chosen by DEC, Intel, Wang and thousands of professional programmers.

POWERFUL UTILITIES ARE A REAL BONUS

Let's C doesn't stop with being a high performance C compiler. It includes utilities you'd expect to pay extra for–like a linker and assembler plus the MicroEMACS full screen editor with source code included. Having the source code not only allows you to customize the editor, it offers a close up, fully commented view of C programming at its best.

REVIEWERS ARE SOLD ON LET'S C, TOO.

"Let's C is an inexpensive, high-quality programming package...with all the tools you will need to create applications."
–William G. Wong, *BYTE*, August 1986.

"Let's C is a thoroughly professional C environment loaded with tools and programming utilities...another fine Mark Williams product."
–Christopher Skelly, *COMPUTER LANGUAGE*, February 1986

"The performance and documentation of the $75 Let's C compiler rival those of C compilers for the PC currently being sold for $500... highly recommended..."
–Marty Franz, *PC TECH JOURNAL*, August 1986

Features

- For the IBM-PC and Compatibles
- 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
- Not copy protected

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
MS 4.0	147

MARK WILLIAMS LET'S C
$75
60 DAY MONEY BACK GUARANTEE

ADD THE *csd* DEBUGGER AND CUT DEVELOPMENT TIME IN HALF.

Invest another $75 and you've got Mark Williams revolutionary source level debugger. *csd* lets you bypass clunky assembler and actually debug in C. That's a big help when you're learning C and indispensable when you're programming. *csd* combines the interactive advantages of an interpreter with the speed of a compiler, slicing development time in half. This is how Byte Magazine summed it up: "*csd* is close to the ideal debugging environment." William G. Wong, *BYTE*, August 1986

ARE YOU STILL RESISTING?

If there's any doubt that now's the time to get your hands on the power of C, consider Mark Williams 60-day money back guarantee. You can't lose. But with Let's C and *csd*, imagine what you could gain.

Ask for Let's C and *csd* at your software dealer's, in the software department of your favorite bookstore, through the Express Program at over 5500 Tandy stores or order now by calling **1-800-MWC-1700.***

*In Illinois call 312-472-6659

Mark Williams Company
1430 West Wrightwood, Chicago, Illinois 60614

Inquiry 212

MARK WILLIAMS LET'S C. ONLY $75.

SYSTEMS

Wyse Announces XT Compatible

Wyse Technology has added the WYSEpc+, an IBM PC XT compatible, to its line of PC-compatible computers. The WYSEpc+ is based on the Intel 8088-1, a dual-speed processor that runs at 4.77 or 9.54 MHz, selectable from the keyboard. The computer includes a built-in display adapter on the motherboard that supports Hercules monochrome as well as IBM monochrome and color graphics adapter modes, 16 shades of gray, and the ability to display 132 columns by 44 lines.

Three models are available. The 1400-01 is a single floppy disk drive system with 256K bytes of RAM for $1265; the 1400-02 comes with two floppy disk drives and 640K for $1445; and the 1400-20 includes a single 360K floppy disk drive, a 20-megabyte hard disk, and 640K for $1995.

All three systems are equipped with two serial ports, one parallel port, a real-time clock with battery backup, two available XT-compatible slots, and a standard AT-style keyboard or the enhanced version with function keys across the top row. All come with MS-DOS 3.1. Contact Wyse Technology, 3571 North First St., San Jose, CA 95134, (408) 433-1000.

Inquiry 567.

The WYSE*pc+, a dual-speed* PC XT*-compatible computer.*

SB180FX Single-Board Computer

The SB180FX, a follow-up to the 8-bit SB180 single-board computer, is available from Micromint. The new version, like the first, is based on a Hitachi HD64180 processor running at 6.144 MHz; the new version's processor, though, can be upgraded to run at 9.216 MHz or 12.288 MHz. The company reports that the SB180FX is software- and hardware-compatible with the SB180 (see September 1985 BYTE, Ciarcia's Circuit Cellar), with the exception of additional connectors that support extra features.

With a base price of $409, the SB180FX is equipped with 256K bytes of on-board dynamic RAM and can accommodate 512K bytes (compared to the 256K in the SB180). The memory can be expanded to 4 megabytes. The system also has an 8K, 16K, or 32K EPROM socket with an 8K ROM monitor. In addition to two serial ports and one parallel printer port, the SB180FX has a 4-bit memory extension address and 8255 PIA with 24 bits of parallel I/O. The board's SMC 9266 disk controller supports four floppy disk drives, and its NCR 53C80 SCSI controller can handle a 32-megabyte hard disk. Thirty-two ports from a total of 256 are available on a 40-pin header, and the system can support 64 additional ports.

With software, the SB180FX sells for $499. Contact The Micromint Inc., 25 Terrace Dr., Vernon, CT 06066, (800) 635-3355; in Connecticut, (203) 871-6170.

Inquiry 568.

ITT's XTRA/286

ITT's Information Systems Division announced an IBM PC AT compatible, called the XTRA/286 Advanced Technology Workstation (ATW), that comes with a display adapter compatible with IBM's Enhanced Graphics Adapter, Color Graphics Adapter, and Monochrome Display Adapter, as well as the Hercules Graphics Card. The machine features a 10-MHz, one-wait-state 80286 processor (which can be switched from the keyboard to run at 6 MHz) and 640K bytes of memory. The ATW includes eight full-length expansion slots (six 16-bit and two 8-bit), plus five half-height drive slots. A serial and parallel port, clock/calendar, and detachable keyboard are standard.

The base model, with a 1.2-megabyte floppy disk drive and the multimode graphics adapter, costs $2499. A model with a 30-megabyte hard disk costs $4299. Contact ITT Information Systems, 2350 Qume Dr., San Jose, CA 95131, (408) 945-8950.

Inquiry 569.

Portable AT Compatible

AMQ Computer is selling a portable computer that's compatible with the IBM PC AT. Called the AMQ 286 Model II, the computer runs on an 8- or 10-MHz 80286 and supports four graphics modes.

About the same size as the Compaq Portable II, the $5995 computer is equipped with a 1.2-megabyte floppy disk drive, a 40-megabyte hard disk drive, and an AT-style keyboard. It comes with 1 megabyte of RAM that can be expanded to 4.1 megabytes on the motherboard. Three full-size expansion slots are available, and a built-in 9-inch dual-mode monitor is standard. Display modes supported include IBM monochrome, color, and enhanced graphics and Hercules monochrome graphics. An interface for external RGB, EGA, and monochrome monitors is standard; a composite-video port is optional.

Other standard features include a serial and parallel port, a real-time clock, a socket for an 80287 math coprocessor, and a 160-watt power supply. Contact AMQ Computer Corp., 655 North Pastoria Ave., Sunnyvale, CA 94086, (408) 720-8055.

Inquiry 570.

(continued)

MARK WILLIAMS C. AN ENLIGHTENING DEVELOPMENT FOR ATARI ST USERS.

If you've tried your hand at developing applications on the Atari ST, you know the problem. Programming tools aren't only hard to come by, they're hard to use. One might even say primitive. But now for some enlightening news: you can have all the power, portability and versatility of the C language from a leader in professional C programming tools, Mark Williams.

BRING YOUR PROGRAMMING UP TO SPEED.

The Mark Williams C compiler produces fast, dense code and supports the complete Kernighan & Ritchie industry standard C. You'll have access to GEM's AES and VDI libraries for programs using graphics, icons and the Atari mouse. And Mark Williams C lets you take advantage of the full 16 megabytes in Atari's 68000 microprocessor.

STREAMLINE DEVELOPMENT WITH POWER UTILITIES.

Mark Williams C is loaded with everything you'll need for professional development. Bring the power of the UNIX environment to your Atari ST with our Microshell Command Processor including pipes, I/O redirection and more. Edit your program with the highly acclaimed MicroEMACS full screen editor. Accelerate and simplify compiling with *make* which finds and recompiles only those modules affected by your changes. Then, when you're ready for debugging, call on our db Symbolic Debugger with single step, breakpoint and stack traceback functions. Over 40 commands, including a linker and assembler, provide a total development package for your Atari ST.

Features

C compiler
- Complete Kernighan & Ritchie C plus extensions
- Up to eight register variables
- Full access to AES and VDI libraries for programs using graphics, icons and mouse
- Complete UNIX-compatible libraries allow easy portability to and from UNIX development environment.
- Over 300 Atari-specific routines
- One-step compiling, linking with cc command
- English error messages
- Lint-like error checking

Microshell Command Processor, powerful UNIX style shell includes I/O redirection, pipes, command substitutions

MicroEMACS Full Screen Editor with commented source code included

Make Program Building Discipline

Complete symbolic debugger with single-step, breakpoints and stack traceback

Assembler, linker and archiver

Powerful Utilities Package: egrep, sort, diff, cmp, pr, tail, uniq, wc and more

Over 600 pages of documentation including 120 sample C programs

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MARK WILLIAMS C FOR THE ATARI ST
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DEPEND ON A NAME WITH A HISTORY OF PERFORMANCE.

Mark Williams C for the Atari ST is part of our growing line of C compilers. A line that includes the C compiler chosen by DEC, Intel, Wang and thousands of professional programmers. Now our Atari C compiler is earning its own reputation:

"Finally a great C compiler that exploits the power of the ST"–Sigmund Hartmann, President, Atari Software Group

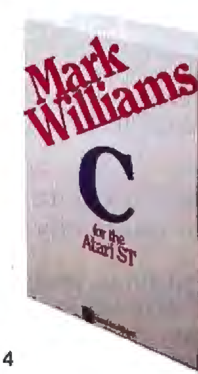
"The all-around best choice for serious software development on the ST."–Douglas Weir of *ANALOG COMPUTING*

GET WHAT YOUR ATARI ST HAS BEEN WAITING FOR.

Mark Williams C is just what your Atari ST was made for: powerful, professional programming. So now that you can have Mark Williams C for just $179.95, what are you waiting for?

Ask your Atari dealer about Mark Williams C or order today by calling **1-800-MWC-1700.***

*In Illinois call: 312-472-6659



Mark Williams Company
1430 West Wrightwood, Chicago, Illinois 60614

Inquiry 213

PERIPHERALS

Okidata's Laserline 6

Okidata has announced its first laser printer, the Laserline 6, that prints 6 pages per minute and features several plug-in modules, one of which enables up to three users to share a single printer.

Fifteen fonts are resident in the Laserline, and additional fonts are available on cartridges. The printer is equipped with a 128K-byte page-image buffer; an optional 384K expansion cartridge provides extra memory for loading additional fonts and macro commands. The company offers three plug-in personality modules. The basic module provides one port and compatibility with the Hewlett-Packard LaserJet, and the advanced module offers one port and compatibility with the HP LaserJet Plus. The third module, also compatible with the HP LaserJet Plus, provides three ports. The advanced and multiuser modules have extended graphics, downloadable fonts, and forms overlay capabilities. All three modules come with a parallel or serial interface.

Suggested retail price for the printer is $1995, plus $200 for the basic plug-in module. The advanced module sells for $400, and the multiuser costs $600. The memory expansion board costs $399; additional font cartridges are $149 each. For more information, contact Okidata, 532 Fellowship Rd., Mt. Laurel, NJ 08054, (609) 235-2600.
Inquiry 571.

Back Up Data Automatically

The ARC 9000, a 60-megabyte streaming tape drive, operates continuously and automatically to back up data as it's written to disk. Designed to work with IBM PCs, XTs, ATs, and compatibles, the unit provides a mirror image of all files and stamps each with the time and date. Files can be restored by time, date, filename, and directory, and by the entire disk. The unit also provides a real-time clock/calendar, a 128K-byte print spooler, battery-operated RAM, and diagnostic routines.

The drive, which sells for $2600, comes with software and a half-slot adapter board with an SCSI interface and processor. An optional half-height hard disk that fits in the unit offers an added 10 to 80 megabytes of storage. For more information, contact Digital Storage Systems Inc., 1234 Sherman Dr., Longmont, CO 80501, (303) 651-6312.
Inquiry 572.

Analyze IEEE-488 Bus Signals

The GBA 1500, an IEEE-488 bus analyzer, enables computers or terminals with an RS-232C port to capture and display up to 16,384 bus transactions. The unit can acquire, store, and display each byte as it's transmitted and then store the data for analysis. It can single-step the bus and display the data in IEEE-488 mnemonics and in hexadecimal format. The unit displays the status of control lines and the current location of its buffer pointer as well.

The GBA 1500 sells for $795. For more information, contact Connecticut micro-Computer Inc., 568 Danbury Rd., New Milford, CT 06776, (203) 354-9395.
Inquiry 573.

Microsoft Adds Menus to Mouse

Microsoft has added extra capabilities to its mouse, including menu support for Lotus 1-2-3, DisplayWrite 3, and MultiMate. In addition, the Microsoft Mouse version 6.0 is bundled with Microsoft Paintbrush and Show Partner, a presentation graphics package.

A serial version of the mouse sells for $195; a bus version, $175; and an InPort version, $125. A programmer's reference kit for writing custom menus costs $25. Contact Microsoft Corp., 16011 Northeast 36th Way, Box 97017, Redmond, WA 98073-9717, (206) 882-8080.
Inquiry 574.

High-Speed Printers from Epson, C. Itoh

Epson's LQ-2500, a 24-pin dot-matrix printer, prints draft-quality text at 324 characters per second and near-letter-quality text at 108 cps with a density of 12 characters per inch. At 10 characters per inch, the printer's speed is 270 cps in draft mode and 90 cps in near-letter-quality mode.

The $1595 printer has an LCD panel on the front for entering and storing printer setup commands. You can store four combinations of command sets and change them at any time.

The 136-column printer comes with serial and parallel interfaces and an 8K-byte buffer. Five typefaces are standard. The printer is compatible with software that works with the Epson LQ-800, LQ-1000, and LQ-1500. Contact Epson America Inc., 2780 Lomita Blvd., Torrance, CA 90505, (800) 421-5426; in California, (213) 539-9140.
Inquiry 575.

C. Itoh's ProWriter C-715 Reliant, a 24-pin dot-matrix printer, prints at 300 cps in draft mode and 100 cps in near-letter-quality mode. The Reliant also offers seven-color printing and credit-card-size plug-in personality cards.

The printer, which sells for $1295, comes with a serial and parallel interface and a 32K-byte buffer. The plug-in cards, which cost $49.95 each, emulate the Epson LQ-1000, IBM Proprinter XL, Toshiba P351, and Diablo 630 printers; the Epson card is standard. The printer also provides a hex-dump mode for debugging that prints hexadecimal and ASCII characters of each byte the printer receives. Contact C. Itoh Digital Products Inc., 19750 South Vermont Ave., Suite 220, Torrance, CA 90502, (213) 327-2110.
Inquiry 576.

Test Dynamic RAMs

A dynamic RAM tester from Bugtrap Instrumentation is capable of testing a variety of dynamic RAMs, including 16K, 64K, 128K, 256K, 1 megabit, and others. The unit tests the DRAM using data patterns loaded into and read from all cells. Access time can be selected from a range of 100 to 300 nanoseconds; a refresh test is also available.

The unit can test a DRAM with a single test sequence or a series of test cycles for identifying intermittent or thermal failures. The Model 8000 Dynamic RAM Tester sells for $1495. Contact Bugtrap Instrumentation, 1209 Alderwood Ave., Sunnyvale, CA 94089, (408) 734-1118.
Inquiry 577.

(continued)

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Since Lotus HAL makes 1-2-3 more accessible for all users, you'll learn more—in less time—about all the capabilities of 1-2-3.

For instance, if you're presently using only the spreadsheet, Lotus HAL will show you how to create graphs and do database functions—far more simply than ever before.

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With Lotus HAL, you'll take shortcuts and accomplish multi-step tasks quickly and easily. So you'll greatly reduce errors—and save time.

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Lotus HAL also makes developing macros simpler than ever—so simple, in fact, that even novice users can create 1-2-3 macros with Lotus HAL. And no matter how familiar with 1-2-3 you are, you'll benefit from being able to write and test macros to make sure they do what you had in mind.

New Power

Lotus HAL will let you take 1-2-3 as far as you need. And if you've been taking it far already, Lotus HAL offers you new commands that will further enhance your productivity.

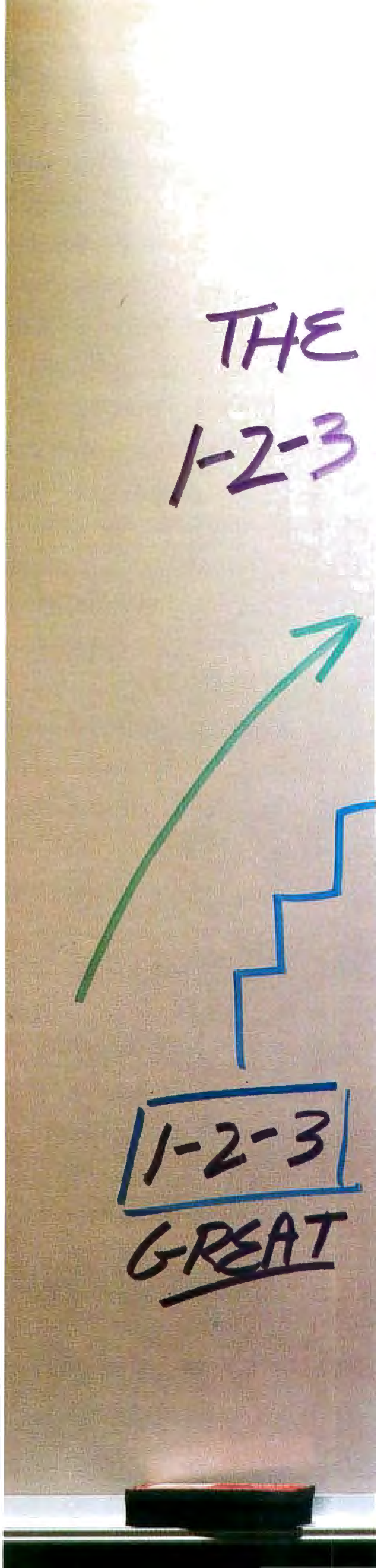
For example, Lotus HAL lets you replace items anywhere in the worksheet (even within formulas), and create a dynamic link between cells in multiple worksheets. It also lets you audit your worksheet—so you can find mistakes without having to review the entire sheet "manually."

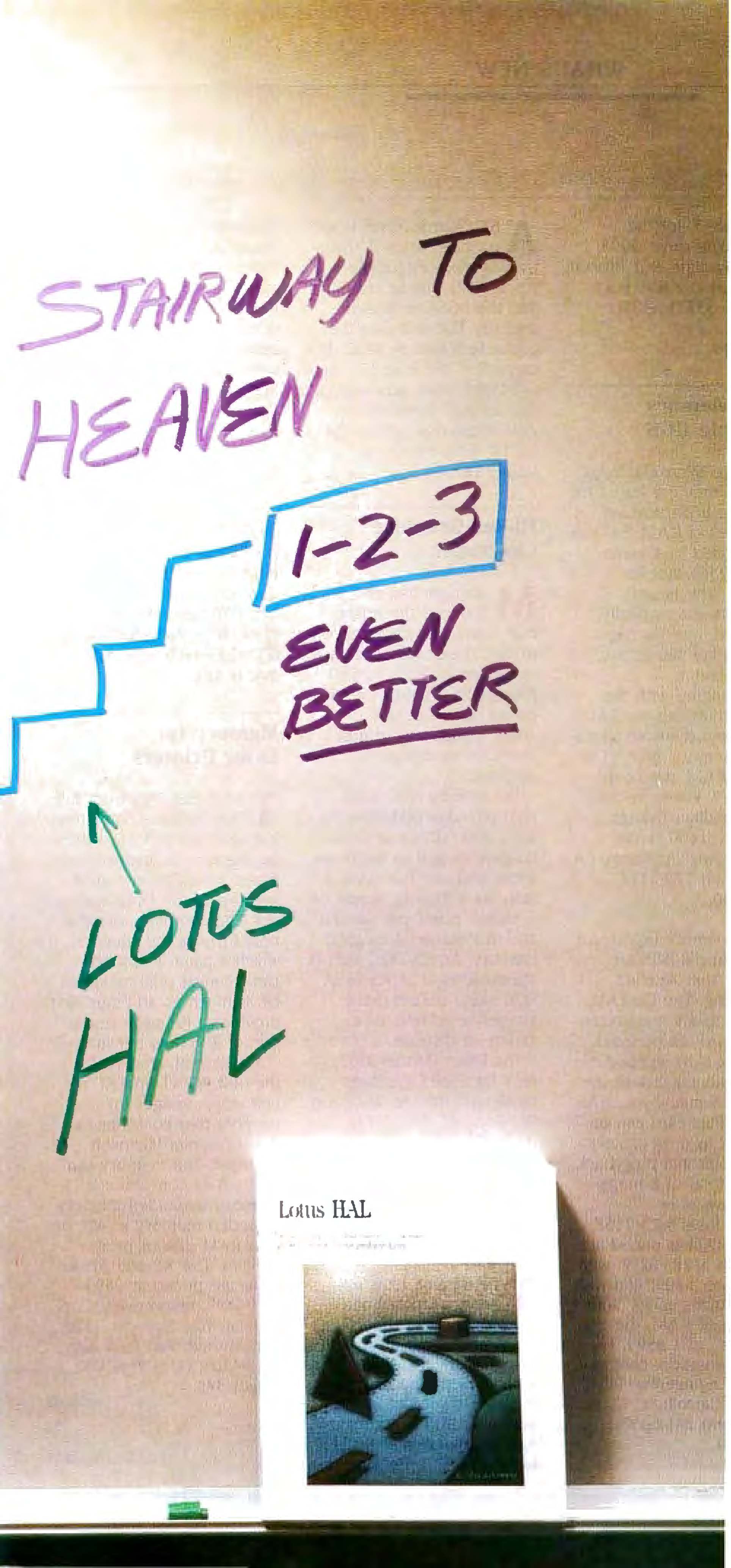
Best of all, while Lotus HAL greatly enhances 1-2-3's commands, it doesn't change either 1-2-3 or the worksheet. It's always available, but it never gets in your way. And you can share data as freely when you're using Lotus HAL as you did when you were using 1-2-3 alone.

In fact, you can do everything you've ever done with 1-2-3 even better...plus a great deal more.

And since Lotus HAL is part of the 1-2-3 system—and the Lotus family—you get an unparalleled commitment to customer service and support that will keep you up and running.

System Requirements.
Lotus HAL requires 1-2-3 Release 1A. Release 2 or Release 2.01 for personal computers from IBM,* COMPAQ, and AT&T, plus 1-2-3 Certified Compatibles; DOS 2.0 or higher. Please refer to your 1-2-3 package or 1-2-3 documentation for appropriate hardware configurations and DOS requirements or consult your dealer.
Lotus HAL resides in memory with 1-2-3 and operates with it; a minimum system configuration of 512K is required.
*Lotus HAL does not operate with 1-2-3 for the IBM PCjr (ROM version), IBM PC Convertible or Release 1A for the IBM 3270 PC.





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ADD-INS

PC Convertible Modem

Megahertz has introduced a Hayes-compatible modem for use with the IBM PC Convertible. Built to the same physical specifications as IBM's modem, the EasyTalk 1200 operates at 300/1200 bps. It comes with two phone jack connectors and features a low power requirement (250 milliwatts when operating) as well as a utility that can turn the modem off to prevent draining the computer's battery.

The modem is capable of full- and half-duplex communication, has auto-answer and auto-dial capabilities, supports rotary and pulse dialing, and is compatible with Bell 103 and 212A and CCITT V.22 standards. Without software, the modem sells for $400; with a full-function communications program, the cost is $450. For more information, contact Megahertz Corp., 2681 Parleys Way, Suite 2-102, Salt Lake City, UT 84109, (800) 338-8726; in Utah, (801) 485-8857.
Inquiry 578.

Up to 54 Megabytes on a 3½-inch Hard Disk

Rodime announced the RO 3000 Series of 3½-inch hard disk drives that provide 45.4 or 54.5 megabytes (unformatted) of storage capacity. The drives use a voice-coil actuator and offer an average access time of 28 milliseconds. Their power consumption is 11 watts.

The company says that the drives can be used with most controllers and multiple drives can be daisy-chained from a single controller. The single-unit OEM price for the 45-megabyte drive is $895; for the 55-megabyte drive, $995. Contact Rodime, 901 Broken Sound Parkway NW, Boca Raton, FL 33431, (305) 994-6200.
Inquiry 579.

Extra Memory for Apple IIGS

Orange Micro's RamPak 4GS memory board for the Apple IIGS provides 512K bytes of RAM that can be expanded to 4 megabytes in 256K-byte increments. The board's memory is automatically configured, and its diagnostics utility can detect RAM problems.

Also bundled with the board are utilities for RAM caching and dynamic allocation of memory. With 512K bytes of RAM, the board costs $259. For more information, contact Orange Micro Inc., 1400 North Lakeview Ave., Anaheim, CA 92807, (714) 779-2772.
Inquiry 580.

Two memory boards for the Apple IIGS are available from Applied Engineering. The GS-RAM offers up to 1.5 megabytes on one card; an optional piggyback card, expandable to 2 megabytes, brings the total to 3.5 megabytes. The GS-RAM Plus card can be expanded to 6 megabytes. With an optional piggyback board, a total of 8 megabytes is available.

The GS-RAM with 256K bytes of RAM is priced at $169; with 512K, $219; with 1 megabyte, $299; and with 1.5 megabytes, $379. With 1 megabyte of RAM, the GS-RAM Plus costs $599. For more information, contact Applied Engineering, P.O. Box 798, Carrollton, TX 75006, (214) 241-6060.
Inquiry 581.

AST's RamStakPlus board provides up to 1 megabyte of memory for the Apple IIGS. The board plugs into the IIGS's extended memory slot and uses the computer's built-in RAM disk capability. The board costs $129. For more information, contact AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 553-0340.
Inquiry 582.

Hi-Res Graphics Controller

Modgraph has announced the Prism high-resolution graphics controller. The board offers a resolution of 1024 by 780 pixels with a choice of 16 colors from a palette of 4096. It supports 16 gray levels for monochrome graphics.

The board's NEC 7220 chip provides primitives for lines, arcs, circles, and rectangles, as well as hardware zoom and pan functions. It features a drawing speed of 1 million pixels per second and dual-ported 4-megabit memory. An RS-232C port is standard, as is an RS-343A RGB video output that's jumper selectable for a variety of displays.

The Prism (Model 3152) sells for $1695. Contact Modgraph Inc., 56 Winthrop St., Concord, MA 01742, (617) 371-2000.
Inquiry 583.

Plug-in Adapter for Serial Printers

The Missing Link, a serial adapter board, enables you to connect serial printers to an IBM PC or compatible without using a serial port. The board occupies a short slot in the computer and is addressed as a parallel printer (LPT1, LPT2, or LPT3). Because the computer addresses the board as a printer device, there's no need for mode commands for initializing COM1 or COM2 and redirecting printer output. The adapter will work with any software, the company says, and any RS-232C printer using the XON/XOFF or ETX/ACK protocols.

The $189.95 board connects to the printer with an existing printer cable or a modem cable. It has a standard RS-232C connector; according to the company, no pin swapping is necessary. Contact Henson Scientific Inc., 870 Seventh Ave., 27th Floor, New York, NY 10019, (212) 245-4180.
Inquiry 584.

Memory for Laser Printers

The JLaser Plus from Tall Tree Systems combines 2 megabytes of RAM with an interface to laser printers based on a Canon engine and the Canon IX-12 scanner. The company says the board triples the speed at which a page is scanned, can increase printing speed by as much as 50 times, and provides a full-page resolution of 300 dots per inch.

Available in versions for the IBM PC XT and AT, the unit stores images in memory that conforms to the Lotus/Intel/Microsoft standard. The memory can function as conventional memory, expanded memory, extended memory in ATs, or as a RAM disk or print spooler. The XT and AT versions are priced at $599 and $699, respectively. Contact Tall Tree Systems, 1120 San Antonio Rd., Palo Alto, CA 94303, (415) 964-1980.
Inquiry 585.

(continued)

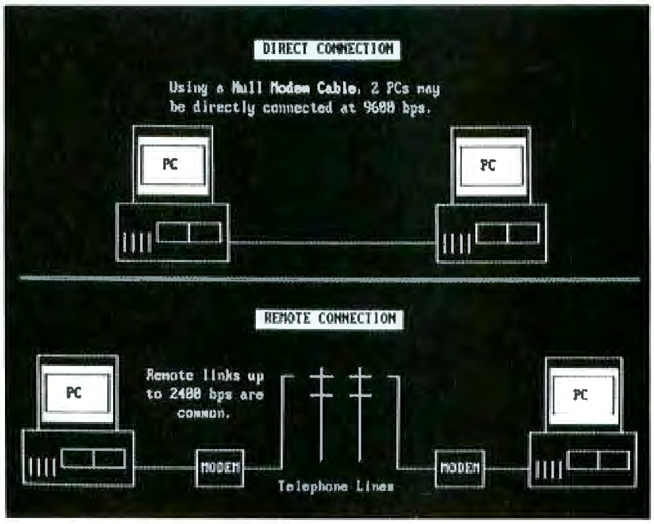
SOFTWARE • PROGRAMMING LANGUAGES AND AIDS

Help Screen Utility

Create context-sensitive on-line help screens with SoftScreen/Help. A screen processor enables you to draw help screens without programming; a screen linker ties the help screens together so that users can select additional help topics at run time; and a run-time manager enables you to integrate the help system with the application program.

SoftScreen/Help runs on IBM PCs and compatibles with MS-DOS or PC-DOS 2.0 or higher. The program sells for $195. For more information, contact Dialectic Systems, 1930 East Marlton Pike, Cherry Hill, NJ 08003-2148, (609) 424-0140.

Inquiry **586.**



SoftScreen/Help, a utility for creating help screens.

Researcher's Expert System

EXPERtIMENTAL DESIGN is an expert system that determines the statistical requirements of projects and suggests the most appropriate of 13 experimental designs.

The program costs $295 and is written in Turbo Pascal. It runs on IBM PCs, XTs, ATs, and compatibles with 256K bytes of RAM and MS-DOS or PC-DOS 2.1 or higher. For more information, contact Statistical Programs, 9941 Rowlett, Suite 6, Houston, TX 77075, (713) 947-1551.

Inquiry **587.**

C++ for MS-DOS Systems

Lifeboat Associates introduced Advantage C++, a software development tool that enables you to design your own data types using object-oriented programming methods. Versions of Advantage C++ are available for use with Lattice and Microsoft C compilers and cost $495.

For more information, contact Lifeboat Associates Inc., 55 South Broadway, Tarrytown, NY 10591, (914) 332-1875.

Inquiry **588.**

Windows Library for C

DataWindows, a window and data-entry library for C programmers, was announced by Greenleaf Software. It offers overlaid windows with screen management, program simplicity, transaction-oriented data entry, and device independence. According to Greenleaf, you can write to any window whether it is showing on the screen or not. DataWindows supports many popular C compilers and sells for $225. The source code is also available for DataWindows in C or assembly language and costs an additional $225.

Contact Greenleaf Software, 1411 LeMay Dr., Suite 101, Carrollton, TX 75007, (214) 631-0811.

Inquiry **589.**

SOFTWARE • SCIENTIFIC AND ENGINEERING

Graphics and Mathematical Toolbox

Math Toolbox enables you to use graphics and mathematical tools for engineering and scientific applications on your IBM PC, XT, or AT. Matrix operations, complex arithmetic, and vector operations in cartesian, polar, cylindrical, and spherical coordinates are included. You can also create two-dimensional screen and printer graphics and histograms of numerical data. And you can store custom-plotting parameters in template files.

Math Toolbox costs $249 and requires 256K bytes of RAM, one 360K floppy disk drive, a Color Graphics Adapter, and PC-DOS or MS-DOS 2.0 or higher. For more information, contact Alpha Applied Research, 2355 McLean Blvd., Eugene, OR 97405, (503) 485-6841.

Inquiry **590.**

Site Planning and Landscape Design

LANDCADD is a set of three programs that make use of AutoCAD 2.18 and 2.5 for producing site plans, cost estimates, and irrigation designs.

The program includes a library of symbols and site amenities and lets you view your plans in three dimensions, from any viewpoint. Each drawing is linked to a database that estimates costs at each phase of design. A zoom feature enables you to view any part of the drawing in detail, and you can input changes through a mouse or digitizer. Hard copy is output through a pen plotter.

The three programs include Site Planning and Landscape Design ($595), Cost Estimating ($395), and Irrigation Design ($395). You can purchase the three packages as a whole for $1095. To run LANDCADD you need an MS-DOS system with 640K bytes of RAM, a math coprocessor, a hard disk drive, a digitizing tablet, and a high-resolution graphics adapter and monitor.

For more information, contact LANDCADD Inc., 10418 East Tanglewood Rd., Franktown, CO 80116, (303) 688-8160.

Inquiry **591.**

Give Your Business A Merry Christmas and Have a Happy New Year!

1987 will be a very good year when you streamline your business with Dac-Easy Accounting. Now is the perfect time to give your business the gift it deserves and start the New Year right. Don't put off any longer the advantages of computerized accounting. At $69.95, Dac-Easy Accounting is a superb value even Scrooge would love.

We've combined seven full-featured accounting modules in a single package including General Ledger, Accounts Payable, Accounts Receivable, Inventory, Purchasing, Billing and Forecasting. This is the software that the readers of PC World have voted as their favorite accounting package in the 1986 World Class Awards. Dac-Easy Accounting received more than five times as many votes as the second place finisher BPI — costing thousands of dollars more.

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Price plus tremendous performance means value, and the experts agree. *InfoWorld* has recognized Dac-Easy Accounting as 1985's "BEST SOFTWARE VALUE."

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Dac-Easy Payroll for 1987 is here just in time to help you get a handle on the new tax laws. Dac-Easy Payroll is the fastest selling payroll package on the market. It not only processes your payroll, but helps you with personnel functions as well. Dac-Easy Payroll automatically calculates payroll taxes for all 50 states, prints checks, W-2's, and allows you to review your departmental payroll taxes hundreds of different ways. Priced at only $49.95, it is another example of the price/performance value of the Dac-Easy Series.

Find out for yourself why Dac-Easy Accounting is the fastest selling accounting package in history. Call us today!

Minimum hardware requirements All Dac-Easy products run on IBM or other compatibles. 256K memory, two disk drives, MS-DOS, PC-DOS 2.0 or later, 132-column printer in compressed mode, color or monochrome monitor.

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Dac-Easy Bonus Pack includes five great software packages for a low $149.95. That means a savings of over $130. You receive Dac-Easy Accounting, Dac-Easy Payroll, Dac-Easy Accounting Tutor, and Dac-Easy Payroll Tutor. Also included is Pop-Up DeskSet Plus, a $129.95 retail value, selected Editor's Choice in a recent PC Magazine review on desktop programs. Don't delay. Order our Bonus Pack today and get the accounting system everyone is talking about!

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30 Day Money-Back Guarantee Dac Software offers an unconditional guarantee on all Dac-Easy products (less shipping charges). There is a $10 restocking fee if the disk seal is broken. This guarantee is available on all products bought directly from Dac Software.

#830

SOFTWARE • SCIENTIFIC AND ENGINEERING

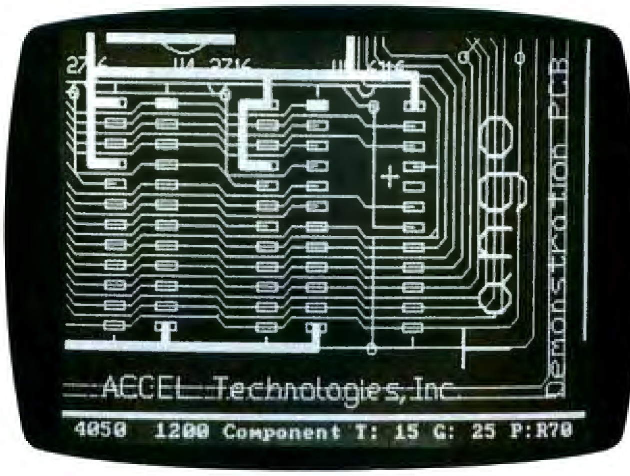
Printed Circuit Board Design

Tango-PCB is a $495 IBM PC program that enbles you to design printed circuit boards up to 32 by 19 inches. Expanding and contracting the layout allows you to place components precisely. Five zoom levels are available from 1.6 by 0.95 inches, expandable to the full 32- by 19-inch workspace capacity.

You have a choice of nine grid sizes for placement of component shapes such as DB-25 connectors and edge connectors with odd spacings. It also offers an eight-layer capability, including power and ground planes, plus text and component overlay. You can create precise microstrip designs with an area-fill command. A library of common components is supplied, and you can add to it by creating your own entries for specialized components. In the Enhanced Graphics Adapter 640- by 350-pixel mode, 16 colors are supported. Four colors are supported in the Color Graphics Adapter 320 by 200 mode.

The program runs on IBM PCs and compatibles with 256K bytes of RAM and MS-DOS or PC-DOS 2.0 or higher. A CGA or EGA with an RGB monitor is also required.

Contact Accel Technologies Inc., 7358 Trade St., San Diego, CA 92121, (800) 433-7801; in California, (800) 433-7802 or (619) 695-2000.
Inquiry 592.



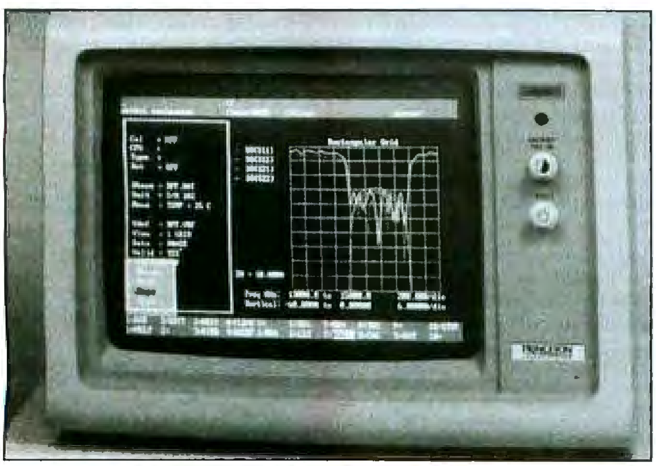
Tango-PCB, a program for designing printed circuit boards.

Computer-aided Testing

A computer-aided test program that calibrates, measures, and manages vector network analyzer data was announced by EEsof. ANACAT has a built-in database, DOS interface, full-screen editor, and color graphics capability.

The database stores and manipulates data retrieved from the network analyzer, and you can use it to store any number of S-parameter measurements, according to EEsof. The database manager enables you to create, delete, and revise test data, and you can present the data in graphs and tables. The database files are also compatible with spreadsheet and database programs.

ANACAT runs on IBM PCs, XTs, ATs, and compatibles and is priced between $5000 and $7500. For more information, contact EEsof Inc., 31194 La Baya Dr., Westlake Village, CA 91362, (818) 991-7530.
Inquiry 593.



ANACAT *handles network analyzer data.*

Graphics and Statistics

You can use Engineering Tool Kit to record numerical engineering data and translate it into graphic forms and statistical analysis reports. You can generate scatter plots, trend charts, and histograms. The program includes a polynomial-regression routine for graphics and statistics for first- to fifth-order polynomials.

Engineering Tool Kit runs on IBM PCs, XTs, ATs, and compatibles and requires a graphics card and two floppy disk drives or a hard disk drive. The IBM version sells for $129. A version for the Apple II family sells for $59, and the 512K Macintosh and the Macintosh Plus version sells for $99.

For more information, contact Sof-Ware Tools, P.O. Box 8751, Boise, ID 83707, (208) 343-1437.
Inquiry 594.

Design Tool for Electrical and Control Engineers

Using control theory, SASP aids in the analysis of feedback control systems for circuit design, digital filter design, servo design, and aerospace autopilot design.

SASP, which stands for Stability Analysis and Simulation Program, runs on IBM PCs and compatibles with 512K bytes of RAM (640K for high resolution), MS-DOS or PC-DOS 3.1 or higher, a hard disk drive, a math coprocessor, and a graphics board. The program works in S-plane, Z-plane, and W-plane plots and can convert transfer functions from one form to another. It enables you to draw a variety of plots, and you can enter transfer functions in polynomial or pole/zero format.

SASP sells for $750. For more information, contact Lewis Engineering Software, 21722 Roscoe Blvd., #24, Canoga Park, CA 91304, (818) 883-2786.
Inquiry 595.

(continued)

SOFTWARE • BUSINESS AND OTHER

Desktop Publishing on the Mac

LetraPage and The Laser Quill are Macintosh desktop publishing programs with word-processing capabilities.

LetraPage features a toolbox with 12 mouse-driven icons that enable you to edit text and create page layouts on screen. Automatic hyphenation, line and depth justification, and a library of 137 kerned letter pairs are offered. You can import files from other Macintosh programs to LetraPage. Documents created can be up to 1024 pages in length in 20 page sizes, with as many as 48 columns.

LetraPage sells for $599. For more information, contact Letraset USA, 40 Eisenhower Dr., Paramus, NJ 07653, (201) 845-6100.
Inquiry 596.

The Laser Quill offers seven levels of superscripts and subscripts, headers and footers, windowing, and search and replace capability. You can output documents to digital typesetting computers that support PostScript or to the Imagewriter, LaserWriter, or other printers.

The Laser Quill enables you to create documents of up to 698 pages. The program sells for $199. For more information, contact Firebird Licensees Inc., 71 North Franklin Turnpike, Waldwick, NJ 07463, (201) 444-5700.
Inquiry 597.

Communications for the 128

A terminal software package for the Commodore 128 was announced by Abacus. SpeedTerm 128 performs VT52 terminal emulation and works with most of the low-cost modems for the 128, according to Abacus.

SpeedTerm costs $39.95 and includes more than 30 commands. The program supports the XMODEM and Punter file transfer protocols and manages a 45K-byte capture buffer. For more information, contact Abacus Software, P.O. Box 7211, Grand Rapids, MI 49510, (616) 241-5510.
Inquiry 598.

Screen Reading for the Visually Impaired

Computer Aids introduced Screen-Talk Pro, a program that uses macros to add audio capability to your applications programs. To run the program you need an IBM PC or compatible with at least 128K bytes of RAM and a voice synthesizer.

Screen-Talk Pro comes with ProKey for macro processing. Other features include the ability to recognize monochrome and color video attributes and a Find command that locates video attributes and other strings of characters on the screen. The program also lets you review text by word, letter, or screen, or you can create up to 10 windows for review.

Screen-Talk Pro costs $395. For more information, contact Computer Aids Corp., 124 West Washington, Lower Arcade, Fort Wayne, IN 46802, (800) 647-8255.
Inquiry 599.

Thinking Cap Outlines on a Commodore

You can create outlines for reports, speeches, resumes, or memos with Thinking Cap. The program sells for $49.95 and handles up to seven levels of information, with 16 subtopics within each level. Once you've established the levels, you can enter details randomly under the appropriate headings, and the program creates the numbering format for an outline up to six pages long. You have a choice of formats, including roman numerals, prose, technical, or numeric. You can also use underlining or boldface. The program has templates for five outlines.

Thinking Cap runs on a Commodore 64 or 128 with a printer. For more information, contact Brøderbund Software Inc., 17 Paul Dr., San Rafael, CA 94903-2101, (415) 479-1700.
Inquiry 600.

PC-to-VAX Communications

Polygon announced poly-STAR, PC-to-VAX communication software. The program emulates Digital Equipment Corp.'s text terminals. It has seamless file transfer capabilities, pop-up window menus, hot-key switching, international keyboard support, and enhanced remote-control features. The program supports modems and has a user-programmable communication language. The phone book feature enables you to automatically dial, connect, and log on.

The program runs on IBM PCs, XTs, ATs, and compatibles with at least 512K bytes of RAM and PC-DOS or MS-DOS 2.0 or higher. Poly-STAR prices start at $200. For more information, contact Polygon Associates Inc., 1024 Executive Parkway, St. Louis, MO 63141, (314) 576-7709.
Inquiry 601.

Term Paper Writer

Personal Choice Software announced Term Paper Writer. The program includes The Notetaker, The Outliner, The Writer, and The Footnoter and Bibliography Compiler.

The Notetaker is an electronic card file that enables you to collect information by source and by topic. The Outliner lets you organize lists of ideas into topical groups or a formal outline. The Writer is a word processor that includes margin-setting, line-spacing, and page-break functions. It also allows you to specify styles such as boldface, underlining, and centering. The Footnoter and Bibliography Compiler will insert footnotes on appropriate pages and compile information for the bibliography from The Notetaker.

Term Paper Writer runs on IBM PCs and Apple IIs and sells for $59.95. For more information, contact Personal Choice Software, P.O. Box 7286, Mountain View, CA 94039, (415) 960-0410.
Inquiry 602.

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, One Phoenix Mill Lane, Peterborough, NH 03458.

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— Jim Lizzio, President Concept Development Corp.

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Inquiry 10 for End-Users. Inquiry 11 for DEALERS ONLY.

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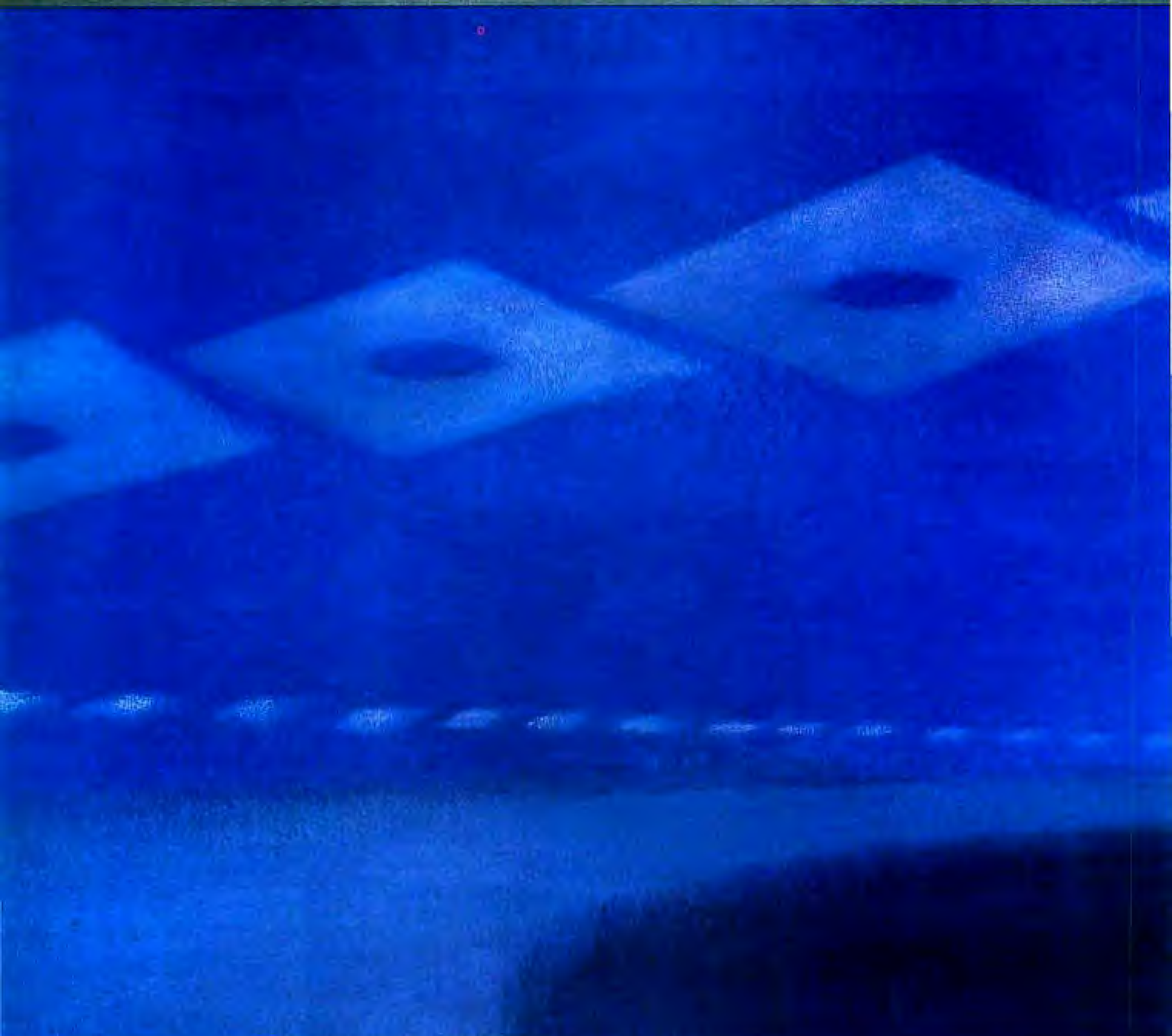

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A·S·K B·Y·T·E

Conducted by Steve Ciarcia

FROM TYPEWRITER TO PRINTER

Dear Steve:

I have an Olivetti TES 401 Electronic Typewriter that I would like to convert into a printer. Do you know of a company that has the plans or parts that will allow the typewriter to interface with a computer's serial or parallel port? Also, the TES 401 has an 8080 microprocessor in it and the motherboard has an unused edge connector. I have been unable to acquire a circuit diagram or pin-out information for the typewriter. Do you know of a source for these?

LARRY PAIVA
Colleyville, TX

In the early days of personal computers—a mere ten years or so ago—there were many conversion kits and instructions being sold for a large number of popular typewriters. Today, I see an occasional conversion kit for IBM Selectrics offered, but little else.

I have been unable to locate a source for schematics or a conversion kit for the Olivetti TES 401 typewriter. Many companies deliberately restrict distribution of parts and circuit diagrams.

Try writing letters to the editors of electronics magazines such as Modern Electronics. *The publication of such letters might yield productive responses and useful information. Some magazines, such as* Electronics Test, *have regular columns specifically for the publication of requests for circuit diagrams and technical manuals. These magazines, unfortunately, are not usually "general circulation" publications, so the best source for them might be the electronics department at a nearby college or university. You might also try a classified ad in magazines such as* Computer Shopper.

While it is possible to convert some electric typewriters for use as printers, they aren't usually designed for the kind of high-volume, high-speed work that a computer generates. Some typewriters are unlikely to endure such usage for a long period of time. If your application involves heavy usage, you should consider getting either a typewriter/printer designed for such purposes or a letter-quality or daisy-wheel printer. At the prices currently advertised, that approach might be less expensive than attempting to convert your Olivetti.—Steve

FLOPPY JUMPERS

Dear Steve:

A friend and I are putting together IBM PC XT clones using Teac 55BV floppy drives. I know how to set up the drive-select lines and the resistor pack on the Teacs, but the rest of the jumpers are a mystery to me. Do you have any suggestions for the proper setup of these jumpers?

EDWIN J. MULLICAN
Gulfport, MS

The jumpers you mention are related to maintenance and format functions and are preset at the factory to accommodate normal applications such as yours.

If you would like to order a service manual describing these jumpers, along with other use and maintenance information, you can contact Teac Corporation of America at 7733 Telegraph Rd., Montebello, CA 90640, (213) 726-0303. They will give you price and ordering information. I find it to be a good practice to have the maintenance manuals for any drives I own, if only for the replacement parts and servicing information.—Steve

MANAGING WORDSTAR THROUGH SUBDIRECTORIES

Dear Steve,

After spending far too much time searching the directory of my hard disk, I finally sat down and arranged the files into subdirectories. Word processing is not the most important task I do, so I copied WordStar (version 2.1) onto a third-level directory. Unfortunately, now I cannot run the program. Is there a way I can run WordStar within a subdirectory?

CINDY SHELTON
Great Falls, MT

The early versions of WordStar were not designed to handle directory names as part of the filename, nor search subdirectories for overlays. There are, however, two or three ways you should be able to run the program from a subdirectory.

The simplest is to use the CD (change directory) command to the WordStar subdirectory to make it the default. You should then be able to run the program and save your files in that subdirectory. The obvious problem with this is that you don't have the freedom to put your word-processing files in other subdirectories.

Alternatively, you could save your files on a floppy disk in drive A or B.

Another way is to copy the WordStar program and overlay files into a RAM disk (say, drive D), switch the C drive default to the directory where you want to save your files, and then switch to the D drive (RAM disk) and load WordStar. This way you can either configure WordStar to look on the C drive for files or simply change the logged drive to C after the program loads.

A final method is to change to the WordStar directory (using CD) and temporarily save your data files to RAM disk while editing. This is the fastest possible way to run WordStar but entails some risk of losing your work due to power failure or forgetting to copy your work off the RAM disk before shutting off the computer. I recommend that you use a batch file to do the directory switching, load the program, and copy the files back to the designated directory when you exit WordStar. For example, assume you have a directory \word with a subdirectory \WS containing the WordStar program files and a batch file named WST.BAT. You

(continued)

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*

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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* Eric Albert, Bill Curlew, Ken Davidson, Jeannette Dojan, Jon Elson, Roger James, Frank Kuechmann, Dave Lundberg, Edward Nisley, Dick Sawyer, Andy Siska, *and* Robert Stek.

MICROSOFT LANGUAGES NEWSLETTER Vol. 1, No. 12

News about the Microsoft Language Family

Debugging with Two Monitors Simultaneously Using the Microsoft® CodeView™ Debugger.

The Microsoft CodeView, the revolutionary window-oriented symbolic debugger in Microsoft C Compiler Version 4.0, is a powerful tool. One of its numerous capabilities is the versatile way it enables programmers to view their code's output on the default monitor and video adapter while debugging on another monitor and video adapter. This is especially helpful for graphical applications. For example, if you have both a Color Graphics Adapter (CGA) and a Monochrome Adapter in the same system, you might want to set up the CGA as the default adapter. You could then debug a graphics program with the graphics display appearing on the graphics monitor and the debugging display appearing on the monochrome monitor. This feature is evoked by typing:

CV/2 ***program name***

If you only have one graphic adapter and monitor in your system, you may use the screen swapping (/S) or flipping (/F) options to view your output while debugging with CodeView.

Finding Null Pointer Assignments with Microsoft CodeView.

When a value is assigned to an uninitialized pointer in C, the Microsoft C runtime code displays:

error 2001: Null pointer assignment

This is because it is impossible to tell at runtime that such an operation has occurred (the runtime routine "_nullcheck( )" checks the first 54 bytes of the data segment to see if they have been changed when the program terminates). With Microsoft CodeView, this problem can be easily discovered. Debug your program with Microsoft CodeView and execute the program up to "main( )" to set the DS register to the program's data segment. Now set a tracepoint on the first byte of the data segment using the command "TPB 0" (the pull-down menu can also be used). Now execute the program using the "go" command. When the program attempts to use an uninitialized pointer, thus writing to location 0, Microsoft CodeView will halt execution of the program just after the offending instruction. This operation can be made even faster using debugging hardware compatible with the Microsoft CodeView debugger.

Debugging Assembly Language Programs with Microsoft CodeView.

Microsoft CodeView has special features for the assembly language programmer. The radix command allows the user to set the default input and output radix so that assembly language programmers can use hex numbers just like the popular Microsoft SYMDEB debugger and DEBUG. To switch to hex simply type:

n16

In addition, the assembly and register displays allow viewing of code at the machine level. If you're debugging Microsoft C code, the assembly display will also show local symbols in the disassembly listing, so "MOV SI, [BP-4]" might be displayed as "MOV i, [count]." A unique backward-scroll mechanism allows you to quickly scroll backward through disassembled code.

For more information on the products and features discussed in the Newsletter,
write to: Microsoft Languages Newsletter
16011 NE 36th Way, Box 97017, Redmond, WA 98073-9717.
Or phone:
(800) 426-9400. In Washington State and Alaska, call (206) 882-8088. In Canada, call (416) 673-7638.

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Microsoft Macro Assembler	4.00
Microsoft Pascal	3.31
Microsoft QuickBASIC	2.00

Look for the Microsoft Languages Newsletter every month in this publication.

also need a path to that directory in the CONFIG.SYS file, for example, path=c: \ word \ ws. Assume also that you have some subdirectories set up in \ word for saving word-processing files, and that one of these subdirectories is called \ myword. The batch file would look something like

cd \ word \ ws
ws
copy d:.* c:%1*

Now, to start word processing from any place in the system with the intent of saving the files in the C: \ myword directory, simply enter the command WST \ word \ myword. DOS will find the batch file and execute the first two commands. When WordStar loads, it takes control while it is running. Change the logged drive to D and do your work.

When you exit to DOS, it will resume execution of the WST batch file and copy all files from D: to C: \ word \ myword. —Steve

CHANGING CHANNELS

Dear Steve:

I have a microcomputer that uses an RF modulator with either channel 3 or channel 4 output. Are you aware of any circuitry or commercial unit that can convert channel 3 (or 4) into channel 7 (or a higher VHF channel)?

Although my problem sounds unique (it has something to do with a foreign TV system), I think the circuit could help people whose RF modulator has only channel 3 output and who receive annoying TV broadcast interference.

FAHFU HO
Wappingers Falls, NY

The only RF modulation modules I have seen on the market are the type that provide VHF channels 3 and 4 selectable outputs. I have not seen adjacent channel interference when the modulator was properly installed with an antenna switch. The output signal level from the modulator is usually higher than the signal received by the television set from a broadcast station when no antenna is connected; the RF modulator's signal wins out.

If you are receiving interference from an adjacent VHF broadcast station, I would suggest shielding your modulator and antenna switch in a metal enclosure that is grounded to the television chassis or a common electrical ground point. In some instances, changing the position of the television receiver will eliminate interference problems.

If you want to experiment with the modulator, you have to raise the carrier frequency in the modulator to that of channel 7. Channel 2 has a video frequency of 55.25 MHz, Channel 3 is at 61.25 MHz, but channel 7 is at 175.25 MHz. You must modify the oscillator-tuned circuit to achieve the higher frequency. Without proper test equipment, this would be a trial-and-error procedure. Also, recognize that the device must be FCC-approved to minimize spurious radiation.—Steve

A TALENTED CONTROLLER BOARD?

Dear Steve:

I am the proud owner of a Percom RFD-40S1 disk drive for use with Atari 400/800 computers. I have heard rumors that the controller board in the drive can support 5¼-inch double-sided double-

(continued)

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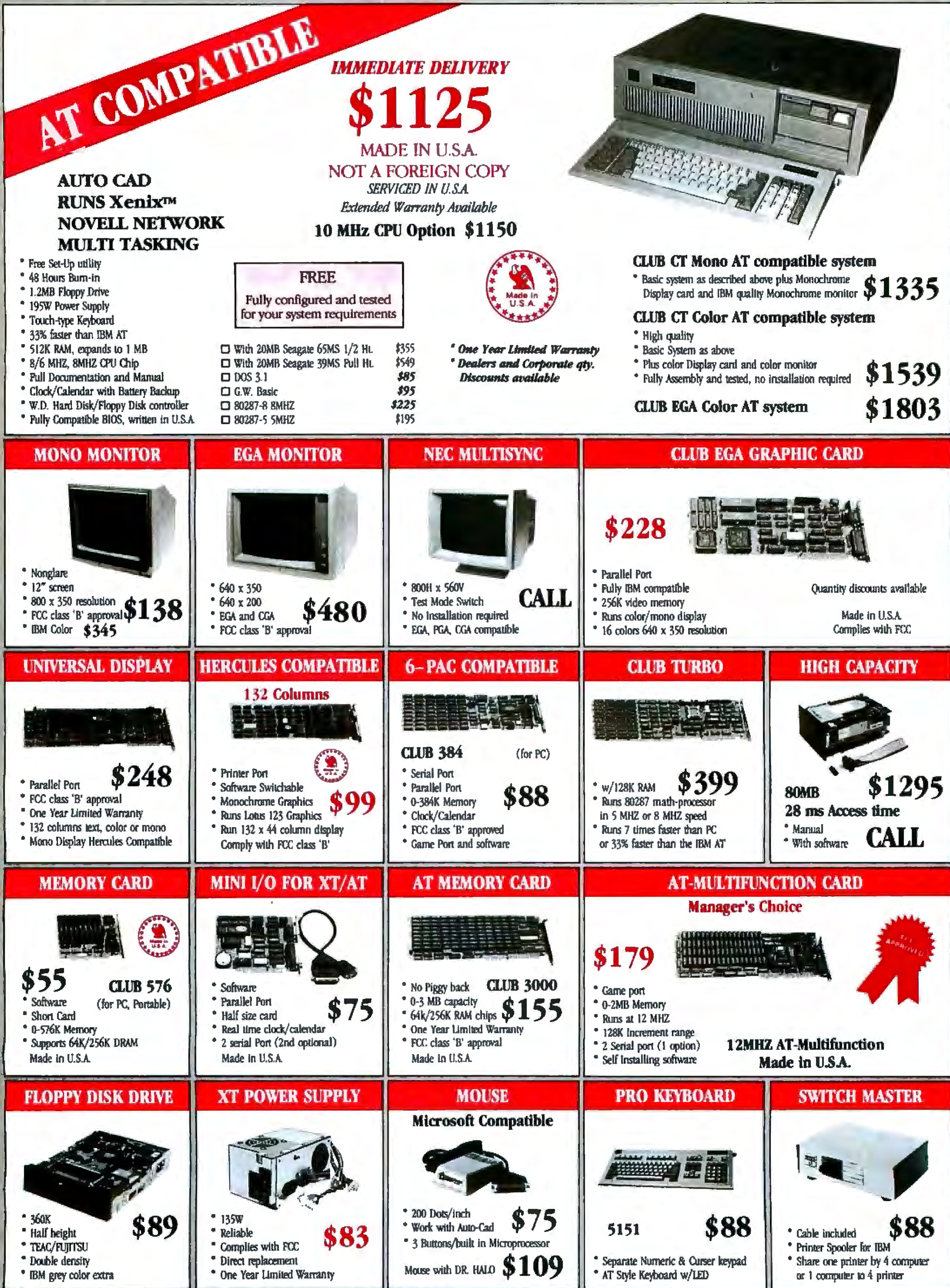
Inquiry 119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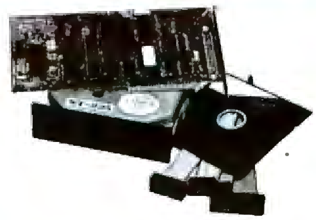

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See page 351.

density drives, 8-inch drives, and even a hard disk with some modifications. However, I have been unable to obtain a definitive answer from anyone that it can support all those drives. Could you tell me if the rumors are true, and if so, what modifications would be necessary?

STEPHEN ARMSTRONG
Norfolk, VA

While I am not specifically familiar with the controller board for the Percom drive you speak of, it is unlikely that the board would support both hard drives and floppies. Controllers for hard disk drives are quite different in design from controllers of floppy drives.

Using a double-sided drive depends not only on the floppy controller chip used but also on the software (DOS). It is likely that the board could support 8-inch drives as well, but again, it depends on what the designers chose to put on the card in the first place. If they did have such expansion in mind at the time of design, it might be an easy matter to expand the system as you indicate.

Such modifications are often distributed through users groups. A directory of users groups that I have lists the following entry:

Tidewater Atari Users' Group
c/o Buck Maddrey
5245 Shenstone Circle
Virginia Beach, VA 23455

Perhaps someone associated with this group near you can provide information on your system.—Steve

CIRCUIT CELLAR FEEDBACK

SPEECH-RECOGNITION SYSTEM

Dear Steve:

I am a member of a group of students designing a speech-recognition system for a class project. We intend for the system to eventually control a mobile robot that recognizes commands such as "stop," "forward," "right," etc. We have decided to restrict the system to speaker-dependent, discrete-utterance recognition. We plan to use an 8085 as the host processor.

Having seen your Lis'ner 1000 project in the November 1984 BYTE, we decided to use General Instrument's SP1000 as the front end of the recognition system. We are now searching for literature to explain the software needed for such a system and we are hoping you can recommend some books or articles.

STEPHEN LEE
Clemson, SC

The problem in searching for references on speech recognition is not in finding articles but in finding the ones that apply to your specific needs. There are hundreds of magazine articles that concern speech recognition. However, many are about specific hardware devices or dedicated systems.

I have listed a few books and articles that may have information you will find useful. Some of these items will have bibliographies that can lead to more sources of information.

BOOKS:

Verbal Control with Microcomputers *by Mike Rigsby (TAB Books, 1982).*

Digital Pattern Recognition *edited by K. S. Fu (Springer-Verlag, 1980).*

Trends in Speech Recognition *by W.*

(continued)

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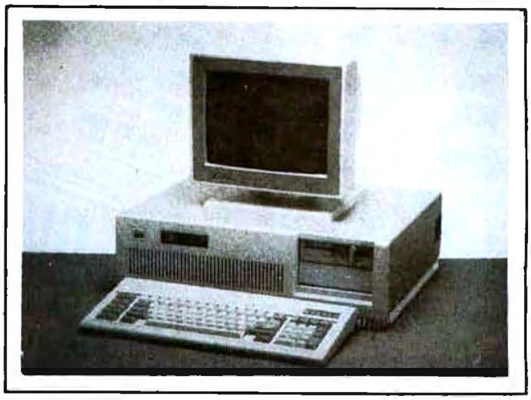

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Toshiba 3100 Laptop $3395

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Lea (Prentice-Hall, 1980).

Automatic Speech Analysis and Recognition *edited by Jean-Paul Haton, (Kluwer Academic, 1982).*

MAGAZINE ARTICLES:

"Speech Recognition for a Personal Computer System" by James R. Boddie, BYTE, July 1977.

"Give an Ear to Your Computer" by Bill Georgiou, BYTE, June 1978.

"How Computers Recognize Speech" by Maryann P. Walsh and Josef Bernard, Computers and Electronics, *July 1984.*

"The Many Sounds of Voice Digitization" by Jacques Saint-Remi, Data Communications, *January 1984.*

"Exploring Practical Speech I/O" by Tom Brighton and Sharon Cooke, Mini-Micro Systems, *May 1982.*

—Steve

8-BIT BUGGY

Dear Steve:

Back in the December 1979 Circuit Cellar you gave an introduction to electrically alterable ROMs and mentioned plans of putting a small computer in your car. While some of the latest production sports cars have computers, these sensors and computer components are not easily obtained by hobbyists.

Some of my friends and I have built racing buggies using somewhat standard frame, block, and transmission parts. Most of them do not even have simple gauges for speed, tach, oil pressure, etc. (We don't race these cars, we build them for appearance and enter them in various contests.) Our latest frame is somewhat more radical than most, and we intend to make the rest of the car match.

I need information on what is available for electronically monitoring the different aspects of a car's operation. Originally, I intended to use a single microprocessor module—say, a 6502 with peripheral interface adapter, ROM, and scratchpad RAM. Is it feasible to have the 6502 measure RPM, MPH, fuel level, and others? Or would it be better to have dedicated circuits do the counting and have the results available to the 6502? I also want to use a simple keypad to make requests to the controller for specific results or to activate various accessories. I would like to display the output on seven-segment LEDs and possibly LED bar graphs. Perhaps I could also add a speech synthesizer.

JAMES DUMESNIL
Port Arthur, TX

It is definitely feasible to use a microprocessor such as a 6502 to monitor such

(continued)

variables as RPM, MPH, fuel level, etc. A brief discussion of shaft encoding to measure speed can be found in Don Lancaster's "Hardware Hacker" column in the September 1985 issue of Modern Electronics. *Several good books are available that contain information pertinent to your project. They contain discussions of various types of sensors and transducers. Two of these books are*

Analog Electronics for Microcomputer Systems *by Goldsbrough, Lund, and Rayner (Howard W. Sams & Co., 1983).*

Microprocessors for Measurement and Control *by David M. Auslander and Paul Sagues (Osborne/McGraw-Hill, 1981).*

Manufacturers such as National Semiconductor and Analog Devices have extensive manuals and applications literature for various converters, sensors, and display devices. You could use the National 74C917 seven-segment display driver to drive a six-digit display. You could display eight digits if you use the Intersil ICM7218 universal LED driver IC. Omega Engineering (Box 4047, Stamford, CT 06907) publishes several handbooks on measurement and control that contain data and information you would find useful.

Finally, several Circuit Cellar projects are relevant to your application. Among them:

"Build a Keyboard Function Decoder," July 1978.

"Build a Low-Cost, Remote Data-Entry Terminal," September 1980.

"Analog Interfacing in the Real World," January 1982.

"Build a Third-Generation Phonetic Speech Synthesizer," March 1984.
—Steve

OUTGROWING THE MODEL 100

Dear Steve,

I am a neophyte computer owner, testing the waters with a Radio Shack Model 100 laptop computer. I bought it with 32K for well under $300. It has worked well, it is certainly cost-effective, and I am having fun figuring out how things work.

But 32K isn't enough. "Upgrades for the TRS-80 Model 100" by Terry Kepner in the December 1985 BYTE tells me I can buy an expansion memory bank that gives me 96K bytes for $425. I'm afraid that's too much for my budget.

Any suggestions on making a low-cost RAM module that leaves the Model 100's ROM and expansion sockets vacant?

STEVEN F. TROTTER
Bel Air, MD

(continued)

Inquiry 4

The TRS-80 Model 100 laptop computer is a very versatile unit. It does, however, have some limitations in its hardware and software—one of them being the difficulty you encounter when you try to add RAM to the system.

The 80C85 microprocessor is designed to address 64K bytes of memory. The Model 100 uses 32K of ROM for its operating system, BASIC, and other software. This leaves only 32K of room available for RAM. The device mentioned in the December BYTE uses the technique of bank switching to control the additional RAM. You cannot, however, have a program larger than 32K, since a program cannot cross a bank boundary.

The high cost involved in this method is due not only to the cost of the memory chips but to address decoding and support ICs. It seems, therefore, that your applications will be quite limited with this machine. Depending on your needs, you might want to consider a larger portable with bigger RAM capacities.—Steve

PERFBOARD

Dear Steve:

I have been looking for a large prototyping board. I had given up hope of finding such a board until I read your article "Build an Audio-and-Video Multiplexer" in the February BYTE. In it, you depicted what appeared to be an 8- by 16-inch prototyping board. Where can I get such a board?

THOMAS J. MILLER
St. Louis, MO

One source for prototyping boards (called perfboards) in the size range you require is

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002
(415) 592-8097

Jameco's catalog number 169P84WE is a sheet of 1/16-inch epoxy-glass perfboard that is 8½ by 17 inches in size.
—Steve ■

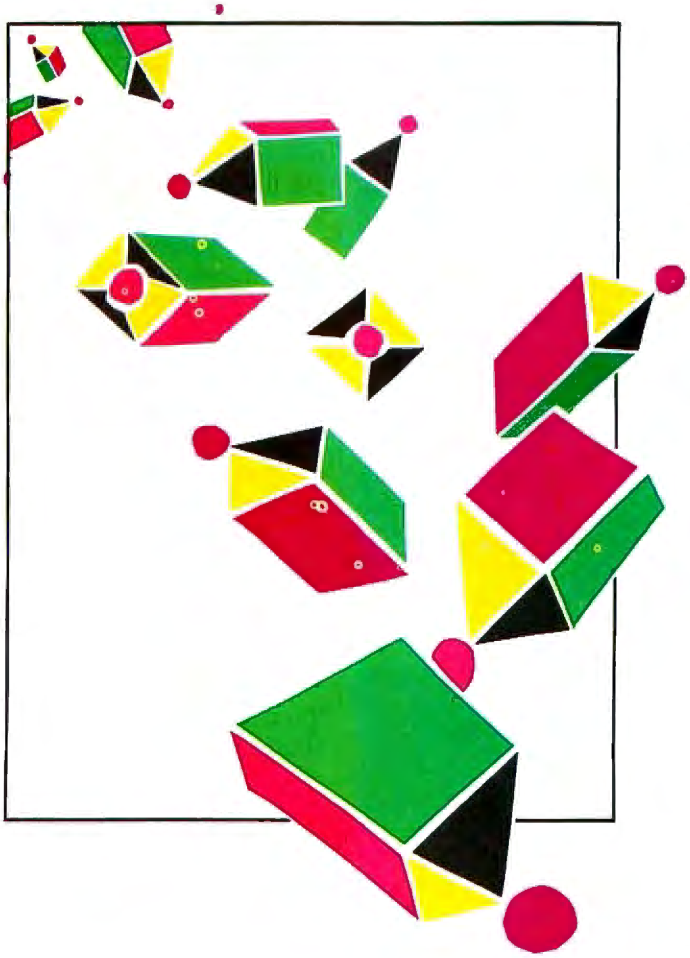
Over the years I have presented many different projects in BYTE. I know many of you have built them and are making use of them in many ways.

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, P.O. Box 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.

PROJECTIVE GEOMETRY AND ITS APPLICATIONS TO COMPUTER GRAPHICS
Michael A. Penna and Richard R. Patterson
Prentice-Hall
Englewood Cliffs, NJ: 1986
403 pages, $41

PROGRAMMING PRINCIPLES IN COMPUTER GRAPHICS
Leendert Ammeraal
John Wiley & Sons
New York: 1986
168 pages, $19.95

A MODEL IMPLEMENTATION OF STANDARD PASCAL
Jim Welsh and Atholl Hay
Prentice-Hall
Englewood Cliffs, NJ: 1986
483 pages, $49.95



PROJECTIVE GEOMETRY AND ITS APPLICATIONS TO COMPUTER GRAPHICS

Reviewed by
John D. Unger

Imagine writing graphics programs that can show a three-dimensional perspective drawing of a specific object, or designing programs that let you zoom in on a circuit board layout to see progressively finer details. *Projective Geometry and Its Applications to Computer Graphics* by Michael A. Penna and Richard R. Patterson explains how to manipulate such graphical concepts and teaches the fundamental principles of projective geometry. The book will be most useful to experienced programmers who need to write sophisticated graphics applications that use two- or three-dimensional perspective and projections.

Penna and Patterson's book is not for those not mathematically inclined. It is a math/analytic geometry book, and as such, the prerequisites for using it include analytic geometry and calculus, a computer background, and familiarity with matrix notation and simple matrix operations.

FOCUS ON DIMENSION

Projective Geometry and Its Applications to Computer Graphics is liberally sprinkled with helpful examples and illustrations. Chapters are divided into sections, each with its own set of exercises. It would be more convenient for a nonclassroom situation if the book also contained an answer section for at least some of the exercises. Most of the book is devoted to teaching the mathematics of projective geometry; only 145 of the book's 400 pages deal with applying the mathematical principles to computer graphics.

The first of two chapters devoted to computer graphics gives an overview of how projective geometry is applied to writing computer graphics applications and centers on a two-dimensional graphics program. The second chapter covers the more complex subjects of three-dimensional graphics, perspective views, hidden-line techniques, rotational graphics, and the like.

These two chapters also introduce several key concepts concerning how to transform an object's coordinate system to the natural coordinate space of the graphics device. A good example involves mapping the *x,y* coordinates of an office building's floor plan onto the row and column coordinates of your screen. The authors pay special attention to coping with computer-related problems that arise in displaying two-dimensional graphics. The finite size of the pixels on a screen and their aspect ratio must be taken into consideration, as must their relationship to the actual screen size in inches. Because the size of a display area

(continued)

ILLUSTRATED BY TAMAR HABER-SCHAIM

on a CRT is difficult to measure accurately, the authors recommend drawing squares on the screen while varying the value of the aspect ratio until the best possible results are obtained. They also point out that the aspect ratio of the plotter or printer used with a given microcomputer frequently differs from that calculated for the CRT.

A SIMULATION

The chapter on three-dimensional graphics includes an intriguing section on writing a program that simulates an enhanced attitude indicator or artificial horizon indicator for an aircraft. It produces an image similar to that seen on programs like Flight Simulator, but the ground is shown simply as a gridded network of lines without any topographic or cultural features. This program is rather complex and uses sophisticated projection techniques. It looks like it would be fun to attempt to write this program for a microcomputer, though quite a challenge as well.

The programs and program fragments in these two chapters are written in pseudocode, which keeps the book from being software- or hardware-specific but prevents the reader from having source code that could simply be copied and then run on a computer. The pseudocode sample programs give *Projective Geometry* a much broader audience than programs written for a specific computer or language would. However, readers have to know something about pseudocode and how to translate this generic language into their favorite source code. The authors indicate that the programs in the book have been implemented on various mini- and microcomputers using Pascal, FORTRAN, and BASIC.

APPLICATIONS

The authors wrote their programs with the assumption that the reader has some sort of graphics library. This library should contain certain primitive graphics functions or procedures. These can be nothing more complex than the graphics available with the GW-BASIC interpreter, which lets you use commands such as MODE, LINE, PRINT, WINDOW, VIEW, and PSET. The book's role is to combine these commands with some matrix operations to produce a program that applies the principles of projective geometry.

I implemented a simple version of the authors' Graph2D program for my AT&T PC 6300 using a C compiler and some graphics library functions I wrote. The only procedure in the program that I couldn't duplicate was one to write character strings on the screen at different scales and rotated at various angles to the horizontal. This simple yet powerful program lets you view any part of a two-dimensional picture at an arbitrary scale and translated or rotated any amount. It is the type of program that has applications for floor plans of buildings, electronic micro circuits, or maps.

Unfortunately, the book does not discuss the details of how to write specific graphics procedures, such as the best (fastest) way to draw a line between two points. The pseudocode examples simply call a function such as DrawLineFrom(U0,V0)To(U1,V1). It is up to the user to figure out

(continued)

how best to write or implement this function using his or her particular software and hardware.

CRISP STYLE

Given the textbook nature of *Projective Geometry*, Penna and Patterson have adopted a lucid and fairly easy-to-read writing style. Make no bones about it, though, the book uses a quantitative approach to the subject; there is very little descriptive material. The organization of the book is straightforward and logical. First the math is presented and then the applications with examples. Fortunately for computer types, the two chapters on computer graphics applications are among the easiest to read. There is about as much jargon as you might expect from a math-oriented textbook; you won't be coddled.

John D. Unger (P.O. Box 95, Hamilton, VA 22068) is a geophysicist for the U.S. government who uses computers to help study the geologic structure in earthquake-prone regions of the eastern U.S.

PROGRAMMING PRINCIPLES IN COMPUTER GRAPHICS

Reviewed by Steve Cunningham

Of his book *Programming Principles in Computer Graphics*, Leendert Ammeraal states that "for anyone who teaches computer graphics, at least some parts of the book will be useful." I'll go beyond that. The book is among the best starting points I've seen for people who need to learn computer graphics, be they students, teachers, or programmers. This slim volume offers a concise, concrete introduction to graphics that prepares the way for additional graphics work. It assumes only that you have previous programming experience.

GENERAL APPROACH WORKS

Some books cover a lot of material but skimp on the details. This one, however, picks its topics carefully and describes each one fully. What Ammeraal covers is line graphics, and he does so in a very thorough, device-independent fashion. All the topics he discusses have complete program listings. His vehicle is C, which could well be the best modern graphics language. Though he uses UNIX C and some of his programs are filters that preprocess scene data for later graphic programs to use, his programs are readily adaptable to other systems or even other languages. The reader needs to provide only the most elementary move and draw routines to make the programs work on essentially any system and provide output to a wide variety of devices. I have written my own graphics package, and I was able to adapt programs readily, even in a raster graphics environment.

The approach of this text is far superior to that of most microcomputer graphics books. By treating the topic in a device-independent way, Ammeraal covers a great deal of material very clearly. Most graphics books, on the other hand, tend to spend so much time discussing machine-

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dependent questions that good general questions are slighted. Moreover, the general approach can be implemented easily on any computer.

Graphics Topics Discussed

Ammeraal starts with two-dimensional graphics and covers transformations, windowing and clipping, recursive drawing, and B-spline curves—all in 30 pages. He conveys more useful information here than most books do in twice the space. He then goes on to three-dimensional topics, including geometry, decomposing polygons into triangles, perspective drawing, backface removal, a hidden-line algorithm, and some applications. He includes all the mathematics required for his techniques, but readers will need some background in math and trigonometry.

The book has two special technical features. First, it introduces the viewing transformation, the fundamental part of 3-D viewing, by locating the eye point in spherical coordinates. This makes the transformation's matrix much clearer than the conventional Cartesian approach but is almost never done in standard texts. Second, the technical centerpiece of the book is its hidden-line algorithm. This is a difficult problem—more difficult than the hidden-surface problem—and its solution is carefully and fully developed. The algorithm is a special case of the classical Roberts algorithm, so it is not as unique as the author feels. However, it works well, is of reasonable length so its source code can be fully included in the book, and is used to produce some very nice illustrations. For a more technical discussion, see David F. Rogers's *Procedural Elements for Computer Graphics* (McGraw-Hill, 1985).

Provides Basic Tools

As good as it is, *Programming Principles in Computer Graphics* is far from a complete source of graphics information. It makes no attempt to cover such topics as raster graphics, surfaces, color, lighting models, fractals, or ray tracing. After working through Ammeraal's book, you will have the tools you need to go on to these areas and work through more advanced texts such as James D. Foley and Andries van Dam's *Fundamentals of Interactive Computer Graphics* (Addison-Wesley, 1982) or D. Donald Hearn and M. Pauline Baker's *Computer Graphics* (Prentice-Hall, 1986).

Steve Cunningham teaches computer science at California State University, Stanislaus (Computer Science Department, Turlock, CA 95380). He is chairman of ACM-SIGGRAPH's *Education Committee and the author of* SIGGRAPH's Computer Graphics Education Directory.

A MODEL IMPLEMENTATION OF STANDARD PASCAL

Reviewed by Paul E. Hoffman

A Model Implementation of Standard Pascal by Jim Welsh and Atholl Hay has many goals: to put the source code for a complete implementation of ISO Standard Pascal into

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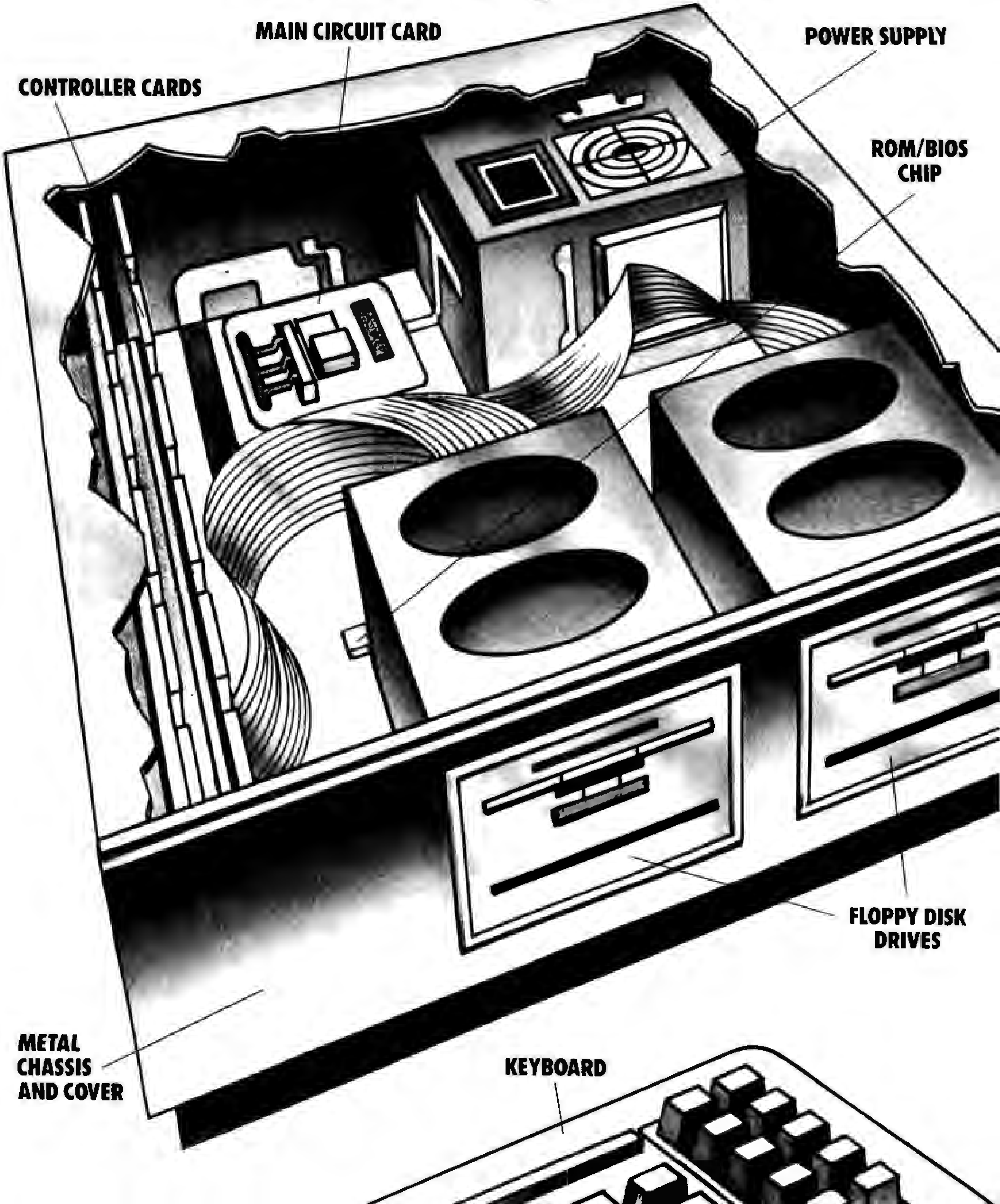
ANYONE CAN BUILD A CLONE, BUT...



the public domain, to show good Pascal programming style by example, to explain how to implement a complete p-code system efficiently and coherently, and to detail the considerations needed to implement a robust compiler.

The book is quite successful in these goals. Because it is highly technical, it will be of little interest to beginning Pascal programmers. However, if you are a mid- to high-level Pascal programmer or you are interested in how compilers are constructed, you will probably find this book fascinating.

THREE SUBSTANTIVE PROGRAMS

The book presents three complete and lengthy programs. The first and longest program is the Pascal compiler. A complete implementation of ISO Standard Pascal (ISO #7185), it takes up about 70 percent of the book. The compiler produces object programs in p-code.

The second program is the P-machine that interprets the p-code from the compiler and executes it on the target machine. The P-machine is designed to run on almost any computer and has no CPU-specific instructions in it. The P-machine program has an interesting feature: If a p-code program terminates abnormally, the P-machine saves a file with run-time information. This is processed by the "postmortem generator."

This third program reads the "corpse" file that is left by the P-machine and gives the programmer valuable information on exactly what went wrong in the program. It analyzes the state of the "dead" program by comparing its values to those of the files generated by the p-code compiler.

A SOUND STRUCTURE

A *Model Implementation of Standard Pascal* consists of a bit of front matter and these three heavily commented programs. All of the text that you would normally find in a book is program comments here. This novel approach has forced the authors to present their material in the same order as it appears in the programs. Of course, this means that the programs must be very well structured or the book wouldn't make much sense. Fortunately, the programs are put together very well and the book is quite readable.

The chapters consist of the functional parts of the programs. For example, the chapters in the postmortem generator section include an overview, global definitions, diagnostic file-reader procedures, error message output procedures, a symbolic variable lister, and a driver program. Each chapter begins with a discussion of the code and an explanation of some of the variables used by the functions and procedures in the chapter.

In addition to the chapter opening, each routine and function in the programs is commented in two ways. Most program units are prefaced with the kind of material you would expect in a book. This consists of a few paragraphs explaining the purpose of the unit, its input and output, and notes on implementation. Some statements in the routines and functions are also commented. The variable

(continued)

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names throughout the book are very well chosen and help to document the program in sections that are uncommented.

One stumbling block in A *Model Implementation of Standard Pascal* is that there is no bookwide index. Each program has a fairly complete index of procedures and functions, but there is no easy way to find where a general topic is covered unless it is mentioned in the table of contents. This makes the book much less useful for the person who wants to find out how small parts of the implementation work. Fortunately, it shouldn't get in the way of most readers.

The Pascal code throughout the book is formatted beautifully. The indentation is flawless even on multistatement lines. In addition, the authors have used the accepted Pascal character formatting throughout, so that all Pascal keywords are in bold, and variable and constant names have initial capitals. A nice touch added by the authors is that all string constants are displayed in a monospaced typewriter font.

An Admirable Job

Writing a compiler is never an easy task. The authors have done an admirable job not only of making the code correct but also of making it easy to follow in the book. This is achieved by organizing the compiler in such a fashion as to hide minor details until after the larger picture is explained.

For example, the first few chapters deal with global definitions and the source input and output. This is followed by a chapter on object code generation, which covers the structure of the p-code file in great detail. The syntactical analysis is covered after this. The authors assume that you already know the rules for writing Pascal programs since these are shown only by following the source code and are not discussed in the comments.

Welsh and Hay don't bother detailing most of the basic concepts that they discuss. Instead, they show how a particular data structure is set up or how a certain procedure converts its arguments. It seems to me that one of the most educational parts of the book is the authors' use of complex data structures to hold the program state and contents of variables.

Although the authors' assumptions of the reader's previous knowledge may seem cavalier, it leaves them more room to discuss the important issue: how to write a compiler well. They do this in a subtle and effective way. Rather than giving "rules" for good compiler construction, they simply show how they did it for ISO Standard Pascal. They let you make your own judgments on how to do it for other languages. Although the book does not address any other languages, the data structures and parsing procedures are appropriate for other programming languages such as BASIC or Ada.

The authors have a few intrinsic features of ISO Standard Pascal working in their favor. It is easier to implement a p-code compiler than a machine language compiler. Also, the highly structured nature of Pascal makes

(continued)

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it easier to determine when the programmer has messed up a program by forming an incorrect structure.

COVERAGE

The book covers a great deal of ground in less than 500 pages. It shows how a compiler and P-machine are constructed and how to write a large and well-structured Pascal program. Although the authors do not belabor the point, any compiler should be well structured in order to assure the programmer that it is complete and correct.

The learn-by-example method has its shortcomings. For instance, the authors do not spend much time discussing the connection between the p-code generator and the P-machine. Readers may want to refer to sections of the P-machine program while reading about the compiler in order to understand why a certain construct is used. This is also true in the section on files used by the postmortem generator. Unfortunately, without an index, this task is not easy.

Since most compilers generate machine or assembly language, books on compiler writing rarely cover p-code in depth. The chapters on the P-machine are a very good introduction on how to implement P-machines while remaining CPU-independent. The authors cover the construction of the P-machine that has to handle memory management, multiple-precision math and strings, file manipulation, and error recovery. The memory-management scheme shown in the book is a good model for any compiler, not only p-code generators.

The chapters on the postmortem generator suffer from lack of explanation of the purpose of many of the procedures. This is unfortunate since very few books even mention methods for handling aborted exits and symbolic debugging of aborted programs. Still, the authors' clear coding style lets you follow the code for the program fairly easily and determine what data the program is working with and what the output will look like.

Another weakness is the authors' assumption that the book is being read from beginning to end. Since the book is organized like the program, various details rely on facts established earlier in the book. There were many places where the book would have been clearer if the authors had reminded the reader about the range of values for certain variables or the purpose of certain procedures that were covered hundreds of pages earlier.

OVERALL

As a program and as a guide, *A Model Implementation of Standard Pascal* makes a very interesting book. The clear structure of the program makes the book understandable and enjoyable. The book goes further to show how a compiler and P-machine are implemented. Many of the often-overlooked aspects of compiler design are covered here in a way that makes them seem natural. This volume will make a good addition to many programmers' libraries. ■

Paul E. Hoffman (2000 Center St., Suite 1024, Berkeley, CA 94704) writes and edits books. He is the editor of Text In Computers, *a new scholarly journal.*

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	Execution Time	Code Size	Compile/ Link Time
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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
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ELECTRONIC MESSAGING '86: THE ERA OF INTERCONNECTION BEGINS, Washington, DC. Electronic Mail Association, 1919 Pennsylvania Ave. NW, Suite 300, Washington, DC 20006, (202) 293-7808. *December* 3–4

SEVENTH ANNUAL COMPUTER LAW INSTITUTE, Chicago, IL. Law & Business, 855 Valley Rd., Clifton, NJ 07013, (800) 223-0231; in New Jersey, (201) 472-7400. *December* 4–5

FIFTH SOUTH JERSEY MICRO SHOW, Parsippany, NJ. Ken Gordon Productions Inc., P.O. Box 13, Franklin Park, NJ 08823, (800) 631-0062; in New Jersey, (201) 297-2526. *December* 7

MICRO COMPUTER FAIR, Oak Lawn, IL. Thomas J. Zarecki, T.J. Enterprises, P.O. Box 255, Chicago Ridge, IL 60415, (312) 839-2611. *December* 7

COMPUTER GRAPHIC ARTS 86/87, New York, NY. Pratt Center for Computer Graphics in Design, 9 Skyline Dr., Hawthorne, NY 10532, (914) 592-1155. *December* 7–10

1986 FALL INDUSTRIAL ENGINEERING CONFERENCE, Boston, MA. Registrar, Institute of Industrial Engineers, 25 Technology Park/Atlanta, Norcross, GA 30092, (404) 449-0460. *December* 7–10

1986 ASME WINTER ANNUAL MEETING: ELECTRONIC PACKAGING—A MULTIDISCIPLINARY CHALLENGE, Anaheim, CA. American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017, (212) 705-7053. *December* 7–12

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NATIONAL DATA COMMUNICATIONS SYMPOSIUM ON LOCAL AREA NETWORKS AND MICRO-MAINFRAME LINKS, Washington, DC. Digital Consulting Associates Inc., 6 Windsor St., Andover, MA 01810, (617) 470-3870. *December* 8–11

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HI TECH UPDATE '86: SMART BUILDINGS, Ottawa, Ontario. Conference Coll Inc., 1138 Sherman Dr., Ottawa, Ontario, Canada K2C 2M4, (613) 224-1741. *December* 10–11

SECOND ANNUAL INTERFACE IN JAPAN CONFERENCE AND EXPOSITION, Tokyo, Japan. The Interface Group Inc., 300 First Ave., Needham, MA 02194, (617) 449-6600. *December* 11–13

TENTH BOSTON AREA MICRO SHOW, Boxborough, MA. Ken Gordon Productions Inc., P.O. Box 13, Franklin Park, NJ 08823, (800) 631-0062; in New Jersey, (201) 297-2526. *December* 14

DEXPO EAST 86, New York, NY. Expoconsul International Inc., 3 Independence Way, Princeton, NJ 08540, (609) 987-9400. *December* 17–19

MICROCOMPUTER GRAPHICS SHOW AND CONFERENCE, New York, NY. Expoconsul International Inc., 3 Independence Way, Princeton, NJ 08540, (609) 987-9400. *December* 17–19

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NEW YORK TIMEX/SINCLAIR ENTHUSIASTS (NYTSE), Stoney McMurray, Editor, 473 Westminster Rd., Brooklyn, NY 11218-6307, (718) 469-5948.

GATEWAY CP/M USERS GROUP, P.O. Box 37022, St. Louis, MO 63141-1522, (314) 569-4399 or 991-4399.

A-PEELING ADS, Apple II users magazine, PD Software, P.O. Box 13256-A, Houston, TX 77219.

THE MACHONOR BULLETIN, CE Software, 801 73rd St., Des Moines, IA 50312-1051, (515) 224-1995.

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Like text mode, RamFont uses a 16-bit word to represent a character on the display.

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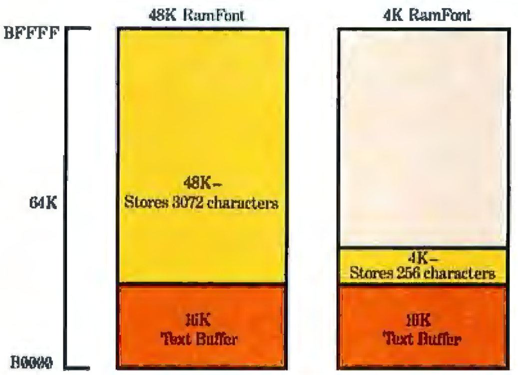
Which allows you to choose from an astonishing 3072 different characters.

While setting the size of your screen cells from eight to nine pixels wide and from four to 16 scan lines tall.



The new RamFont mode displays 3072 programmable characters at the speed of text mode, or replaces the standard character set with one of your choice in 4K RamFont mode.

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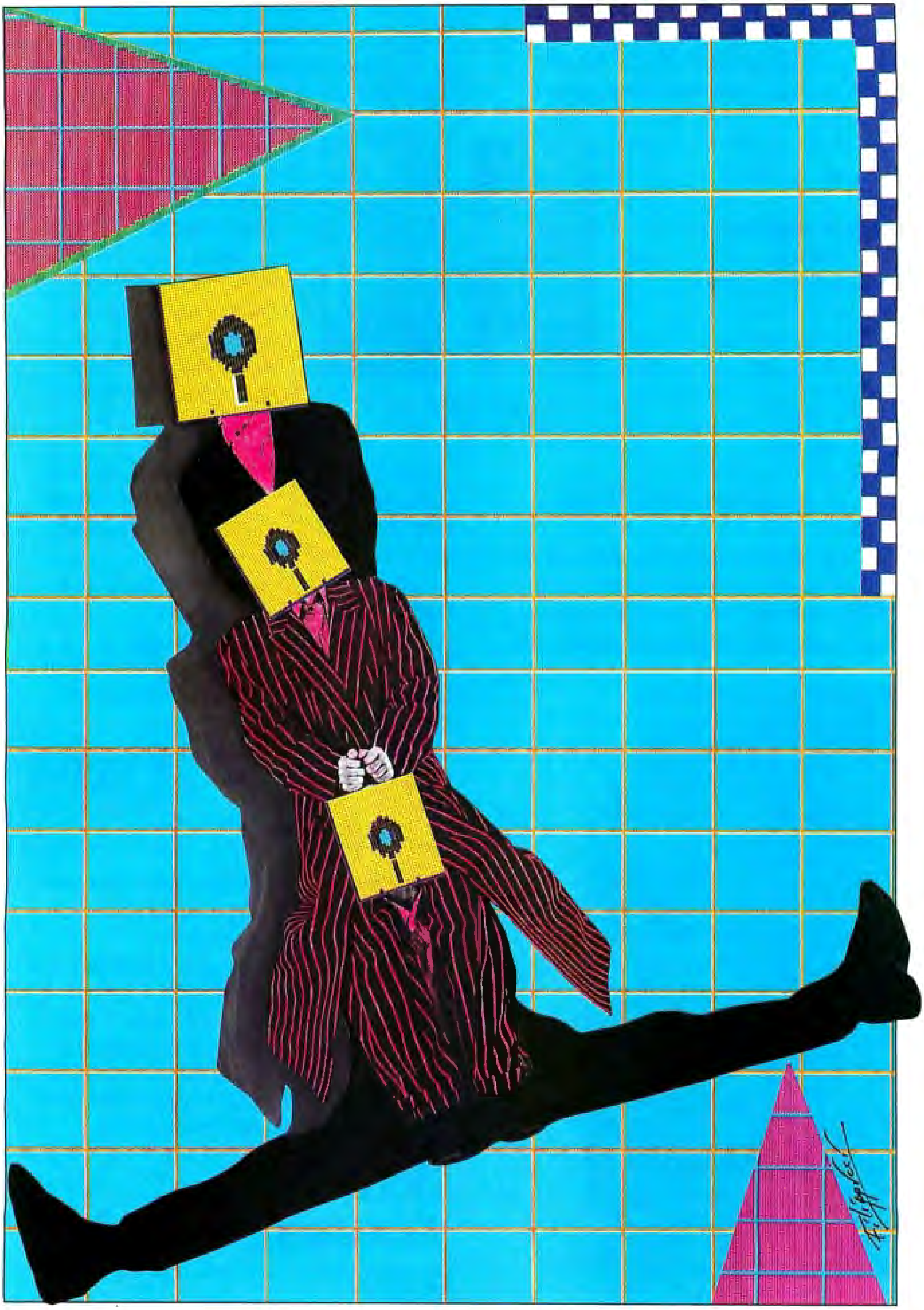

Features

IN THE CIRCUIT CELLAR this month, Steve Ciarcia continues with his GT180 project, which is designed to provide Professional Graphics Adapter–like resolution on the SB180 single-board computer. In this second of three parts, Steve focuses on the hardware. He gives a description of the major VLSI components and also includes the hardware schematic of the GT180 itself. While presented as an SB180 XBUS peripheral device, the GT180 can also be used in many other "ported" graphics applications.

In "Using DOS Functions from Turbo Pascal," our Programming Project for December, Douglas F. Yriart explains how to call on operating system functions from programs written in Turbo Pascal running under PC-DOS or MS-DOS. You may never need to write another line of assembly language code.

David M. Smith's "A Program for Approximating Integrals," this month's Programming Insight, explores Aitken extrapolation. By using this technique, you can approximate integrals with a minimum of function evaluations.

Next, Joel West looks at the trips and traps you're liable to encounter in "Debugging Macintosh Applications." Having wrangled with the Mac himself as well as having gleaned advice from commercial developers, West has developed a checklist on how to get an application up and running on the Macintosh.

This month's features end on a sobering note. "Local Effects of Nuclear Weapons" by John R. Fanchi presents two BASIC programs: One lets you determine the immediate thermal, percussive, and radiative effects of nuclear detonations on yourself and your immediate surroundings; the other examines longer-term effects, including fallout distribution.

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BUILD THE GT180 COLOR GRAPHICS BOARD

PART 2: HARDWARE

BY STEVE CIARCIA

A description of the components and the hardware schematic

Last month I introduced my new Professional Graphics Adapter (PGA)–like GT180 graphics adapter for the SB180 and SB180FX computers and discussed the basics of CRT controllers. This month I'll continue with a description of the major VLSI components. I'll also include the hardware schematic of the GT180 itself. While presented as an SB180 XBUS peripheral device, the GT180's combination of high-level integrated circuitry, parallel port interfacing, and Borland International's Graphix Toolbox standard software facilitates its use in many other "ported" graphics applications (see photo 1).

FEW CHIPS ARE USED

The key to the GT180's design is a recently announced CMOS VLSI graphics processor, the Hitachi HD63484 ACRTC (advanced CRT controller), and two companion chips: HD63485 GMIC (graphic memory interface controller) and HD63486 GVAC (graphic video attributes controller). These are supplemented by a highly integrated CMOS palette D/A converter—the Brooktree BT450.

The block diagram in figure 1 shows that these chips, in combination with a 512K-byte frame buffer (sixteen 64K by 4-bit dynamic RAM chips), need little extra support to achieve an entire graphics drawing and display subsystem. The 512K-byte frame buffer can hold three or four screens as well as a library of graphics objects like windows, fonts, and icons. A standard shift register allows input from an IBM PC–compatible keyboard. Finally, a few TTL chips and a PAL (programmable array logic) generate the control signals to interface the ACRTC, keyboard shift register, and palette D/A converter to the SB180's XBUS. The GT180 can directly connect to a number of standard CRTs—both TTL and analog—like the Princeton Graphics SR-12 and SR-12P.

THE HD63484 ACRTC

The ACRTC, an incredibly powerful CMOS chip containing more than 100,000 transistors, needs to perform a number of tasks. First, it must generate the CRT timing signals, including HSYNC and VSYNC. Next, it must perform display-control tasks like scanning the frame buffer while keeping track of cursors, split screens, and windows. Finally, it must assist the application pro-

(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. The author of several books on electronics, he can be reached at P.O. Box 582, Glastonbury, CT 06033.

grammer by providing built-in drawing algorithms and commands. The ACRTC integrates all these functions on a single device.

Examining the ACRTC block diagram (see figure 2) reveals that it contains three separate microprocessors (16-bit CPUs)—one CPU for each of the primary tasks: CRT timing generation, display control, and drawing. The ACRTC contains more than 200 bytes of command and control registers used in conjunction with 38 high-level drawing commands (see figure 3). The registers and commands will be explained and put to good use in next month's software description.

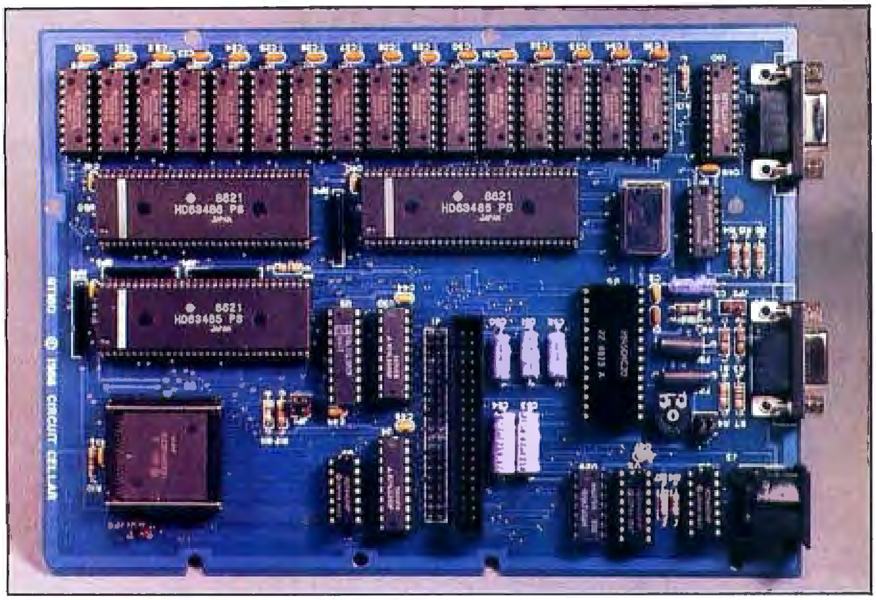


Photo 1: *The* GT180 *graphics adapter. The various connectors along the right-hand side are (from top to bottom): a* DB-9 *connector for analog* RGB *output, another* DB-9 *connector for* RGBI TTL *output, and a* DIN *connector for an* IBM PC*–compatible keyboard.*

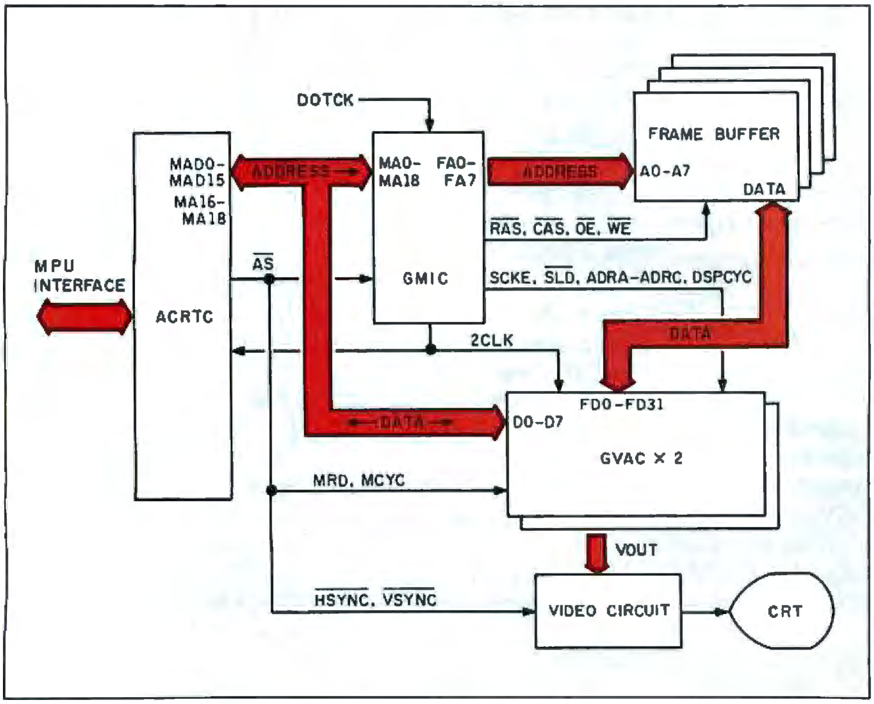


Figure 1: A *block diagram of the* GT180.

GMIC AND GVAC

It is possible to use the ACRTC by itself in a graphics design. However, for a design exploiting all the ACRTC features, the amount of TTL support logic required is large. Furthermore, due to the complexity and high speed required of the support logic, such a circuit would be difficult to design and debug.

For example, during a drawing operation, the ACRTC treats the frame buffer as a simple linear sequence of 16-bit words, just like a regular 16-bit CPU. However, during a display refresh, the frame buffer needs to read 64 bits at one time to keep up with the high speed requirements of a fast CRT. Thus, the frame buffer's address-decode and data-buffer circuits must be dynamically reconfigured for 16- and 64-bit operations. On the display-controller side, ACRTC features (like windows, horizontal smooth scroll, and zooming) require circuits to interact with and control the 64-bit high-speed video shift registers.

To help the designer eliminate much of the TTL support logic and lessen the design complexity, I have used the HD63485 GMIC and HD63486 GVAC support ICs. The GMIC manages the multiplexed addressing of the frame buffer's DRAMs and generates the required control signals like $\overline{RAS}$, $\overline{CAS}$, and $\overline{WE}$. Each GVAC includes two 16-bit shifters, so two GVACs provide a 64-bit shift register. The GVACs also map ACRTC 16-bit drawing accesses to the 64-bit frame-buffer bus. The GMIC and GVAC are manufactured using a special process called Hi-BiCMOS, which combines the speed and drive of bipolar (64 megahertz, IOL=24 milliamperes) with the low power operation of MOS (less than 1 watt).

This subsystem (ACRTC, GMIC, GVAC, and frame buffer) can directly interface to a digital RGBI (red-green-blue-intensity) monitor. The addition of the BT450 palette D/A converter allows the connection of an analog

CRT for finer color selection. In the past, the designer would have to build a palette D/A converter by combining a static RAM palette with three separate video D/A converters—a difficult and expensive task. Now, the BT450 combines the 16- by 12-bit palette RAM and three separate 4-bit 30-MHz to 70-MHz D/A converters. Watch for the availability of new palette D/A converter chips like the BT450 to cause a trend to analog displays, even for low-cost computers.

THE GT180 HARDWARE

The GT180 board consists of a number of distinct sections: the graphics display and control section (the ACRTC, GMIC, and GVACs), monitor interface (the palette D/A converter and TTL buffers), SB180 XBUS interface circuitry, and the IBM PC keyboard adapter. The complete GT180 schematic is shown in figure 4.

The interface between the ACRTC, PC keyboard register, palette D/A con-

(continued)

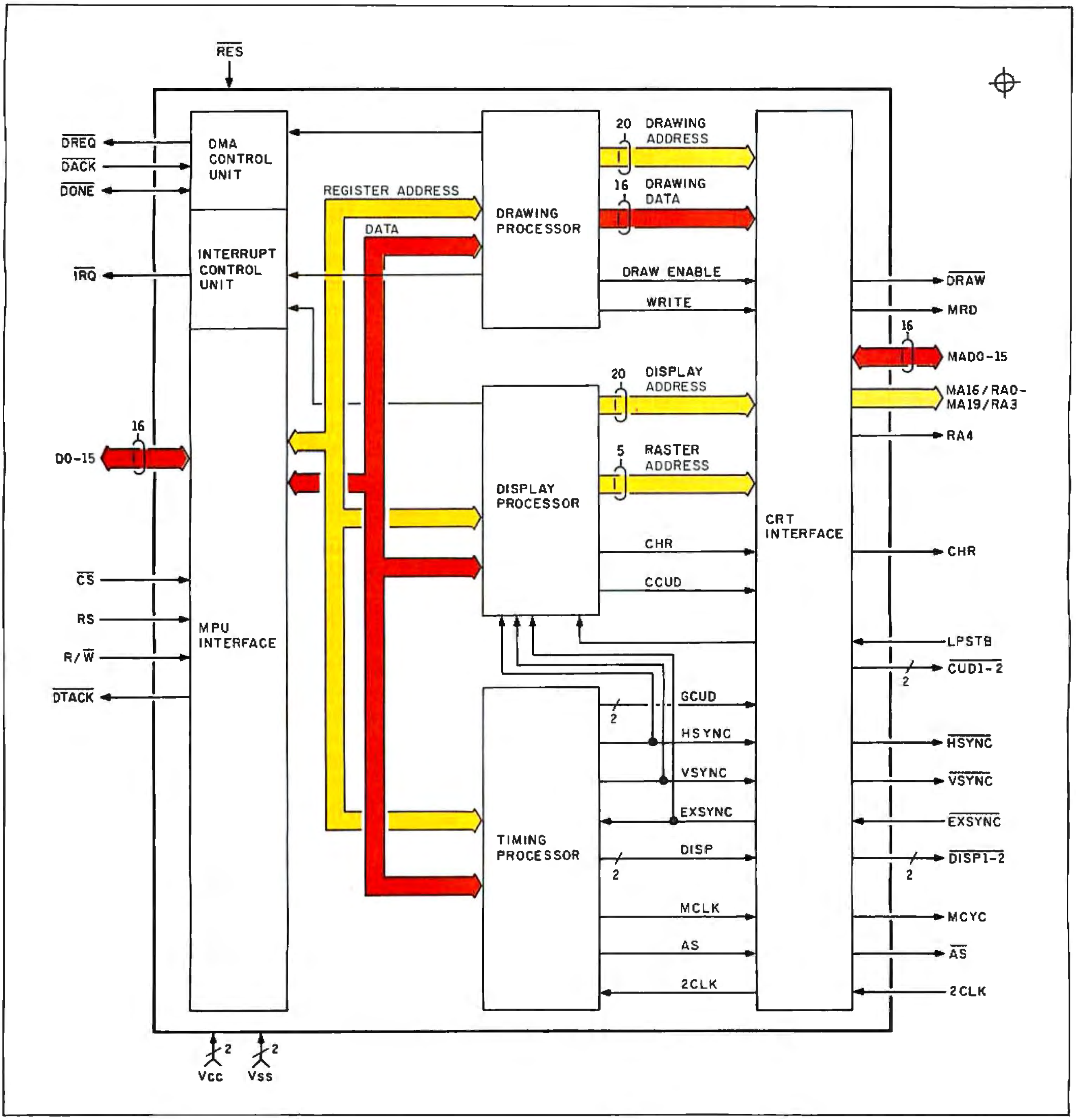
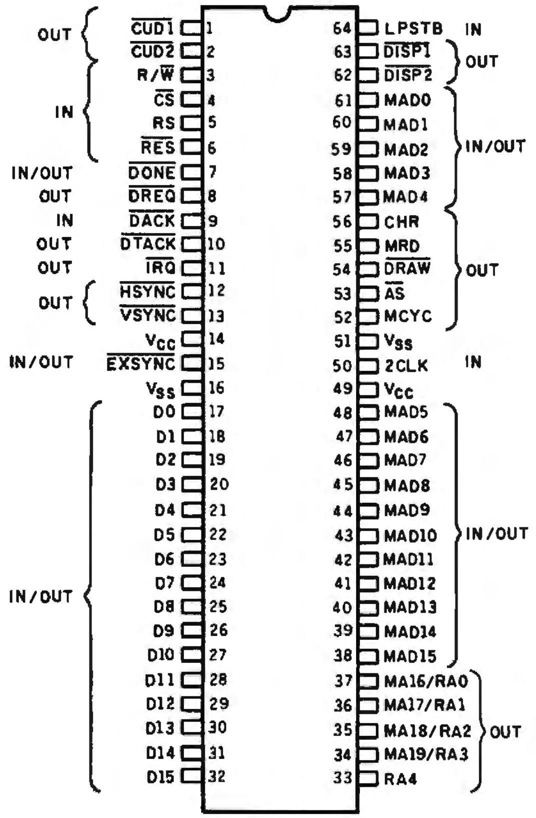


Figure 2: A *block diagram of the* ACRTC *chip.*

(a)



(b)

TYPE	MNEMONIC	FUNCTION
REGISTER-ACCESS COMMANDS	ORG	SET ORIGIN POINT
	RPR, WPR	READ/WRITE PARAMETER REGISTERS
	RPTN, WPTN	READ/WRITE PATTERN RAM
DATA-TRANSFER COMMANDS	DRD, DWT, DMOD	DMA READ/WRITE/MODIFY
	RD, WT, MOD	READ/WRITE/MODIFY
	CLR	CLEAR
	CPY, SCPY	COPY
GRAPHIC-DRAWING COMMANDS	AMOVE, RMOVE	MOVE
	ALINE, RLINE	LINE
	ARCT, RRCT	RECTANGLE
	APLL, RPLL	POLYLINE
	APLG, RPLG	POLYGON
	CRCL	CIRCLE
	ELPS	ELLIPSE
	AARC, RARC	ARC
	AEARC, REARC	ELLIPSE ARC
	AFRCT, RFRCT	FILLED RECTANGLE
	PAINT	PAINT
	DOT	DOT
	PTN	PATTERN
	AGCPY, RGCPY	GRAPHIC COPY

Figure 3: *(a) A pin-out diagram of the* ACRTC; *(b) the* ACRTC's *command list.*

verter, and the SB180 (or SB180FX) XBUS expansion bus requires some "glue" logic. Fortunately, a PAL is easily used for a major portion of this circuitry. Besides decoding port addresses for the ACRTC, D/A converter, and keyboard port, the PAL inverts the polarity of the R/W signal during direct memory access. This is required because the 64180 includes the DMAC (DMA controller) on-chip. The interface between the SB180 and the ACRTC provides a number of options, including status polling, interrupts, and DMA. Some or all of these techniques can be used, depending on the requirements of your application.

I have provided the IBM PC–compatible keyboard port to permit evolution of the GT180. If an application doesn't need the ASCII terminal normally connected to the SB180 (all references to the SB180 include features that are also incorporated in the new SB180FX), the PC keyboard and color display can be used as the main console. The SB180's RS-232 port previously used for the terminal connection could be used for another purpose, like a mouse, plotter, or digitizing tablet.

Graphics Display and Control

The heart of the GT180 board lies in the four-chip set consisting of the ACRTC, GMIC, and two GVACs. Because the GMIC and GVACs were designed around the ACRTC, interconnection is simple. The four chips share a common 16-bit data bus with three additional data lines going between the ACRTC and GMIC. The GMIC controls RAM addressing via eight address lines, four write-enable lines, an output-enable line, and RAS (row address strobe) and CAS (column address strobe). The GVACs control all data access to the RAM and extract assorted attribute information from the data lines.

Monitor Interface

The GT180 supports both digital and analog RGB monitors. The digital-monitor interface simply consists of the red, green, blue, and intensity outputs of the GVACs plus HSYNC and VSYNC from the ACRTC buffered through a 74S241 (IC10). Jumper JP3 allows selectable inversion of both the HSYNC and VSYNC signals. If the jumpers are installed, IC1 inverts the signals.

The analog RGB section is a bit more involved. The RGBI signals coming from the GVACs are fed into the palette D/A converter (IC6). These signals are used to reference the color look-up table, which provides the color information to the D/A converters. The RGB outputs of IC6 are capable of driving the monitor directly with 75-ohm termination (R1, R2, and R3). The SYNC signal is made up of HSYNC combined with VSYNC via an exclusive-NOR operation and buffered through IC10. Finally, the MODE signal controls whether the Princeton SR-12P monitor runs in 400-line or 480-line mode. You should remove JP2 for 480-line operation.

Noise is a critical factor to consider in the design of video circuitry. To minimize the noise imposed on the palette D/A converter through the power supply, ferrite beads are used to isolate power for IC6 from the rest of the board. The beads filter out any high-frequency noise created elsewhere on the board that could result in garbage in the final picture.

INTERFACE CIRCUITRY

The GT180 is designed to be plugged into the 40-pin XBUS on either an SB180 or the SB180FX. The SB180 doesn't provide any output buffers, so line loading is an important consideration when producing a peripheral (the 180 XBUS is buffered). The GT180 uses the data, address, and bus-control lines in numerous places on the board, so two 74LS245s (IC4 and IC30) have been added to buffer the majority of interface lines. The direction of data flow through the data-bus buffer (IC4) is controlled by an $\overline{RD}$ line from the SB180 and an enable output from the PAL (IC5).

We need some additional circuitry to decode I/O ports for the devices on the board. The ACRTC needs two ports, the palette D/A converter needs two ports, and the keyboard needs at least one port. It would also be nice to use jumpers to change the location of the GT180 I/O ports within the expansion space to avoid conflicts with other peripherals plugged into the same system. Ordinarily, such decode circuitry would require many TTL gates occupying a good deal of board space. Instead, this is a perfect application for a PAL.

PAL DECREASES INTERFACE COMPLEXITY

A PAL is a device similar to a PROM in that it can be custom-programmed for an application by the designer. The GT180 uses a 16L8. The "16" means the device has 16 possible inputs, the "8" means it has 8 possible outputs, and the "L" in the middle indicates that the outputs are active-low.

A PAL gains more flexibility from the fact that most of the outputs can also be defined as inputs. However, since there are only 18 pins on the chip for I/O, the sum of inputs plus outputs cannot exceed 18. You can, for example, have 14 inputs and 4 outputs. The GT180's PAL uses 11 inputs and 7 outputs.

Inside the chip is a series of AND and OR gates. The inputs to the chip are directed to the inputs of the AND gates, and the outputs of the AND gates are directed to the inputs of the OR gates. The OR gates' outputs are sent to a buffered inverter and then to the chip's outputs. This arrangement of gates makes implementing standard sum-of-products logic equations easy.

The programmable array comes into play when you decide how the inputs to the chip are to be connected to the inputs of the gates within the chip. An array of fuse links is used for this. The chip's input pins are connected to the columns of the array, and the inputs to the gates are connected to the rows. At each row-column intersection is a fuse connecting the row to the column. On an unprogrammed chip, all the fuses are intact, so all the chip's inputs are connected to all the logic inputs. In the process of programming the chip, all unwanted fuse links are literally blown out by the PAL programmer, leaving just the links that connect the desired chip input to a particular gate input.

Most of the PAL inputs are standard bus signals necessary for I/O port decoding. Two select lines are also defined that let you select one of four base locations for the GT180 I/O ports. JP1 is used to set these select lines.

The $\overline{DMA}$ input is not a standard bus signal. When the ACRTC generates a DMA request, it is latched by IC3 and sent to the $\overline{DMA}$ input on the PAL (as well as to the $\overline{DREQ0}$ input on the SB180). The ACRTC requires that R/W be inverted during a DMA transfer, so this is taken care of within the PAL.

There are also seven outputs defined on the PAL. The $\overline{BDSEL}$ line goes active anytime the board is referenced and is used to enable the data-bus buffer (IC4). $\overline{ACRCS}$ provides chip select to the ACRTC, and $ACR/\overline{W}$ provides the R/W signal to the ACRTC. $\overline{ACDACK}$ is the DMA acknowledge signal to the ACRTC. $\overline{DACCS}$ is the chip select for the palette D/A converter, while $\overline{KEYCS}$ is the chip select for the keyboard adapter.

The last PAL output is labeled $\overline{EXSEL}$. A little history is necessary to explain this signal. When I designed the COMM180 board (see the December 1985 Circuit Cellar), I hadn't considered that I would be designing something like the GT180. Consequently, I made the assumption that only one expansion board would ever be plugged into the SB180 at any one time. Therefore, the data-bus buffer is enabled whenever $\overline{EXSEL2}$ from the SB180 goes active, even though there are gaps in the expansion space that the board uses. When I sat down to look at doing a graphics board, I realized that if someone wanted to use the GT180 with a hard disk on an SB180, I had to make some allowance for plugging both a COMM180 and a GT180 into an SB180. (The SB180FX incorporates both the floppy disk and SCSI controllers on the same board and therefore does not require the COMM180 to add a hard disk. Refer to the What's New section in this issue for further details.)

The GT180 uses eight I/O ports. The base address for the ports is jumper-selectable and can be set for either E0, E8, F0, or F8 hexadecimal. (For the remainder of the article, all port

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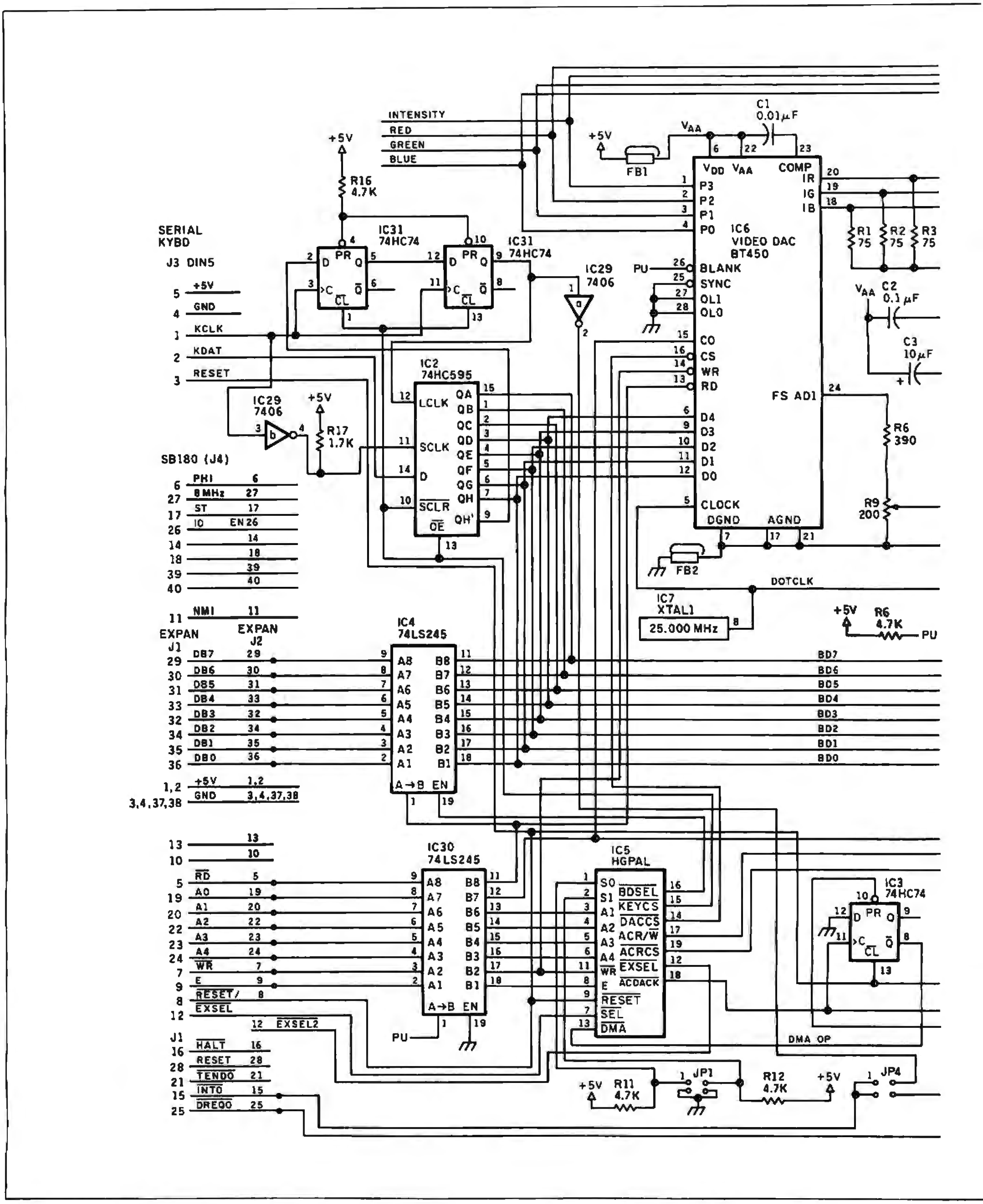
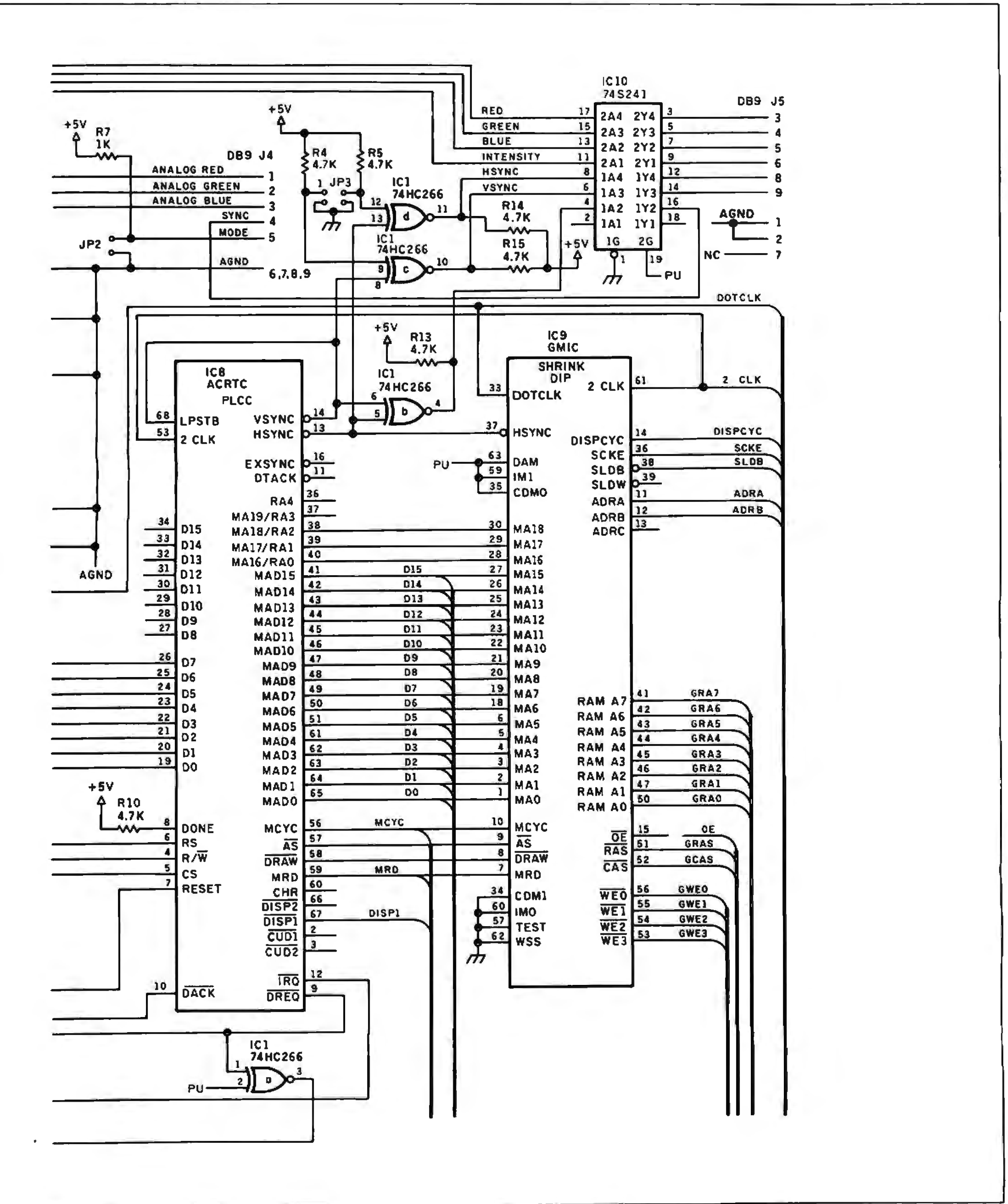


Figure 4: *The schematic of the* GT180.


IC10
74S241
DB9 J5
DB9 J4
IC1
74HC266
IC8
ACRTC
PLCC
IC9
GMIC
SHRINK
DIP
AGND
DOTCLK
2 CLK
RED
GREEN
BLUE
INTENSITY
HSYNC
VSYNC
ANALOG RED
ANALOG GREEN
ANALOG BLUE
SYNC
MODE
R4 4.7K
R5 4.7K
R7 1K
R10 4.7K
R13 4.7K
R14 4.7K
R15 4.7K
JP2
JP3
+5V
PU
NC

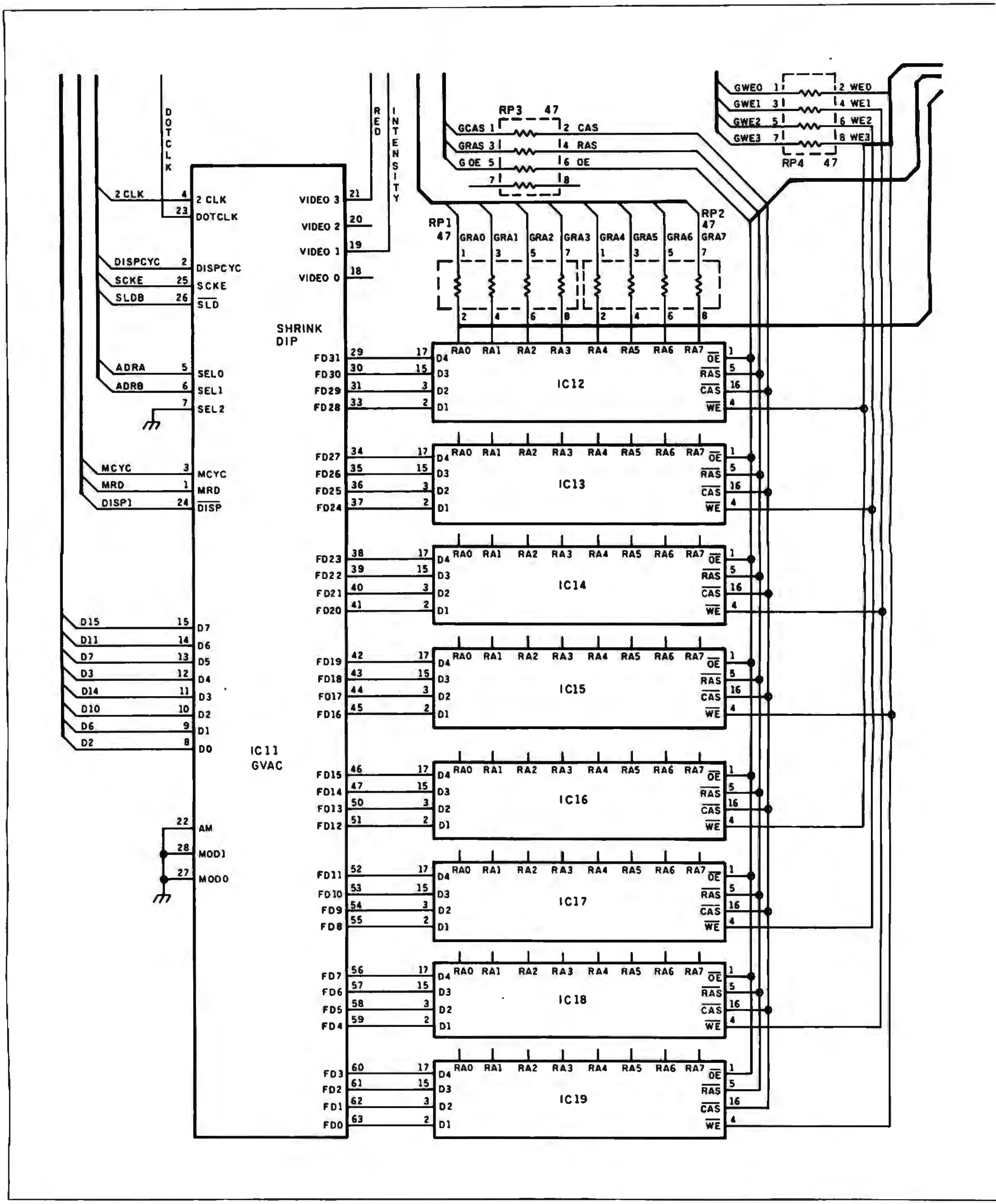
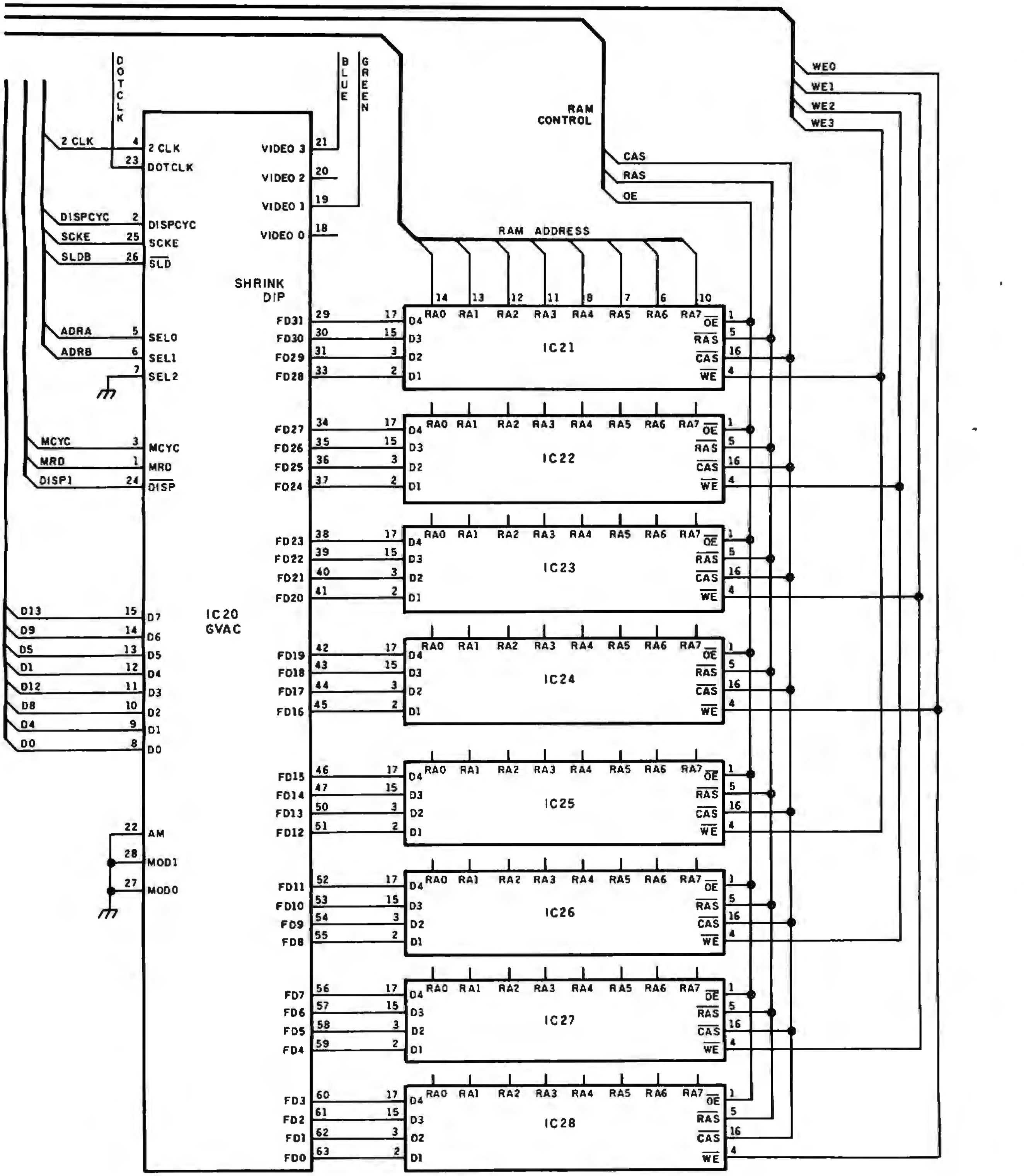


Figure 4 *continued.*



RAM CONTROL
WE0
WE1
WE2
WE3
CAS
RAS
OE
RAM ADDRESS
DOTCLK
BLUE
GREEN
2 CLK
DISPCYC
SCKE
SLDB
ADRA
ADRB
MCYC
MRD
DISP1
D13
D9
D5
D1
D12
D8
D4
D0
2 CLK
DOTCLK
DISPCYC
SCKE
SLD
SEL0
SEL1
SEL2
MCYC
MRD
DISP
D7
D6
D5
D4
D3
D2
D1
D0
AM
MOD1
MOD0
VIDEO 3
VIDEO 2
VIDEO 1
VIDEO 0
SHRINK DIP
IC20 GVAC
FD31
FD30
FD29
FD28
FD27
FD26
FD25
FD24
FD23
FD22
FD21
FD20
FD19
FD18
FD17
FD16
FD15
FD14
FD13
FD12
FD11
FD10
FD9
FD8
FD7
FD6
FD5
FD4
FD3
FD2
FD1
FD0
IC21
IC22
IC23
IC24
IC25
IC26
IC27
IC28
RA0 RA1 RA2 RA3 RA4 RA5 RA6 RA7
OE
RAS
CAS
WE
D4
D3
D2
D1

$$\overline{BDSEL} = \overline{S0} \cdot \overline{S1} \cdot \overline{A3} \cdot \overline{A4} \cdot SEL + S0 \cdot \overline{S1} \cdot A3 \cdot \overline{A4} \cdot SEL + \overline{S0} \cdot S1 \cdot \overline{A3} \cdot A4 \cdot SEL + S0 \cdot S1 \cdot A3 \cdot A4 \cdot SEL$$

$$\overline{ACRCS} = BDSEL \cdot \overline{A1} \cdot \overline{A2} \cdot E \cdot \overline{DMA}$$

$$\overline{ACDACK} = RESET + BDSEL \cdot \overline{A1} \cdot \overline{A1} \cdot E \cdot DMA$$

$$ACR/\overline{W} = BDSEL \cdot \overline{DMA} \cdot \overline{WR} + BDSEL \cdot DMA \cdot WR$$

$$\overline{KEYCS} = BDSEL \cdot A2 \cdot E \cdot \overline{DMA} + RESET$$

$$\overline{DACCS} = BDSEL \cdot A1 \cdot \overline{A2} \cdot E \cdot \overline{DMA}$$

$$\overline{EXSEL} = SEL \cdot \overline{BDSEL}$$

Figure 5: *Equations for the* GT180's PAL.

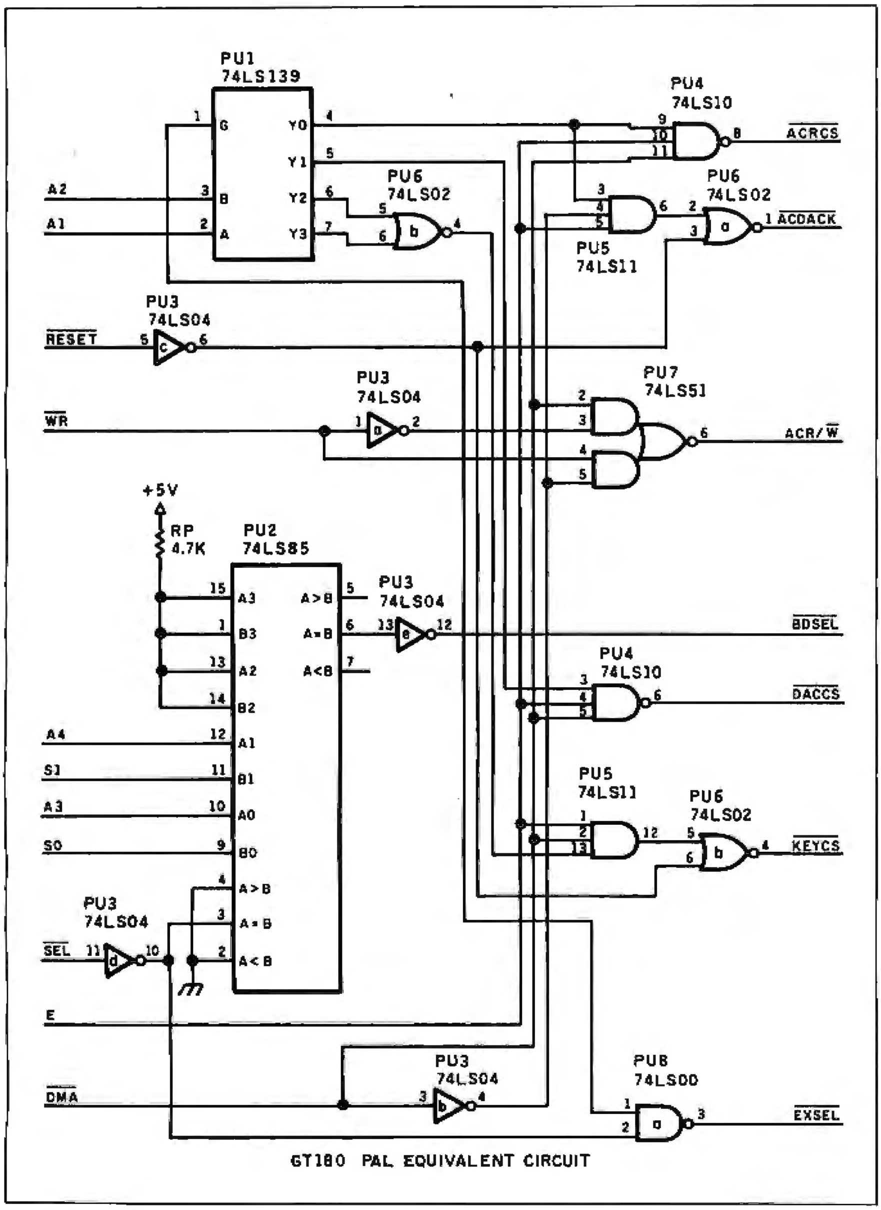


Figure 6: *The schematic of a discrete logic equivalent to the* GT180's PAL.

addresses will be in hexadecimal.) Since a fully populated COMM180 uses ports E0–E7 and F0–FF, the logical base address for the GT180 is E8. (The SB180FX has three additional address lines for decoding ports 40–7F, but the GT180 doesn't currently use any of them.)

The GT180 can be used in many different hardware configurations. There are mounting holes that line up with those on the SB180 as well as those on the SB180FX, so mounting the GT180 to either of the main processor boards is a simple task. The 40-pin XBUS expansion connector is in the same place on both the SB180 and the SB180FX.

Additional expansion boards can be plugged into the pass-through connector located on the GT180. These boards can employ any of the I/O addresses not being used by the graphics board. A second 40-pin connector on the GT180 passes all the signals straight through, except $\overline{EXSEL2}$. This signal is generated by the PAL, and it is presented on the second connector only if the GT180 is not being selected. Consequently, this is the appropriate connector to attach a COMM180 board to. (The COMM180 should never be plugged into the main pass-through connector since bus-contention problems would occur.)

To aid you in building your own GT180, I have listed the PAL equations for IC5 in figure 5. Also, figure 6 shows the schematic of a discrete component equivalent to the PAL if you want to build the GT180 but do not have the facility to program a PAL. When you are done, you are welcome to download utilities and other graphics software that I will post on BYTEnet, BIX, and the Circuit Cellar BBS to aid in checking out your handiwork.

The Keyboard Adapter

The IBM PC keyboard uses a synchronous serial interface to talk to the host computer. While the typical IBM connection allows data flow to and from the keyboard, the circuit used on the GT180 only reads from the keyboard. This greatly simplifies the circuit.

Five lines connect the keyboard to the computer. Two are for +5 volts and ground, one is a power-on reset signal that initializes the keyboard, and the last two carry the data signal and clock signal. Data is sent from the keyboard using a 9-bit serial stream. You can think of the first bit as a start bit. The remaining 8 bits contain the code for the key being pressed (or released), with the low-order bit arriving first. The falling edge of the clock signal is used to indicate valid data is present on the data line. (Note: IBM PC keyboards are not ASCII-compatible.)

The core of the keyboard adapter is a 74HC595 (IC2) 8-bit shift register with a built-in three-state latch. It also has an unbuffered output, QH', that reflects the state of the last bit in the shift register. This is normally used to cascade multiple registers. Data is fed into the D input directly from the keyboard. The clock is inverted since the chip assumes valid data on the rising edge of the clock pulse.

When the register is read or a reset is performed, IC2 and IC31 are cleared. Data arriving from the keyboard is shifted into IC2, and the data presently in the register is shifted up one bit (A to B, B to C, etc.). When all the data has been received from the keyboard, the shift register will contain the 8-bit keycode. The problem now is how to latch the data into the register's output buffers and tell the computer that a key was pressed.

Remember that an extra start bit was sent by the keyboard. This high bit will appear on the QH' output as the seventh data bit being clocked into the shift register. Data from the QH' output is clocked into IC31a one-half clock period after it appears on QH'. Half a clock period later, the last bit of the keycode is shifted into the shift register. Half a clock period after that, the data from IC31a is clocked into IC31b. The output of IC31b immediately strobes LCLK on IC2, causing the current state of the shift register to be latched into the output buffers. The output of IC31b is also connected to an open-collector inverter (IC29) and can be used as an interrupt to the SB180.

A subsequent read to the keyboard port will place the byte in the output buffers onto the data bus and will clear the shift register and IC31 so they are ready for the next keystroke. The data in the output buffers is not cleared and is available until the next byte is received from the keyboard.

Selecting a Color Monitor

Whether or not a particular monitor is suitable for use with the GT180 depends on two factors: the monitor's bandwidth and its physical interface.

The analog RGB interface has three analog signal lines—one each for red, green, and blue—with a peak voltage of +0.6 V for maximum brightness. There is also a negative composite sync at TTL levels that consists of the HSYNC and VSYNC signals combined. This type of interface is compatible with the SR-12P monitor mentioned before.

The digital TTL interface includes four TTL-level lines for the red, green, blue, and intensity lines. There are also two more TTL-level lines for separate HSYNC and VSYNC signals. This type of interface is compatible with most monitors designed for IBM's CGA board. Unfortunately, some monitors on the market don't fit the format of either of the two interfaces described above. You will probably have problems with such monitors, so it's best to avoid them altogether.

The GT180 is designed and presented as a 640- by 480-pixel resolution display controller. However, you can configure it by software to resolutions of 640 by 400, 640 by 350, 640 by 200, 320 by 200, etc. (all with 16 colors). Ultimately, the frequency of the crystal oscillator you use on your GT180 board controls the resolution you can expect and the monitor you can use. A 25-MHz oscillator will give you a PGA-like 640 by 480 or 640 by 400 resolution but requires a high-

(continued)

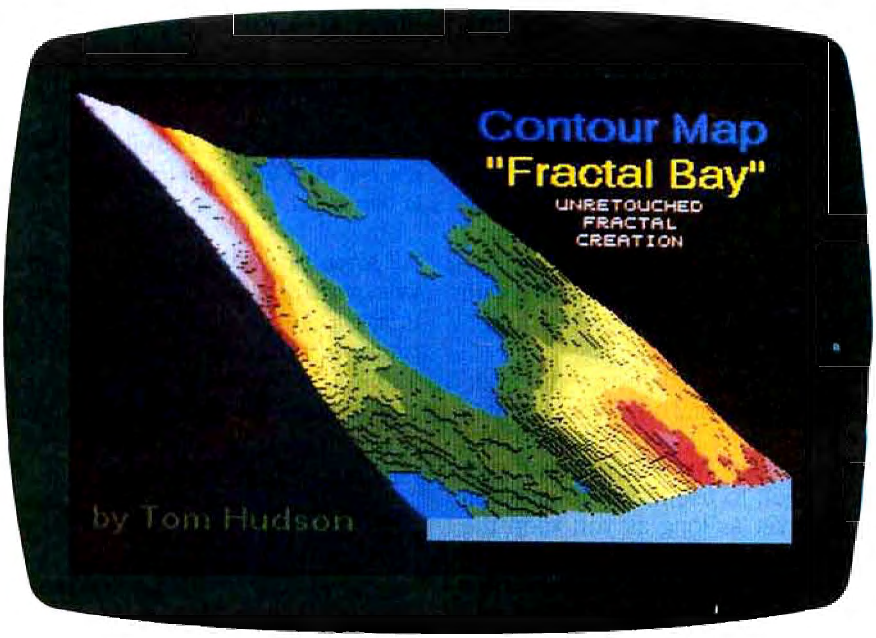


Photo 2: *This screen picture was produced using the* GT180 *and a Princeton* SR-12P *monitor.*

Photo 3: *Another screen picture using the* GT180 *and* SR-12P.

quality 30-MHz monitor like the SR-12P (see photos 2 and 3).

In order to use a less expensive EGA- or CGA-compatible color monitor intended for the IBM PC, you must use a lower oscillator frequency and give up some resolution. A CGA monitor, for example, has a 15-MHz bandwidth and will support only a resolution on the order of 640 by 200. The newer EGA monitors have a higher bandwidth and a resolution of 640 by 350 (an EGA monitor is RGBI and not analog). You will have to slow the GT180 down by a proportionate amount to use a slower scan rate. Use a crystal oscillator in the range of 12 to 13 MHz for a 640 by 200 monitor. (Note: Software utilities included with the GT180 allow use of the lower-resolution monitors.)

The flexibility offered by the interchangeable crystal oscillators coupled with the ability to set up the ACRTC's internal timing registers from software allows you to use most monitors on the market as long as you keep the bandwidth limitations in mind.

One tidy and relatively inexpensive way to get around most of the problems listed above is to use a monitor that can support a range of scan rates and either of the interfaces mentioned. No such animal? Well, NEC makes a MultiSync monitor that will adapt to whatever scan rate you are using and accepts either analog or digital RGB inputs.

CIRCUIT CELLAR FEEDBACK

This month's feedback begins on page 58.

NEXT MONTH

Part 3 looks at the GT180 Graphix Toolbox software. ■

Special thanks to Tom Cantrell, Ken Davidson, and Mike Weisert for their contributions to this project.

All screen pictures presented in this article were produced using the GT180 *with a* Princeton SR-12P *monitor. The bit-mapped pictures were originally composed on an* Atari 520ST *using* DEGAS *by Tom Hudson. They are reproduced and used here by permission.*

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   board with Modula-2 and GT180 Graphix Toolbox $499
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   SB180 Modula-2 with Graphix Toolbox alone $89
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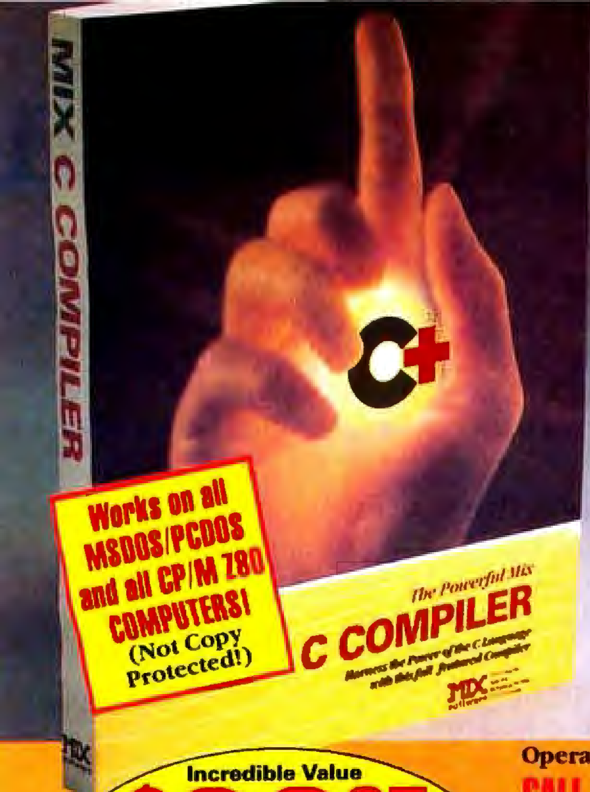

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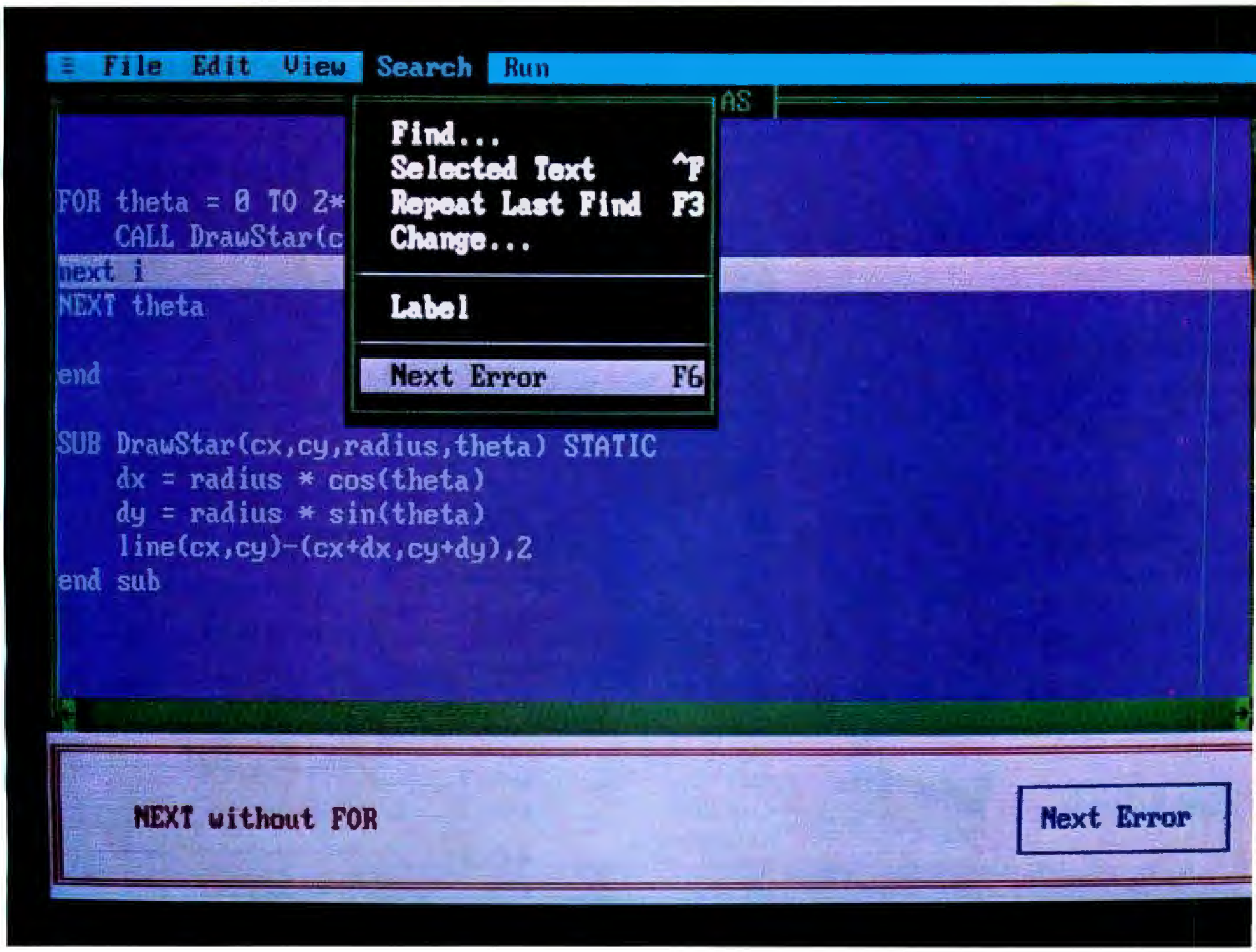

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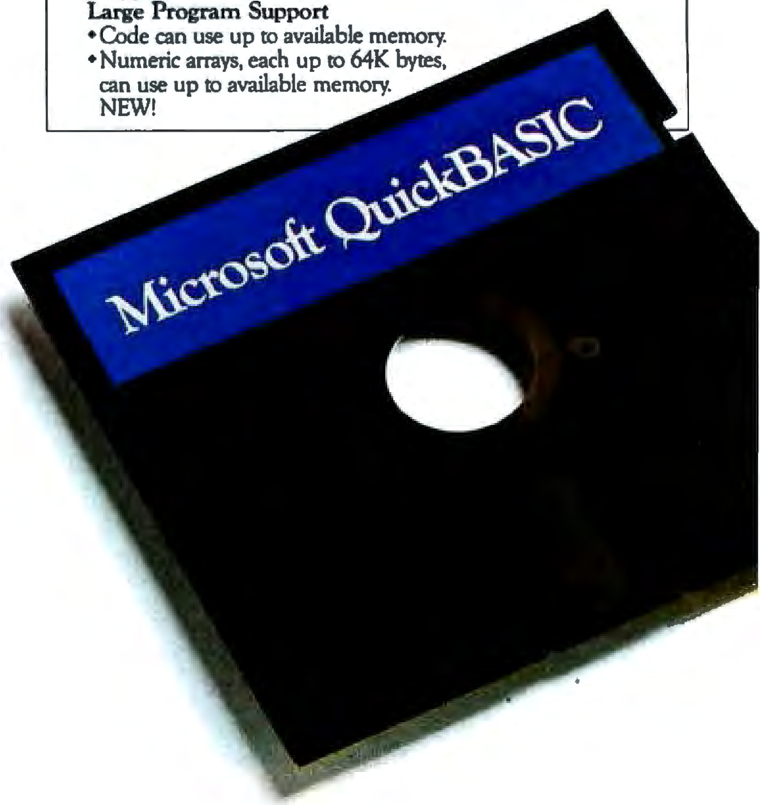

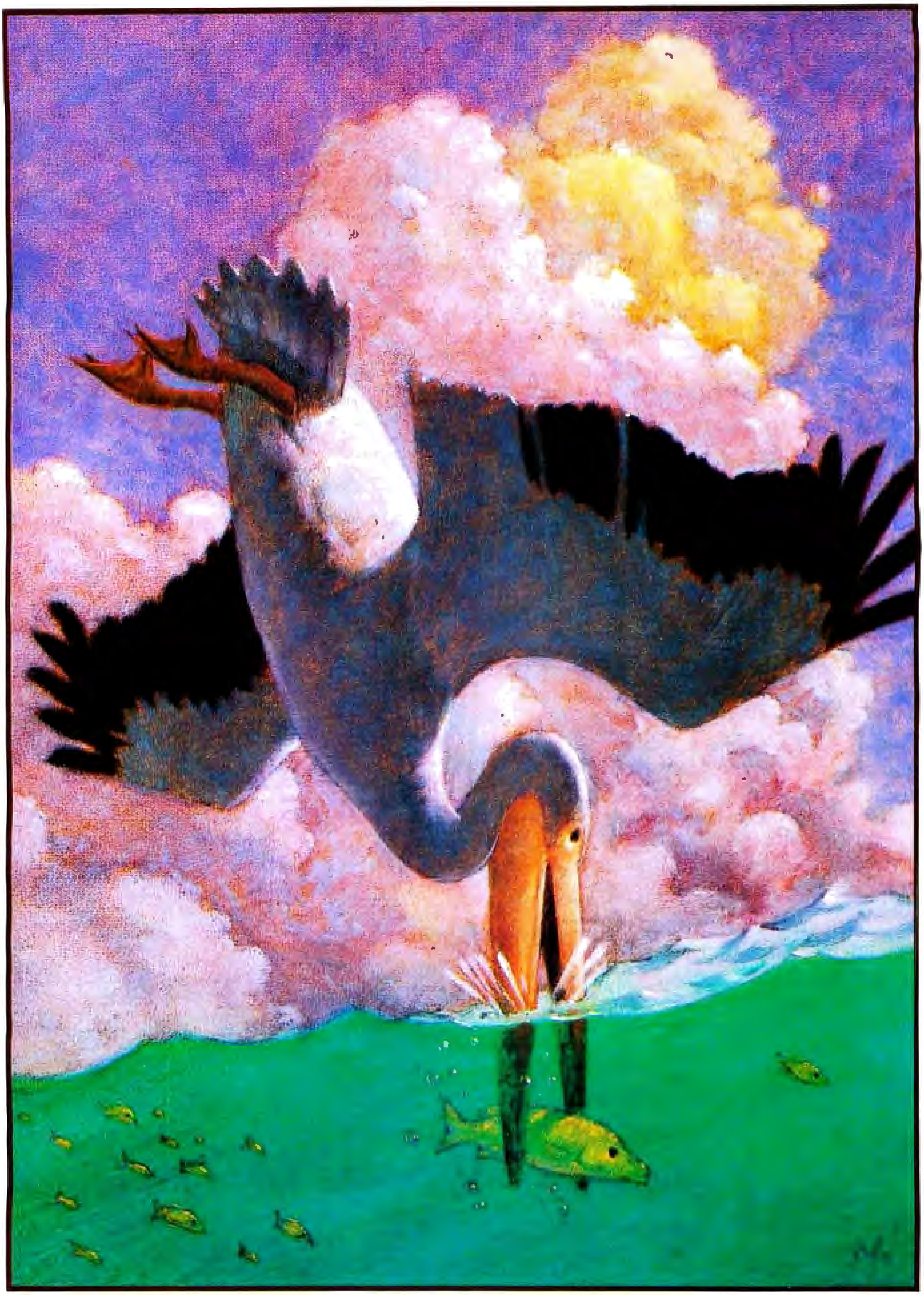

ILLUSTRATED BY BART GOLDMAN

USING DOS FUNCTIONS FROM TURBO PASCAL

BY DOUGLAS F. YRIART

You need never write a line of assembly language code

When you decide whether to use a high-level language or assembly language to write an application program, you must weigh several trade-offs. One element to consider is which operating system services the high-level language provides access to versus the services available directly to an assembly language program. This article demonstrates how to call on operating system functions from programs written in Turbo Pascal running under PC-DOS or MS-DOS. You can apply the techniques described to other implementations of Pascal or to other high-level languages as long as the language in question provides facilities for making calls to the operating system and the ability to examine the values returned in the CPU registers.

The program DirectoryDemo (listings 1 through 6 inclusive) returns a disk directory with filenames and sizes by searching for matches to the specified input pattern, much as the DIR command does. In addition to demonstrating how to use DOS function calls, the procedures and functions that make up the program can be used within other programs to automatically process a group of files or show you a list of available files and information about them. [*Editor's note: The program* DIRDEMO.PAS *is available on disk, in print, and on* BIX. *See the insert card following page* 320 *for details. It is also available on* BYTE*net. See page* 4.]

DOS AND HIGH-LEVEL LANGUAGE SERVICES

DOS provides a number of functions for handling I/O from the console, mass storage, and other devices so that assembly language programmers have a standard means of dealing with these devices. Higher-level languages use some of these functions as well. To open a file in Turbo Pascal, you need only assign a filename to a file variable. In an assembly language program, you must take care of numerous details, such as setting up a file control block (FCB), before you can ask DOS to open the file.

An operating system as rich as MS-DOS or PC-DOS provides many more I/O and memory management functions than are available in a higher-level language. There are two reasons for this. First, different operating systems provide different functions; to let you write portable programs, languages provide for only those functions

(continued)

Douglas F. Yriart (6805 *Melrose* Dr., *McLean*, VA 22101) *is a commander in the* U.S. *Naval Reserve and the chief of the computer user center for the* U.S. *Office of Personnel Management in Washington*, D.C. *He has a* B.A. *in international relations from Johns Hopkins University.*

that are reasonably standard across operating systems. Second, some limit must be set on the facilities provided by a language so that it does not become unwieldy. However, in exchange for portability and simplicity, you lose access to some useful capabilities.

Implementations of some high-level languages provide a back door through which you can access functions or perform tasks they do not provide. Usually, the method used is either to allow the inclusion of in-line assembly language code or to provide a means of linking assembly language modules with compiled programs. To take advantage of these facilities, you must write assembly language code.

Turbo Pascal lets you include in-line assembly language code in your programs. However, this facility is not generally needed because the language contains the facilities to make calls to the operating system and to load and examine the CPU registers. Thus, you can build procedures and functions to perform tasks not built into the language without resorting to assembly language. The price of using this capability is that your programs are not portable to other operating systems.

DOS provides two sets of functions for file management. The traditional set is FCB-oriented. To use these calls, the application program must build the FCB and pass it to DOS. The new, extended set of functions was introduced with DOS 2.0 and is easier to use. For a detailed explanation of DOS functions, see references 1 and 2.

Memory Organization

To understand the operation of DOS functions, you need to know how memory is organized in computers using the Intel 8088/8086 family of CPUs. The CPU registers are 16 bits wide and can contain unsigned integers in the range from 0 to 65,535. To address more than 64K bytes of memory, these CPUs use a scheme of 20-bit segmented addresses made up of a base segment address, which is a multiple of 16, and a relative offset from that base. With this technique, you can access any byte in the CPU's 1-megabyte address space. The CPU divides this area into four segments that you can use concurrently—the code, data, stack, and extra segments. A pair of registers is provided for referencing each of these areas—one contains the segment address; the other, the current offset.

DOS manages memory dynamically. The actual address at which a program resides is not established until the program is executed. DOS loads the CPU code-segment register with the appropriate segment address when it loads the program into memory.

As part of the load process, DOS also sets up a number of work areas for its own use. Their positions are variable, depending on a number of factors outside program control. To use some of the DOS function calls, programs need to be able to access these work areas. The data transfer area (DTA) in particular is needed when you use the extended file and directory services.

The DTA is where the directory search functions return information on the files they find. DOS establishes a default DTA in the program-segment prefix (PSP), another area it sets up while initializing a program. Programs can also establish and change their own DTAs once they begin running. DOS provides a function for setting the address of the current DTA. More important for our purposes, DOS also provides a function that reports the address of the currently active DTA.

Calling DOS Functions

Reference 1 describes two preferred ways to invoke DOS functions. Both methods require that you place the number of the function to be called in the CPU's AH register. In addition, you may need to place values in other CPU registers, depending on the call. After making a call, the function often returns information in the CPU regis-

Listing 1: *The type, constant, and variable declarations for the program DirectoryDemo.*

```
program DirectoryDemo;
{ Copyright June 1985 by D. F. Yriart. }

type
  UserSpec    = string[64];
  Registers   = record
                  AX,BX,CX,DX,BP,SI,DI,DS,ES,Flags : Integer;
                end;
  FileName    = string[13];
  DTAPointer  = ^DTARecord;
  DTARecord   = record
                  DOSReserved : array[1..21] of byte;
                  Attribute   : byte;
                  FileTime,     { special format }
                  FileDate,     {    "       "   }
                  SizeLow,
                  SizeHigh    : Integer;
                  FoundName   : array[1..13] of char;
                end;

const
  NUL        = ^@;     { character 0              }
  SeekAttrib = $10;    { files & sub-directories  }

var
  TransferRec   : DTAPointer;
  MatchPtrn     : UserSpec;
  RetName       : FileName;
  FilSize       : Real;
  Count         : Integer;
  NoFind, LastFile,
    SubDirec    : Boolean;
```

ters. For example, if an error occurs, many of the functions turn on the carry flag in the flags register and return an error code in the AX register.

Calling a DOS function is a three-step process.

1. Set up the call:
   A. Place the desired function number in the AH register, and
   B. Place any other data in other registers as appropriate.
2. Make the call.
3. Check the carry flag in the CPU's flags register.
   A. If it is on, an error has occurred; handle it as necessary.
   B. If it is off, there is no error; examine the appropriate registers for returned information.

In a Turbo Pascal program, you call DOS functions by using the predefined procedure MsDos, which requires a Registers record as its parameter. That record contains integer fields corresponding to most of the CPU registers. To set up the call, you assign values to the appropriate fields. Each register is 16 bits, or 2 bytes, wide. The AH register is the high-order byte of the AX register. To get the function number into AH, you must multiply it by hexadecimal 100 ($100 in Turbo Pascal notation, which will be used throughout this article) and assign the result to the AX field of the Registers record. When the DOS function has completed its operation, the corresponding fields in the record will contain any values that were returned in the CPU registers.

Several DOS functions, including the one that makes an initial directory search, need information that does not fit in the CPU registers. This information is stored in an ASCIIZ string—a string of ASCII characters without an initial length byte that is terminated by a byte of binary zeros. The binary zeros are supplied by terminating the string with the NUL character, which is the ASCII character zero. When you set up the call, you use a pair of registers containing the ASCIIZ string's segment and offset addresses to reference the string.

To demonstrate how to implement DOS function calls in a Turbo Pascal program, let's use functions $4E (FindFirst) and $4F (FindNext). Function $4E locates the first file that matches the input specification. Function $4F finds additional matches. You also need to use function $2F (GetDTA) to determine the location of the current DTA, because directory search functions return information about the files they find in the DTA.

Listing 2: *Procedure* PointDTA, *which finds the location of the program's* DTA.

```
procedure PointDTA(Var DTARec : DTAPointer);

Const   GetDTA = $2F00;    { function number }

var
   Regs : Registers;

Begin
      Regs.AX := GetDTA;
      MsDos(Regs);
      DTARec := Ptr(Regs.ES,Regs.BX);
End;
```

Listing 3: *Function* SizeOfFile, *which is used to calculate file size.*

```
function SizeOfFile(HiWord, LoWord : Integer) : Real;

Var
   BigNo, Size : Real;

Begin
      BigNo := (MaxInt * 2.0) + 2;
      if HiWord < 0 then Size := (BigNo + HiWord) * BigNo
         else Size := HiWord * BigNo;
      if LoWord >= 0 then Size := Size + LoWord
         else Size := Size + (BigNo + LoWord);
      SizeOfFile := Size
End;
```

The Demonstration Program

DirectoryDemo is the name of the demonstration program. It includes a function, SizeOfFile, and three procedures, PointDTA, FindFirst, and FindNext. As input, the program accepts a standard DOS file specification, which may include drive name, path name, and filenames. The file specification may include the global characters * and ?. The program output consists of a three-column screen listing of filenames (along with file sizes) and subdirectories that match the input specification. Subdirectories are displayed in low intensity with a file size of 0 bytes since they are not regular files. The display concludes with a count of the files and subdirectories found.

DirectoryDemo compiles correctly with versions 2 and 3 of Turbo Pascal for the IBM PC. The program has run and functioned correctly on systems running PC-DOS versions 2.0 and 2.10 and also under Compaq's MS-DOS 2.11. It will run on PC-DOS version 3.0 but under certain conditions may fail. Apparently, DOS 3.0 returns additional error codes beyond those used by DOS 2.x. DirectoryDemo uses several of the "new" DOS functions and therefore does not work on DOS 1.0 or 1.1.

Data Types, Constants, and Variables

Three defined data types are important to the program DirectoryDemo (listing 1), and two procedures actually do the directory search. The Registers

(continued)

Listing 4: *Procedure* FindFirst, *which finds the first directory entry.*

```
procedure FindFirst(Pattern : UserSpec;
  Var Found : FileName; Var Size : Real;
  Var NoMatch : Boolean; Var LastOne : Boolean;
  Var SubDir : Boolean);

Const   FindFirst   = $4E00;  { function number }

Type
  ASCIIZ      = array[1..64] of char;

var
  FileSpec : ASCIIZ;
  Regs     : Registers;
  PosInStr,
  Count    : Integer;
  FoundLen : Byte absolute Found;

Begin
  for PosInStr := 1 to length(Pattern) do
    FileSpec[PosInStr] := Pattern[PosInStr];
  FileSpec[length(Pattern) + 1] := NUL;
  With Regs do
  begin
    DS := Seg(FileSpec);
    DX := Ofs(FileSpec);
    CX := SeekAttrib;
    AX := FindFirst;
    MsDos(Regs);
    if (Flags and 1) > 0 then
      begin
        Case AX of
             2 : begin    { No match }
                   NoMatch := True;
                   LastOne := True;
                 end;
            18 : begin    { No more files }
                   NoMatch := False;
                   LastOne := True;
                 end;
        else
          writeln(^G'Can''t interpret error return code');
          Halt;
        end;    { Case }
      end
    else
      begin    { No error return code }
        NoMatch := False;
        LastOne := False;
      end;
  end;    { with Regs }

  if (not NoMatch) then
  with TransferRec^ do
  begin
    Found := FoundName;
    Count := 0;
    While Found[Count] <> NUL do Count := Count + 1;
    FoundLen := Count;
    For Count := length(Found) + 1 to 13
      do Found := Found + ' ';
    if (Attribute and SeekAttrib) > 0
      then SubDir := True
      else SubDir := False;
    if not SubDir
      then Size := SizeOfFile(SizeHigh,SizeLow)
      else Size := 0.0;
  end;    { with TransferRec }
End;
```

data type is a record containing integer fields that represent the CPU registers. This type of variable is passed as a parameter to the predefined procedure MsDos whenever a DOS function is called. The fields in this record contain the values to be loaded into the CPU registers. When the call returns, those fields contain the values that the DOS function call is returning. Both MsDos and its parameter record are described in the Turbo Pascal manual (reference 3).

The other two data types, DTARecord and DTAPointer, work together. DOS returns the information for each file found in the DTA in a specific format. DTARecord is a record whose fields correspond to the layout of that data. DTAPointer defines a pointer to DTARecord. When you set the pointer to point to the DTA, you can directly access the information returned by the directory search calls in the fields of DTARecord.

For convenience, two global constants have been defined. NUL has the value of ASCII character zero and is used as a terminator in constructing the ASCIIZ string that is passed to the function that begins the directory search. The other constant, SeekAttrib, has a value of $10. When you conduct a directory search, you can specify the attribute of the files you want to find. The subdirectory attribute is $10, and it tells the search to return subdirectories as well as files that match the input search criterion.

The three Boolean variables NoFind, LastFile, and SubDirec are used to report the progress of the search after each call and whether the name being returned is a subdirectory name, so that it can be displayed in low intensity.

Getting the DTA Address

The program's first procedure, PointDTA (listing 2), is used to find the location of the current DTA and to set its pointer, TransferRec. The program calls DOS function $2F to get the address of the DTA. In writing procedures or functions that use DOS function calls, I restrict each to a single DOS function. In addition, I declare the DOS function number as a con-

(continued)

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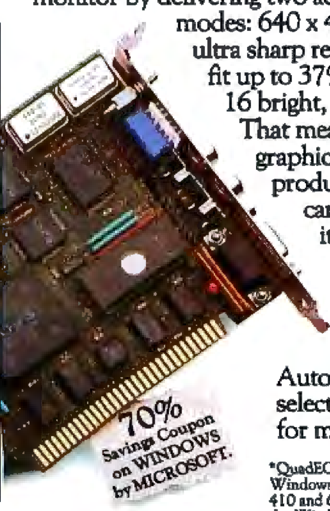

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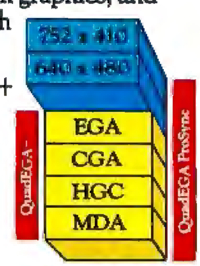

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stant already multiplied by $100 (in this case $2F00) so that you can load it into the AH register simply by assigning the value to the AX register. DOS function $2F returns the address of the DTA in the ES and BX registers. The ES register contains the segment address, and BX, the offset. You set the pointer value using Turbo Pascal's predefined function Ptr.

CALCULATING THE FILE SIZE

Function SizeOfFile (listing 3) calculates the size of each file found during the directory search. The function returns a value of type Real, since DOS file sizes can exceed 32,767 bytes (MaxInt for Turbo Pascal). DOS delivers the size of each file in a pair of 2-byte words, HiWord and LoWord, which are passed as parameters to SizeOfFile. This presents a minor problem. The value of each word is expressed as a 16-bit unsigned integer, a data format unknown to Turbo Pascal. Therefore, values greater than MaxInt appear to be negative when these words are treated as signed integers.

The problem is resolved by creating a real variable, BigNo, containing the value 2^{16}, and subtracting negative values from it to find the true value of the word. To find the file size, you determine the value of the high-order word, multiply it by BigNo, and add the value of the low-order word to it.

FINDING THE FIRST FILE

The procedure FindFirst (listing 4) searches for the first occurrence of a filename to match the input criterion. It invokes DOS function $4E to begin the search and lays the groundwork for subsequent calls to DOS function $4F, which returns additional matches, if any. FindFirst loads the appropriate registers, makes the call, checks for errors, and, if it finds a match, returns the filename and size and a flag signifying whether that file is a subdirectory. If the search fails, FindFirst uses a pair of flags to signal the failure.

DOS function $4E requires as input an ASCIIZ string containing the pattern to be matched. The ASCIIZ string is loaded into the local variable FileSpec. Turbo Pascal's predefined functions Seg and Ofs are used to load FileSpec's segment and offset addresses, respectively, into the DS and DX fields of the Registers record, which is called Regs.

The attribute of the files you are searching for is an optional parameter of DOS function $4E. You load it into the CX register before making the call. Since in this case you want to locate all files and subdirectories in the appropriate directory that match your specification, you load CX with the constant SeekAttrib.

After making the call to function $4E, FindFirst checks the carry-flag bit in the Flags field of the Regs record to find out if the function has returned an error code. The codes report the status of the search if the function fails to find a match. DOS 2.x reports one of two possible conditions: error 2, indicating that no match was found, or error 18, indicating that the last file that matches the input specification has been found. (FindFirst is coded so that if any error code other than 2 or 18 is returned, the program halts with the message "Can't interpret error return code." In a production system, you would want to provide a more graceful way of handling this. Procedure FindNext works the same way.)

If the carry-flag bit is not turned on, there is no error code to check, and a file matching the input specification has been found. FindFirst transfers the information about the file from the fields of the DTA record to variables for return to the main program. For this example, three pieces of in-

(continued)

Listing 5: *Procedure* FindNext, *which is used to find subsequent directory entries.*

```
procedure FindNext(Var Found : FileName; Var Size : Real;
  Var LastOne : Boolean; Var SubDir : Boolean);

Const   FindNext    = $4F00;    { function number }

var
  Regs  : Registers;
  Count : Integer;
  FoundLen : Byte absolute Found;

Begin
  With Regs do
  begin
    AX := FindNext;
    MsDos(Regs);
    if (Flags and 1) > 0 then
      if AX = 18 then LastOne := True
      else
        begin
          writeln(^G'Can''t interpret error return code');
          Halt;
        end
    else LastOne := False;
  end;  { with Regs }

  with TransferRec^ do
  begin
    Found := FoundName;
    Count := 0;
    While Found[Count] <> NUL do Count := Count + 1;
    FoundLen := Count;
    For Count := length(Found) + 1 to 13
      do Found := Found + ' ';
    if (Attribute and SeekAttrib) > 0 then SubDir := True
      else SubDir := False;
    if not SubDir then
      Size := SizeOfFile(SizeHigh,SizeLow)
    else Size := 0.0;
  end;     { with TransferRec }
End;
```

formation about each file are returned: its name and extension, its attribute (whether it is a subdirectory or a normal file), and its size.

Function $4E returns the filename and extension in a single field, separated by a period and terminated by a NUL. There may be garbage characters in the remainder of the field if the name and extension do not fill the entire field. The Boolean variable SubDir is set to True and the file size is set to zero if it is a subdirectory. If not, the file size is calculated by function SizeOfFile. The date and time of the file's last update are also available in the DTA; however, for the sake of simplicity, decoding these fields has been left out of the demonstration program. Both the date and the time are stored in special packed formats (see reference 1).

FINDING ADDITIONAL FILES

The procedure FindNext (listing 5) searches for additional files that meet the specification set up by FindFirst. All you need to do is load the AX field of the Regs record with the function number $4F and make the call. As in FindFirst, the procedure checks the carry flag for an error condition. DOS function $4F returns only a single error code, 18, when the last matching file has been found. If no error is reported, the process of capturing and returning the information from the DTA is the same as in FindFirst.

THE MAIN PROGRAM

The main program (listing 6) has three basic sections: a setup phase, a loop that searches for files matching the input specification, and a closeout phase.

In the setup phase, you are asked to enter a specification, procedure PointDTA sets the pointer to the DTA, and the program invokes procedure FindFirst to look for the first match. Since this is merely a demonstration program, there is no check to ensure that your input is valid. (Note that in DOS function calls, you may delimit path names with slashes as well as the backslashes we are used to.)

If FindFirst is successful, the main program enters a loop that displays information about each file found and invokes procedure FindNext to search for another match until no more are found. Subdirectories are displayed in low intensity; all other files are shown in regular intensity. When the main program has found the last matching file, it closes out the display with a summary message and exits.

CONCLUSIONS

The program DirectoryDemo serves two purposes: It illustrates how to use DOS functions from within a Turbo Pascal program, and it shows how to invoke the directory search services provided by DOS to locate and process a group of files whose names match a given specification.

The techniques in this article also apply to invoking DOS and BIOS services through interrupts using Turbo Pascal's predefined procedure Intr. In this case, in addition to loading the appropriate fields in the Registers record, the program must specify the desired interrupt number.

With the procedures MsDos and Intr and similar "hooks" to the operating system that other high-level languages may provide, you can have full access to the rich variety of services provided by DOS functions and interrupts without ever having to write a line of assembly language code. Programs can perform almost any task the hardware is capable of. The price is that programs that make use of these services through function calls and interrupts are not portable to other operating systems without extensive modification. ■

Listing 6: *The main body of the program* DirectoryDemo.

```
BEGIN
  ClrScr;
  writeln(' -- Demonstration of Directory Search Calls --');
  write('    Find? ');
  readln(MatchPtrn);
  writeln;
  Count := 0;
  PointDTA(TransferRec);
  FindFirst(MatchPtrn,RetName,FilSize,NoFind,LastFile,
    SubDirec);
  if NoFind or LastFile then writeln('File not found.')
    else
      begin
        While (not LastFile) do
          begin
            if SubDirec then LowVideo;
            write(RetName,'  ',FilSize:8:0,'    ');
            NormVideo;
            Count := Count + 1;
            if (Count mod 3) = 0 then Writeln;
            FindNext(RetName,FilSize,LastFile,SubDirec);
        end;
      end;

  if (Count mod 3) <> 0 then writeln;
  writeln;
  write('*** ',Count,' Files or ');
  LowVideo;
  write('Sub-Directories');
  NormVideo;
  writeln(' found ***');
END.
```


REFERENCES

1. *Disk Operating System Technical Reference*. Microsoft Corp. and International Business Machines Corp., first edition, version 2.10, September 1983.
2. Norton, Peter. *The Peter Norton Programmer's Guide to the IBM PC*. Bellevue, WA: Microsoft Press, 1985.
3. *Turbo Pascal Reference Manual*, version 3. Scotts Valley, CA: Borland International Inc., 1985.

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A PROGRAM FOR APPROXIMATING INTEGRALS

BY DAVID M. SMITH

Gauss approximation with Aitken extrapolation yields increased precision

THE PROBLEM OF computing the value of a definite integral arises often in scientific, engineering, and other technical applications. Most of these integrals cannot be found exactly using techniques of calculus. Instead, they must be approximated using numerical methods, which work by evaluating the function at a finite number of points and doing a weighted sum of the function values. As more and more function values are computed, the sequence of approximations converges to the correct value of the integral.

However, the rate of convergence can differ widely for various functions. For one function, 30 evaluation points might produce an approximation correct to five significant digits (SD), while 1000 points might be needed to get the same degree of accuracy in the approximation of another function. Because of the need for many function evaluations, numeric approximation of an integral tends to be time-intensive and thus expensive.

This article presents a method for approximating integrals with a minimum of function evaluations. The technique, called Aitken extrapolation, is incorporated into the program in listing 1. A more accurate version of the program, written in FORTRAN, is available separately. [*Editor's note: Both programs are available on disk, in print, and on* BIX. *See the insert card following page* 320 *for details. Listings are also available on* BYTE*net. See page* 4.] I'll review some

(continued)

David M. Smith *teaches numerical analysis and computer-related mathematics at Loyola Marymount University. He can be reached at the* Mathematics Department, LMU, Loyola Blvd. *at West 80th St., Los Angeles,* CA 90045.

ILLUSTRATED BY LANE SMITH

Listing 1: A BASIC *program to approximate the integral of a function (defined in lines* 170 *and* 180). *The program uses Gauss approximation and Aitken extrapolation.*

```
100 DEFDBL A-H,L,O-Z
110 REM Use EPS=1E-6 if functions are single precision.
120 EPS=1E-10
130 SQT3=SQR(3)
140 DIM TABLE(20)
150 LG10=LOG(10)
160 DEF FNL10(X)=LOG(X)/LG10
170 F$="f(x)=SQR(EXP(x)-1)/SIN(x)"
180 DEF FNF(X)=SQR(EXP(X)-1)/SIN(X)
190 T1$="######   #####.##########    ####    ----"
200 T2$="######   #####.##########    ####    ###"
210 T3$="######  #####.##########    ----"
220 T4$="######  #####.##########    ###"
230 PRINT "Approximating the integral of the function:"
240 PRINT "         "; F$
250 INPUT "Number of lines in Gauss column (>1)";KL
260 INPUT "Lower limit for integral";A
270 INPUT "Upper limit for integral";B
280 IF B<=A THEN PRINT "Error. Lower limit <= upper
    limit.": STOP
290 PRINT
300 GOSUB 410
310 PRINT
320 FOR J=1 TO 20
330 INPUT "Enter 1 for next Aitken column, 0 to quit";CQ
340 IF CQ=0 THEN J=20: GOTO 390
350 GOSUB 760
360 PRINT
370 KL=KL-2
380 IF KL<3 THEN J=20
390 NEXT J
400 END
410 IF KL<1 THEN PRINT "Error in Gauss subroutine: KL<1.":
    STOP
420 NLINES=KL
430 NSUBS=1
440 NFUNCT=0
450 PRINT "Gaussian integration table for the function"
460 PRINT F$; ",  for x= ";A; " to ";B;"."
470 PRINT "Table contains ";NLINES; " lines."
480 PRINT
490 FOR JLINE=1 TO NLINES
500 XH=(B-A)/NSUBS
510 XH2=XH/2
520 XR=XH2/SQT3
530 START1=A-XH2-XR
540 START2=A-XH2+XR
550 SUM=0
560 FOR K=1 TO NSUBS
570 SUM=SUM+FNF(START1+K*XH)+FNF(START2+K*XH)
580 NEXT K
590 SUM=SUM*XH2
600 NFUNCT=NFUNCT+2*NSUBS
610 IF JLINE>1 THEN 650
620 PRINT "    N        Gauss             NF  Est.S.D."
630 PRINT USING T1$; NSUBS,SUM,NFUNCT
640 GOTO 720
650 RELERR=EPS
660 IF SUM<>0 THEN RELERR=ABS(TABLE(JLINE-1)-SUM)/ABS(SUM)
670 IF SUM=0 AND TABLE(JLINE-1)<>0 THEN
    RELERR=ABS(TABLE(JLINE-1)-SUM)/ABS(TABLE(JLINE-1))
680 IF RELERR<=0 THEN RELERR=EPS
690 NUMSD=-FNL10(RELERR)
700 IF NUMSD<0 THEN NUMSD=0
```

(continued)

analytic techniques for simplifying integrals to obtain increased precision.

FIRST APPROXIMATIONS

To use Aitken extrapolation, we need a set of approximations to the integral of $f(x)$ from a to b. Table 1 gives such a table for the function $f(x)=\sqrt{e^x-1}/\sin x$ from 0 to 1. The table was generated using the Gauss formula.

The Gauss formula approximates the area under a function from x_{i-1} to x_i as follows:

$$\int_{x_{i-1}}^{x_i} f(x)\,dx \approx \frac{x_i - x_{i-1}}{2} \times \left(f\left(\frac{x_i + x_{i-1}}{2} - \frac{x_i - x_{i-1}}{2\sqrt{3}}\right) + f\left(\frac{x_i + x_{i-1}}{2} + \frac{x_i - x_{i-1}}{2\sqrt{3}}\right) \right).$$

In line 1 of the table, the Gauss formula is applied to the entire interval (0,1). In the second line, the interval is divided into two subintervals and the Gauss formula is applied to each subinterval; the two approximations are totaled to produce the value shown in the Gauss column. In general, for each nth line in the table, the program divides the interval into 2^{n-1} subintervals and applies the Gauss formula to each. These values are summed to get an approximate integral from a to b.

The Est. SD column of table 1 is a conservative estimate of the number of significant digits in the latest approximation, based upon a comparison with the Gauss number in the previous line of the table.

One advantage the Gauss rule has over more popular integration rules like Simpson or trapezoidal is that the function is not evaluated at either of the endpoints of the interval of integration. For functions with singularities, this means you can code the function into the program more easily, without having to make a special case to avoid division by zero, and so on. This makes the code for the function easier to write and faster executing.

AITKEN EXTRAPOLATION

Once the Gauss table has been computed, we have a sequence of approx-

(continued)

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```
710 PRINT USING T2$;NSUBS,SUM,NFUNCT,NUMSD
720 NSUBS=2*NSUBS
730 TABLE(JLINE)=SUM
740 NEXT JLINE
750 RETURN
760 IF KL<3 THEN PRINT "Error in Aitken: KL<3.": STOP
770 KLM2=KL-2
780 PRINT: PRINT "Aitken column. ";KLM2;" entries."
790 PRINT: PRINT "  Line    Aitken           Est.S.D.
800 KLM1=KL-1
810 FOR JLINE=2 TO KLM1
820 TOP=(TABLE(JLINE+1)-TABLE(JLINE))^2
830 BOT=TABLE(JLINE+1)-2*TABLE(JLINE)+TABLE(JLINE-1)
840 IF BOT=0 THEN TABLE(JLINE-1)=TABLE(JLINE+1) ELSE
    TABLE(JLINE-1)=TABLE(JLINE+1)-TOP/BOT
850 JLM1=JLINE-1
860 IF JLINE<=2 THEN PRINT USING T3$;JLM1,TABLE(JLM1):
    GOTO 940
870 RELERR=EPS
880 IF TABLE(JLM1)<>0 THEN RELERR=ABS(TABLE(JLM1-1)-
    TABLE(JLM1))/ABS(TABLE(JLM1))
890 IF TABLE(JLM1)=0 AND TABLE(JLM1-1)<>0 THEN
    RELERR=ABS(TABLE(JLM1-1)-TABLE(JLM1))/ABS(TABLE(JLM1-
    1))
900 IF RELERR<=0 THEN RELERR=EPS
910 NUMSD=-FNL10(RELERR)
920 IF NUMSD<0 THEN NUMSD=0
930 PRINT USING T4$;JLM1;TABLE(JLM1);NUMSD
940 NEXT JLINE
950 RETURN
```

Table 1: *Gaussian integration table for the function*

$f(x) = \sqrt{e^x - 1}/\sin x$, for $x=0$ to 1.

The BASIC program in listing 1 produced the data for the table. Each successive line of the table corresponds to a finer approximation. The number of subintervals used is "n," "Gauss" is the resulting approximation, "NF" is the number of function evaluations used to produce the current estimate, and "Est. SD" is a conservative estimate of the number of significant digits in the approximation.

n	Gauss	NF	Est. SD
1	1.9285506935	2	—
2	2.0298952302	6	1
4	2.1019189001	14	1
8	2.1529799461	30	2
16	2.1891343294	62	2
32	2.2147171070	126	2
64	2.2328132539	254	2
128	2.2456114423	510	2
256	2.2546619381	1022	2
512	2.2610618921	2046	3
1024	2.2655874445	4094	3

imations $T_1, T_2, T_3, \ldots$, which converges to the correct value of the integral. The number of subintervals used increases geometrically (1, 2, 4, 8, . . .). Numerical analysis tells us that such a sequence is linearly convergent, or nearly so.

Aitken extrapolation uses this linear-convergence property to derive additional accuracy from the Gauss table results without the need for further function evaluations. If we let T represent the exact value of the integral, and e_i the error in the Gauss approximation on line i, then $T_i - T = e_i$. By the definition of linear convergence, there exists a constant c for which $e_i = ce_{i-1}$ for every i. Assuming this gives us three equations in three unknowns, T, e_i, and c: $T_i - T = e_i$, $T_{i+1} - T = ce_i$, and $T_{i+2} - T = c^2 e_i$. Solving for T yields

$$T = T_{i+2} - \frac{(T_{i+2} - T_{i+1})^2}{T_{i+2} - 2T_{i+1} + T_i}.$$

This is the formula for Aitken extrapolation. In practice, the convergence is not precisely linear, so this computed T is still not the exact result, but it is often more accurate than any of the three values used to generate it. Unlike the Gauss values, which are each the sum of n terms, the Aitken values derive from only a few arithmetic operations. The time needed to compute the values in the Aitken column is negligible when compared to the time taken for the Gauss column.

Table 2 gives the Aitken extrapolations to the integral of the function using the data in table 1. Each Aitken value is found using three successive numbers in the previous column (either Gauss or Aitken) and extrapolating to the limit under the assumption that the numbers are part of a linearly convergent sequence. Thus line 1 in the Aitken column with nine entries was computed using the Gauss approximations with $n=1$, 2, and 4. Line 2 in that column used the Gauss approximations with $n=2$, 4, and 8, and so forth. Then line 1 of the Aitken column with seven entries used the same formula with the approximations on lines 1, 2, and 3 from the previous Aitken column.

Notice that each new Aitken column has two fewer entries than the previous one.

The Aitken table gives a final approximation accurate to at least nine SD, even though the Gauss approximation was accurate to only two SD. The singularity is what makes the approximations so bad in the Gauss column. For a well-behaved function, the Gauss accuracy would be ten or twelve SD, so the Aitken extrapolations would not be necessary.

On the other hand, computing the Aitken columns takes almost no time when compared to the time required to calculate the Gauss column. A compiled version of the Aitken program (listing 1) took 2 minutes, 15 seconds to produce the results of tables 1 and 2, running on an IBM PC without floating-point hardware. Since the running time increases with the total number of function computations, it would take about twice as long to add one more line to the Gauss table with $n=2048$.

HANDLING SINGULARITIES

Before applying the program to an integral, you should locate all singular-

(continued)

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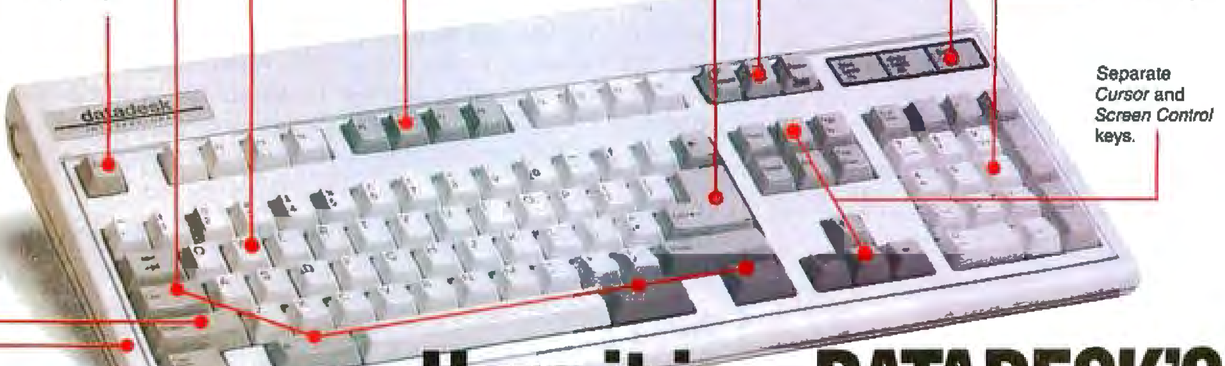

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Table 2: *Successive Aitken extrapolations based on the data in table 1. The BASIC program in listing 1 produced the data.*

Aitken column. 9 entries.

Line	Aitken	Est. SD
1	2.2788375790	—
2	2.2773551404	3
3	2.2768225975	4
4	2.2766261985	4
5	2.2765539625	4
6	2.2765278095	5
7	2.2765184458	5
8	2.2765151139	6
9	2.2765139321	6

Aitken column. 7 entries.

Line	Aitken	Est. SD
1	2.2765240364	—
2	2.2765114484	5
3	2.2765119368	7
4	2.2765129672	6
5	2.2765132235	7
6	2.2765132734	8
7	2.2765132825	8

Aitken column. 5 entries.

Line	Aitken	Est. SD
1	2.2765119185	—
2	2.2765110082	6
3	2.2765133084	6
4	2.2765132854	8
5	2.2765132845	9

Aitken column. 3 entries.

Line	Aitken	Est. SD
1	2.2765116604	—
2	2.2765132856	6
3	2.2765132844	9

Aitken column. 1 entry.

Line	Aitken	Est. SD
1	2.2765132844	—

Table 3: *This table summarizes the results of applying Aitken extrapolation to a function over a specified interval. The "Aitken columns" show the number of significant digits obtained in each step. In this case, we see that dividing an integral at its singularity point before starting numeric approximation greatly improves the significant digit yield (compare run 1 and runs 2A and 2B).*

Run	Function	Interval	Aitken columns			
1	$\lvert x-0.3\rvert^{0.33333}$	(0,1)	2			
			2	3		
			3	3	3	
			3	3	4	5
			4	4	5	5
			4	4	5	
			5	5		
			5			
2A	$\lvert x-0.3\rvert^{0.33333}$	(0,0.3)	5			
			6	8		
			7	10	9	
			8	9	9	9
			9	9	9	9
			9	9	8	
			9	10		
			10			
2B	$\lvert x-0.3\rvert^{0.33333}$	(0.3,1)	5			
			6	8		
			7	9	9	
			8	10	10	10
			10	10	10	11
			10	9	9	
			10	9		
			10			

ities of the function that lie inside the interval of integration. Break the integral up into subintervals bounded by these singularity points; Aitken extrapolation works best when the points where $f(x)$ is computed approach the singularity in a regular manner. This is true if the singularity is an endpoint but is not usually true otherwise.

For example, consider the integral

$$\int_0^1 |x - 0.3|^{0.33333}\, dx .$$

The function has a mild singularity at $x=0.3$, since even though it is continuous, its derivative is undefined there. Table 3 compares the results of integrating the entire interval as opposed to integrating the two subintervals (0,0.3) and (0.3,1).

In run 1, Aitken extrapolation is not able to gain much accuracy over the initial results in the Gauss column, finishing with about five SD correct. In runs 2A and 2B the partial results can be added to get about nine SD correct.

The function

$$f(x) = \frac{1}{x^4 + x^2 + 1}$$

is nice and smooth on the interval (0,3). Gauss integration does not really need much help from Aitken (see table 4, run 1). But the same function on the larger interval (0,300) doesn't yield so easily to Gauss approximation, and even Aitken extrapolation is ineffective through 1024 subintervals (table 4, run 2).

A person might formulate such an integral in an attempt to approximate the integral of $f(x)$ from 0 to infinity. The reasoning would go something like this: Since $f(x)$ is less than x^{-4} for all x, the error made in stopping at $x=b$ is less than

$$\int_b^\infty x^{-4}\, dx = \frac{1}{3} b^{-3} .$$

Setting this to 10^{-8} (a reasonably small error tolerance) and solving for b yields about 300.

However, as the results of table 4, run 2 suggest, chopping the integral off at some large value is seldom a good way to handle an integral to infinity.

Here again, the techniques of calculus can improve the situation. The idea is to find a change of variables that reduces the problem to a mathematically equivalent one on a finite

(continued)

Some integrals require preliminary analysis and more than one run of the program.

interval. This avoids the necessity of truncating the interval and gives a shorter interval that can be expected to converge more rapidly. Note, however, that the substitution variable must be continuous on the original interval. For example, the substitution $u=1/x$ could not be used if the original interval contained zero, since $1/x$ is not continuous there. For the problem at hand, $1/x$ makes a good substitution (zero winds up as the endpoint of the reconstituted integral).

We split the interval in two and change variables in the second part:

$$\int_0^1 \frac{1}{x^4+x^2+1}\,dx + \int_1^\infty \frac{1}{x^4+x^2+1}\,dx$$

$$= \int_0^1 \frac{1}{x^4+x^2+1}\,dx + \int_1^0 \frac{-u^{-2}}{u^{-4}+u^{-2}+1}\,du$$

$$= \int_0^1 \frac{1}{x^4+x^2+1}\,dx + \int_0^1 \frac{u^2}{u^4+u^2+1}\,du$$

$$= \int_0^1 \frac{x^2+1}{x^4+x^2+1}\,dx\ .$$

Here the two parts happen to combine nicely into one integral at the end, but even if the two parts are integrated separately they are both now well-behaved functions on small intervals. Table 4, run 3 shows that the Aitken program has no trouble with the reformulated integral, quickly surpassing the BASIC compiler's intrinsic precision.

This function can be integrated analytically to get the exact value of $\sqrt{3}\pi/6$, but most people could get the approximate result faster using the program than doing it by hand.

The last problem is slightly harder:

$$\int_0^1 \frac{\sqrt{x}}{x-1} - \frac{1}{\log x}\,dx\ .$$

For this function, the only possible singularities are at $x=0$ and $x=1$, but table 5, run 1 shows that Aitken extrapolation does not help much. After inspecting the singularity, an expert might make the substitution $u=x^2$ to get an equivalent integral that is well behaved, but let's try a more straightforward attack.

When functions like this one give the Aitken program trouble, it is important to realize that most of the error comes from the one or two subintervals containing singularities. To get much accuracy we need to use very small subintervals near singularities, but much larger subintervals will suffice elsewhere. Therefore, we split the interval into three parts, with small intervals around the endpoints.

Running the program three times for the intervals (0, 0.01), (0.01, 0.99), and (0.99, 1), we are able to get seven or eight SD for the first interval, nine or ten for the middle interval, and even more (the compiler's precision becomes the limiting factor) for the last interval (see table 5, runs 2A–2C).

Because of the different magnitudes of the integrals, their sum should be accurate to seven or eight SD. Most of the error is coming from the first interval, where there is a singularity. The immediate high accuracy of the output for the third interval indicates no such problem there. If we wanted to try for still more accuracy, a reasonable set of intervals would be (0, 0.001), (0.001, 0.1), and (0.1, 1).

As shown, these output tables contain a lot of information. In addition to an approximation of the integral, we get a good idea of how accurate the Aitken method is and an indication of the presence and severity of any singularities in the intervals used.

Table 4: *Aitken extrapolation is effective for this function on a small interval (run 1), but not when the interval is extended toward its singularity point. However, converting to an equivalent integral using calculus eliminates the problem (run 3). Note that values above 10 or 11 are suspect; in such cases we have probably exceeded the precision of the* BASIC *compiler.*

Run	Function	Interval	Aitken columns			
1	$1/(x^4+x^2+1)$	(0,3)	2			
			5	7		
			8	9	11	
			9	11	12	14
			13	14	15	14
			14	15	15	
			15	15		
			15			
2	$1/(x^4+x^2+1)$	(0,300)	0			
			0	0		
			0	0	0	
			0	0	0	0
			0	0	0	0
			1	1	2	
			2	2		
			4			
3	$\frac{x^2+1}{x^4+x^2+1}$	(0,1)	6			
			7	8		
			10	12	12	
			12	13	13	13
			13	14	15	17
			13	16	17	
			14	17		
			15			

CONCLUSION

We have seen several examples of techniques for using the Aitken program to solve fairly difficult integrals. We were able to evaluate each integral to high precision, although some re-

(continued)

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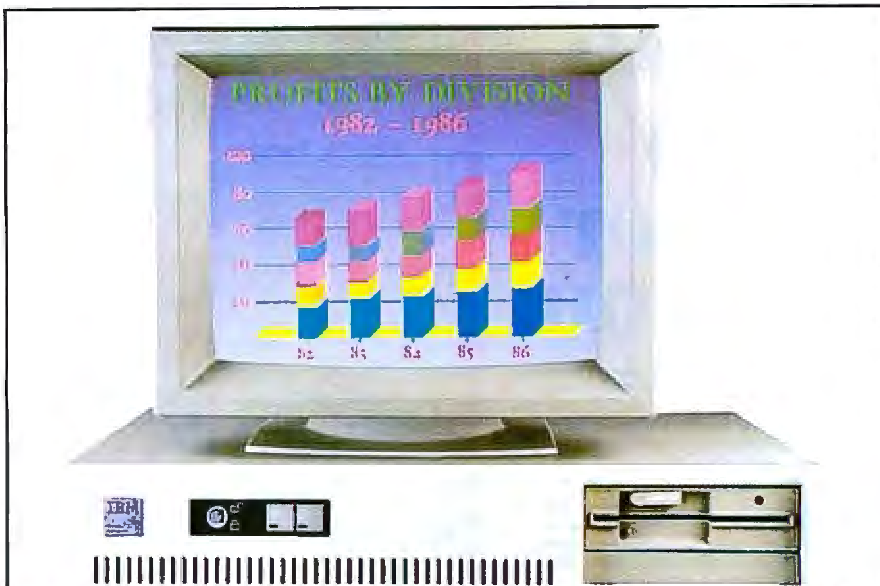

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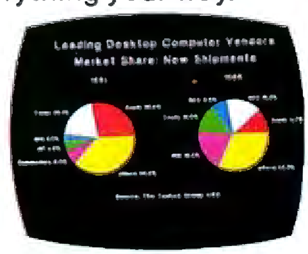

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Table 5: *In this case, the function integrates nicely except when it approaches the two singularity points 0 and 1. The solution is to break up the interval into three parts, with small intervals around the two singularities and a large interval covering the "well-behaved" middle section. Values above 10 or 11 are suspect; in such cases we have probably exceeded the precision of the BASIC compiler.*

Run	Function	Interval	Aitken columns			
1	$\frac{\sqrt{x}}{x-1} - \frac{1}{\log x}$	(0,1)	3			
			3	4		
			5	5	5	
			3	3	3	3
			3	4	4	5
			4	5	6	
			5	6		
			6			
2A	$\frac{\sqrt{x}}{x-1} - \frac{1}{\log x}$	(0,0.01)	4			
			4	6		
			5	7	8	
			5	8	8	8
			6	8	7	7
			6	8	8	
			7	8		
			8			
2B	$\frac{\sqrt{x}}{x-1} - \frac{1}{\log x}$	(0.01,0.99)	3			
			4	5		
			5	4	5	
			5	4	5	5
			5	6	7	10
			7	9	10	
			8	10		
			10			
2C	$\frac{\sqrt{x}}{x-1} - \frac{1}{\log x}$	(0.99,1)	12			
			11	11		
			12	12	13	
			13	13	13	14
			11	12	13	13
			11	10	10	
			11	10		
			10			

quired preliminary analysis and more than one run of the program.

However, a theorem says that given any program to approximate integrals by sampling function values at a finite number of points, functions exist for which that program fails. The program will get the wrong answer, and any estimate of the error it computes will be wrong as well.

On the other hand, almost all the problems found in applications in science and engineering can be handled in ways similar to the examples we have seen. And in dealing with very tough functions where the program does *not* get much accuracy, the lack of accuracy is almost always obvious from looking at the Est. SD columns.

Thus the Aitken extrapolation technique illustrated in listing 1 provides a powerful tool so that someone who is not an expert in numerical analysis can quickly do applications requiring the evaluation of definite integrals. ■

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Gerald, Curtis F., and Patrick O. Wheatly. *Applied Numerical Analysis*. Reading, MA: Addison-Wesley, 1984. A more recent standard numerical analysis text that gives derivations of the Gauss and Aitken formulas.

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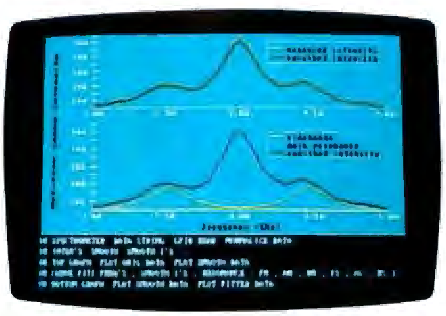

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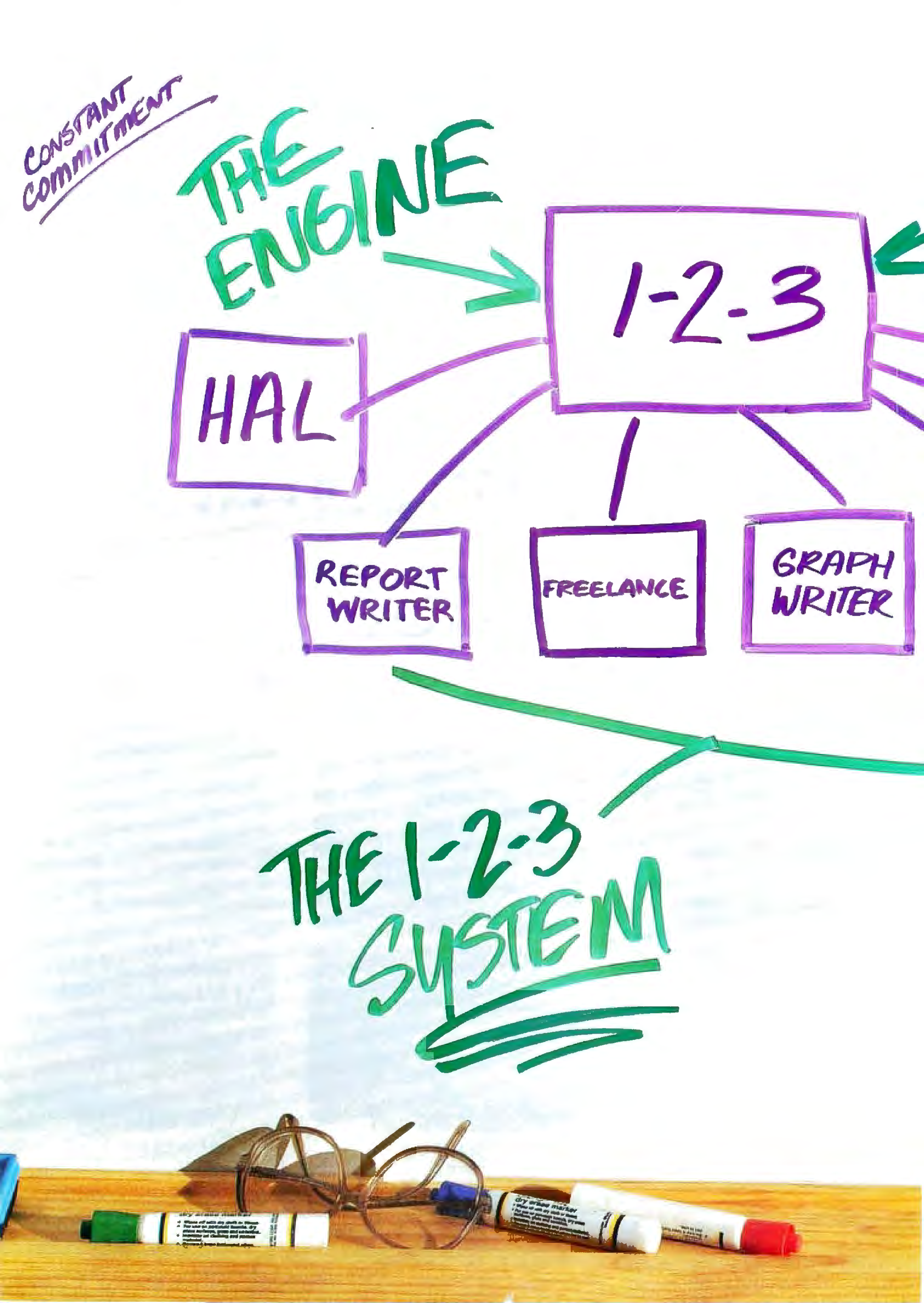
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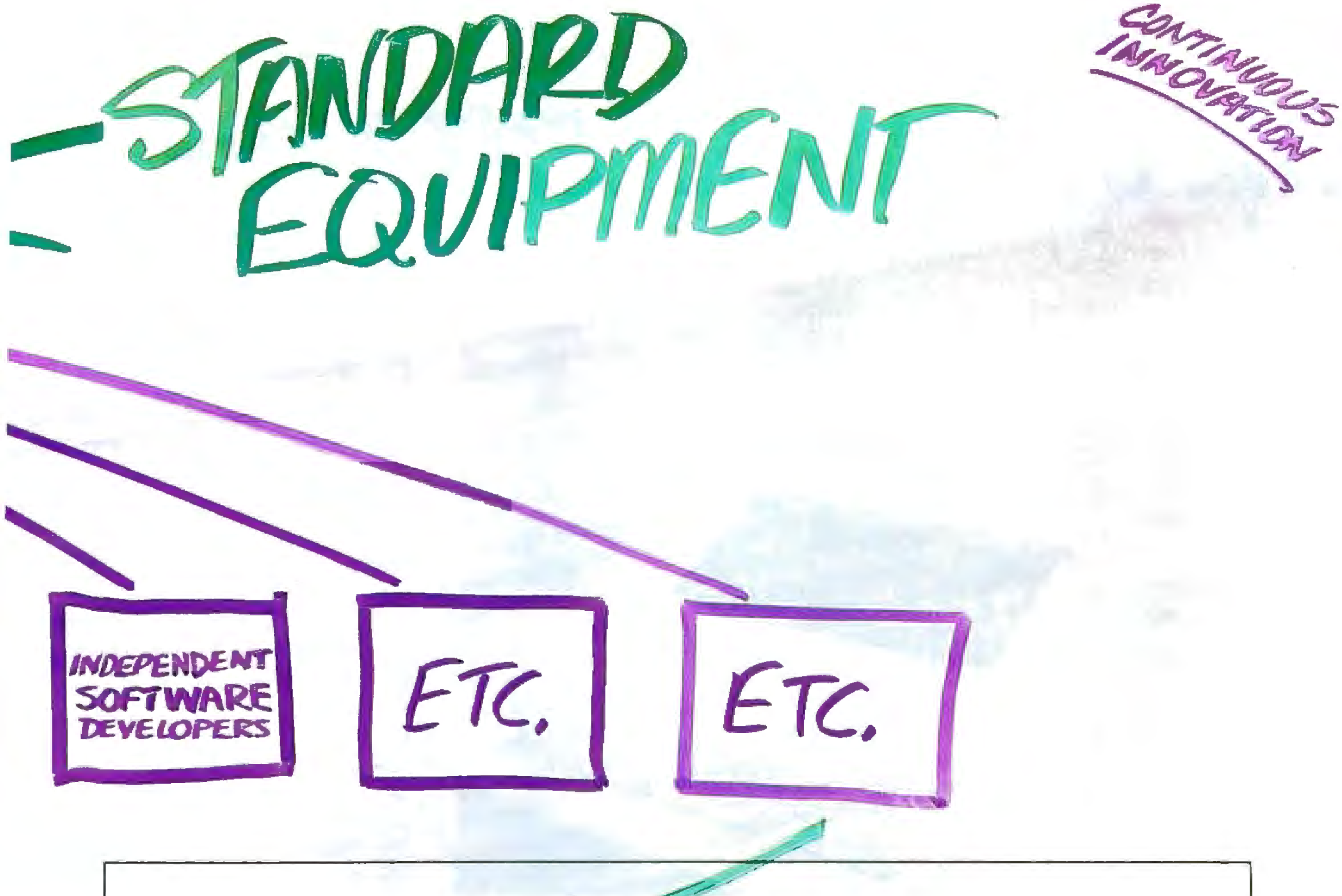

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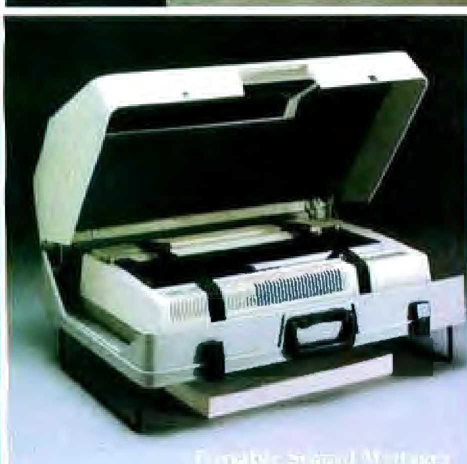

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BY JOEL WEST

DEBUGGING MACINTOSH APPLICATIONS

A look at the trips and traps you're liable to encounter

Debugging on an advanced windowing microcomputer like the Macintosh is more difficult than debugging in a "traditional" line-oriented environment for at least two reasons. First, the extensive use of pointers to data structures (and the Mac's double-indirected handle) means that only a small error in a pointer variable can lead to a fatal error. Second, a single-tasking microcomputer is often only one step away from fatal crashes, with little recourse once the program fails. Unlike on a multitasking mainframe, there's no memory management unit to assure that the system keeps running in the event of a program failure.

Having wrangled with the Mac myself as well as gleaned advice from commercial developers, I have developed a sort of checklist on how to get an application up and running on the Macintosh (the principles are applicable to other windowing 68000-based systems). I have also added advice on the psychology of debugging, based on several years' experience with a mainframe programming language. I assume that you are an accomplished programmer working on a complete stand-alone application with a compiled language, such as Pascal or C. I'll use C for examples, although analogs are available in Pascal. I'll also assume you've read at least the introductory chapters of *Inside Macintosh*.

THE BLACK ART OF DEBUGGING

It came as a shock the first time I realized that I hadn't really written a program until the last bug was out of it. While occasionally a small program

(continued)

Prior to joining Western Software Technology (P.O. Box 2733, Vista, CA 92083), Joel West helped users debug programs as a compiler writer for CACI Inc. He is now working on a forthcoming Bantam book on Macintosh programming.

ILLUSTRATED BY WARREN GEBERT

worked properly (or nearly so) the first time, usually extensive debugging was required.

Although debugging a complex piece of systems code may be as much fun as cleaning bedpans, it requires the surgeon's patience and insight. In fact, I've found it actually ends up resembling the well-known scientific method:

- Analyze the symptoms
- Hypothesize a possible explanation
- Predict effect of hypothesis
- Look for predicted results

In both the scientific and debugging laboratories, you don't know what the answer is, and if you make too many assumptions you will never know the answer. Instead, you systematically test hypotheses until you find one that appears valid; the proof comes in the correcting and retesting.

Great contributions to science come through genius, and the genius of debugging is an intuitive understanding of what's going wrong, even with inadequate evidence. In short, you need the ability to make an educated guess. A good hunch can pay off on the probabilities, much as a blackjack player knows that it's a good bet to double on an ace.

For example, suppose you've just added 50 lines of new code and your program crashes. But only three of those lines use new routines or data structures, and only one routine call includes a null pointer. Without attempting to propose other hypotheses, you could investigate whether that null pointer (NIL to Pascal users) is causing the problem.

When it comes time to investigate a failing program, there are really two ways to approach it. If you wrote the program, you can work from the source code to improve your understanding of the program. Eventually, you will understand exactly what the program is doing and see where it's going wrong. I'll call this the analytic approach.

I call the other approach symptomatic—you work backward from the point of failure. This technique is necessary when there are interactions with code you didn't write (such as the Macintosh Toolbox or a desk accessory). However, in my years of customer support, I discovered that many programmers get lost chasing symptoms. The frustrated cry of "I changed A and B broke" often indicates an undue reliance on symptoms to provide the magic answer.

In general, I've found a hybrid method to be the most successful: Gather information on as many symptoms as possible, then closely examine the code that seems suspect. It helps, of course, to pay close attention to Macintosh-specific interactions and to keep an eye out for their common problems.

Diagnosing the Symptoms

To illustrate the symptomatic approach, I'll use an actual problem. In this case, starting a certain desk accessory (DA) within a particular application worked, but starting the DA a second time crashed the computer. I devised a number of questions to test alternate hypotheses that explained the DA's failure.

Are there other interactions at work? Does it fail only when the selection involves an update event, because the DA was covered by some other window? Or does it fail only if you perform a memory-intensive operation in between—such as printing? Perhaps something is getting purged from memory where you didn't expect it.

Is the problem "Opening a currently open DA" or "Opening a DA previously opened"? The former suggests a problem in the reentry logic, while the latter suggests a purged memory problem.

Did it make it into the DA, or does it fail in the application before reaching the DA? This may require program modifications or a debugger, as discussed later.

Does it fail under other programs, or only this one? It might be the program that's causing the problem (the actual answer, in this case).

Isolating at least some symptoms is essential to finding a problem. If you can't always reproduce the problem, then you will have to use a purely symptomatic approach to tell you what sections of code deserve further attention. Knowing a failure is in a specific section, you can often spot a particular problem—a dubious null pointer—through pure analysis.

The article "Debugging Techniques" by Gregg Williams in BYTE's June 1985 issue describes general approaches to debugging. As he notes, you must follow what every good programmer has learned: Don't assume anything. Experienced hands advise that a "paranoid style" of Macintosh debugging is the key to success.

Preparing for Surgery

It helps to come prepared to the operating room. I've found the following to be extremely helpful to have within reach while I'm working on the Macintosh:

- The source listing, soon to be copiously annotated.
- Operating system documentation—*Inside Macintosh*.
- Hardware documentation, such as a good 68000 manual.
- Quick-reference documentation posted within sight. I personally keep "Inside Macintosh Quick Reference" clipped to the curtains of my office.
- A hex-to-decimal calculator.
- Specialized tools, such as MacsBug, TMON, MacNosy, resource editors.

As with any operation, you should set aside enough time to complete the surgery. If you don't have a lot of time, it may be more appropriate to gather further symptoms in hopes that they might help you guess the solution.

Common Illnesses

There are two major categories of fatal problems on the Macintosh, although the two categories overlap.

First, memory management problems are considered inevitable in Macintosh development, particularly with the elaborate dynamic relocation scheme provided by the Memory Manager, designed to milk every byte out of the original 128K-byte RAM machine. Most memory is referenced via a double-indirected pointer, referred to as a *handle*. The handle points to the master pointer, which in turn points to the actual data. When memory is tight, the Memory Manager shuffles data to create contiguous space, and the master pointers are updated to reflect the changes.

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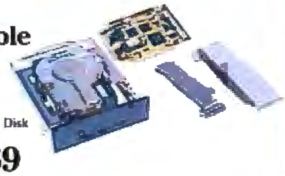

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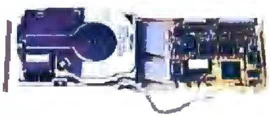

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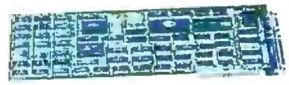

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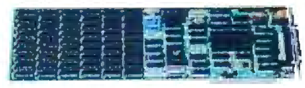

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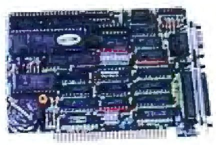

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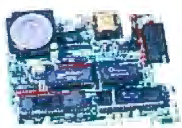

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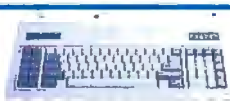

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Second, the Macintosh ROM is optimized for speed, not user-friendly development. Thus, most routines do not validate all their arguments. Passing a bad argument can cause a delayed crash, or no crash at all. Needless to say, a large subset of bad argument-induced failures includes memory management problems.

In some ways, the tendency for catastrophic failure can be made into an advantage. A crash close to the problem area places you that much closer to the solution.

MEMORY LAPSES

Common memory management problems include

• Zero pointer (also includes null and empty handles)—Although some routines (yours or the toolbox) may check for zero pointers, in most cases you're asking for trouble. Figure 1 diagrams the various null and empty alternatives for pointers and handles, shown in increasing order of reliability.

• Wild pointer—This is probably the most common, or at least most noticeable, point of failure. Accessing any wild pointer gives your program a 50/50 chance of addressing an odd memory location. This causes the 68000 to generate an interrupt, prompting the familiar "Sorry, a system error occurred" dialog box to appear with ID=02. Even if the pointer is even, writing to a high memory address will cause another common failure—random screen display and sound leading to the dreaded "bomb box."

• Relocated memory block—The symptoms of this will be garbage data values, sometimes including a null or wild pointer. Memory blocks allocated by NewHandle will be dynamically relocated when more memory is needed. This is done in a process known as "heap compaction," the goal of which is to create large areas of contiguous free memory by combining the scattered fragments of unused memory that develop as programs acquire and release memory blocks in the course of their execution. Unless you know otherwise, you should assume that any procedure called may request memory allocation, thus risking heap compaction. Alternately, memory blocks can be locked against relocation.

• Purged block—If there is not enough free memory for the Macintosh to allocate a requested block even after compaction, the Memory Manager will try to create free space by purging some blocks from the heap. Newly allocated memory blocks cannot normally be purged, but many user and system resources are. A purged block looks like any other empty handle, and the same null pointer symptoms apply.

• Clobbered block—The symptoms are similar to those of a relocated block. A possible reason is an underestimate of the amount of memory needed when another block was allocated or the failure to limit use of that block to its actual size. A call to ReAllocHandle can be used to expand the block when its space is used up.

• Out of memory—Any time you try to allocate memory, the attempt can fail for lack of memory. If your program doesn't check for failure, Murphy's law suggests it will fail at the least opportune time—such as in the middle of updating a large file.

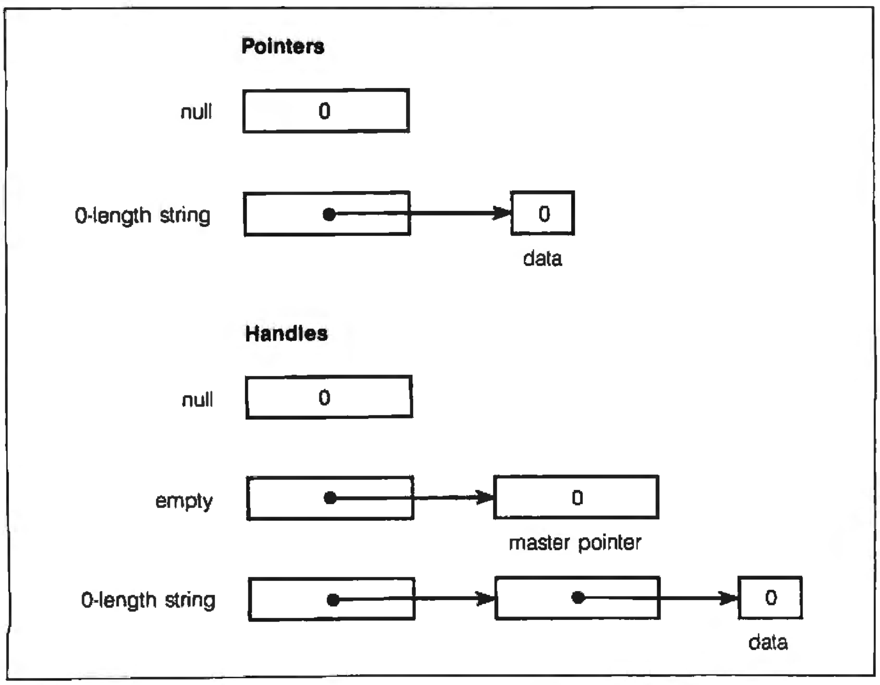

Figure 1: *Null pointers and null and empty handles can get unsuspecting routines into trouble.*

Since memory management problems are so common, you may want to force them to become more conspicuous:

• You can force relocated and purged block problems to the surface by making frequent calls to CompactMem and PurgeMem.

• Allocate a large memory block, or use Switcher or a RAM disk to use up the available memory, thus forcing out-of-memory conditions.

• Set location 0000 to an odd value, then a zero handle will cause an address error. If you choose an unusual value—such as 5A65426F hexadecimal or ASCII "ZeRo"—you will be able to recognize an attempt to dereference location zero.

Also, most Mac debuggers have a "heap scramble" option that forces frequent purging relocation of blocks. The TMON debugger also marks deallocated memory with odd values to force additional wild pointer errors.

DUBIOUS ARGUMENTS

Many of the argument-related problems are, in fact, memory manage-

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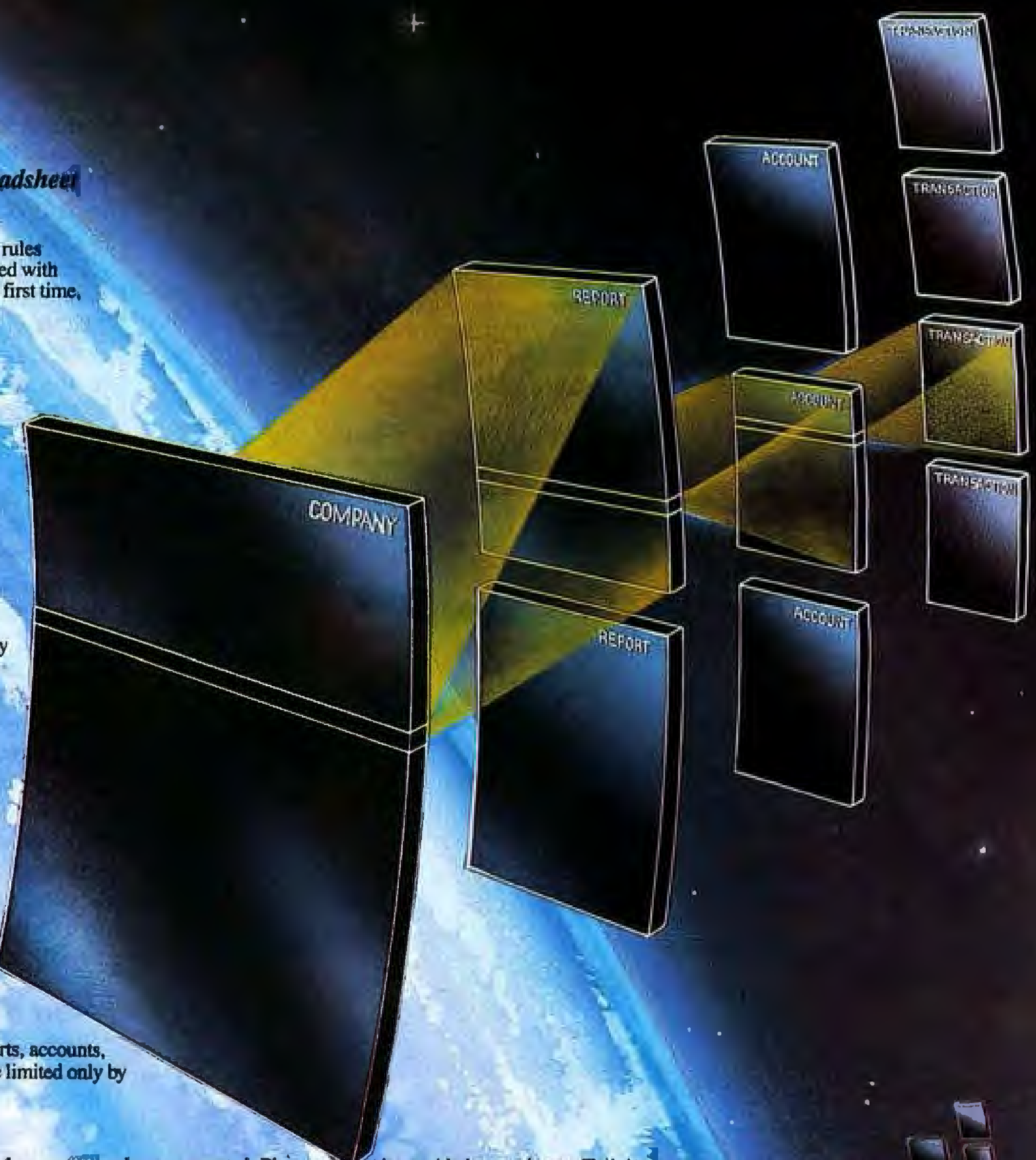

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ment problems. For example, very few ROM routines are designed to manage null handles; instead, they usually expect empty handles or handles pointing to zero-length strings.

Many incorrect argument references can be validated by carefully examining the documentation and sample code. If worse comes to worst, you can use MacNosy (a smart disassembler) to reverse-engineer the routine to find out what arguments it is expecting.

Finally, owners of TMON have the best argument-checking option of all. TMON includes user extensibility, as demonstrated by Extended User Area (EUA), a 5000-line enhancement to TMON placed in the public domain by its author, Darin Adler.

Among other features, EUA includes "discipline," a dynamic validation of toolbox arguments based on an earlier implementation by Steve Capps. For example, a pointer, handle, or the master pointer of a handle is checked for zero, an odd value, or other unreasonable values. It also looks at Rectangles, GrafPorts, WindowRecords, and so on, to make sure the fields have reasonable values.

If for no other use, the discipline of EUA is recommended as a final pass through a finished program to catch subtle or obscure bugs. The validation is good enough to find lingering bugs in a number of commercially released products.

Print Statements Revisited

There are two practical approaches to track down such problems: compiling debugging traces into the source code or using some form of debugger. Which approach you should take depends on the particular problem and your own personal skills.

If you're used to debugging without getting down to the machine level, I'm sure that print statements are by now a familar fixture.

The debugging print statement is a standard approach and the best one available without special tools. Simply place an identifying print statement within your code somewhere in the likely vicinity of the bug. Then execute the code and note whether or not the program "makes it" to the print statement. Continue this process, using a binary search to converge on the routine, or even statement, causing the failure.

The debugging print statement approach requires some translation into the Mac's window environment. A number of options are available:

- Debugging window—This is the best approach to port existing programs with debugging traces, or for developing large systems that will require permanent debugging code. It's really the same as the line-oriented print statements, but with a dedicated window. When debugging a screen-oriented program, the windowing metaphor is an advantage—the added complexity provides added capabilities. The additional window introduces new window-related events, however, making it a bad choice for low-level debugging.
- Serial port—You can send debugging information out of either of the Mac's serial ports to a printer or another computer. Although this introduces the complications of serial I/O to your application, for most programs this adds the fewest interactions.
- Reserved screen area—If you bypass the Window Manager entirely, you can avoid the interactions associated with windows becoming active and inactive. Instead, you can write directly to a particular location on the screen by using the SetPort routine to set the drawing area to the desktop. You should either choose an area of the screen not used for any other purpose—such as the upper right corner—or do as the debuggers do and save and restore the previous screen contents using CopyBits.
- Dialog box—In this approach every print statement gets a temporary window. It is one of the easiest to implement, as shown in listing 1 and figure 2. It has the disadvantage of being very distracting for large amounts of debugging information and also causes a large number of additional interactions. These can be minimized by choosing a small window in an unused corner of the screen.

(continued)

When adding debugging code, you also need selectivity. If you display intricately detailed debugging information, the output will be overwhelming. You need a way to turn it on and off, or to select levels or areas of debugging.

One approach is a separate debugging menu that disappears from the finished product. An even easier method is to use a particular combination of keys—for example, command-Option-space—as an on/off toggle.

Choosing Your Instruments

Where print statements fail, or are unlikely to produce results, assembly-level debuggers will be the only way to get answers. They also allow you to track a problem without modifying your program.

There are a number of debuggers available. The most commonly used is MacsBug, Apple's family of line-oriented single-Mac debuggers. The MacsBug variants trade off features in exchange for memory usage.

The MacsBug debuggers are part of the new Macintosh Programmer's Workshop (MPW), the older Macintosh 68000 Development System (MDS), as well as Apple's periodic Software Supplement. They are also included with many third-party compilers and MacNosy. A very limited version is included in the 128K ROM of the Macintosh Plus and the enhanced 512K.

Most systems also include Apple's MacDB, which is the least intrusive and uses the least amount of memory of any debugger. It achieves this by requiring a second Macintosh as a windowing control terminal connected via serial port to the Mac you are debugging on.

Finally, TMON from ICOM Simulations (formerly sold by TMQ Software) is an advanced, single-Mac debugger that supports multiple windows. It includes user extensibility, as well as improved formatting and a number of extensions over MacsBug.

The basic features of all debuggers include displaying and modifying registers, disassembling code, single-stepping, setting breakpoints, and displaying the heap. All allow you to use

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Listing 1: A *windowed analog to debugging print statements; (a) shows the source code of the program to be debugged, and (b) is the input for the* RMaker *(resource compiler) utility program that generates the program's associated resource file.*

(a)

```
#ifdef DEBUG
#define MADEIT(string) madealert(string);
#define ALRT_madeit 9001
#else
#define MADEIT(x)
#endif
    ...
madealert(msg)
char *msg;
{   ParamText(msg,NULL,NULL,NULL);
    NoteAlert(ALRT_madeit,NULL);
}
    ...
MADEIT("out of SetUp")
    ...
MADEIT("into print initialization routine")
```

(b)

```
Type ALRT              ;;Alert template
,9001                  ;;Resource ID
45 125 200 345         ;;top left bottom right
9001
444

Type DITL              ;;Dialog item list
,9001                  ;;Resource ID
2                      ;;2 items in list
button                 ;;button item
120 80 140 140         ;;top left bottom right
OK
staticText Disabled
Made it ^0, Kemosabe! ;;message
```

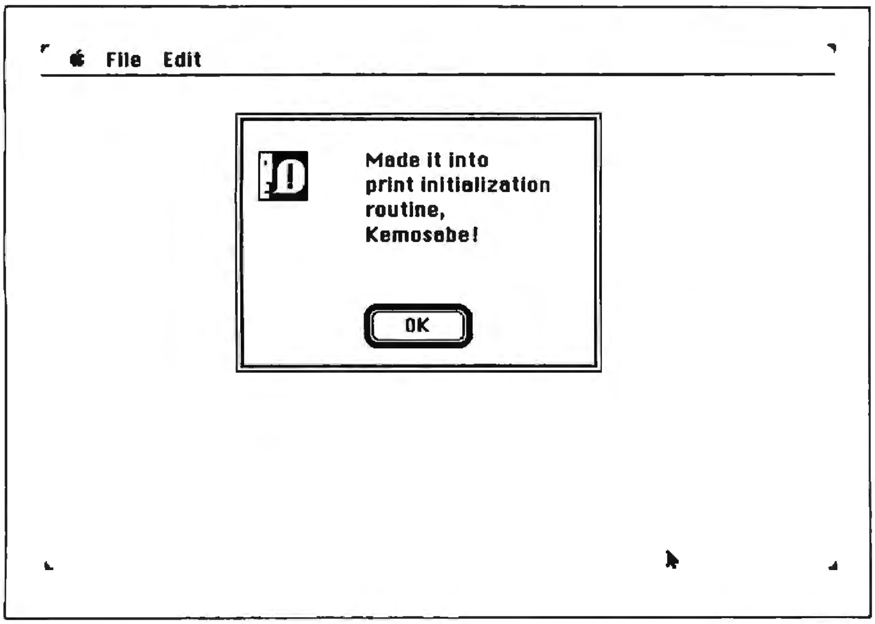

Figure 2: A *debugging dialog box, generated by the program shown in listing 1.*

the interrupt button (the button to the rear on the programmer's switch attachment) to transfer control to the debugger for further commands.

In addition, many have found Mac-Nosy essential for understanding how the Mac toolbox and operating system work, beyond the level described in the documentation. In the end, as any systems programmer will tell you, the code is the documentation.

Opening Up the Patient

When it comes time to break out a machine language debugger, you'll need to have handy an assembly code listing of the failing routine or program. For the purposes of illustration, I'll assume that you are using the MacsBug debugger, whose major commands are summarized in table 1.

Start first at the point where the Macintosh crashes. You can examine the registers (the TD command in MacsBug), memory (DM), and disassemble instructions (IL) to find out where the program failed.

Many compilers allow you to make your routine names available to the debugger. If the compiler you are working with doesn't, the ordering of trap names around the failure should correspond to the same clustering in your source listing. Or you can trace traps (AT) to find the specific ones called immediately prior to failure. For brevity, you can limit the trace to only a numerical range of traps, such as those in the File Manager.

Once you have found the failure point—or if it can't be isolated—you usually want to place a breakpoint just before it. The approaches include

- Using the debugger, set breakpoint (BR) at the entry to particular routines.
- The debugger can be set to stop upon reaching a particular trap (AB).
- If your compiler includes an in-line assembler, you can compile in F-series traps (op codes in the range F000 to FFFF hexadecimal) at key locations in your program to immediately invoke the debugger, as in

```
#ifdef DEBUG
#define USERBRK(i)
```

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```
asm { dc.w 0xF000+i }
. . .
USERBRK(0x20)
```

The availability of 4096 distinct traps allows you to use each breakpoint as an unambiguous sentinel indicating progress within your program. However, on a future 68020-based Macintosh, these op codes will be reserved for 68881 coprocessor instructions, so you would use the _Debugger trap (A9FF hexadecimal).

Once in the general vicinity of the problem, you can use single-stepping (S) to monitor the value of key registers or arguments up to the point of failure. Most of the time you'll want to use the single-step command that steps through traps as one instruction (T). If there are compiled breakpoints in the program, the go command (G) will continue execution until the program reaches the next breakpoint.

Finally, if you want to save your RAM disk, or just avoid rebooting, the ExitToShell trap (ES) will normally place you safely back in the Finder.

Machine language debugging is made much more difficult by those development systems that use "glue routines" to bind your program to ROM traps. In such code, a direct reference to a particular trap won't be in your routine; instead you'll find that your program calls a subroutine that references the trap. Based on experience, I would make this a major consideration in choosing development software for the Macintosh.

Table 1: *The most often used subset of MacsBug commands. The commands with an asterisk are included in the built-in debugger on the Macintosh Plus.*

*DM addr nbytes	Display memory
*SM addr val1 val2	Set memory values
IL addr num	Disassemble num lines at addr
*SM PC 4E71	No-op at current PC location
*An or Dn	Show address or data register n
*{An,Dn} value	Set address or data register n
TD	Display all registers
PC addr	Set program counter
BR addr count	Breakpoint at addr after count
S num	Step number of instructions
T	Single-step past trap
ST addr	Step until PC reaches addr
ES	Exit to shell (Finder)
HD	Formatted heap dump
*G addr	Branch to specified address
*G 40F6D8	Exit to shell (128K ROM)
AB trap1 trap2†	Breakpoint at specified traps
AT trap1 trap2†	Trace specified traps

† If trap1, trap2 omitted, for all traps

Items Discussed

Macintosh 68000 Development System $195
Apple Computer Inc.
205025 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Includes editor, assembler, linker, MacsBug, and MacDB debuggers.

Macintosh Software Supplement ....price varies
Apple Computer Mailing Facility
467 Saratoga Ave., Suite 621
San Jose, CA 95129
(408) 988-6009
Each update can include revisions to development tools (MacsBug, ResEdit) and new or revised chapters of *Inside Macintosh.*

MacNosy...................$75
Jasik Designs
343 Trenton Way
Menlo Park, CA 94025
(415) 322-1386
Includes MacsBug. Be sure to specify version for 64K or 128K ROM.

TMON $100
ICOM Simulations Inc.
626 Wheeling Rd.
Wheeling, IL 60090
(312) 520-4443
You can also request information on the public domain Extended User Area, which includes "Discipline," an extension of TMON that validates arguments on trap calls.

Preventive Medicine

As you may have concluded by now, it is cost-effective to avoid or reduce actual debugging on a system such as the Mac. The previous sections, plus some hands-on debugging of your own, will offer some clues as to what maladies to guard against.

A brief list of remedies includes

• Compiler checking—A high-level language provides tremendous productivity advantages over assembly or low-level languages, customarily at the expense of speed and size. All languages are not created equal and, in particular, compile-time verification of argument parameters is extremely valuable. A compiler that detects a pointer where you should be using a handle can save you hours of hair-pulling. In this regard, Pascal (or Modula-2) with its data-type checking has a marked advantage over C. To remedy this problem for devoted C users, at least one version of the lint interface-checking utility is under development for the Mac.

• Desk checking—This may sound obvious, but if you're treading in a new area of the toolbox, you should verify the interfaces manually by checking that they correspond to definitions in *Inside Macintosh.* (For more information refer to *Macintosh Technical Note #43.*)

• Prototyping—If you're really not sure how a particular manager or routine works, make a simple test. In particular, if you want to pass a null pointer as an argument, and the documentation doesn't explicitly endorse it, test it first. Assuming it works will likely cost you more time in the long run. Also, it's easier to isolate problems in small test cases than if you add the code directly to your program.

• Modular libraries—As Bruce Webster noted in his article "Subroutine Libraries in Pascal" in BYTE's June 1985 Programming Techniques theme issue, "Libraries can be a real lifesaver." Smart programmers always plagiarize themselves: Once you've developed an interface or library you like, use it over and over again.

A library is particularly useful if you are, for example, moving a number of programs from another system to the Mac, or if you wish to maintain a common programming style across several systems. But if your goal is a quality product rather than a hack job, don't attempt to "kludge up" untranslatable idioms.

For example, many file systems use a character style of indicating a directory's file path, such as the "/foo/bar/bas" style of UNIX. However, the Macintosh uses a file definition of

```
struct filedef {
        int vrefnum;
        char fname[255];
        }
```

Some programs bypassed this approved approach and appended the filename to the volume name. These programs broke under Apple's Hierarchical File System (HFS); vrefnum was extended to become a directory identifier, not just a volume identifier.

• Following specifications—If you follow the standardized, documented interfaces provided by large corporations—such as Apple or Microsoft—you will benefit from the company's promises of upward compatibility. However, there are no guarantees what a team of programmers will do with undocumented behavior of the old code, particularly "features" they didn't even know about. The problem with HFS above is one example.

• Anticipating errors—It is tempting when hacking out early code to ignore many error conditions. However, this only guarantees loss of sleep at some later date when an unchecked error condition causes a delayed-failure crash. Certain error conditions—lack of memory or disk space—must always be allowed for, while others—a missing code segment from your program—may be safe to ignore, if you're feeling brave.

SUMMARY

The standard principles of debugging on other systems generally apply to the Mac. Isolating problems through binary searches, collecting symptoms, print statements, desk checking, and good coding practices are all standard techniques that can also be applied within a complex windowing environment. Some approaches require some translation, however, and the intricate suite of toolbox routines presents its own set of unique problems.

Finally, as with other systems, there's no substitute for adequate preparation and painstaking, methodical analysis. While debugging Macintosh programs requires a great deal of skill, once you master the high learning curve, you will be able to recognize common patterns of failure and their solutions. ■

FURTHER READING

Rose, Caroline, ed. *Inside Macintosh*. 3 vols. Reading, MA: Addison-Wesley, 1985. (This is supplemented by *Macintosh Technical Notes*, published bimonthly by Apple.)

Snively, Paul. "Debugging with TMON." *MacTutor*, September 1985.

Snively, Paul. "TMON Revisited." *MacTutor*, July 1986.

Taylor, Tom. "MacsBug Debugs Modula Code." *MacTutor*, December 1985.

Webster, Bruce. "Subroutine Libraries in Pascal." BYTE, June 1985.

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ACKNOWLEDGMENTS

I'd like to thank Eric Zocher of Silicon Beach Software and Darin Adler of ICOM Simulations for sharing their experiences in Macintosh development.

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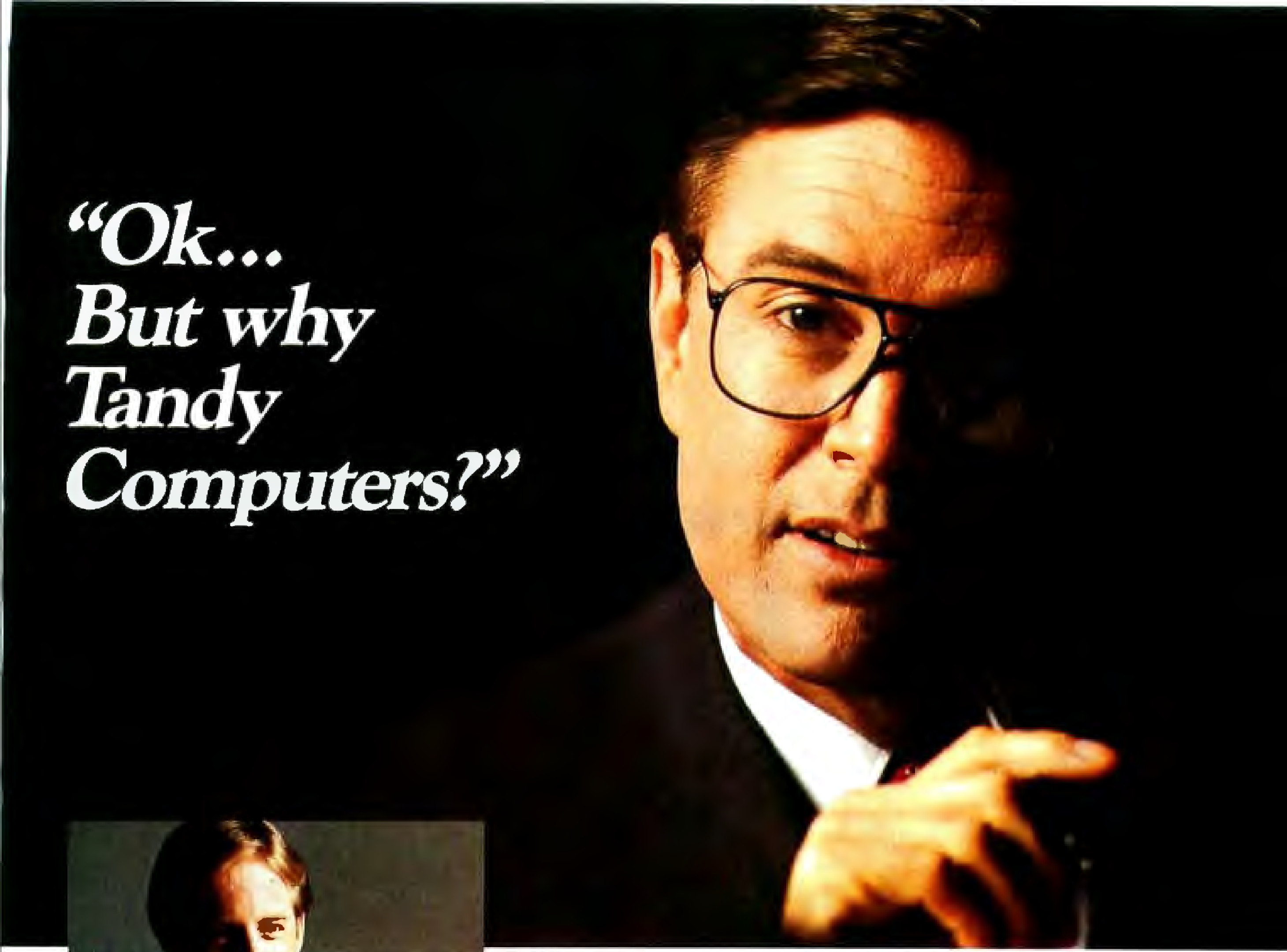


Tandy 3000 HD

Tandy 3000 HL

Tandy 1000 SX

BY JOHN R. FANCHI

LOCAL EFFECTS OF NUCLEAR WEAPONS

Calculate the impact of atomic blasts on your surroundings

The prospect of nuclear war is and will continue to be a major source of international concern. Yet, despite the daily discussion of nuclear issues, few people have a working knowledge of the effects of nuclear weapons. Fortunately, acquiring a working knowledge does not require specialized skills. Models are a particularly valuable tool for understanding this complex subject. References 1 through 5 describe the effects of nuclear weapons in a fairly nontechnical manner.

We'll look at three major topics: the basic effects of nuclear detonations, the distribution of nuclear fallout, and the climatic effects of pollutants dispersed in the atmosphere after a nuclear exchange. The models used to describe the latter two effects are relatively simple, yet they highlight important physical effects while providing reasonable quantitative estimates.

Each model is presented from the perspective of an observer at a specified location in relation to a nuclear detonation. This perspective emphasizes the local aspects of the effects.

I have provided references for readers interested in historical reviews of the nuclear age (references 3, 7, and 8); current policy concerns (references 9 and 10); and advice on how to survive a nuclear confrontation from a governmental (reference 11) or an individual (reference 12) perspective. The references represent the most prominent views expressed publicly today.

SUMMARY OF NUCLEAR DETONATION EFFECTS

As noted earlier, I will discuss the effects of nuclear detonations from the

(continued)

John R. Fanchi (1078 East Otero Ave., Littleton, CO 80122) is a research scientist in the oil industry. He has a Ph.D. in physics from the University of Houston.

ILLUSTRATED BY MARY ANN SMITH

Electromagnetic pulse can short-circuit electrical equipment.

perspective of an observer at a given distance D from a blast with a yield Y. Yield is the total effective energy released by a nuclear explosion. The observer's distance from the blast is known as the *slant range* and will be expressed in units of miles in subsequent calculations. The yield Y is expressed in units of megatons. Yield raised to the ⅔ power gives equivalent megatons (EMT). EMT is useful because it is directly proportional to the area of blast damage caused by a nuclear detonation (references 1 and 2). It is worth noting here that 400 EMT of retaliatory yield is considered sufficient to achieve "mutual assured destruction." As of 1982 the U.S. and the U.S.S.R. had warheads capable of delivering approximately 4000 and 6000 EMT. Typical intercontinental ballistic missiles have yields of 9 and 20 megatons for the Titan II (U.S.) and the SS-18 (U.S.S.R.). Submarine-launched ballistic missiles have yields on the order of 0.05 to 1 megaton (reference 2).

Four important effects of a nuclear detonation are dependent on D and Y. They are overpressure, thermal flux, electromagnetic pulse (EMP), and radiation dosage. *Overpressure* is the increase in ambient pressure caused by the detonation. *Thermal flux* is the total thermal energy propagating outward from the detonation point per unit cross-sectional area transverse to the direction of propagation. The *EMP* calculation estimates the magnitude of a very strong but short-duration electrical field generated by atmospheric relativistic electrons. The electrons attain relativistic energies as a result of Compton scattering with gamma rays. Gamma rays are emitted by decaying excited states of fission fragments following an airburst. Perhaps the most important effect of the EMP is its ability to short-circuit electrical equipment, especially solid-state devices. Subsequent estimates of these effects require the height h at which the detonation occurs, the fraction f of explosive energy appearing as thermal (heat) energy in the nuclear fireball, and an atmospheric transmission factor T_A that accounts for the absorption of thermal energy in the atmosphere.

Airbursts, such as the detonations over Japan in World War II, can be hundreds or thousands of feet in the air. An airburst is defined as a burst below 100,000 feet (sections 1.31 through 1.38 of reference 13) but high enough that the fireball at maximum luminosity does not touch the earth's surface. One important difference between groundbursts and airbursts is the relative fallout generated by each. Groundbursts generate the most fallout, or radioactive dust. As the height of the blast increases above the surface of the earth, the suction of dust and debris from the ground into the atmosphere is reduced with a corresponding decline in fallout. Once h is specified, a thermal energy fraction f is estimated. The variable f ranges from 0.15 (groundburst) to 0.35 (airburst). The fractional atmospheric transmission factor T_A depends on the wide variability of weather conditions. It is a value between 0 and 1, though it is usually on the order of 0.5.

Four important blast characteristics are now computed (references 1 and 5).

Thermal flux (calories/sq cm):

$$Q = 3000\, fYT_A/D^2. \tag{1}$$

Blast overpressure (psia):

$$P = 22.4\, Z^3 + 15.8\, Z^{1.5}, \tag{2}$$

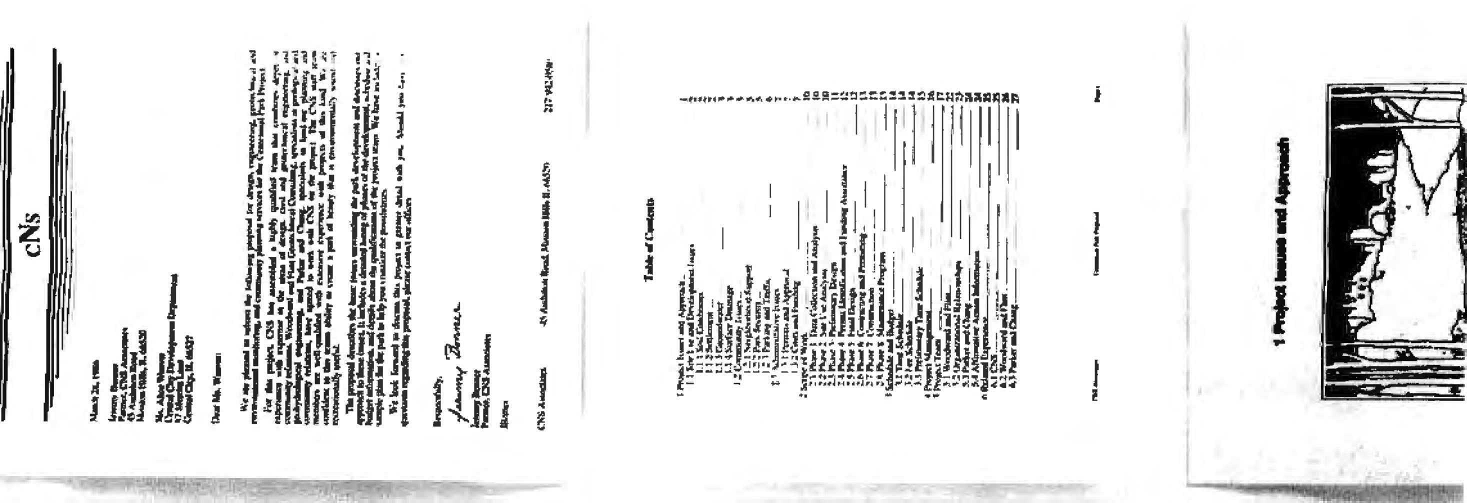
where

$$Z = Y^{1/3} / D. \tag{3}$$

Electromagnetic pulse range (miles):

$$\text{EMP} = (2Rh/5280)^{0.5}, \tag{4}$$

(continued)



Listing 1: *The program* BLAST.BAS.

```
10 REM
20 REM
30 REM NUCLEAR BLAST CALCULATION
40 REM (C) JOHN R. FANCHI, JUNE 1985
50 REM MICROSOFT BASIC FOR CP/M-80 OPERATING SYSTEM
60 REM PART OF THIS CODE IS EXCERPTED FROM J.R. FANCHI'S
70 REM ADVENTURE SIMULATION GAME "NUCLEAR SURVIVAL"
80 REM CHR$(26) CLEARS THE SCREEN
90 DIM ANSER$(2)
100 PRINT CHR$(26)
110 PRINT TAB(20); "*** NUCLEAR BLAST CALCULATION ***"
120 PRINT
130 PRINT TAB(21);"(C) John R. Fanchi, JUNE 1985"
140 PRINT
150 PRINT "The calculations performed here are based on information published"
160 PRINT "by the American Institute of Physics."
170 PRINT
180 INPUT "HIT CARRIAGE RETURN WHEN YOU ARE READY TO PROCEED";ICAR$
190 PRINT CHR$(26)
200 PRINT
210 INPUT "Specify your slant range (distance) from the blast in miles";D
220 PRINT
230 REM ............................DETERMINE WEAPON YIELD (Y)
240 PRINT "Specify the yield of the blast in megatons.  Typical values range"
250 INPUT "from 0.8 to 20 megatons";Y
260 REM ................................DETERMINE BLAST HEIGHT
270 PRINT
280 INPUT "Specify the height of the blast in feet";H
290 PRINT
300 PRINT "Specify the thermal energy fraction.  This is the fraction of heat"
310 PRINT "energy in the nuclear fireball.  It should be between 0 and 1.  A"
320 INPUT "typical value is 0.35";TEF
330 PRINT
340 REM ............................DETERMINE TRANSMISSION FACTOR
350 PRINT "Specify the atmospheric transmission factor.  It should be between"
360 INPUT "0 (very cloudy day) and 1 (perfectly clear day)"; TAU
370 PRINT
380 REM ..............................CALC BLAST EFFECTS
```

(continued)

```
390 REM THERMAL FLUX Q
400    Q=3000*TEF*TAU*Y/(D*D)
410 REM BLAST OVERPRESSURE P
420    Z=(Y^(.333))/D
430    P=22.4*(Z^3) + 15.8*(Z^(1.5))
440 REM EMP RANGE
450    EMP=SQR(2*H*3963/5280)
460 REM RADIATION DOSAGE REM
470    REMS=250*1000*Y/(16*3.1416*D*D)
480 PRINT
490 PRINT "The NUCLEAR BLAST had the following effects:"
500 PRINT
510 PRINT TAB(10);"THERMAL FLUX (cal/sq cm)";TAB(50);Q
520 PRINT TAB(10);"OVERPRESSURE (lb/sq in)";TAB(50);P
530 PRINT TAB(10);"EMP RANGE (miles)";TAB(50);EMP
540 PRINT TAB(10);"RADIATION DOSAGE (rems)";TAB(50);REMS
550 PRINT
560 INPUT "HIT CARRIAGE RETURN WHEN YOU ARE READY TO PROCEED";ICAR$
570 PRINT CHR$(26)
580 PRINT
590 REM ...............................OVERPRESSURE EFFECTS
600 IF P<20 THEN 640
610 PRINT "Overpressure has caused winds in excess of 500 miles per hour."
620 PRINT "Even multi-story reinforced concrete buildings are leveled. "
630 GOTO 820
640 REM
650 IF P<10 THEN 700
660 PRINT "Overpressure has caused winds in excess of 300 miles per hour."
670 PRINT "Most factories and commercial buildings are leveled, as are small"
680 PRINT "wood and brick residences."
690 GOTO 820
700 REM
710 IF P<5 THEN 750
720 PRINT "Overpressure has caused winds in excess of 160 miles per hour."
730 PRINT "Unreinforced brick and wood houses are leveled. "
740 GOTO 820
750 REM
760 IF P<2 THEN 790
770 PRINT "Overpressure has caused winds in excess of 70 miles per hour."
780 GOTO 820
790 REM
```

```
800 PRINT "Overpressure has not had a significant effect on wind conditions"
810 PRINT "or the structures of buildings."
820 REM
830 PRINT
840 REM ..............................THERMAL EFFECT
850   IF Q<10 THEN 880
860   PRINT "Thermal flux has burned you to a crisp."
870   GOTO 980
880 REM
890 IF Q<5 THEN 920
900   PRINT "You have suffered third degree burns because of THERMAL FLUX."
910   GOTO 980
920 REM
930 IF Q<1 THEN 960
940   PRINT "You have suffered second degree burns because of THERMAL FLUX."
950   GOTO 980
960 REM
970   PRINT "THERMAL FLUX has added to your tan. "
980 PRINT
990 REM ..............................RADIATION EFFECTS PRINT
1000 PRINT
1010 IF REMS<5000 THEN 1050
1020   PRINT "You are experiencing convulsions, tremors and ataxia because"
1030   PRINT "of RADIATION exposure.  No treatment will help you."
1040   GOTO 1330
1050 REM
1060 IF REMS<1000 THEN 1120
1070    PRINT "You have diarrhea, fever and a disturbance of your body "
1080    PRINT "chemistry because of RADIATION exposure.  Treatment may"
1090    PRINT "alleviate pain, but it will not save your life.  You have"
1100    PRINT "less than 2 weeks to live. "
1110    GOTO 1330
1120 REM
1130 IF REMS<600 THEN 1190
1140    PRINT "You have very severe leukopenia and internal bleeding."
1150    PRINT "You have also developed ulcers and infection is likely because"
1160    PRINT "of RADIATION exposure.  You need hospitalization but none is"
1170    PRINT "available, therefore you have less than a month to live."
1180    GOTO 1330
1190 REM
```

(continued)

```
1200 IF REMS<200 THEN 1250
1210    PRINT "Your symptoms range from leukopenia to hair loss because of"
1220    PRINT "RADIATION exposure.  Hospitalization is required and is"
1230    PRINT "available to you because you have a reasonable chance to live."
1240    GOTO 1330
1250 REM
1260 IF REMS<100 THEN 1310
1270    PRINT "RADIATION exposure has made you sick--vomiting, headache, some"
1280    PRINT "loss of white blood cells and dizziness.  This is good.  You"
1290    PRINT "will completely recover."
1300    GOTO 1330
1310 REM
1320    PRINT "You have survived RADIATION exposure with NO effects."
1330 PRINT
1340 REM ..............................EMP EFFECT
1350 IF D>EMP THEN 1410
1360 PRINT "Your distance from the blast is within the range of the "
1370 PRINT "electromagnetic pulse (EMP).  The EMP is capable of burning"
1380 PRINT "out electrical instruments."
1390 PRINT
1400 GOTO 1440
1410 REM
1420 PRINT "You are outside the range of the electromagnetic pulse (EMP)."
1430 PRINT
1440 PRINT
1450 INPUT "Do you wish to try again (Y/N)";IANS$
1460 PRINT
1470 IF IANS$="Y" THEN 100
1480 SYSTEM
1490 END
```

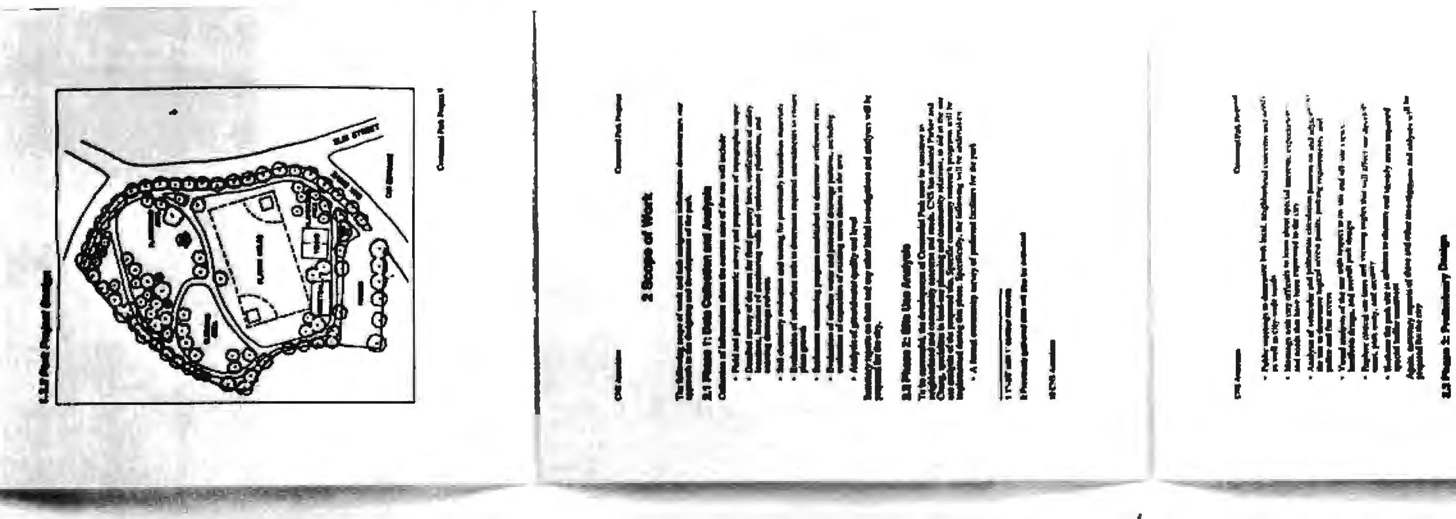
where R is the radius of the earth in miles.

Radiation dosage (rems):

$$REMS = 250\,(1000Y)/(16\pi D^2), \quad (5)$$

where I have assumed that a 1-kiloton fission bomb has delivered about 250 rads of neutrons at a distance of 0.5 mile and that 1 rad is approximately equal to 1 rem. The latter assumption implies a relative biological effectiveness of unity (reference 1).

A few comments should be made about the limitations of equations 1 through 5. Thermal flux is most deadly if you are in direct view of the detonation. Virtually any shelter can effectively shield a person from thermal flux. Equation 1 does not take into account firestorms resulting from the thermal flux, which can also be lethal. The overpressure estimate in



equation 2 is reasonable for surface bursts but will underestimate airburst overpressures. It is sufficient for conveying the concepts of shock wave and atmospheric pressure changes (wind) as a result of a nuclear detonation. Detailed airburst overpressure calculations are discussed in sections 3.64 through 3.78 of reference 13. The EMP range estimated in equation 4 is the maximum distance that the EMP can reach. Electrical equipment damage is greatest near the detonation point and declines as you approach the edge of the EMP range. A detailed discussion of the destructive potential of the EMP effect is given in sections 11.27 through 11.59 of reference 13. Estimating radiation dosage, particularly biologically damaging radiation dosage, is the most complicated and uncertain of the nuclear detonation estimates. Equation 5 is a simple estimate. It does not include air-secondary gamma radiation or gamma radiation from fission fragments. The basic concept—that radiation is released in lethal amounts—is adequately represented.

Listing 1, BLAST.BAS, is a short program that calculates Q, P, and REMS for a nuclear detonation. It is written in Microsoft BASIC for the CP/M-80 operating system. [*Editor's note: These programs will run on most machines that use the Microsoft* BASIC *interpreter.*] Once Q, P, and REMS are known, an interpretation of their effect on physical and biological systems is made using the tables provided by Sartori in reference 1. Several numerical examples are presented in table 1.

Table 1: *Example outputs from program* BLAST.BAS.

Input Values			Calculated Values			
Height (ft)	Yield (Mt)	Slant range (mi)	Thermal flux (cal/cm²)	Over-pressure (psia)	EMP range (mi)	Radiation dosage (rems)
0	1	1	525.0	38.0	0	4974
0	1	10	5.3	0.5	0	50
0	1	20	1.3	0.2	0	12
0	20	1	10500.0	517.0	0	99472
0	20	10	105.0	2.7	0	995
0	20	20	26.0	0.8	0	249
1000	1	1	525.0	38.0	39	4974
1000	20	20	26.0	0.8	39	249

For all examples f = 0.35 and T_A = 0.5.

NUCLEAR FALLOUT

Nuclear fallout is the deposition of radioactive dust and debris carried into the atmosphere as a result of a nuclear detonation. The point of deposition of the fallout depends on climatic conditions such as ambient air temperature and pressure and wind conditions.

Let's look at a simple model of the spatiotemporal distribution of fallout. The model assumes that the distribution of fallout proceeds as a random walk (or Brownian motion) distribution (reference 14). Although many other factors play a role in determining fallout distribution (reference 15), the random walk model is a reasonable method for estimating the time it takes fallout to reach a particular location. A Gaussian distribution is the solution of the convection-diffusion equation representing the random walk problem. I make the additional assumption that gravity minimizes vertical movement of radioactive par-

(continued)

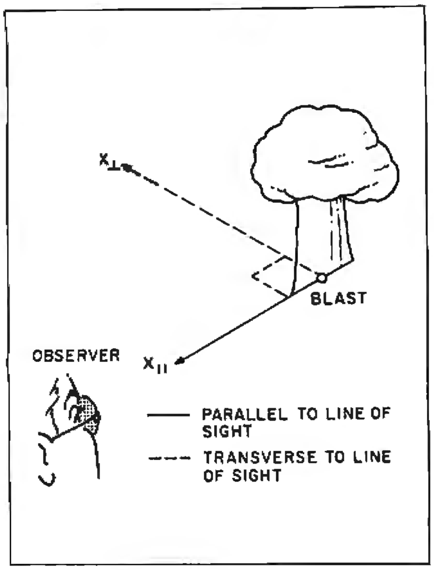


Figure 1: *Coordinate system for fallout calculation.*

ticulates so that fallout is distributed primarily in the horizontal plane. With these assumptions, and separating the wind velocity into two components aligned parallel and transverse to the observer's line of sight (figure 1), I obtain a fallout distribution of the form seen in figure 2, where $v_\parallel$, $v_\perp$ and $D_\parallel$, $D_\perp$ are the velocity and dispersion of the radioactive particulates, respectively. The velocity is typically wind velocity, and the constant U_0 is defined as the maximum

$$U(x_\parallel, x_\perp, t) = \frac{U_0 x'_\parallel x'_\perp}{\sqrt{D_\parallel D_\perp t^2}}\, e^{\left[-\frac{(x_\parallel - v_\parallel t)^2}{4D_\parallel t} - \frac{(x_\perp - v_\perp t)^2}{4D_\perp t}\right]}$$

Figure 2: *Fallout distribution equation.*

$$U(D,0,t) = U_0 \frac{t_{max}}{t}\left\{ e^{\left[\frac{(D - v_\parallel t_{max})^2}{4D_\parallel t_{max}} - \frac{(D - v_\perp t_{max})^2}{4D_\parallel t}\right]} \times e^{[(v_\perp^2 t_{max} - v_\perp^2 t)/4D_\perp]}\right\}$$

Figure 3: *Fallout distribution equation as a function of time.*

value of the fallout at the observer's location. A value of the constant $x'_\parallel$ $x'_\perp$ is fixed by the condition

$$U\,(x_\parallel^{obs},\ x_\perp^{obs},\ t_{max}) = U_0\,. \qquad (6)$$

The coordinates $(x_\parallel^{obs},\ x_\perp^{obs})$ are the observer's coordinates $(D,0)$, and t_{max} is the time when $U(x_\parallel^{obs},\ x_\perp^{obs},\ t)$ is a maximum. The maximum is determined by setting the first time derivative of U to 0 and solving for t. The result is

$$t_{max} = (1\,/\,2\gamma)\ \{1 + [1 + 4(D^2/4D_\parallel)\gamma]^{1/2}\}. \qquad (7)$$

where γ is given by

$$\gamma = (v_\parallel^2\,/\,4D_\parallel) + (v_\perp^2\,/\,4D_\perp). \qquad (8)$$

Collecting the above results yields the

(continued)

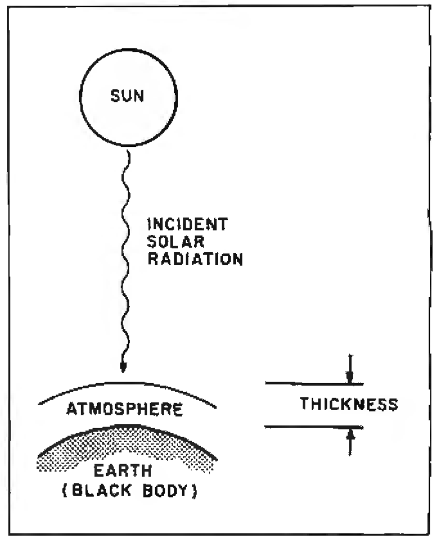


Figure 4: A *simple temperature model.*

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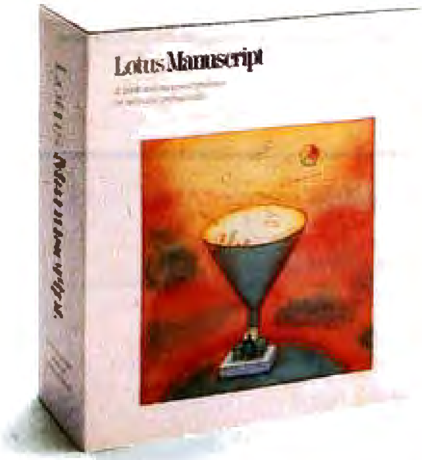

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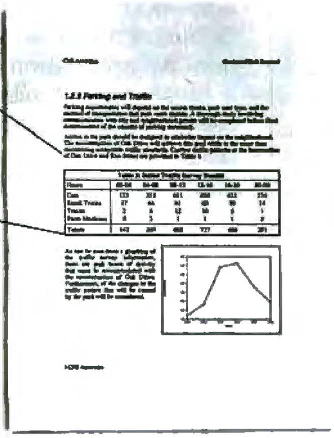

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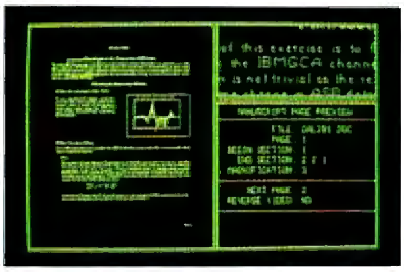

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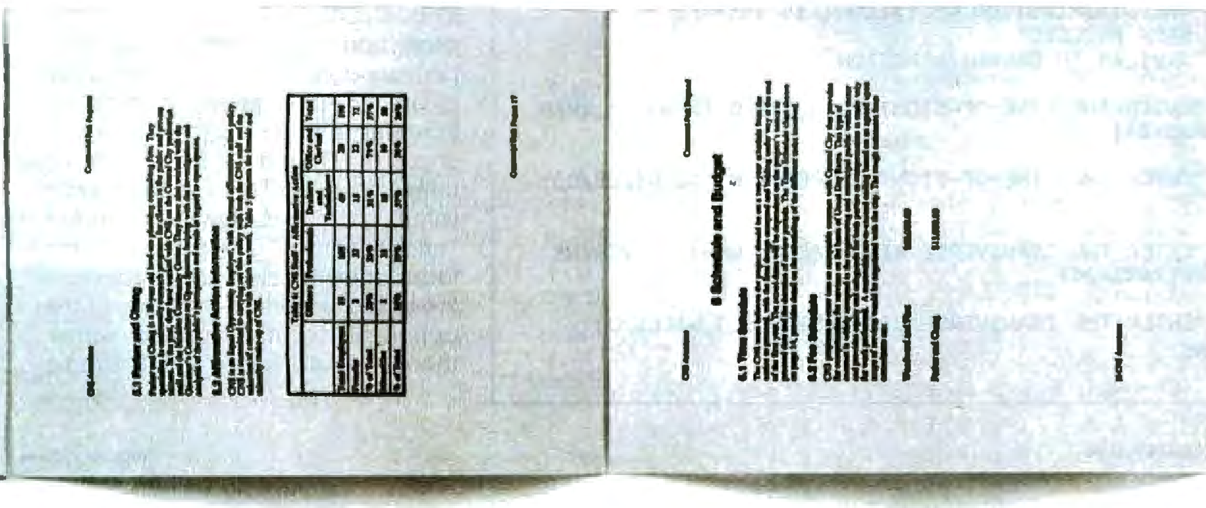

Table 2: *Temporal dependence of fallout as calculated by program* FALOUT.BAS.

Hours	Normalized distribution
0.623	0.001
0.637	0.011
0.651	0.062
0.665	0.223
0.680	0.535
0.694	0.876
0.708	1.000
0.722	0.814
0.736	0.481
0.750	0.211
0.765	0.069
0.779	0.017
0.792	0.003

Parameters:

Y = 1 Mt	V_{line} = 10 mph	D_{line} = 2 sq mi/day
D = 10 miles	$V_{transverse} = V_{line}$	$D_{transverse} = D_{line}$

Listing 2: *The program* FALOUT.BAS.

```
30 REM FALOUT - A NUCLEAR FALLOUT CALC PROGRAM
40 REM (C) JOHN R. FANCHI, JULY 1985
50 REM MICROSOFT BASIC ON CP/M-80 OPERATING SYSTEM
60 REM CHR$(26) CLEARS SCREEN
70 PRINT CHR$(26)
80 PRINT " FALOUT - ESTIMATING THE DISTRIBUTION OF NUCLEAR
   FALLOUT"
90 PRINT
100 PRINT "(C) J.R. FANCHI, JULY 1985
110 PRINT: PRINT: PRINT
120 PRINT "ESTIMATING RADIATION DOSAGE"
130 PRINT
140 INPUT "ENTER THE YIELD OF THE NUCLEAR BLAST IN MEGATONS:
    ", Y
150 PRINT
160 INPUT "ENTER YOUR DISTANCE FROM THE BLAST IN MILES: ", D
170 PRINT
180 REMS=250*(1000*Y)/(16*3.1416*D*D)
190 PRINT "ESTIMATED RADIATION DOSAGE IN REMS: ",REMS
200 PRINT
210 PRINT: PRINT: PRINT
220 PRINT "ESTIMATING FALLOUT DISTRIBUTION"
230 PRINT
240 PRINT "THE DISTRIBUTION OF FALLOUT IS TREATED AS A
    RANDOM WALK PROCESS"
250 PRINT "SIMILAR TO BROWNIAN MOTION."
260 PRINT
270 INPUT "ENTER THE LINE-OF-SIGHT WIND SPEED (MPH): ",VPAR
280 VPAR=VPAR*24!
290 PRINT
300 INPUT "ENTER THE LINE-OF-SIGHT DISPERSION (SQ MILES/D):
    ",DPAR
310 PRINT
320 INPUT "ENTER THE TRANSVERSE WIND SPEED (MPH): ",VTRANS
330 VTRANS=VTRANS*24!
340 PRINT
350 INPUT "ENTER THE TRANSVERSE DISPERSION (SQ MILES/D):
    ",DTRANS
```

(continued)

expression for the fallout distribution as a function of time at the observer's location, as seen in figure 3. This equation represents an instantaneous distribution of fallout. Fallout effects on biological material are cumulative. If you want an estimate of radioactive dosage at the observer's location, integrate the equation in figure 3 with respect to time.

A major source of uncertainty in using this or any other fallout model is the determination of the constant U_0. This constant depends on the number and type of nuclear detonations. A superposition principle can be applied for multiple blasts since the convection-dispersion equation is a linear partial differential equation. For my purpose here, it is sufficient to evaluate the ratio $U(D,0,t)/U_0$ for a single blast. The equation in figure 3 specifies the spatiotemporal fallout distribution and can be used to estimate both the time and duration of fallout for a specified observer's location. An application of this equation is presented in table 2. In that example the peak fallout from a 1-megaton blast reaches an observer 10 miles away in about 40 minutes. Listing 2, FALOUT.BAS, is a program that performs the fallout distribution calculation. It is written in Microsoft BASIC for the CP/M-80 operating system. Additional information about fallout is presented in reference 13. [*Editor's note:* BLAST.BAS *and* FALOUT.BAS *are available on disk, in print, and on* BIX. *See the insert card following page* 320 *for details. Listings are also available on* BYTE*net; see page* 4.]

NUCLEAR WINTER

One of the more controversial issues to be debated in recent years is the prediction of significant climatic temperature declines resulting from an increase of atmospheric particulates following a nuclear exchange (references 16, 17, and 18). The predicted temperature decline would generate wintry conditions, hence the phrase "nuclear winter." The essence of the ideas upon which these predictions are based, as well as the ideas of the opponents of the nuclear winter theory, is laid bare by the simple

(continued)

```
360 PRINT
370 REM
380 PRINT "RADIATION DOSAGE AT YOUR LOCATION AS A FUNCTION
    OF TIME"
390 PRINT "DAYS","REMS","NORM","HRS"
400 REM
410 ALPHA=D*D/(4*DPAR)
420 BETA=-2*D*VPAR/(4*DPAR)
430 GAMMA=VPAR*VPAR/(4*DPAR) + VTRANS*VTRANS/(4*DTRANS)
440 TFAC=SQR(1+4*ALPHA*GAMMA)
450 TYMMAX=(1+TFAC)/(2*GAMMA)
460 FACMAX=((D-VPAR*TYMMAX)^2)/(4*DPAR*TYMMAX)
470 FACMAX=FACMAX+VTRANS*VTRANS*TYMMAX/(4*DTRANS)
480 FOR I=1 TO 20 STEP 1
490 TYM=TYMMAX*(1-.02*(10-I))
500 FACPAR=0! : FACPER=0!
510 DISPAR=D-VPAR*TYM
520 DISPER=VTRANS*TYM
530 FACPAR=DISPAR*DISPAR/(4!*DPAR*TYM)
540 IF DTRANS<>0! THEN FACPER=DISPER*DISPER/(4!*DTRANS*TYM)
550 FACTOR=FACPAR+FACPER
560 COEF=TYMMAX/TYM
570 EFFREM=REMS*COEF*EXP(FACMAX-FACTOR)
580 NORM=EFFREM/REMS
590 TYMHRS=TYM*24
600 PRINT TYM,EFFREM,NORM,TYMHRS
610 NEXT I
620 END
```

Table 3: *Estimate of optical depth.*

Conditions	Temperature	Exponential factor
Sunny day	100°F (311°K)	0.648
Cloudy day	80°F (300°K)	0.560

Parameters:
A = 0.39 ϵ = 1.00

climatic temperature model depicted in figure 4. It consists of an incident electromagnetic energy source (the sun), a single absorbing layer of material (the atmosphere), and a black body (the earth). The amount of energy reaching the surface of the earth is the amount of solar energy transmitted (not absorbed or reflected) by the atmosphere. This transmitted energy is assumed to be responsible for the temperature of the earth's surface. Geothermal sources are neglected in the present simple model. Given these assumptions and performing an energy balance at the earth's surface yields

$$I_0 \, \epsilon \, e^{(-\delta x)} = \sigma \, T^4, \qquad (10)$$

where I_0 is incident solar radiation, ϵ is emissivity (or absorptivity by Kirchhoff's radiation law), δ is optical depth, x is the atmospheric thickness, σ is Boltzmann's constant, and T is absolute temperature of the earth's surface. Stefan's law—an exponential absorption law (references 19 and 20)—and an emissivity of 1 for a black body were used to derive equation 10. Solving equation 10 for surface temperature yields

$$T = [I_0\epsilon/\sigma]^{1/4} \, e^{[-\delta x/4]}. \qquad (11)$$

The incident solar radiation is a function of the solar constant I_s and the albedo A, which is the fraction of solar radiation reflected by the atmosphere (reference 19):

$$I_0 = I_s(1-A). \qquad (12)$$

Optical depth depends on weather conditions. An estimate of the exponential factor can be easily obtained by rewriting equation 10 in the form

$$e^{(-\delta x)} = [\sigma T^4] / [I_s(1-A)\epsilon]. \qquad (13)$$

Values of the constants in equation 13 are

I_s = 1340 watts/m² – °K⁴
σ = 5.67 × 10⁻⁸ watts/m² – °K⁴
ϵ = 1.0 for a black body,

and

A = 0.39 (reference 19).

In these units, T must be in degrees Kelvin. Substituting these constant values into equation 13 and solving for different values of T corresponding to different weather conditions yields estimates of the exponential factor. Table 3 presents two examples. These results are comparable to those reported in reference 16.

Surface temperature estimates are obtained by substituting the exponential decay values back into equation 12. Expressions for the temperatures in degrees Fahrenheit for a sunny day and a cloudy day are given in equations 14 and 15, respectively:

$$T_s = (173.6\ ^\circ F)[(1-A)\epsilon]^{1/4}. \qquad (14)$$
$$T_c = (150.9\ ^\circ F)[(1-A)\epsilon]^{1/4}. \qquad (15)$$

In the nuclear winter scenario, the factor $(1-A)\epsilon$ is presumed to get smaller because of increased reflection of solar radiation resulting from additional particulates in the atmosphere (reference 16). Opponents of the nuclear winter scenario argue that the emissivity is a function of electromagnetic wavelength. As a consequence, the greenhouse effect may tend to increase emissivity and the surface temperature of the earth would not change significantly (reference 17). Insufficient information is presently available for knowing which scenario is more likely. Efforts are underway to resolve the controversy (reference 18). ■

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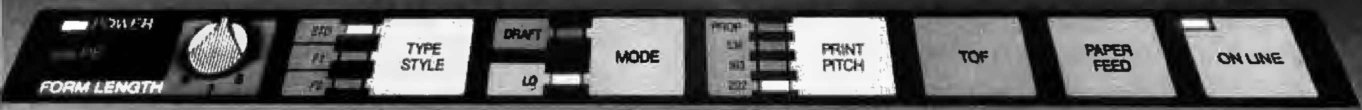

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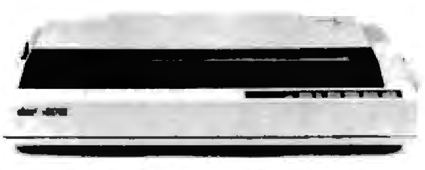

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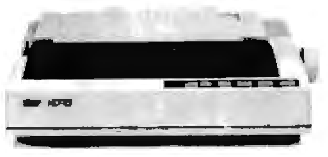

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Graphics Algorithms

THE WORD GRAPHICS, derived from the Greek *graphikos*, to write, can be loosely defined as the process of representing a three-dimensional entity on a two-dimensional surface using mathematical rules of projection. The latest generation of personal computers, such as the Amiga, Atari, Macintosh, and advanced workstations, all emphasize the use of graphics. Business, engineering, medicine, and the arts have all reaped benefits from advances in the art of computer-generated images.

Programmers are continually searching for better methods, or algorithms, for representing these three-dimensional entities on computer displays. The quest for more speed, animation, and better color and realism in computer-generated graphics continues unabated.

Our December Theme articles present some interesting and innovative algorithms involving a wide range of applications. Gordon Hughes's "Henon Mapping with Pascal" demonstrates how to map complex mathematical functions that describe the behavior of dynamic systems such as asteroids, satellites, and charged particles.

The use of graphics does not always have to serve a specific application, however. We'll explore the domain of purely free-form recreational graphics. In "Abstract Mathematical Art," Kenneth E. Perry uses a BASIC program to produce cellular automata, the mathematical relatives of the Game of Life, and Peter B. Schroeder's "Plotting the Mandelbrot Set" examines the fractal geometry of nature in stunning displays on the Amiga personal computer.

The advent of high-performance, dedicated graphics microprocessor chips will provide the thrust for the next generation of graphics-oriented personal computers. Carrell R. Killebrew Jr. provides an inside look at the Texas Instruments TMS34010 Graphics System Processor. In the very near future the new generation of graphics engines will endow desktop machines with capabilities previously limited to large mainframe computers.

Engineers and scientists have a longstanding interest in plotting mathematical equations in three dimensions. "Graphing Quadric Surfaces" by George Haroney includes short BASIC routines that generate three-dimensional plots of equations in multiple colors. Steve Enns's "Free-Form Curves on Your Micro" explains how your personal computer can produce Bézier and B-spline curves that are normally confined to CAD/CAM and other high-end design applications.

All but one of the Theme articles include source code so you can experiment with these algorithms on your own personal computer and experience firsthand the fascination of computer graphics.

—Charles Weston, Technical Editor

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HENON MAPPING WITH PASCAL

BY GORDON HUGHES

A window on the world's endless complexity

IN 1968, MICHEL HENON of the Institute for Astrophysics in Paris proposed a simple quadratic mapping of the plane as a model for the study of dynamical systems such as the motion of asteroids, satellites, or charged particles in an accelerator. Henon's mapping (see the text box "Creating a Henon Mapping" on page 170) is based on George Birkhoff's discovery in 1917 that you can reduce the study of conservative systems with two degrees of freedom to the study of area-preserving mappings of the plane. Thus, Henon set out to find an area-preserving mapping that was simple in nature but retained all the characteristics of more complicated mappings.

Although the mapping Henon proposed is easy to describe and program, it yields results of great complexity. Since Henon mappings simulate the behavior of physical systems, they indicate that many such systems are more complex than previously imagined. Mathematicians and physicists are only beginning to understand the nature of this complexity and what it says about physical systems such as the asteroid belt. In a series of results during the years 1954 to 1963, mathematicians A. N. Kolmogorov, V. I. Arnold, and J. Moser provided a partial explanation for the strange behavior of such systems. These results are now known as the KAM theorem. It is an important theorem in modern physics and has aroused a great deal of interest.

WHAT IS THE KAM THEOREM?

The KAM theorem explains mathematically what happens when a small external force disturbs a stable dynamical system, such as a satellite in orbit around Earth. One such disturbance that satellites regularly undergo is the uneven pull of gravity due to Earth's bulge at the equator. For the planets and the asteroids orbiting the sun, the chief disruptive force is the pull of Jupiter. It causes a perturbation in their orbits so that the orbits are not precisely elliptical. The question that the KAM theorem addresses is whether these slight irregularities have long-term effects leading to eventual instability.

The theorem shows that under small disturbances a stable system undergoes changes but remains stable except for microscopically small bands of potential instability corresponding to "resonances" between the original system and the disturbance. With an asteroid disturbed by Jupiter, such a resonance will occur if the ratio of their periods is a rational number: For example, a 2/5 resonance occurs if two orbits by Jupiter take the same amount of time as five orbits of the asteroid. The KAM theorem proves that as long as the disturbances remain small the relative size of these resonance bands is insignificant and stability is assured.

Figure 1 is a Henon mapping that simulates a system undergoing successively larger disturbances. The inner curves represent a system's reaction to small disturbances and show that the system is altered slightly but remains stable. (The microscopic resonance bands are much too small to be visible in this scale.)

However, if the disturbance in-

(continued)

Gordon Hughes is a professor of mathematics at California State University. He worked as an engineer in the early Polaris program. He has a B.A. in physics from Brown University and a Ph.D. in mathematics from the University of California. He can be reached at the Department of Mathematics, California State University, Chico, CA 95926.

creases in magnitude past a certain threshold value, some of the resonance bands will suddenly widen. In figure 1, for example, the first noticeable widening is the resonance band with six "islands," indicating a 1/6 resonance. An asteroid with a period 1/6 that of Jupiter would find itself on such a resonance band.

With even higher disturbances, the resonance bands might dominate the system's behavior, as indicated by the outer band of seven large islands. The scattered dots around these islands indicate areas of instability. Similar areas exist between the islands of each resonance band. An asteroid caught in one of these regions could experience erratic behavior and even be thrown from its orbit, as indicated by the faint dots escaping around figure 1. Such resonances are believed to cause the Kirkwood gaps in the asteroid belt.

Scientists have known for some time that resonances between two interacting forces can lead to instability in the form of erratic or extreme behavior. In electrical circuits, such resonances are sometimes exploited to amplify selected signals. But the KAM theorem shows that, at least for small interactions, the resonances don't lead to abrupt changes in behavior. The system "stretches" smoothly and doesn't break.

EXTENDING THE KAM THEOREM

Although the KAM theorem is a landmark result in the study of stability, it is concerned entirely with very small disturbances. Thus, it doesn't address the question of the sudden widening of the bands, nor does it attempt to explain the exact nature of the resonance bands. The KAM authors knew that these regions would be very complex in nature due to the buildup of resonances. The close-up in figure 2 gives some hint of the complexity involved. The pointed region at the center is an unstable hyperbolic fixed point that always exists between stable islands. You can see two thin resonance bands just to the left of this point. At the top and bottom are the edges of the large islands. The smaller islands are secondary resonances of the large islands. These in turn generate third-order resonances and the process continues forever with endless chains of smaller and smaller islands extending into the chaotic center region. The central region appears to be a scattering of random points but is actually a complex interweaving of tiny islands and their corresponding hyperbolic points.

As far back as 1892, Henri Poincaré predicted the possibility of chaotic behavior in certain celestial motions due to these resonances. Since then, a number of prominent physicists and mathematicians have wrestled with the question. George Birkhoff invented an elaborate code called "symbolic dynamics" to represent the structure of these regions. Recent studies by mathematicians such as Stephen Smale center on using mathematical topology, an outgrowth of geometry.

These questions are not just theoretical. The KAM theorem applies to a wide range of ordinary physical systems. Therefore, the study of resonance thresholds and the resonance bands has a number of practical ramifications for items in the physical world, from atomic particles to galactic clusters. At the 1985 NATO conference on the stability of the solar system (see Szebehely in the bibliography), a number of results centered on the KAM theorem and its consequences for the stability of the planets and satellites. Because stability is concerned with a system's long-term behavior, many years may pass before scientists observe any effects. The solar system's long-range stability is still an open question. For asteroids, satellites, and charged particles in an

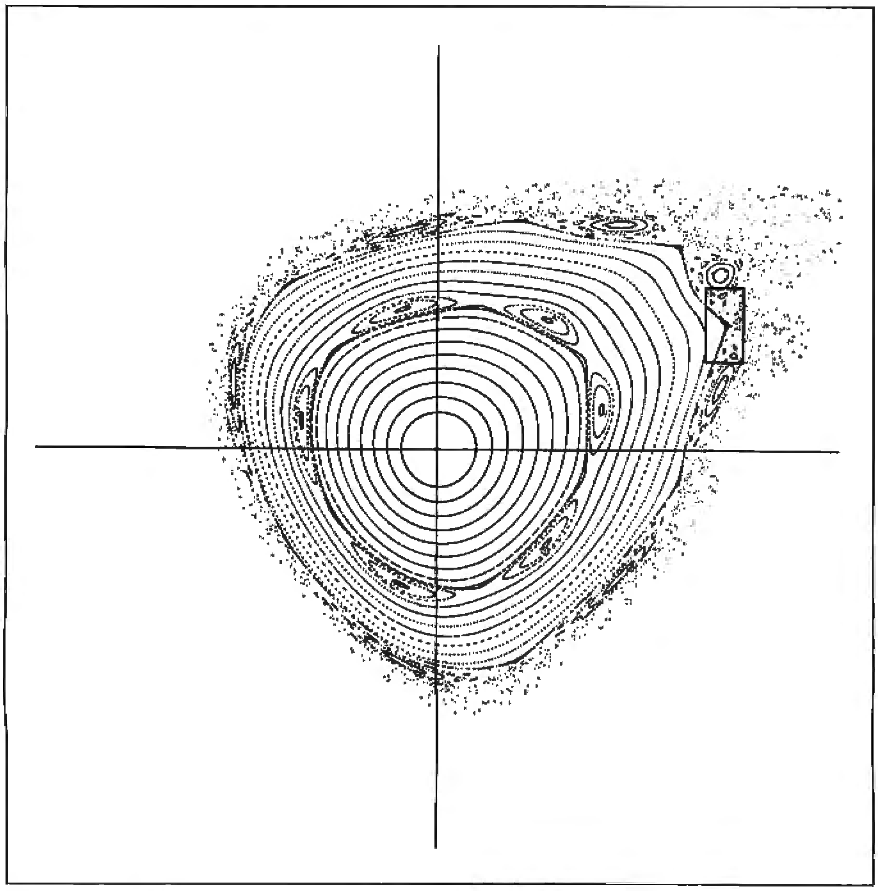

Figure 1: A *Henon mapping with phase angle A* = 1.111 *radians. The scale is* −1.2 *to* 1.2 *on both the x and y axes. Thirty-eight orbits are shown, each consisting of* 700 *iterations of a single starting point. The outlined area is enlarged in figure* 2. (*Use the parameter file* A111P.01 *with* HENON2.COM *or the values above with* HENON1.COM *to create this mapping.*)

accelerator, the effects of any instability are magnified either by their relatively small size or by their high energies. These provide good test cases for the KAM theorem.

COMPUTER SIMULATION

Among the most useful tools for investigating the behavior of physical systems is computer simulation. Typically, such simulations are complex and require extensive numerical integration. Even on large-scale computers, these simulations can take hours. However, almost any microcomputer can carry out an iterative simulation such as the Henon mapping in a matter of minutes. Using Turbo Pascal on an IBM PC, you can generate the mapping in figure 1 in about 50 seconds. Listing 1, HENON1.PAS, contains a short Henon mapping program. [*Editor's note: Turbo Pascal source code listings for* HENON1.PAS *and* HENON2.PAS *(a longer, more comprehensive Henon mapping program) are available on disk, in print, and on* BIX*; see the insert card following page* 320 *for details. Listings are also available on* BYTEnet*; see page* 4.]

Such simulations provide insight into the structure of resonance bands and the possible mechanisms for their widening. For example, simulations conducted by Joseph Ford at Georgia Tech seem to indicate that widening is brought on by neighboring resonances combining together. L. Jackson Laslett at the Lawrence Berkeley Laboratory devised an iterative mapping similar to Henon mapping to show the side effects of resonances between a beam of charged particles and the guiding electrical field.

The amount of detail available on a Henon mapping is more a function of software than of hardware. The difference between a display at 640 by 200 pixels and one at 320 by 200 is not significant if you can magnify the area of interest sufficiently. However, accurate magnification of a Henon mapping requires speed and precision. At high magnification, you may need to generate 10,000 points to get one within the region of interest. Since the mapping is iterative, you

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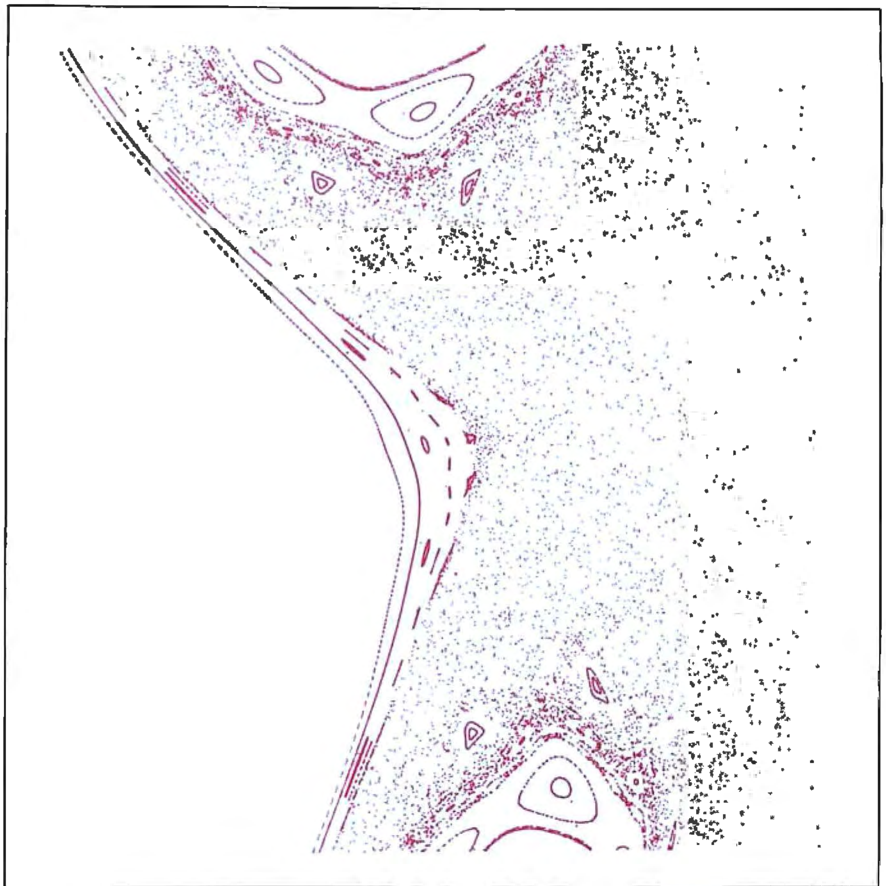

Figure 2: *An enlargement of the outlined area in figure* 1. *This mapping also has a phase angle A* = 1.111 *radians. The scale is* 0.74 *to* 0.95 *on the x axis and* 0.27 *to* 0.48 *on the y axis. Thirty-two orbits are shown, each consisting of* 10,000 *points. (Due to the number of points per orbit, this particular* Henon *mapping is quite time-consuming to produce. Its parameter file is* A111P.02. *However, you can save time by using the stored screen file* A111.02 *with* HENON2.COM.)

Listing 1: HENON1.PAS, *a short Pascal program for generating Henon mappings. This is written in Turbo Pascal for 640- by 200-pixel resolution on an IBM PC. To see a sample plot, use the defaults by pressing Return when asked for data. (Note: Both* HENON1.PAS *and* HENON2.PAS *are written to be executed as .COM files.)*

```
PROGRAM HENON1;  {short version of Henon mapping program}
CONST
  MAXREAL: REAL = 1E+10;
VAR
  I,J,P1,P2,ORBITN,POINTS, RESPONSE:INTEGER;
  R,L,T,B,A,XOLD,YOLD,XNEW,YNEW,X0,Y0,DX0,DY0,XSCALE,YSCALE,
    COSA, SINA:REAL;
  GRID: BOOLEAN;     {set this to FALSE to turn off the grid}

BEGIN
  GRID:=TRUE;A:=1.111;L:=-1.2;R:=1.2;B:=-1.2;T:=1.2;
  X0:=0.098;Y0:=0.061;DX0:=0.04;DY0:=0.03;ORBITN:=25;
  POINTS:=500;

WHILE RESPONSE <> 2 DO      {quit when RESPONSE is 2}
```

(continued)

```
BEGIN
  CLRSCR;GOTOXY(2,1);
  WRITELN('INPUT PHASE ANGLE A (IN RADIANS BETWEEN 0
    AND PI)');
  READLN(A);
  WRITELN('INPUT STARTING POINT FOR FIRST ORBIT (X0,Y0)');
  READLN(X0,Y0);
  WRITELN('INPUT X AND Y INCREMENTS IN THE ORBITS: DX0,DY0');
  READLN(DX0, DY0);
  WRITELN('INPUT NUMBER OF ORBITS');
  READLN(ORBITN);
  WRITELN('INPUT NUMBER OF POINTS PER ORBIT');
  READLN(POINTS);
  WRITELN('INPUT LEFT AND RIGHT WINDOW VALUES');
  READLN(L,R);
  WRITELN('INPUT BOTTOM AND TOP WINDOW VALUES');
  READLN(B,T);

  HIRES;
  HIRESCOLOR(3);

  IF GRID THEN    {draw reference grid if GRID is TRUE}
    BEGIN
      P1:=ROUND((0.0-L)*640/(R-L));     {find origin}
      P2:=ROUND((T-0.0)*200/(T-B));
      IF ((R-L)<R) AND ((T-B)<T) THEN   {origin off screen so}
      BEGIN P1:=630;P2:=190 END;        {draw axes at margin}
      DRAW(0,P2,640,P2,1);
      DRAW(P1,0,P1,200,1);
      FOR J:=0 TO 20 DO
        BEGIN
          DRAW(64*J,P2+3,64*J,P2-3,1);
          DRAW(P1+5,20*J,P1-5,20*J,1);
        END;
      WRITELN('XGRID: ',(R-L)/(640/64):6:5);
      WRITELN('YGRID: ', (T-B)/(200/20):6:5);
    END;

  GOTOXY(1,1);                   {display plot parameters}
  WRITELN('A = ',A:6:5);
  WRITELN('X0= ',X0:6:5,' Y0= ',Y0:7:6);
  WRITELN('DX0 = ',DX0:7:6);
  WRITELN('DY0 = ',DY0:7:6);
  WRITELN('X SCALE: ',L:6:5,' TO ',R:6:5);
  WRITELN('Y SCALE: ',B:6:5,' TO ',T:6:5);
  WRITELN('                          ');
  WRITELN('                          ');
  GOTOXY(1,22);
  WRITELN('ORBITS CAN BE ADVANCED MANUALLY BY PRESSING ANY
    KEY');

  COSA:=COS(A);SINA:=SIN(A);
  XOLD:=X0;YOLD:=Y0; {starting point for first orbit}
  XSCALE:=640/(R-L);YSCALE:=200/(T-B);
  FOR J:=1 TO ORBITN DO {main loop, J is orbit number}
  BEGIN
    GOTOXY(1,19);
    WRITELN('Orbit #',J,   ' of ', ORBITN);
    WRITELN('Current X0,Y0 =',XOLD:6:5,'  ',YOLD:6:5);
    I:=1;
    WHILE I <= POINTS DO   {WHILE allows easy abort}
      BEGIN
      IF (ABS(XOLD)<MAXREAL) AND (ABS(YOLD)<MAXREAL) THEN
      BEGIN
        XNEW:=XOLD*COSA-(YOLD-XOLD*XOLD)*SINA; {Henon map}
        YNEW:=XOLD*SINA+(YOLD-XOLD*XOLD)*COSA;
        IF (ABS(XNEW-L)<MAXINT/XSCALE) AND
          (ABS(T-YNEW) < MAXINT/YSCALE) THEN
        BEGIN
```

(continued)

cannot skip intermediate points in the calculations. This slows things down considerably.

Also, at high magnification, the points plotted may differ only by the 10th or the 15th decimal place. You can't ignore any of these digits because the intermediate points—those outside the region of interest—must all be generated with high precision. Therefore, extended precision is necessary to allow good magnification. You can obtain reasonable results with Pascal and extended precision (11 decimal places). The extra speed and precision of 8087 support would be welcome for high magnifications.

INTERPRETING HENON MAPPINGS

Because Henon mappings simulate dynamical systems undergoing disturbances, you can use them to illustrate the workings of the KAM theorem. But a Henon mapping does not represent a physical picture of the system's motion. Rather, it is a cross section of that motion in terms of a phase plot. For planetary motion, this phase plot may resemble an actual orbit, but there are some important differences.

A phase plot is a graph where one axis is the rate of change, or derivative, of the other axis. For example, in figure 1 the horizontal axis represents position, and the vertical axis, velocity. Such phase plots are common for studying a physical system's long-term behavior.

PHASE PLOTS FOR TWO PHYSICAL SYSTEMS

Figure 3 shows the phase plot for a pendulum. It has one degree of freedom since the only motion is angular. The horizontal axis is the angular position θ (in radians), and the vertical axis is the angular velocity $d\theta/dt$ (in radians per second). If you raise the pendulum slightly and let it go, it oscillates back and forth forever (ignoring friction). During each oscillation, there is a smooth and continuous trade-off between the velocity and the position, that is, between kinetic energy (KE) and potential energy (PE). On the phase plot this shows up as a rotation around one of

(continued)

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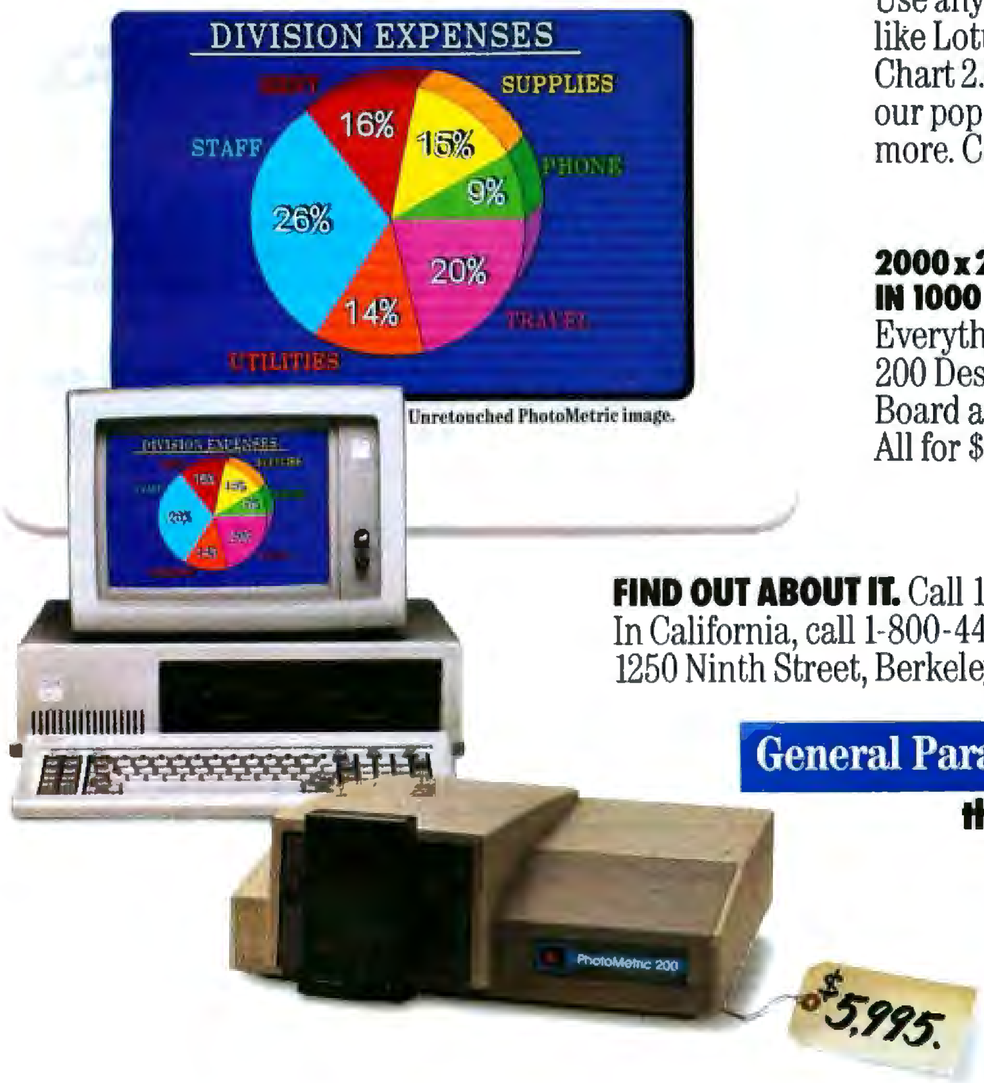

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```
        P1:=ROUND((XNEW-L)*XSCALE); {scale new point}
        P2:=ROUND((T-YNEW)*YSCALE);
        PLOT(P1,P2,1);
      END;
      XOLD:=XNEW;
      YOLD:=YNEW;
    END;
      IF KEYPRESSED THEN I:=POINTS+1 ELSE I:=I+1;
  END;  {WHILE I. End of orbit plot}
  XOLD:=X0+J*DX0;  {next starting point}
  YOLD:=Y0+J*DY0;
 END; {for J}
GOTOXY(1,22);
WRITELN('SELECT ONE: (1) NEW PLOT (CARRIAGE RETURNS WILL
 REPEAT CURRENT DATA)');
WRITELN('             (2) QUIT');
READLN(RESPONSE);
END;
END.
```

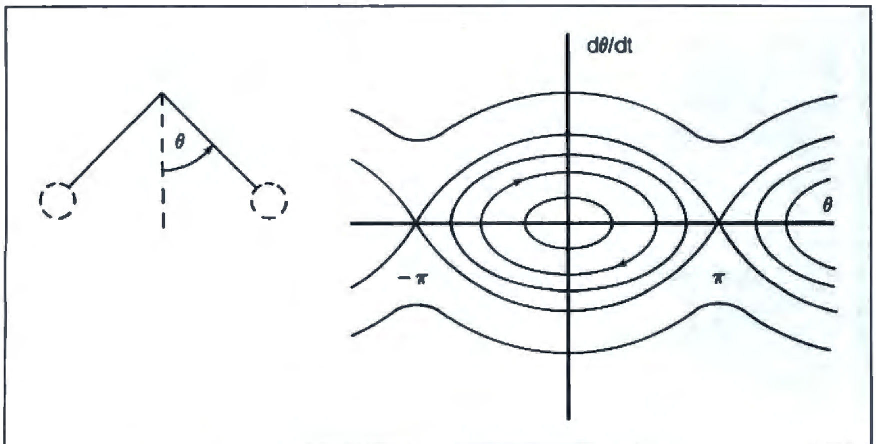

Figure 3: *Phase plot of a pendulum. For a starting position between 0 and π, the phase plot will follow one of the ellipses as the pendulum rotates. For a starting position at π or −π, the pendulum could fall right or left as indicated by the crossing lines.*

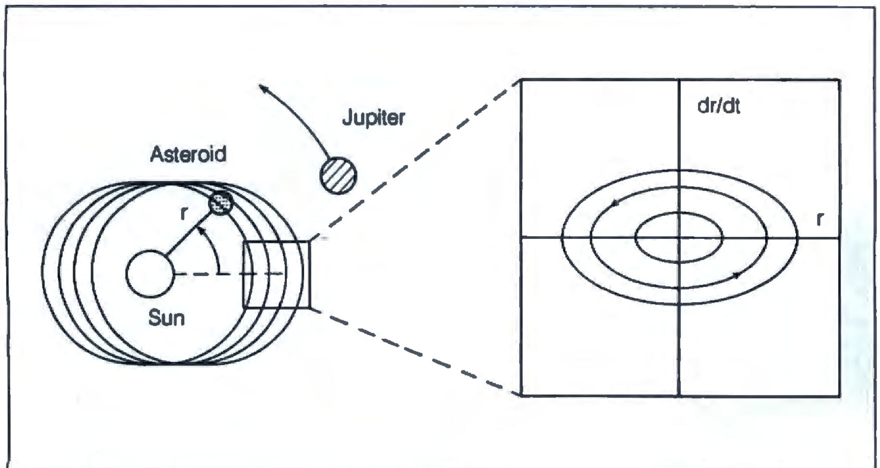

Figure 4: *Phase plot for an asteroid under the influence of the sun and Jupiter. Though there are two degrees of motion, angular and radial, only the radial motion is shown in the phase plot.*

the ellipses. The actual ellipse depends on the pendulum's starting position and starting velocity. For small oscillations, these ellipses are nearly circles. In a nonconservative system where frictional forces are allowed, the ellipses become spirals indicating a slowing of the pendulum. Since Henon mappings deal with conservative systems, no such spirals are seen. If you assume that the pendulum is on a rigid bar and is given sufficient push (large initial angular velocity), it might become a rotor and not oscillate at all. This scenario is represented by the wavy lines at the top and bottom of figure 3.

The phase plot in figure 4 is a Poincaré cross section that represents motion with two degrees of freedom, such as an asteroid orbiting the sun. The asteroid's orbit is assumed to lie in a plane, so the two possible motions are angular and radial. You can describe the asteroid's position in polar coordinates as (r,θ). Note that the orbit shown in figure 4 is not quite closed. This is due to the disruptive pull of Jupiter (and, to a lesser extent, the other planets).

There are now two possible phase plots: r versus dr/dt and θ versus $d\theta/dt$. One way to combine these is to place one plot perpendicular to the other and take the Cartesian product. This yields motion on a torus (doughnut). One phase plot winds *around* the torus, and the other simultaneously winds *along* the torus. The end result looks like wire coiled around a doughnut.

Torus plots are a useful way to picture motion, but they are not always easy to draw or interpret. As an alternative, Poincaré suggested using just one phase plot (for example, r versus dr/dt) and setting the remaining position variable, θ, to 0 (or any constant). This means that the plot gives r versus dr/dt at only one point in the orbit: when $\theta = 0$. Plotting just one point per orbit certainly doesn't show the asteroid's detailed motion, but for many applications, such as the study of stability, the long-term motion is sufficient.

What does such a phase plot look like? If the orbit is a perfect ellipse (without the pull of Jupiter), all you

(continued)

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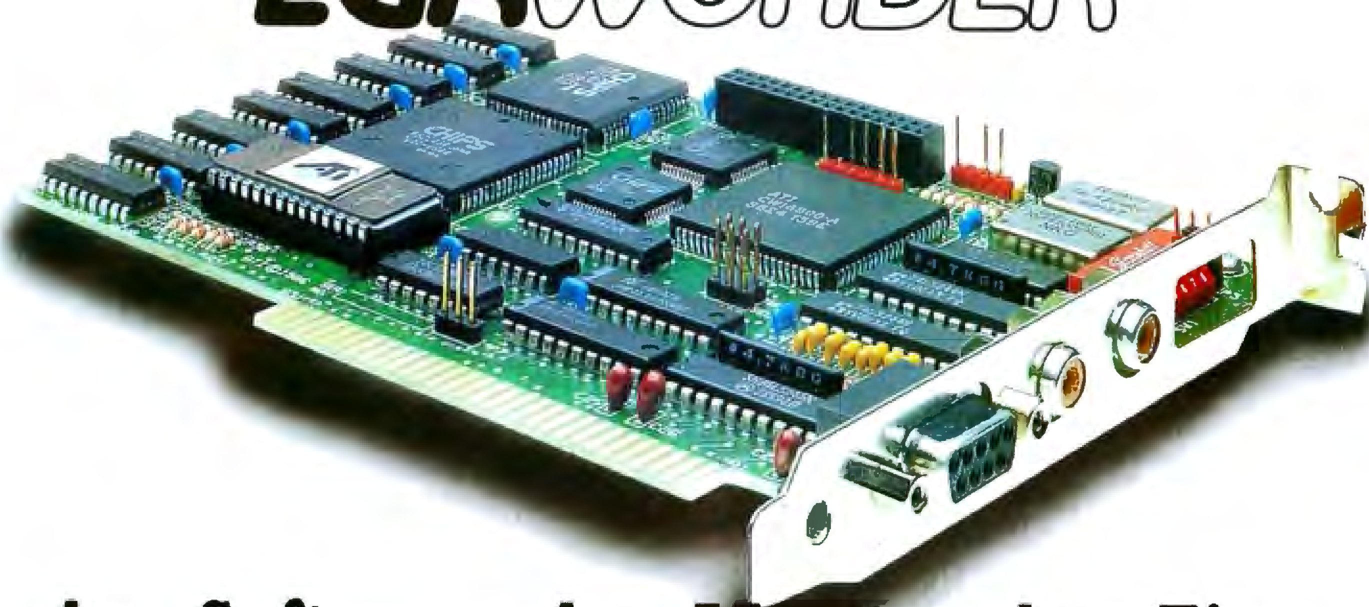

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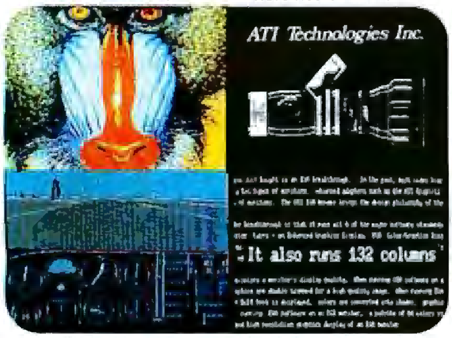

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would see is the same point over and over again as the asteroid returns to $\theta = 0$ with the same radius r and radial velocity dr/dt. This is called a fixed or stationary point, and it corresponds to the center of the phase plot in figure 4. (For any Henon mapping, the origin (0,0) is always a fixed point because this corresponds to an undisturbed system.) With the effects of Jupiter, the path of the asteroid may wander around, but the movement is regular because it is tied in with the 11.86-year period of Jupiter. Therefore, the motion tends to repeat on multiples of 11.86 years. For most asteroids, the 11.86 years does not mesh exactly with their periods so there is no resonance. These are the closed curves in the phase plots. Theoretically, an asteroid could follow one of these curves forever. If an asteroid has a period that is an even ratio with respect to Jupiter's, this resonance could magnify the gravitational effects of Jupiter and possibly cause instability.

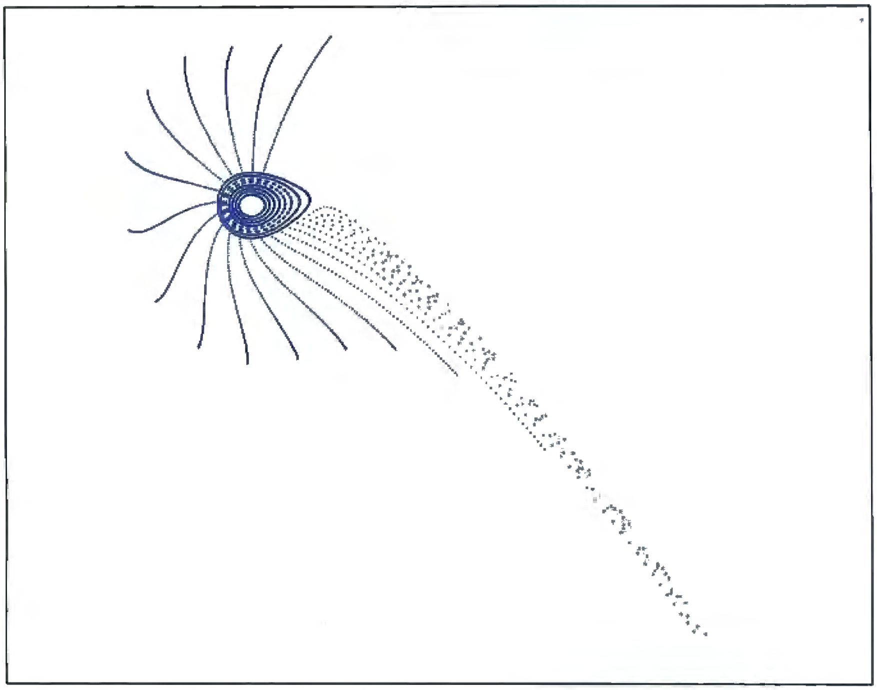

Figure 5a: A *Henon mapping of the phase angle A, where A* = 0.264 *and the scale is* −1.2 *to* 1.2 *with* 25 *orbits and* 300 *points per orbit. The powerful hyperbolic point at the tip of the figure is responsible for the "aura" of points around the figure. (The parameter file is* A0264P.01.)

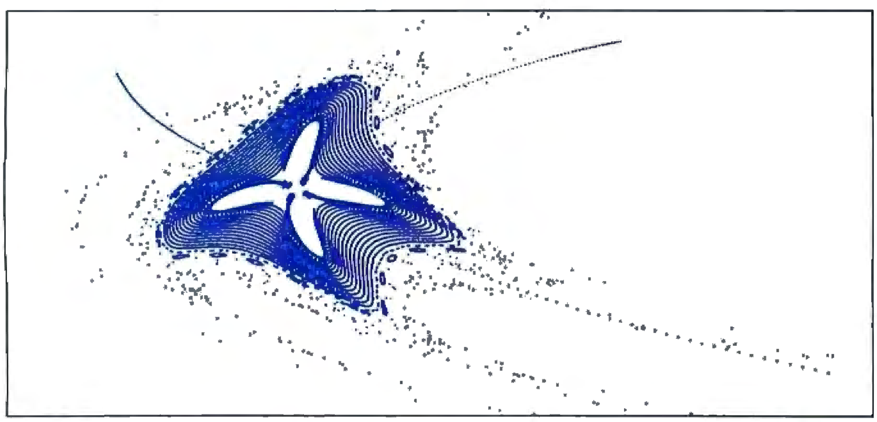

Figure 5b: A *Henon mapping of the phase angle A, where A* = 1.5732 *and the scale is* −3.0 *to* 3.0 *with* 70 *orbits and* 400 *points per orbit. In this "sea creature," A is close to 90 degrees with the result that the inner orbits are dominated by four fixed points. This causes the early breakdown into the four islands. (The parameter file is labeled* A15732P.01. *Two other mappings are available in parameter files* A2012P.01 *and* A2075P.01.)

It is no coincidence that the Poincaré phase plot in figure 4 resembles a Henon mapping. Whenever the system is conservative, the resulting Poincaré map is area-preserving and so resembles a Henon mapping. Conversely, you can regard every Henon mapping as a phase plot of a physical system. For example, the two Henon mappings in figures 5a and 5b simulate phase plots for different physical systems.

Advantages of a Phase Plot

Even though a phase plot sometimes makes it difficult to visualize the actual motion of a particle, the final picture provides a record of the overall behavior for extended periods of time. Generally, a smooth closed curve indicates a regular periodic, or almost periodic, motion, while a scattering of points indicates irregular motion. The islands in figure 1 represent stable orbits that have "locked on" to the particular resonance. The area between the islands is the source of irregular behavior.

From a purely practical standpoint, it is often easier to obtain a phase plot than to solve for the complete equations of motion. Even for the simple pendulum in figure 3, obtaining θ as a function of time involves evaluating an elliptic integral—a process you can do only by approximation. For example, if you assume the oscillations are small, then $\theta(t)$ is approximately a cosine curve.

A Closer Look

The center of figure 1 corresponds to an undisturbed, stable system, such as to an asteroid in an undisturbed orbit around the sun. It is a fixed point because the asteroid always returns to this point at the end of each revolu-

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CREATING A HENON MAPPING

A Henon mapping is an area-preserving map of the plane given by

$$X(n+1) = X(n) * \cos(A) - (Y(n) - X(n)^2) * \sin(A)$$
$$Y(n+1) = X(n) * \sin(A) + (Y(n) - X(n)^2) * \cos(A)$$

Here, A is a fixed constant called the phase angle. First, choose a value for A between 0 and π. (Values outside this range are acceptable, but you won't obtain any new mappings.) Next, choose an initial point ($X(0)$,$Y(0)$) and use it to compute ($X(1)$,$Y(1)$), then ($X(2)$,$Y(2)$), etc. This generates one orbit of the Henon mapping. Typically, it will resemble a closed curve after a few hundred iterations. In figure 1, A is 1.111, and the inner curve has 700 points generated with a starting value of ($X(0)$,$Y(0)$) = (.098,.061).

Next, choose a starting point ($X(0)$, $Y(0)$) for the second orbit and continue. A typical mapping might contain 15 to 20 orbits, depending on the detail desired. Figure 1 contains 38 orbits. You can use any value for the starting point, but for $X(0) > 1/\sin(A)$, the successive points grow rapidly. For example, with $A = 1.111$, any starting point beyond $X(0) = 1.116$ grows quickly, and the orbit degenerates to a few points on the screen.

A program to generate these mappings will have two nested loops: the outer loop to choose the starting values ($X(0)$,$Y(0)$), and the inner loop to generate the orbit (see listing 1).

Note that the mappings have a symmetry about a line that makes an angle of $A/2$ with the positive X axis. For figure 1, this angle is 1.111/2 radians, which is about 32 degrees.

tion around the sun. For convenience, you can regard this point as the origin (0,0).

A phase plot has two basic types of fixed points: elliptic and hyperbolic. This center point, or origin, is an elliptic fixed point because the nearby curves are ellipses. An elliptic fixed point is naturally stable; a small error in position or velocity is not disastrous—the system remains on an elliptic curve close by. For example, the center of the phase plot in figure 3 is an elliptic fixed point, and it corresponds to a stationary pendulum. It is a stable point: if you make a small mistake in positioning the pendulum, it doesn't cause much change in the orbit.

By contrast, if the pendulum is on a rigid bar and is moved all the way to the "high noon" position ($\theta = \pi$, $d\theta/dt = 0$), this would also be a fixed point but it would be extremely unstable. This is called a hyperbolic fixed point because the curves near it are hyperbolic, $(y - c) = 1/(x - d)$. They are the crossing lines seen in the phase plot in figure 3. Relationships of this type are inherently unstable near the central point, (c,d), because a small change in either x or y yields a large change in the other. For a pendulum, the smallest error in position would cause it to fly off on one side or the other. In stability theory, these hyperbolic fixed points are the "bad guys," and they show up in the resonance bands.

THE RESONANCE BANDS

In figure 1, the two major resonance bands are the band of six and the outer band of seven. These two bands appear to be different in character, but they are actually similar. Because the outer band is so wide, more detail is visible, but the tiny islands and the "fuzzy" scattering of points are part of every resonance band. If you enlarged the islands in the band of six, you would find a similar structure.

The small islands represent secondary resonances. They are the *bands of the bands*. These secondary resonances occur because each of the large islands represents a new stable fixed point just like the origin. Therefore, according to the KAM theorem, these islands also stretch and then break to form resonance bands. This is an endless process as the new islands spawn even smaller islands corresponding to higher resonances that resemble the harmonics of a piano string, but in two dimensions.

The scattering of points visible in the outer band is caused by dense accumulations of hyperbolic fixed points. To see how these hyperbolic "bad guys" got here, recall that the resonance bands are formed from the remnants of rational orbits. These are the orbits that mesh exactly with the disruptive force; for example, a 2/5 resonance indicates that two orbits by Jupiter match exactly five orbits of the asteroid. These rational orbits are the ones destroyed to form the resonance bands. (The widening is the result of the rational orbit absorbing nearby orbits.) When these rational orbits are deformed into the bands, the islands are formed. But according to the Poincaré-Birkhoff Fixed Point theorem, these stable islands must alternate with hyperbolic fixed points. The islands and the hyperbolic points have the same origin. They are both created when the rational orbit is deformed by the disturbance.

Since any resonance band has an infinite number of islands, it also has an infinite number of hyperbolic points. These stable and unstable points are interwoven in a complex nesting pattern. To make matters worse, the curves joining these hyperbolic points (called *separatrices*) are turned into incredible jumbles of zigzags, known as *tangles*. This means that each of the islands is surrounded by rings of tangles. In figure 2, all you can see of this chaos is a sea of dots that appear to be totally random.

The structure of these regions is much too complex to be visualized in a phase plot. Many attempts have been made to draw these regions. V. I. Arnold, one of the KAM authors, has drawn some excellent illustrations showing the nesting as windings of tori. Ralph Abraham at the University of California (Santa Cruz) has published a "Visual Mathematics Library" with drawings of some tangles. It is this unimaginable complexity that mathematicians like George Birkhoff,

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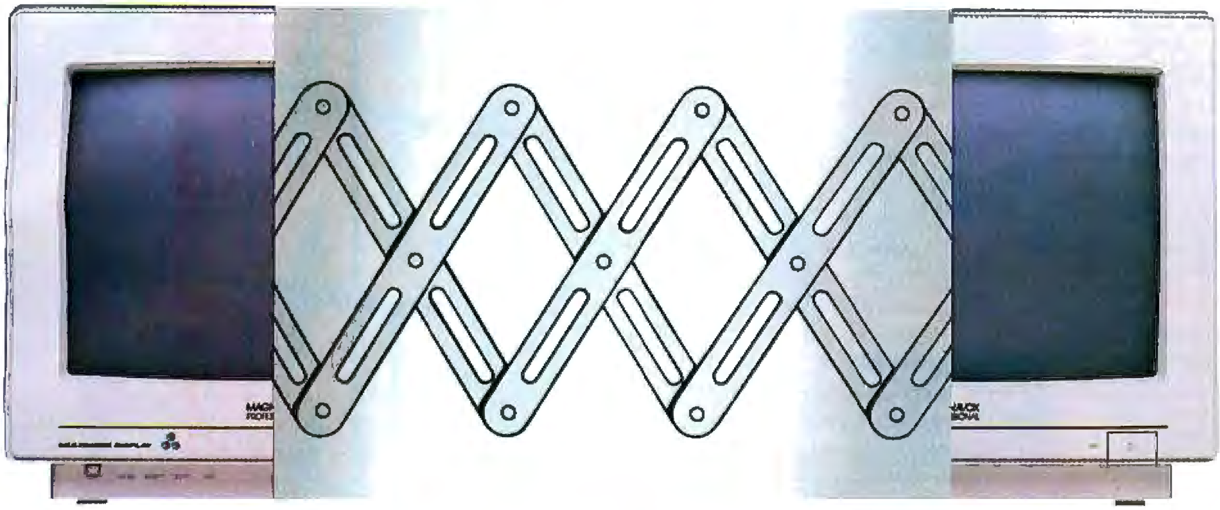

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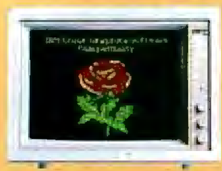

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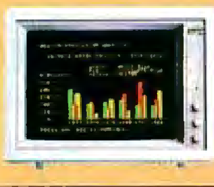

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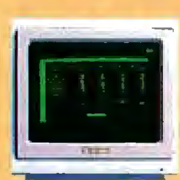

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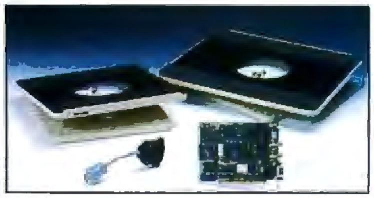

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Jurgen Moser, Stephen Smale, and others have been attempting to unravel. It is the key to the nature of the resonance bands and, therefore, crucial to the question of stability.

RATIONAL VS. IRRATIONAL

Since the rational orbits are deformed into the resonance bands, the remaining curves must correspond to irrational orbits. Here there is no buildup due to resonances, so the status quo is maintained and the overall motion is stable. For example, Earth seems to follow a peaceful irrational orbit with respect to Jupiter. The gravitational pull of Jupiter does cause perturbation of Earth's orbit, but there is no apparent buildup of forces as there could be with a resonance.

Not all irrational orbits are safe. If it happens to be too close to a rational orbit, the irrational orbit can be absorbed into the resonance band. For small disturbances, this absorption is minimal, and the irrational orbits dominate the behavior. Paradoxically, there are many more irrational numbers than rational ones, so if you pick an orbit at random (by choosing a starting point (x,y) or (r,θ)), it will almost certainly correspond to an irrational orbit. This is why the KAM theorem works: The rational resonance bands, even with the neighboring rationals and irrationals, are still insignificant for small disturbances. The end result is a stable system where the irrational orbits dominate and the resonance bands have no appreciable effect. At higher energies though, these rational orbits absorb many more nearby orbits and become a significant factor.

ORBIT WATCHING WITH PASCAL

When you watch an individual orbit in slow motion on the computer, the successive points are rotations by a fixed angle called the *winding number*. For an irrational orbit, this angle never comes out even, so the points never repeat. They wind forever, either clockwise or counterclockwise. For a rational orbit, the points eventually repeat and a resonance occurs. Think of the successive points as the path of the asteroid, and the total curve as

(continued)

HENON MAPPING

the period of Jupiter. There is a resonance when these two mesh exactly (in time, not physically). On the screen it looks as if the points are stationary.

However, it is unusual to see perfectly stationary points, because these are the orbits that will bifurcate into bands. The orbit is "trying" to be stationary, but the disturbance won't let this happen. The stationary points are distorted into islands just as in figure 1.

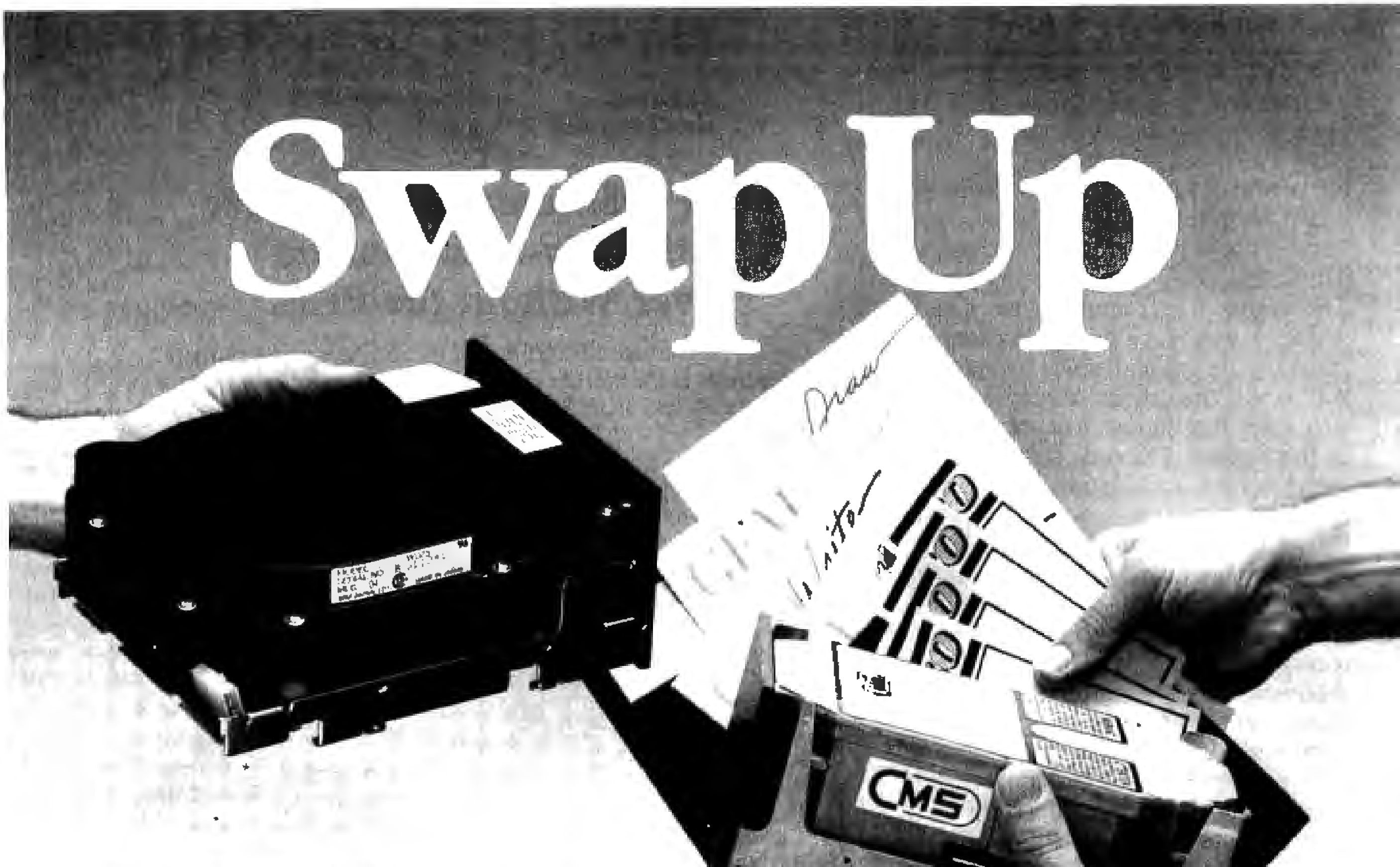
Remember, for the purposes of computer simulation all numbers must be rational, since they are stored only to a limited number of digits. This is not a problem, because the KAM theorem is really a matter of degree: There is a hierarchy of rational numbers, from the major resonances such as 1/1, 2/3, 1/5, etc., down to the essentially irrationals represented by numbers such as 78438166/1677743295. Note that in the Henon mappings the major resonances give the wide bands. These are the most powerful resonances.

THE FATE OF A PHYSICAL SYSTEM

There are two broad types of behavior for a physical system on one of these resonance bands: stability and chaos. The islands represent regions of relative stability, and the area between the islands represents potential chaos. If a system locks on to the resonance and follows the islands, it behaves in a regular fashion. For example, if an asteroid followed the seven islands in figure 1, it would have a period of 1/7 that of Jupiter (i.e., every seven revolutions, it would repeat itself). If it were on the outer edge of the islands, it would still be regular but would not quite repeat itself.

If the system is on one of the small islands corresponding to higher resonances, it travels a more varied path, but the overall behavior is still regular. For example, an asteroid that starts out on one of the eight smaller islands is still tied to the seven large islands, but there is a secondary winding, or perturbation, as it visits the eight islands. The overall motion is similar to that of the seven islands. For the

(continued)



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HENON MAPPING

microscopic islands, the many levels of windings cause a great deal of small variation, but the motion is still bound to the large islands. The real danger, especially with the higher resonances, is that a very small change in conditions, such as a minor collision or the pull of Earth, Mars, or Saturn, would tend to disrupt this rather delicate stability. Surrounding these islands are regions dominated by unstable hyperbolic points.

If a physical system didn't lock on to the resonance, it could exhibit erratic behavior as represented by the regions between the islands. If it got too near a powerful hyperbolic point, it could be thrown out like a slingshot. If it got too near one of the tangles, the system would experience a localized chaos as it followed an "orbit" that was a maze of zigzags.

THE KIRKWOOD GAPS

Using the asteroids as a guide, the stable phenomenon of "following the islands" or "orbit-locking" seems rare. In fact, the asteroids are conspicuously missing from the resonance bands. These gaps were first observed in 1886 by Daniel Kirkwood, a U.S. mathematician and astronomer, who suspected that the gaps correspond to resonances with Jupiter. Recent calculations by M. V. Berry at the Wills Physics Laboratory in Bristol, England, indicate that indeed these gaps coincide closely with the major resonances between the asteroid's orbit and Jupiter's. Instability has been the dominant factor causing asteroid ejection. Calculations by Andrea Milani and Anna Nobili at the University of Pisa indicate that secondary disturbances caused by the slight eccentricity of Jupiter's orbit might have speeded this up, making the delicate orbit-locking unlikely. (They did, however, find a possible orbit-locking between Jupiter and Uranus.)

Where do the ejected asteroids go? Wandering asteroids with erratic behavior have been observed, but it is difficult to trace their paths back in time to determine whether this is due to resonances or not. Some astronomers believe that a few of these erratic asteroids join the cloud of

(continued)

Halley's comet could be an asteroid that suffered the fate of a KAM resonance.

comets at the extremes of the solar system. Halley's comet could be an asteroid that suffered the fate of a KAM resonance.

THE RINGS OF SATURN

The rings of Saturn have gaps similar to the gaps in the asteroids. The rings are composed of thousands of rocks and ice particles that are influenced by the gravitational pull of Saturn's satellites, most notably Mimas, and the major resonances here are between the period of the particle and the period of Mimas. The important 1/3 resonance coincides closely with a well-known gap between ring B and the Crepe ring. The 1/2 resonance seems slightly out of alignment with the Cassini gap, but the astronomer F. Franklin has shown that if you include the mass of the B ring, the 1/2 resonance coincides very closely with the Cassini gap.

SUMMARY

The theoretical study of stability is one of the more difficult fields of mathematics, and results such as the KAM theorem are of a highly technical nature. Yet, through the medium of computer simulation using iterative mappings such as the Henon mapping, you can gain significant insight into the nature of these studies. This visual insight can be a powerful tool. Most of the laws of physics were obtained through keen observation followed by mathematical analysis. Now anyone with a microcomputer has a window from which to observe some of the more exotic behavior that underlies the world. ■

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ABSTRACT MATHEMATICAL ART

BY KENNETH E. PERRY

Use a BASIC program to explore the fascinating world of linear cousins of the Game of Life

COMPUTER-GENERATED mathematical art is art created by pure mathematics as opposed to other forms of computer graphics. In this article, the mathematical entities are "one-dimensional cellular automata." I have found their study exciting and astounding.

One-dimensional cellular automata are linear versions of the two-dimensional automata whose classic example is John H. Conway's Game of Life. The text box "The Origins of Cellular Automata" on page 182 explains the evolution of the ideas that led to the development of these structures.

This article discusses these automata, elaborates the rules that define them, and presents a program in IBM PC BASIC that you can use to find these hidden structures. You will need a color adapter and color monitor to use the program. See the text box "BASIC Program Notes" by George A. Stewart on page 190.

DEFINING THE AUTOMATON

In the years since its invention, the cellular automaton has not had much exposure in the general scientific press. One exception occurred in 1971, when Martin Gardner in *Scientific American* revealed to the world Conway's Game of Life (reference 1).

Conway's game is a two-dimensional cellular automaton in which each cell can take on one of two states, 0 or 1, and its future depends on its own state and that of all eight neighbor cells, both orthogonal and diagonal (this is known as the "Moore neighborhood" after Edward F. Moore, who first discussed rules using this neighborhood).

In 1984 three articles appeared concerning a new breed, the one-dimensional cellular automaton (see references 2, 3, and 4). Two of the articles were written by Dr. Stephen Wolfram of the Institute for Advanced Study in Princeton, New Jersey, and the other made reference to him.

Although the transition rules for one-dimensional cellular automata are very simple and easy to state, some of these automata can exhibit behavior of astonishing complexity. Wolfram is attempting to gain an analytic understanding of how such automata evolve. Reading these articles (and especially looking at the stunning color reproductions of computer graphics) stimulated in me a strong desire to program these automata on my own computer. Listing 1 is one of the results.

Interpreted BASIC is much too slow to program two-dimensional cellular automata. However, for one-dimensional automata the case is quite different. The field, instead of being n by n, is 1 by n, and the number of cells is in the tens or, at most, the hundreds. Having said this, I must still admit that this BASIC program is rather slow.

The type of automaton I have programmed consists of a linear row or "field" of cells whose maximum length is dictated by the number of pixels on a horizontal screen line. Each cell can take on one of four different states numbered 0, 1, 2, and 3. The transition rule for the next state of the cell depends on the sum of the states of three cells—the cell itself and its two neighbors. Since the largest possible value of each cell is 3, the greatest possible sum of three cells is

(continued)

Kenneth E. Perry (22 Sedgemeadow Rd., Wayland, MA 01778) joined the group that built Howard Aiken's Mark IV computer shortly after World War II, which led to a lifetime career in digital logic and programming. Retired, he's still at it.

9, and the sum can take on any value from 0 to 9. A typical rule can be defined as follows:

Sum	0	1	2	3	4	5	6	7	8	9
Rule	0	2	3	0	0	0	0	0	0	0

This rule is as follows: If the sum is 0, the next state will be 0; if the sum is 1, the next state will be 2; if the sum is 2, the next state will be 3; if the sum is 3, the next state will be 0; and so forth.

The first digit of a rule is usually 0; otherwise, the entire initial array of 0-cells will reverse states in a single generation. The other nine digits can each take on any one of the four values from 0 to 3. The number of different possible rules is therefore 4^9, or 262,144.

One advantage of the one-dimensional automaton is that it is possible to display a history of its development on a two-dimensional color display screen (with the states 0, 1, 2, and 3 represented by the colors black, red, green, and blue, respectively), while for the two-dimensional automaton only one generation at a time can be displayed.

The program creates a display of 90 generations of an automaton containing 160 cells (the display density can be increased to show 190 by 255 if desired). The horizontal axis represents space and the vertical axis, time. It is important to keep in mind that although the display is two-dimensional, the automaton is unregenerately one-dimensional.

The evolution of this type of automaton over succeeding generations (or clock ticks) is determined entirely by the rule and the initial state of the

(continued)

THE ORIGINS OF CELLULAR AUTOMATA

The time was the early fifties. John von Neumann (1903–1957) had set himself the task of demonstrating that a self-replicating automaton, a robot that could reproduce itself, was possible in principle using the following approach.

Consider a conceptual robot (there was never any thought of actually building anything) wandering at random about an imaginary warehouse containing elementary spare parts scattered about the premises (a badly managed warehouse, but the robot, to be credible, must get along with a minimum of outside help). The robot identifies the parts it needs and assembles these parts to construct an exact copy of itself. In order to direct its operations and make its decisions, the robot contains a conceptual computer, a "universal computer" capable of computing anything that is computable. Such a conceptual universal computer had been invented in 1936 by Alan Turing, and if there was one thing about which von Neumann had no doubt whatever, it was that his self-replicating automaton would contain a Turing machine.

Von Neumann had made some progress with this "kinematic" approach, but he was not satisfied with it. He found it difficult to develop a set of rules of operation that was simple enough to be enlightening. Additionally, the idea of moving pieces of hardware around did not seem to have any place in a fundamental mathematical theory.

Then one day a colleague, Stanislaw M. Ulam, had a bright idea that he passed along to von Neumann. Consider a large array of rectangular cells (a very large checkerboard some hundreds of cells on a side). Each cell can take on, at any one time, one of a certain number of states numbered 0, 1, 2, 3, 4, and so on (in the simplest case only two states are provided for, labeled 0 to 1). The zero state (also called dead, passive, or quiescent) is always one of the allowed states, and initially all cells are in the zero state. Every cell in the array is allotted the same number of possible states.

Each cell has a rule (the transition rule) based on the states of some of its near neighbors, and perhaps on its own state as well, that specifies at time t what its state will be at time $t+1$; all cells change state simultaneously (in computer terms that would be called a clocked synchronous system). Every cell obeys this rule.

To start the automaton, a certain number of cells are placed into nonzero states, and then the clock is turned on.

Ulam had invented the two-dimensional cellular automaton, and von Neumann was quick to recognize the merit of the idea. Each cell's dependence, for its future state, *on only its immediate neighbors*, either orthogonal or diagonal, is the very essence of cellular automata. Unlike in the kinematic example, nothing moves; only information is passed from cell to cell.

Take, as a trivially simple example, the rule that the next state of any cell is dependent only on the neighbor cell that shares its northern border. The cell will take on at time $t+1$ the state of this neighbor at time t. All cells of the array are initially 0, then one cell at the northern boundary of the array is forced into the 1 state. The state of that cell will move, with each tick of the clock, from cell to cell down its column until it reaches the southern boundary. Thus, information has been passed across the array.

When von Neumann seized on the idea, he did it in no small way. The final version of the cellular array took on a size of some hundreds of thousands of cells, each of which could take on one of 29 possible states, that is, the quiescent state plus 28 nonquiescent states. The next state of a cell depended on its own state plus the state of the four neighbor cells with common borders. This is known as the "von Neumann neighborhood." He showed that a Turing machine could be constructed from these cells and that a "constructing automaton" controlled by this machine could send out a "constructing arm" into unoccupied (quiescent) territory of the array. By setting the states of the cell one by one, the automaton would end up with an exact copy of itself.

The result was published posthumously in 1966 as the *Theory of Self-Reproducing Automata*, edited and completed by Arthur W. Burks from von Neumann's unfinished manuscripts (Urbana, IL: University of Illinois Press, 1966). A detailed and quite readable account of von Neumann's automaton is given in the first essay of *Essays of Cellular Automata*, also edited by Arthur W. Burks (Champaign, IL: University of Illinois Press, 1970).

Listing 1: A BASIC *version of the one-dimensional cellular automata program written for the* IBM PC *with color graphics.*

```
10 REM One-dimensional cellular automata
20 REM by Kenneth E. Perry
30 REM ----------------------------------------------
40 REM Screen setup
50 KEY OFF
60 SCREEN 1,0       :REM Medium resolution (320 x 200)
70 COLOR 0,0        :REM Use color palette 0
80 REM ----------------------------------------------
90 REM Initialize variables
100 DEFINT A-Z      :REM All variables are integers
110 HRES=320        :REM Number of points horizontally
120 VRES=200        :REM Number of points vertically
130 SF=2   :REM SF=1 for denser graph
140 BY=10  :REM Offset to leave one line blank
150 GN=INT(VRES/SF)-BY
160 MC=INT(HRES/SF)            :REM Maximum number of cells
170 IF MC>255 THEN MC=255 :REM Prevent string overflow
180 MI=40  :REM Characters/line in graphics mode
190 BG=0   :REM Color of background
200 NU$="" :REM No spaces inside quotes
210 DIM CL(3), A(MC-1), B(MC-1), RU(9), K$(-INT(-MC/MI))
220 REM Initialize color mapping
230 FOR J=0 TO 3: READ CL(J): NEXT J
240 DATA 0,2,3,1
250 REM ----------------------------------------------
260 REM Initialize the rule
270 R$="0000000000"            :REM Ten zeros
280 CLS
290 PRINT "Current rule is shown below. The rule"
300 PRINT "must contain exactly 10 digits, using"
310 PRINT "only 0, 1, 2, and 3."
320 PRINT "Move the cursor across the rule, make"
330 PRINT "changes as desired, and press <cr>."
340 PRINT: PRINT R$
350 LOCATE 7,1
360 LINE INPUT RT$
370 IF RT$=NU$ THEN END
380 IF LEN(RT$)<>10 THEN 280
390 OK=(1=1)
400 FOR J=1 TO 10  :REM Make sure the rule is valid
410 RU(J-1)=VAL(MID$(RT$,J,1))
420 OK=(OK AND RU(J-1)>=0 AND RU(J-1)<=3)
430 NEXT J
440 IF NOT OK THEN 280 ELSE R$=RT$
450 REM ----------------------------------------------
460 REM Get the number of cells in each generation
470 PRINT USING "How many cells/line (### to ###)";MI,MC;
480 INPUT NC
490 IF NC<MI OR NC>MC THEN 470
500 NL=INT((NC-1)/MI)+1 :REM Lines needed to show 1st gen.
510 REM ----------------------------------------------
520 REM Get the initial state of the cellular automaton
530 PRINT
540 INPUT "Initial=predefined or random (P/R)";PR$
550 IF PR$<>NU$ AND INSTR(1,"Rr",PR$)>0 THEN GOSUB 900
    ELSE GOSUB 970
560 A(0)=0: A(NC-1)=0      :REM Force boundaries to zero
570 REM ----------------------------------------------
580 REM Start the cellular automaton running
590 CLS
600 PRINT "Rule ";R$               :REM Display rule
610 FOR J=0 TO 3
620 LOCATE 1,20+J*4
630 PRINT USING "#=";J
640 NX=168+J*32
```

(continued)

automaton. The simplest initial state consists of all cells in the field zero except the one that we call the "seed."

Let's see what happens with the above rule and a single cell near the middle of the field in state 1. This can be shown as follows:

1. Initial state	00000100000
Sum	00001110000
2. Next state	00002220000
Sum	00024642000
3. Next state	00030003000
Sum	00333033300
4. Next state	00000000000

The sums of 3, 4, and 6 all result in next states of 0, and the structure dies out after only three generations. The word *structure* describes the evolution and history of an initial state or seed in a particular automaton. The word *automaton* names the object defined by three things: (1) the field of cells (1 by 160 in this case), (2) the neighborhood (three cells in this case), and (3) the particular 10-digit rule that is selected.

Suppose we change the rule to 0230101000 so that sums of 4 and 6 generate next states of 1. The history of the first few generations, without specifically indicating the successive sums, becomes

1. First state	1
2. Next state	222
3. Next state	31113
4. Next state	10001
5. Next state	2220222
6. Next state	311111113
7. Next state	100000001
8. Next state	22200000222

It is apparent that this structure will expand forever. The rate at which a structure expands or propagates is called its "speed," and the maximum possible speed is 1 (Conway calls this the "speed of light"), that is, a speed of one cell in each generation. The speed of expansion (in either direction) of the above structure is 2/3, or two cells in three generations.

Another possibility is a structure that neither expands without bound nor dies out but persists in a self-perpetuating state. An example is the rule 0010000000 with initial state 11 (i.e., any two adjacent cells in state 1 with all other cells 0). The first sum will

(continued)

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```
650 LINE (NX,0)-STEP(7,7),CL(J),BF
660 NEXT J
670 FOR Y=0 TO GN-1
680 FOR X=0 TO NC-1
690 IF X=0 OR X=NC-1 THEN V=3 ELSE V=CL(A(X))
700 PSET (X*SF,Y*SF+BY),V  :REM Display the point
710 NEXT X
720 REM ---------------------------------------------
730 REM Compute new state of automaton
740 FOR X=1 TO NC-2  :REM Don't change boundary cells
750 Z=A(X-1)+A(X)+A(X+1)
760 B(X)=RU(Z)
770 NEXT X
780 REM Copy new values to A() from B()
790 FOR X=1 TO NC-2: A(X)=B(X): NEXT X
800 IF INKEY$<>NU$ THEN Y=GN-1 :REM Exit if key pressed
810 NEXT Y
820 WHILE INKEY$<>NU$: WEND :REM Clear keyboard buffer
830 LOCATE 1,17: PRINT "Continue or quit (C/Q)?";
840 CQ$=INKEY$
850 IF CQ$=NU$ THEN 840
860 WH=INT((INSTR(1,"CcQq",CQ$)+1)/2)+1 :REM wh = 1,2,3
870 ON WH GOTO 840, 590, 280
880 REM ---------------------------------------------
890 REM Random initialization of automaton
900 RANDOMIZE
910 FOR J=0 TO NC-1
920 A(J)=INT(RND*4)          :REM Random values from 0 to 3
930 NEXT J
940 RETURN
950 REM ---------------------------------------------
960 REM Initialize array A() with a preset pattern
970 FOR J=1 TO NL
980 IF NC>=J*MI THEN LL=MI ELSE LL=NC-(J-1)*MI
990 K$(J)=STRING$(LL,".")
1000 CLS
1010 PRINT "Rule is: "; R$
1020 PRINT USING "Cells in range ### to ###:"; (J-1)*MI+1,
     (J-1)*MI+LL
1030 PRINT "Move cursor across the field and make"
1040 PRINT "changes as desired. Then press <cr>."
1050 PRINT K$(J)
1060 LOCATE 5,1
1070 LINE INPUT K$(J)
1080 NEXT J
1090 K$=K$(1)+K$(2)+K$(3)+K$(4)
1100 REM Convert string to array values
1110 FOR J=1 TO NC
1120 KK$=MID$(K$,J,1)
1130 IF INSTR(1,"0123",KK$)=0 THEN A(J-1)=BG ELSE A(J-1)=
     VAL(KK$)
1140 NEXT J
1150 RETURN
```

be 1221 and the next state will be 0110, and so will all future states. I like to think of this as a cyclically repeating structure with a period of 1 because all of these permanent entities are cyclic and most have periods of 2 or more. The period of a cyclic structure is the number of generations before the cycle repeats. Some have very long periods and are astonishingly complex.

A structure that eventually dies out is called a "finite structure." Some of these structures can have very long histories before their demise. One shown in the September 1984 *Scientific American* (page 200) had been traced for 1200 generations and was still reproducing and expanding, so whether or not it is indeed finite had not been established. It was generated by the rule 0230011133 and the initial state 11. I programmed the automaton and followed it for hundreds of generations, until it grew too wide for the screen. The fate of such a structure cannot be predicted and can be determined only by simulating it and following it to the end.

These one-dimensional automata are "mathematically irreducible"—there is no shortcut to determine whether a given automaton with a given rule and a given initial state will lead to a cyclic structure of long period, a finite structure of long life, or some other possibility. Therefore, the approach taken by this program is not naive. We are not playing a trivial game whose outcome could be more easily predicted by a more sophisticated mathematical approach.

Of course, a particular outcome can be found much more quickly by expedients such as using a programming language that is inherently faster, a search algorithm that recognizes certain results by techniques more sophisticated than watching the screen, or special hardware that performs the simulation faster than even a computer programmed in machine language.

To find the structures that are shown in this article, I wrote my program in 8088 assembly language. It runs a couple of hundred times faster than the interpreted BASIC program of listing 1. [*Editor's note: The author has provided a set of Pascal programs that duplicate the operation of the* BASIC *program in listing* 1, *but at a much faster rate. Source listings of these programs with documentation, plus the program in listing* 1, *are available on disk, in print, and on* BIX; *see the insert card following page* 320 *for details. Listings are also available on* BYTEnet; *see page* 4.]

Tables 1 and 2 display examples of various structures. Table 1 shows an automaton that supports three different cyclic structures at periods 6, 2, and 1, each defined by its initial state. Of course, any of the states in the cycle can be the initial state. A "state" of a structure is a sequence of cellular "states" that begins and ends with nonzero (or nonbackground) cells and contains mostly nonzero (or nonbackground) cells.

Table 2 shows two automata that support two different propagating cyclic structures that do not stay in

(continued)

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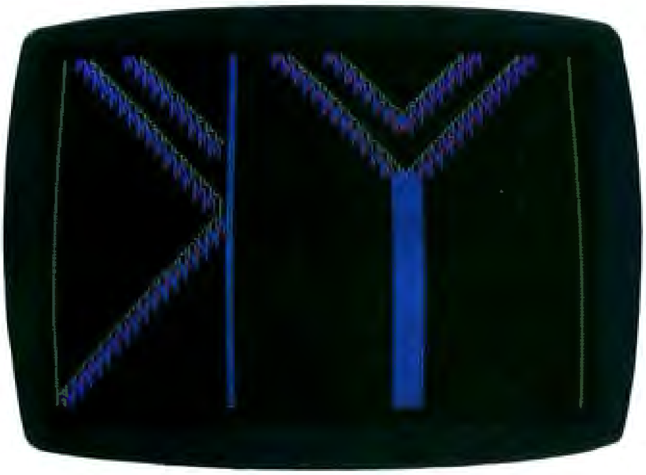

Photo 1: *An example of how gliders react when they encounter fixed structures (rule* 0020303113).

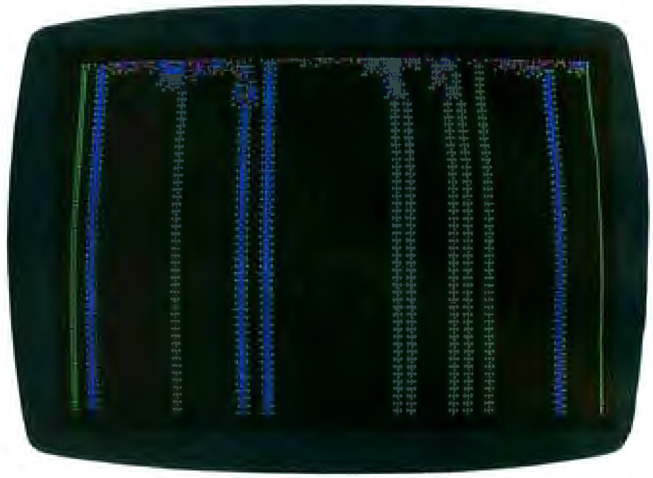

Photo 2: *A class* 2 *automaton showing a pattern of simple, cyclic structures of short period (rule* 0302003132).

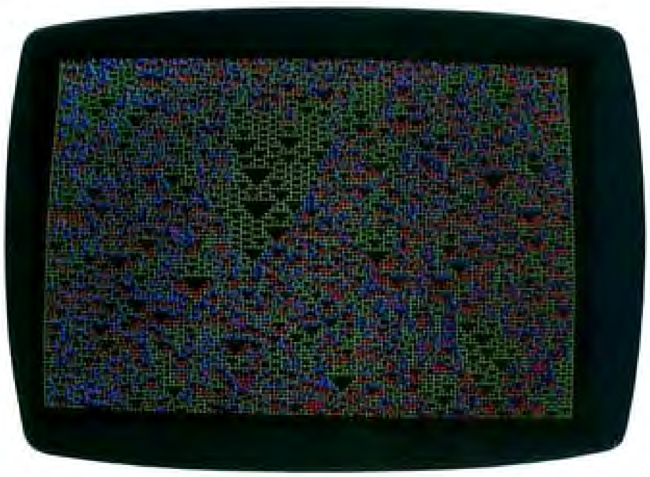

Photo 3: *A class* 3 *automaton exhibiting constantly changing, chaotic behavior (rule* 0121230210).

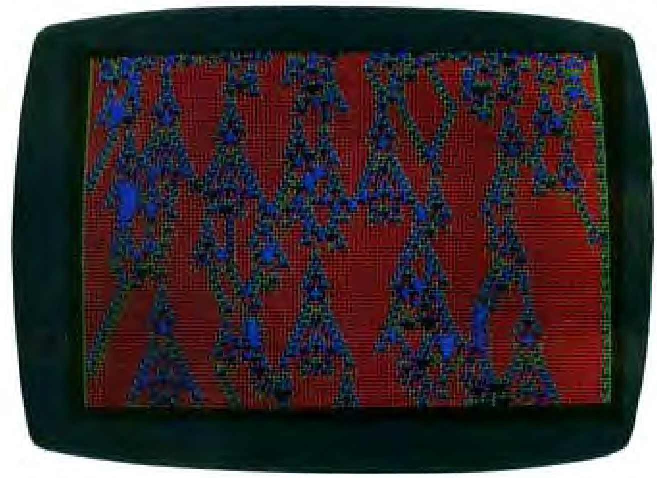

Photo 4: *A class* 4 *automaton that demonstrates the emergence of a nonzero background (rule* 0231123003).

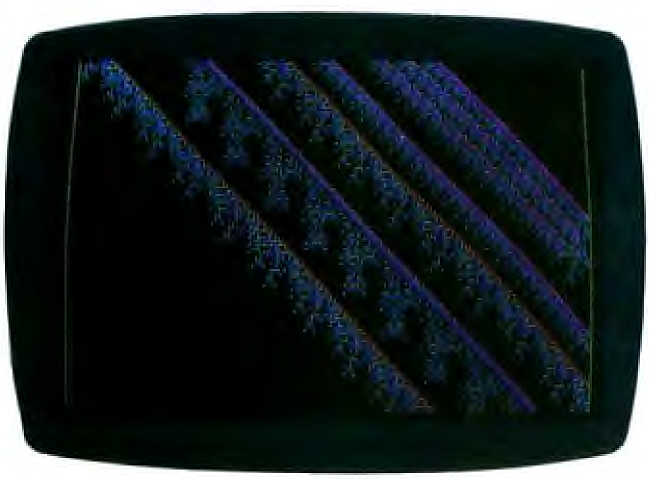

Photo 5: *A complex automaton from a random seed, regenerated for display with a nonrandom initial state (rule* 0102330312).

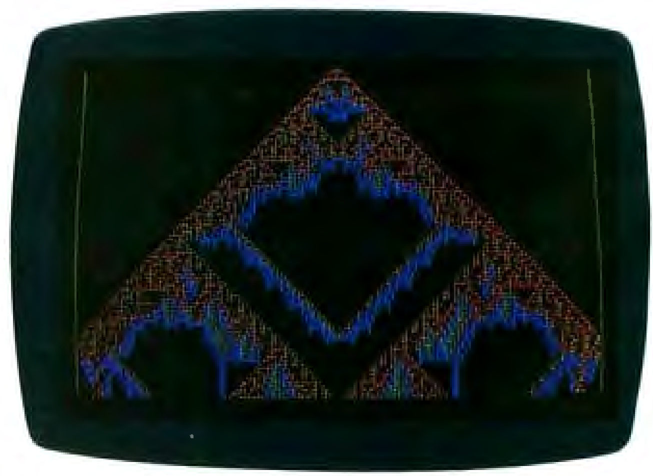

Photo 6: *An automaton discovered by initializing the field to a state with one nonzero cell in the center (rule* 0120133230).

place as do those in table 1 but travel laterally across the field; I call them "gliders." The first example has a period of 4 and travels with a speed of 1; the second has a period of 2 and a speed of ½. You can see that the states of a glider must be asymmetric and that the direction of travel can be changed by reversing the initial state. From this point of view the one-dimensional field can be thought of as a transmission line with structures propagating down it at speeds equal to or less than the "speed of light."

One might ask what happens when a glider encounters a sedentary structure or when two oppositely directed gliders meet each other. Some examples of this are shown in photo 1, an automaton that has the rule 0020303113. In this example, when the glider encounters a fixed structure, it is either stopped and destroyed or "reflected" to travel in the opposite direction. When two gliders collide they either destroy each other or combine to create a new stationary structure. The reason for the alternate behavior is that this glider has a period of 3 and thus consists of three different states; what happens depends on which state first senses the encounter. You can see from this photo that an automaton can contain, at one time, several different structures that evolve independently and do not interfere with each other.

EXTRAORDINARY STRUCTURES

One of the objects of this game is finding complex examples of cyclic structures and very long finite structures.

Photos 2 through 4 show how various automata evolve from random initial states. I have found that the best way to search for interesting rules is to observe how they develop from random initialization. Usually the rule controls the large-scale appearance of the picture on the color monitor screen, while the random initial state affects the detailed or fine-scale appearance. The programmer can generally recognize the "signature" picture of the rule regardless of the random initial state.

Stephen Wolfram has found that all one-dimensional cellular automata of the type I am describing can be placed into four different classes.

Class 1 contains those automata that, for any random initial condition, evolve in only a few generations to the state where all of the automaton's cells are in state 0 (or possibly all in the same nonzero state). These automata always die out very quickly; the other three classes live a very long time if not forever.

Class 2 automata very quickly reach a state where all that remains is a number of simple cyclic structures of short period (see photo 2).

Class 3 automata never die out and never reach the simple stable state of class 2. Instead, they exhibit a constantly changing chaotic behavior (see photo 3). It has been my observation that of all possible rules, more than half show class 3 behavior. Although class 3 behavior is chaotic, it is not random or even pseudorandom. A close inspection of the photo will show many small-scale structures for which the chance of having been generated by a random process is vanishingly small. About 80 percent of randomly initialized automata will fall into class 3.

The only class that I would recommend as being worth investigating in detail is class 4. Roughly one in 30 or one in 50 of randomly selected rules will generate a class 4 automaton. An example of this class is shown in photo 4.

Regardless of the random initial state, certain structures always seem to evolve within a few states for class 4 automata. One feature of these automata that is entirely controlled by the rule is the background color (black, red, and green, respectively, in these photos). It is clear that, whatever the random initial state, the background specified by the rule very quickly shows itself.

How does the rule specify and force a nonzero background? Here's a hint: Note that for a background of 1 (red) the rule number must have a 1 in the place corresponding to a sum of 3. This is necessary for the background to sustain itself since three 1s equal 3. Likewise, for a green background, the rule must have a 2 opposite the

(continued)

Table 1: *The rule defining a one-dimensional cellular automaton supporting three different cyclic structures with periods of 6, 2, and 1. Note: Leading and trailing zeros are omitted.*

```
sum     0 1 2 3 4 5 6 7 8 9
rule    0 2 3 0 3 1 0 1 3 0

state         1 1 1 3
sum         1 2 3 5 4 3
state       2 3 0 1 3
sum       2 5 5 4 4 4 3
state     3 1 1 3 3 3
sum     3 4 5 5 7 9 6 3
state     3 1 1 1
sum     3 4 5 3 2 1
state     3 1 0 3 2
sum     3 4 4 4 5 5 2
state     3 3 3 1 1 3
sum     3 6 9 7 5 5 4 3
state         1 1 1 3

state     3 1 1 0 1 1 3
sum     3 4 5 2 2 2 5 4 3
state     3 1 3 3 3 1 3
sum     3 4 7 7 9 7 7 4 3
state     3 1 1 0 1 1 3

state     3 1 1 3
sum     3 4 5 5 4 3
state     3 1 1 3
```

Table 2: *Propagating automata or gliders that move laterally across the field.*

```
sum     0 1 2 3 4 5 6 7 8 9
rule    0 1 0 3 2 2 0 2 3 2

state     2 2 2 2 3
sum     2 4 6 6 7 5 3
state     2 0 0 2 2 3
sum     2 2 2 2 4 7 5 3
state           2 2 2 3
sum           2 4 6 7 5 3
state           2 0 2 2 3
sum           2 2 4 4 7 5 3
state             2 2 2 2 3

sum     0 1 2 3 4 5 6 7 8 9
rule    0 1 3 0 2 2 3 1 3 0

state     3 3 3 2 3
sum     3 6 9 8 8 5 3
state     3 0 3 3 2
sum     3 3 6 6 8 5 2
state       3 3 3 2 3
```

BASIC Program Notes

BY GEORGE A. STEWART

The BASIC program for the IBM PC (adapted from Perry's original program) lets you try any rule on a random or predefined cellular automaton. It also lets you specify the size of the automaton; the larger the automaton, the longer the program takes to calculate and display each successive state of development.

Lines 90–240 initialize certain program constants. Some of these you may change for special effects as noted in the remarks. The color codes in line 240 correspond to black, green, red, and brown in IBM color palette 0. Array CL( ) rearranges the codes to approximate the colors used in the photographs accompanying this article.

Lines 260–440 prompt you to enter the rule. A "dummy" rule is shown so that you can edit or replace it. In any case, you must move the cursor across all 10 digits of the rule, making changes as desired.

Lines 460–500 let you specify the number of cells in each generation, and lines 520–560 let you select either random or predefined initialization. Subroutines at line 900 and 970 handle the two initialization options.

The program block from 580 to 710 displays a heading and the current state of the automaton. Lines 610–660 print a "color key" to aid in interpreting the progression from one generation to another. The boundary cells are always 0, but the program displays them as color 3 (brown) so they will be visible on the screen (line 690).

Lines 730–810 calculate the next state of the automaton by summing the adjacent cells and applying the rule (lines 750–760). If you press a key while the program is presenting the automaton, a continuation menu appears on the top line, giving you a chance to quit or continue.

Lines 890–940 constitute the random initialization subroutine, and lines 960–1150 make up the predefined state subroutine. The latter subroutine lets you edit the initial state by showing the cell in expanded form. To specify the initial state, you move the cursor across the dots, placing a 0, 1, 2, or 3 as you wish. (The dots will be interpreted as background cells, color 0. To make the dots signify another cell type, change line 190.)

Since the automaton is magnified for editing, it may take several steps to view and edit an entire line. The program displays a maximum of 40 dots or cells at once. Thus a 160-cell automaton will require editing four lines of dots. Remember to move the cursor across all the displayed dots, making changes as you go along. Do not use the delete or backspace key because these will change the length of the input line; instead, use the cursor motion keys and type the desired numbers to make the changes you want.

George A. Stewart is a BYTE technical editor. He can be reached at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Table 3: *A list of 100 rules that generate interesting patterns when specified using the BASIC program in listing 1.*

#	Rule	#	Rule	#	Rule	#	Rule
1	0 001 033 232	26	0 031 202 120	51	0 131 202 112	76	0 232 320 233
2	0 001 321 021	27	0 031 312 330	52	0 200 213 313	77	0 233 332 230
3	0 001 321 200	28	0 100 023 321	53	0 201 102 332	78	0 300 231 232
4	0 001 330 123	29	0 100 222 313	54	0 201 120 011	79	0 301 220 300
5	0 002 023 330	30	0 100 332 102	55	0 201 220 111	80	0 301 223 033
6	0 002 320 123	31	0 100 332 202	56	0 202 032 321	81	0 302 032 310
7	0 010 212 332	32	0 102 013 322	57	0 202 301 321	82	0 302 033 010
8	0 010 322 003	33	0 102 030 022	58	0 202 330 211	83	0 302 230 132
9	0 010 332 330	34	0 102 323 201	59	0 203 002 120	84	0 302 311 102
10	0 010 332 321	35	0 102 330 023	60	0 203 021 013	85	0 303 023 003
11	0 011 202 122	36	0 102 330 312	61	0 210 033 210	86	0 303 210 023
12	0 012 003 101	37	0 102 330 322	62	0 211 030 031	87	0 310 012 320
13	0 012 011 001	38	0 103 022 021	63	0 211 303 210	88	0 310 021 113
14	0 012 031 221	39	0 103 023 003	64	0 213 102 233	89	0 310 103 220
15	0 012 300 103	40	0 103 202 100	65	0 220 132 200	90	0 310 122 002
16	0 012 322 132	41	0 103 220 011	66	0 221 312 221	91	0 322 202 330
17	0 013 103 112	42	0 103 220 232	67	0 222 100 323	92	0 323 101 303
18	0 020 122 112	43	0 112 322 130	68	0 223 010 033	93	0 330 102 221
19	0 021 312 200	44	0 120 302 230	69	0 223 200 322	94	0 330 102 303
20	0 023 302 220	45	0 120 133 230	70	0 230 011 001	95	0 331 310 203
21	0 030 023 231	46	0 120 203 330	71	0 230 120 333	96	2 000 133 101
22	0 030 210 333	47	0 121 302 210	72	0 230 122 000	97	2 031 013 013
23	0 031 022 131	48	0 130 023 230	73	0 230 210 333	98	2 112 013 330
24	0 031 100 120	49	0 130 203 301	74	0 231 220 233	99	2 120 203 330
25	0 031 123 002	50	0 131 123 000	75	0 231 331 233	100	3 310 013 031

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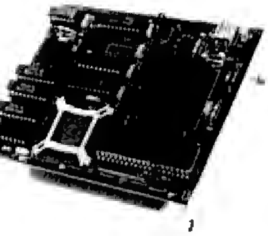

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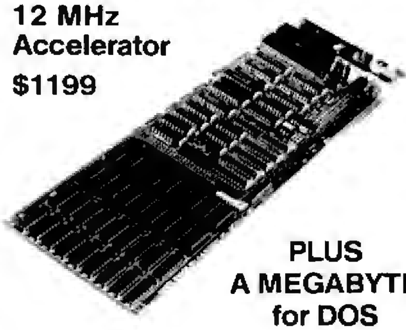

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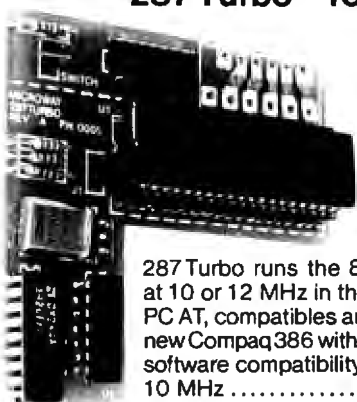

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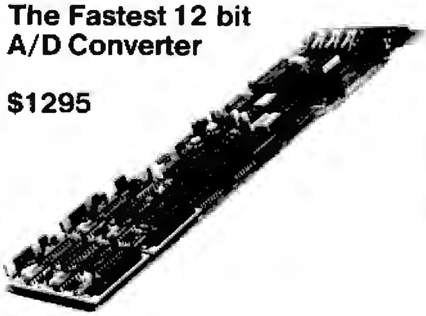

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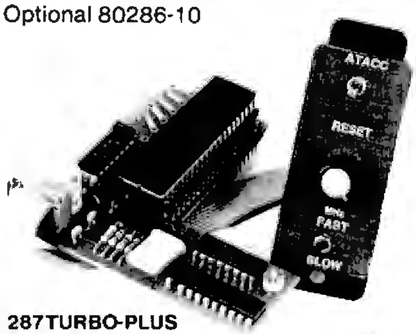

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The field of complex systems theory touches on many phenomena, including the growth of a snowflake and complex patterns found in sea shells.

sum of 6, and for blue there must be a 3 at the sum of 9. These are necessary but not sufficient conditions for a rule to force a nonzero background.

Class 4 automata are characterized by the ability to support a number of different, often complex, "persistent structures," as Wolfram calls them, namely stationary cyclic structures and gliders.

It is not easy to know if you have found *all* of the persistent structures that are supported by a rule, particularly if the only method used is the random initial state of the automaton. A structure appears only if one of its states is created by chance, and even then it may be destroyed by interference from nearby structures. Some simple structures will appear almost every time you try a new random initialization, and some complex structures, all of whose states are very long (10 or 20 cells), have such a low creation probability that they are never seen.

Luck and patience are the principal weapons for bagging the big game in this abstract wilderness.

Photo 5 comes from an automaton that supports some rather baroque gliders that, while propagating, sputter off structures of pendulant filigree. These gliders were, as usual, found by chance and patience in the random initial state mode, then carefully arranged in the predefined initial state mode to produce the picture shown.

An alternative method of searching for class 4 automata, and one that I used before discovering the random-search method, is to initialize with a field consisting of a single nonzero cell, preferably in the exact center of the field. This usually displays the automaton expanding at some speed less than or equal to the speed of light and sometimes shows the automaton to best advantage. Photo 6 shows an example of how very complex and enchanting structures can evolve from apparently simple beginnings.

Table 3 is a list of 100 of the rules that I found to produce interesting displays on the color screen.

CLOSING WORDS

Programming cellular automata is an interesting computer pastime and something worth studying for the fun of it. This is a valid approach; to quote from reference 2, "The cellular automaton can be viewed as a 'digital universe' worth exploring for its own sake, quite apart from its utility as a model of the real world."

But the people who make it their business to investigate these things take them more seriously and (as I understand it) believe that the study of complexity in these automata may lead to a better understanding of complexity in nature. This field is called "complex systems theory," and it touches on many phenomena, including the growth of a snowflake, complex patterns found in some sea shells, and perhaps even the development of a single cell into a multicellular adult organism.

The Game of Life is a very good game, but, as I have tried to show, it is only one of an infinite number of undiscovered entities that exist in the digital universe of cellular automata. ■

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THE TMS34010 GRAPHICS SYSTEM PROCESSOR

BY CARRELL R. KILLEBREW JR.

This bit-addressable graphics engine features an on-chip instruction cache and pipelined architecture

THE TEXAS INSTRUMENTS TMS34010 Graphics System Processor (hereafter referred to as the GSP) can execute at burst rates of 6 million instructions per second (MIPS) when it is clocked at 50 megahertz. On-chip hardware generates bit-mapped graphics an order of magnitude faster than general-purpose microprocessors. Pipelining enhances the GSP's processing capabilities; during one 160-nanosecond machine-state time, the GSP can read from two registers, write to one register, decode one instruction, execute the current instruction, and initiate or complete a local memory cycle.

The TMS34010 chip achieves this performance through internal parallelism, supported by a 256-byte instruction cache, thirty-one 32-bit registers, variable-width ALUs (arithmetic logic units), single-cycle instructions, a barrel shifter, and mask-merge hardware. The built-in VRAM/DRAM (video RAM/dynamic RAM) interface and display control circuitry simplify interface design. The GSP functions as the host central processor or as a dedicated slave processor via an 8- or 16-bit host port, providing indirect access to the GSP's local memory space.

BASIC ARCHITECTURE

The GSP provides separate interfaces to the graphics display, the host processor, and its own local memory bus. The host interface determines whether the GSP is functioning independently or as a slave to a host processor. When functioning as a slave, the GSP host interface transfers programs, data, and graphics display lists between host memory and the GSP's local memory. In stand-alone applications, the GSP manages its own peripherals via the local memory bus. Display refresh and local memory refresh are performed by the local memory controller at intervals controlled by programming on-chip I/O registers. All instructions and data used by the GSP during program execution come from its local memory.

Instructions are normally fetched from local memory and stored on-chip in the 256-byte instruction cache. When a cache miss occurs, the GSP fetches and loads instructions into the least-recently-used segment of the cache. Instructions are decoded prior to execution (pipelining). All major data paths, registers, and ALUs in the GSP are 32 bits wide. Pixel sizes are fixed at binary powers of two (1, 2, 4, 8, 16), but data other than pixels can be arbitrarily sized between 1 and 32 bits (programmable field width). Data fields less than 32 bits are extended to 32 bits when loaded into GSP registers. This extension feature is also programmable. Note that data fields can cross word boundaries, but those that do require multiple memory cycles.

The GSP achieves its high graphics operation throughput by processing several pixels in parallel. When the pixel size is programmed, the ALUs

(continued)

Carrell R. Killebrew Jr. is a graphics engineering manager at Texas Instruments. He can be contacted at Texas Instruments, 9901 South Wilcrest, P.O. Box 1443, MS 6410, Houston, TX 77099, or via BIX. A TI-supported BIX conference (ti.graphics) is available for additional information.

The author gratefully acknowledges the editorial contributions of Jerry Van Aken (TI) and Chuck Weston (BYTE).

are configured to perform simultaneous Boolean or arithmetic operations upon multiple pixels of that size. (The ALU carry chain is broken at pixel-size intervals, creating a series of smaller ALUs.) Plane masking and transparency are applied concurrently with Boolean or arithmetic operations, thereby increasing graphics parallelism. Photo 1 shows the GSP's 22 pixel-processing operations.

DISPLAY CONTROL

The display control interface provides direct control of display devices (color monitors, laser printers, etc.) and initiates VRAM shift-register load cycles for display refresh. The display control signals consist of a clock input (VCLK), horizontal and vertical synchronization inputs/outputs (HSYNC and VSYNC), and a blanking output (BLANK). HSYNC, VSYNC, and BLANK timing is controlled by values loaded into timers and comparators from the display control I/O registers. As an added capability, software can configure either or both HSYNC and VSYNC as inputs, thus slaving display timing to other devices/systems, such as cameras or multiple GSPs. (Note that VCLK is independent of the GSP processor state clocks and increments the display control timers.)

You can use the display interrupt to synchronize graphics drawing to the display. This GSP internal interrupt ensures that objects move only once per frame interval. The display interrupt occurs whenever the vertical line count equals the value in the display interrupt (DPYINT) register.

Display refresh is accomplished by the VRAM shift-register load cycles, which take place on the GSP's local bus: Display refresh cycles typically occur once per display scan line, consuming approximately 1.5 percent of local memory bandwidth. Display control logic initiates requests for these cycles at programmed intervals.

HOST INTERFACE

Host processors can communicate with the GSP via the host interface at sustained maximum data rates of 5 megabytes per second. The host interface is configurable for 8- or 16-bit slave buses and provides bidirectional pipelined DMA between local memory and the host data register.

The interface is implemented with four host registers and a host communications bus (see figure 1). A 32-bit address pointer into GSP local memory is formed by concatenating two host address registers, HSTADRH and HSTADRL. The host data register (HSTDATA) contains 16 bits of data from the location in GSP local memory to which the host address registers point. The host control register (HSTCTL) contains two 3-bit message fields (one field for host-to-GSP communications and one field for GSP-to-host communications), 2 bits controlling host-related interrupts, the GSP halt bit, a cache flush bit, 2 bits to control auto-incrementing the host address registers upon HSTDATA read/write, and a bit to control most-significant-byte convention (Intel versus Motorola).

The host communications bus has 16 data lines (HD15–0) and 10 control lines consisting of a chip select (HCS), read and write strobes (HREAD and HWRITE), upper and lower data-byte strobes (HUDS and HLDS), a transaction-ready signal to the host (HRDY), function selects (HFS0 and HFS1), an interrupt to the host (HINT), and the GSP reset (RESET). Data-drive conditioning by HUDS and HLDS can force either HD15–8 or HD7–0 to remain tri-stated during a host interface access.

The GSP powers up halted or free-running depending on the state of HCS when RESET transitions from a low to high state. In the case of a halted power-up, you can load the boot program via the host interface, eliminating the cost of boot ROMs. The GSP, used as the host processor (as in a 32-bit personal computer), would typically use the free-run mode on power-up. All host interface registers are also accessible as I/O registers in GSP local memory space.

LOCAL MEMORY INTERFACE

The GSP interfaces directly to dynamic and video RAMs, supporting instruction fetch and data manipulation at 6 megabytes per second. This local interface consists of 16 triply multiplexed address/data lines (LAD0–15), an input clock (INCLK), two output clocks (LCLK1 and LCLK2), and 12 control signals.

A microcoded memory controller schedules DRAM and display refresh, arbitrates local bus access by all devices, and generates all local memory control signals. In addition to managing the local memory interface,

(continued)

Photo 1: TMS34010 *pixel-processing operations, including Booleans and arithmetics.*

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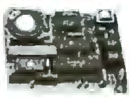

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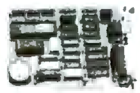

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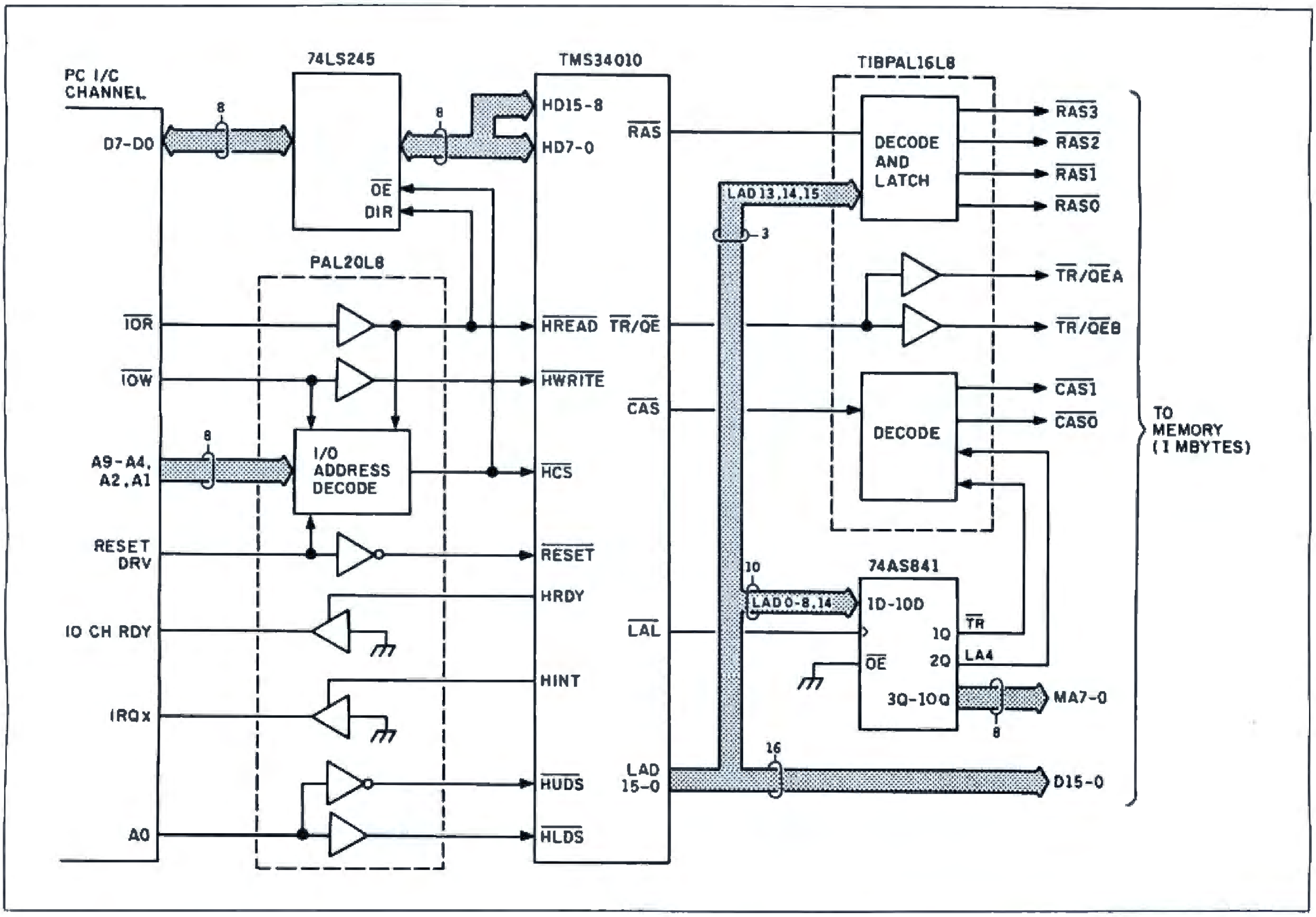

Figure 1: A *typical* TMS34010 PC-*compatible interface, using four* TTL *packages. This interface supports a* 1024-*horizontal by* 756-*vertical* 8-*bit-per-pixel display and* 256K *bytes of program memory.*

the bus controller improves instruction execution times and performs data alignment on variable-width data fields.

A typical memory cycle takes two GSP machine states. The first state transmits the memory address, and the second state transfers the data. During the address portion of the cycle, both row and column addresses are broadcast on the LAD pins accompanied by $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$ strobes. The address bits available on any individual LAD pin are offset by eight to facilitate direct connection to 64K by 1-bit and 64K by 4-bit (256K) DRAMs and VRAMs. An additional strobe ($\overline{\text{LAL}}$) is provided to externally latch column addresses.

A dynamic memory interface (microprocessors traditionally have static memory interfaces) simplifies system design. Both $\overline{\text{RAS}}$-only DRAM-refresh and $\overline{\text{CAS}}$-before-$\overline{\text{RAS}}$ DRAM-refresh memory cycles are supported for GSP local memory. Display refresh is accomplished by a variant of the basic memory cycle in which the $\overline{\text{TR}}/\overline{\text{QE}}$ signal toggles to indicate a VRAM shift register transfer cycle.

Instruction times are improved during write operations by decoupling the execution unit from the local bus with the memory controller's 32-bit write queue. Instructions can write from 1 to 32 bits to the queue. The controller completes the write to local memory; it can delay instructions requiring access to local memory if it has not completed a previous write. The memory controller automatically performs the bit-alignment and data-field insertion/extraction needed for data transfer operations.

Instruction Cache

The GSP's on-chip 256-byte instruction cache lets the local bus transfer data as its primary function. Instruction fetches compete less with data accesses for memory-bus bandwidth because most of the GSP's execution time is spent in loops contained in the instruction cache, and the cache is always accessible in a single machine state (160 ns). Local memory instruction fetches require two machine states (320 ns). The instruction cache yields another performance increase because instruction decode occurs while the preceding instruction is executing. (Instruction decode is not pipelined when executing from local memory.)

The cache holds 128 16-bit instruction words. Instructions consist of single-word op codes as well as immediate data and immediate addresses. Data that is not part of an instruction is always accessed in local memory, not the cache. The cache is

(continued)

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organized as four segments of 64 bytes. Each segment may contain a program loop from a different area of memory. Instructions stored in the cache are prefetched without delay. When a cache "miss" occurs (the next instruction is not present in the cache), the four-word block of instructions containing the next instruction is fetched from local memory and loaded into the least-recently-used (LRU) segment. The four-word instruction blocks are known as subsegments. There are eight subsegments in each segment. Cache control logic manages subsegment loading into the LRU segment. An LRU stack indicates which segment has been least recently used.

Software can disable and flush the cache when the cache flush (CF) bit in the host control high-byte (HSTCTLH) register is set to 1. When the cache is disabled, the processor fetches one instruction at a time from local memory for execution. Flushing the cache forces the cache to load new instructions. Resetting CF to 0 enables the cache and causes an immediate cache load. The cache disable (CD) bit of the control register only temporarily disables the cache when set to 1. When CD is reset to 0, instructions retained in the cache are once more available for execution. Both the host and GSP software can manipulate CF and CD.

Instruction cache operation is automatic and transparent to software. Tuning software for the cache is usually unnecessary due to GSP architecture and instruction set synergism. Code loops are smaller because of the specialized graphics instructions, and the large general-purpose register files let operands remain in registers. A number of graphics parameters can be placed in dedicated memory locations (the on-chip I/O registers), which also eliminates the code necessary to move them into and out of registers (see figure 2, the GSP programming model).

MEMORY

Memory size is specified in bits because the GSP is a bit-addressable, field-width-programmable processor. Although the GSP architecture supports a 4-gigabit (512-megabyte) address space, the first-generation device does not make the most significant 2 address bits available (30 bits of address equals 1 gigabit, or 128 megabytes).

In GSP memory, the least significant bit of data always has the least significant memory address. When accessing memory, the GSP always reads or writes 16 bits of data per bus cycle. Bit-level addressing is transparent to the programmer. The local memory controller initiates the read-modify-write cycles, performs the mask-merge operations, and keeps track of the next bit available for use.

The GSP memory organization consists of traps and vectors at the top of memory, followed by the I/O registers, and then the general-purpose usage at the bottom of memory (see the memory map in figure 2). GSP accesses to the I/O registers are internally decoded, and their addresses are not broadcast on the local bus.

VARIABLE-WIDTH DATA

GSP data is not fixed at discrete sizes (e.g., bit, byte, word, double word) as is common in most processor architectures. The GSP supports four types of data structure: bytes, bit fields 1 and 2, pixels, and two-dimensional pixel arrays.

While the byte size is fixed at 8 bits, sizes of the other data structures are software-configurable. Fields and bytes can start at any bit address. Data-word (16-bit) boundary alignment is not required. Pixels can be 1, 2, 4, 8, or 16 bits and are packed 16, 8, 4, 2, or 1 to a memory word, respectively.

The most common data type is the bit field. The GSP simultaneously supports two independently sized bit fields, each from 1 to 32 bits wide. Since all data paths and registers in the GSP are 32 bits wide, a field-extension bit associated with each field size causes data to be internally extended to 32 bits. Bit-field size and extension are specified in the STATUS register.

Graphics is supported by the pixel data type. Pixel size is specified in the PSIZE register. The GSP supports a "packed-pixel" data format in which all bits belonging to a pixel are contained in the same memory word. Pixels are constrained to word boundaries in memory. In contrast, a planar-pixel-organized format places each of the bits comprising a pixel in a different region of memory. (See the text box "Packed-Pixel Memory Organization" on page 200.)

REGISTERS

The STATUS register contains the N (negative), C (carry), Z (zero), and V (overflow) flags set according to the results of arithmetic and logical oper-terrupt enable bit (IE), the PBX flag (indicating that LINE, PIXBLT, or FILL (indicating that LINE, PIXBLT, or FILL execution was interrupted), and two sets of field-size and field-extension bits (FS0, FE0; FS1, FE1). When the extension bit for a field is set to 0, the field is extended with 0s during register loads. Conversely, data is sign-extended when the extension bit is set to a 1.

The program counter (PC) is 32 bits wide, but the 4 least significant bits are always 0s. Instructions are one or more 16-bit words long and are always aligned to even, 16-bit-word boundaries. The PC can be loaded with immediate data or changed as a result of instruction execution (branches, calls, etc.) and interrupts. The PC always points to the address of the next instruction to be executed.

The stack pointer (SP) points to the word at the top of the system stack. (The system stack grows toward lower memory addresses; therefore, the top of the stack is at the lowest stack address.) The SP is addressable as register 15 in both the A and B register files. The user can implement additional stacks with any of the 30 general-purpose registers.

GRAPHICS REGISTERS

The twenty-eight 16-bit I/O registers are associated with interfaces and graphics functions. The CONTROL register is the most important of the I/O registers associated with graphics and contains bits that control graphics processing. Transparency is enabled by setting the pixel transparency bit (T) to 1. Transparency prevents new

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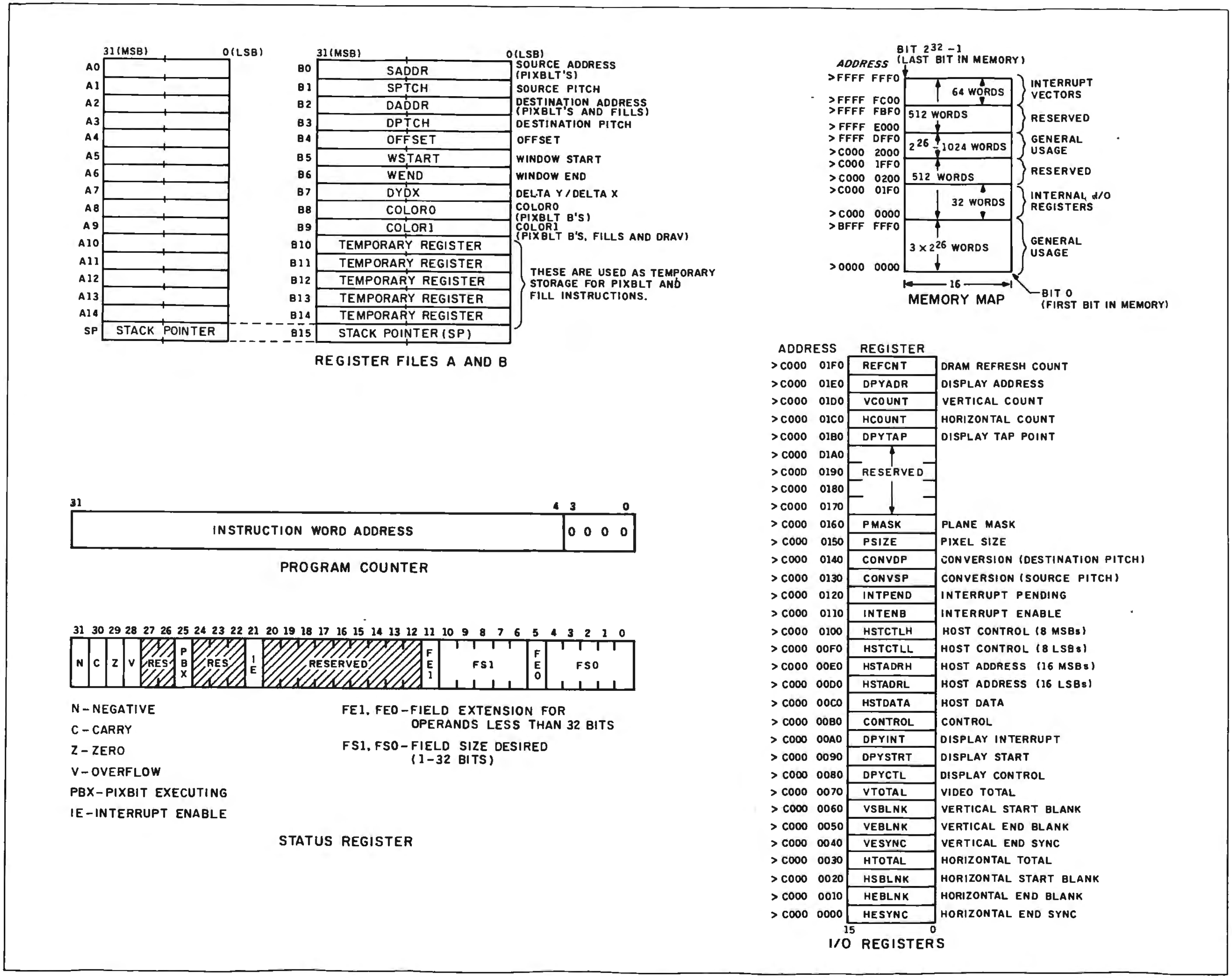

Figure 2: *The programmer's model of the TMS34010 GSP.*

pixels with a value of 0 from overwriting older pixels (only meaningful portions of foreground objects obscure background objects). A 2-bit, window-checking (W) field supports four different window operations, including clipping and picking of screen objects. By setting W appropriately, you can inhibit pixel writes and/or generate interrupts. The PBH bit determines whether PIXBLTs and FILLs take place from left to right or right to left, and the PBV bit selects from top to bottom or bottom to top. Control of pixel-processing order is provided for those instances in which source and destination pixel arrays overlap.

The CONTROL register's pixel-processing (PP) field is 5 bits wide and lets the programmer select among 22 pixel-processing operations. These operations include 16 two-operand Boolean operations and 6 two-operand arithmetic operations. Pixel processing is invoked whenever you use the PIXBLT, FILL, DRAV, PIXT, and LINE instructions.

Two registers, CONVSP and CONVDP, provide the GSP with information on the "pitch" of source and destination pixels. Pitch is the difference in memory addresses between two vertically adjacent pixels in a bit map or pixel map. Pitch is useful for com-

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PACKED-PIXEL MEMORY ORGANIZATION

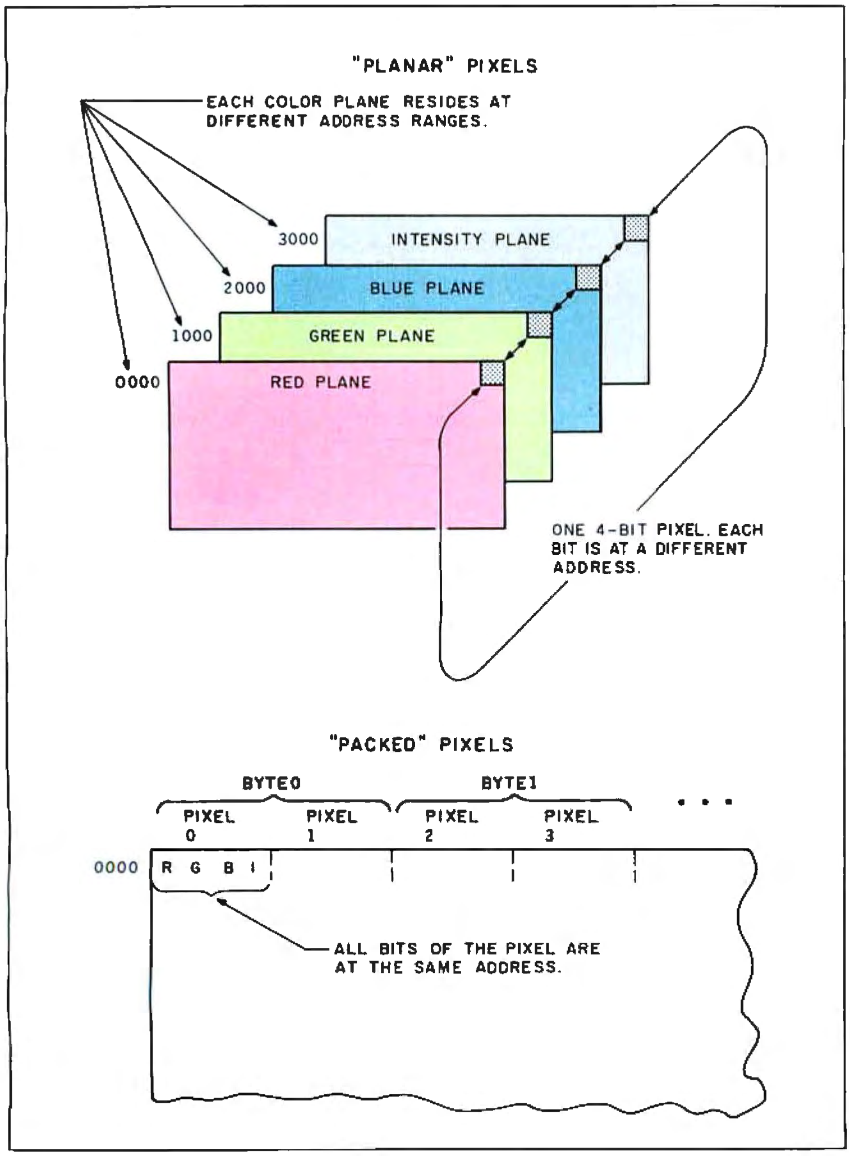

Figure A: *Planar- and packed-pixel memory organization.*

Packed pixels have an advantage in operations that act upon all bits of the pixel, because the entire pixel is accessed in a single bus cycle. Graphics systems with bit-plane-organized memories are usually limited to Boolean operations on pixels due to the difficulty of handling carries between bits. In bit-plane-organized memory, the memory words from each bit plane must be fetched, and 1 bit from each word extracted and combined with all of the constituent bits of the pixel before arithmetic operations can begin on the pixel. This is a great disadvantage in applications that combine anti-aliased images, for example.

In a packed-pixel-organized memory, all bits comprising the individual pixel are contained within the same word, eliminating the steps needed to manipulate pixels in a planar-pixel-organized memory. Variable-width ALUs allow parallel processing on each pixel (byte) simultaneously (some pixels are actually larger than 1 byte in size). For instance, one 32-bit packed-pixel memory word would contain all eight of the 4-bit pixels shown in figure A. (Only one instruction is required to process every pixel.)

During graphics operations, pixel array size is specified by placing the x and y dimensions in the lower and upper 16 bits, respectively, of general-purpose register B7. Plane masking prevents operations from affecting all bits in a given pixel array, thus providing most of the advantages of a bit-plane organization in a packed-pixel system. In the TMS34010, pixels have a processing advantage over bit fields. Bit fields can be processed one at a time, but multiple pixels can be processed in parallel.

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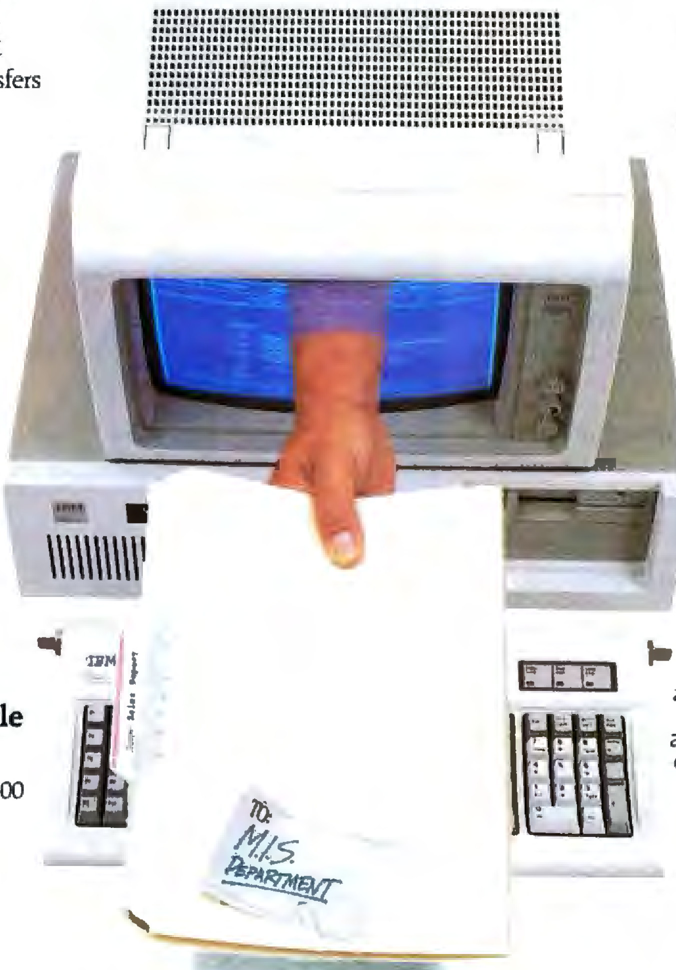

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puting the memory address of data to be accessed in an x,y fashion. Although linear storage (consecutive memory addresses) might be desirable for disk usage, on a display it is more natural to manipulate two-dimensional arrays of pixels and to specify data locations as being offset by x and y displacements from an origin. The GSP uses the CONVSP and CONVDP registers to support windowing computations, to perform x,y-to-linear address conversions, and to adjust the starting corner address for PIXBLTs.

The pixel size (PSIZE) register provides GSP microcode with the bit width of pixels being processed. The microcode uses PSIZE primarily to disconnect the ALU carry chain between pixels so that the ALUs can simultaneously process multiple pixels. Pixel bits (planes) can be protected or masked from pixel-processing operations if you set the appropriate bit in the plane mask (PMASK) register. Plane masking creates effects such as text planes that overlay graphics planes. This is one way of mixing text and graphics on a display without destroying useful information.

CONTROL, PSIZE, and PMASK let GSP graphics algorithms be virtually independent of pixel size and processing. For instance, using one algorithm to draw XORed circles with 4-bit pixels and a different algorithm to draw ORed circles with 8-bit pixels is no longer necessary. A single, robust, circle-drawing algorithm controls pixel processing (transparency, masking, Booleans, and arithmetics) and pixel size by modifying only the CONTROL, PSIZE, and PMASK registers.

Registers COLOR0 and COLOR1 reduce the amount of table area necessary to store multicolored fonts. A 1-bit-per-pixel representation of the font or object is stored in memory, along with two color attributes, a "0" color (in COLOR0) and a "1" color (in COLOR1). Figure 3 shows the expansion of a 4-bit, 1-bit-per-pixel pattern into four 4-bit pixels.

General-Purpose Registers

The GSP has thirty 32-bit general-purpose registers divided into two files, A and B. General-purpose registers can be used for both address pointers and data, and they are easier for programmers to use, since no special characteristics are associated with any particular register.

Processors with many general-purpose registers are faster for most applications, since time-consuming data swapping between memory and registers is reduced (on-chip registers are faster than main memory). Graphics operations are especially demanding, since many variables must be manipulated during drawing operations.

Graphics Operations

Graphics operations implicitly use the B register file for operands and temporary storage. This convention allows graphics microcode direct access to operands affecting the graphics operation. Other benefits accrue to this design as well; iterative graphics instructions are interruptible. For example, if a LINE operation violates a window boundary, the operation can be interrupted, a decision made, and the operation restarted or aborted. Graphics instructions can be restarted because the microcode stores temporary variables in registers B10 through B14 when the interruption occurs.

The PSIZE register lets the ALUs process each pixel as an individual entity (the fourth bit of a 4-bit pixel has no effect upon the first bit of an adjacent pixel). Additional ALU support for graphics includes a single-cycle, 32-bit barrel shifter and mask-merge hardware for changing pixel locations within data words and registers.

For all graphics operations, the least significant pixel address on the display is located at the origin, which is software-configurable to the upper left or lower left corner of the display.

GSP Instructions

The GSP has a complete general-purpose instruction set (127 instructions) with enhancements for floating-point arithmetic, graphics, and windowed environments. The general format for all instructions follows the convention that the first instruction word (16 bits) contains the op code and subsequent words contain immediate data or immediate addresses. Addressing modes include direct register, indirect through a register, indirect through a register with a signed displacement, indirect through a register with predecrement, indirect through a register with postincrement, and absolute address.

The GSP executes floating-point operations as fast as floating-point coprocessors by using special instructions and hardware. Floating-point software uses the fast (160-ns) barrel

(continued)

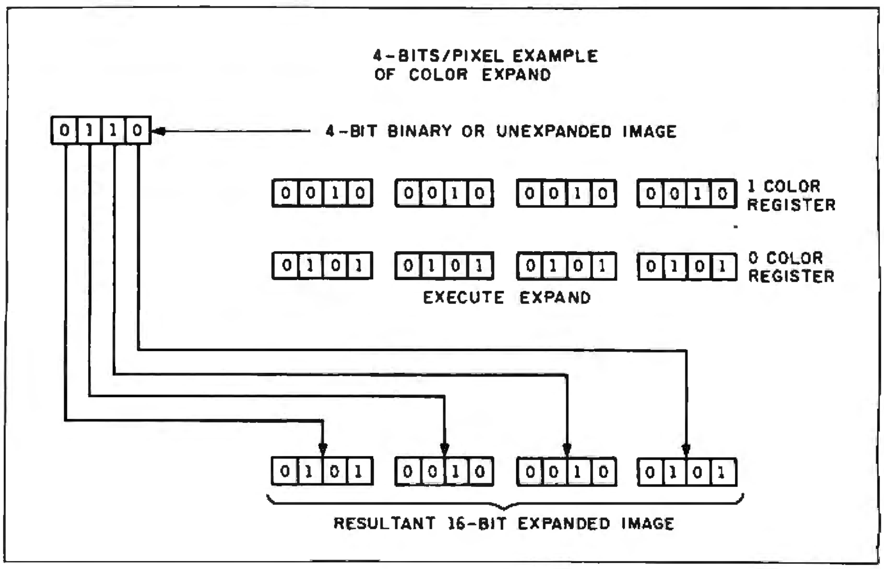

Figure 3: *The color expand operation.*

shifter and mask-merge hardware to extract exponents and mantissas from floating-point data. After the exponents and mantissas of the multiplier and the multiplicand have been manipulated appropriately, the leftmost one of the resulting mantissa is detected with the LMO (leftmost ones detect) instruction in a single machine state (160 ns). The position of the leftmost one determines how many positions the barrel shifter will rotate the mantissa for normalization. After normalization, the exponent is adjusted, and the exponent and mantissa are spliced back together using the inverse of the sequence that dissected them.

PIXBLT OPERATIONS

The most important graphics instruction is the PIXBLT. This importance is underscored by the fact that most of the graphics microcode is dedicated to the PIXBLT instruction. PIXBLT, or pixel block transfer, is closely related to the BITBLT (bit block transfer), a method for operating on two-dimensional bit arrays with Boolean operators. BITBLT is good for dealing with black-and-white displays but has drawbacks when handling gray-scale and color displays (what does it mean to XOR red with green?). PIXBLT is the concept of the BITBLT generalized to operations on two-dimensional pixel arrays using arithmetic as well as Boolean operators.

Consider the graphics problem of minimizing the "jaggies." Jaggies is another name for aliasing, which is the stair-step effect visible when displaying nonvertical or nonhorizontal lines. Anti-aliasing methods have been developed to fool the eye into seeing a smooth nonjagged line by setting pixels adjacent to the line to lower intensity values than the original pixels. In the case of two intersecting anti-aliased lines, computing the intensity values of pixels formed by merging two lower-intensity pixels with only Boolean operators is much more difficult (perhaps impractical) than the case where some simple arithmetic operators are available; hence the PIXBLT.

The GSP PIXBLT supports all 16 two-operand Boolean instructions, as well as add (two pixels to each other), subtract (two pixels, one from the other), add-with-saturate (clamp at all 1s), subtract-with-saturate (clamp at all 0s), minimum (compare two pixels, picking the pixel with the minimum value), and maximum (inverse of minimum).

When you invoke PIXBLT, registers B0 through B7 must already contain the source pixel-array address and pitch, destination pixel-array address and pitch, location of the screen origin, window start and end corners, and pixel-array dimensions. Additionally, if you invoke PIXBLTB (PIXBLT with binary expansion), registers B8 and B9 must contain the background and foreground colors, respectively. For all PIXBLTs, the CONTROL, CONVSP, CONVDP, PSIZE, and PMASK registers must also contain the information appropriate to the desired result.

WINDOWING

The GSP supports windowed environments with two types of clipping: post-clipping and pre-clipping. Both prevent drawing operations from altering display memory outside the currently active window, but pre-clipping is faster.

In post-clipping operations, all the computations necessary to draw the pixel are completed, the pixel location is compared to the available window, and if the pixel lies outside the window, it is not drawn. The GSP supports post-clipping for all instructions capable of drawing pixels by using the W field in the control register.

Pre-clipping is automatically applied to PIXBLTs and FILLs. Pre-clipping is typically applied to line-drawing operations and involves trivial rejection of lines and line segments that lie completely outside the window. Trivial rejection lets the drawing engine (in this case the GSP) conserve all the bandwidth that would have been consumed computing pixels that can't be seen. The GSP supports implementation of the Cohen-Sutherland algorithm for pre-clipping with a special instruction (CPW).

CPW, compare point to window, generates the clipping data used in the Cohen-Sutherland algorithm. The GSP hardware generates 4-bit "outcodes" when CPW is used to compare the endpoints of a line or line segment to the active window. If the result of ANDing the two outcodes of a line (segment) is nonzero, that line (segment) lies completely outside the window and no further processing is required. A zero result from ANDing outcodes means a more rigorous test must be applied. This subject is discussed in the book *Fundamentals of Computer Graphics* by James D. Foley and Andries Van Dam (Addison-Wesley, 1982).

ELIMINATING HAND-TUNING

One of the primary objectives of the GSP's architectural specification is to eliminate hand-tuning graphics code to the application, pixel size, and screen resolution. In the current generation of personal computers, hand-tuning is necessary to achieve acceptable graphics performance. Marginal graphics performance makes using graphics standards difficult. Using standard interfaces makes performance even worse.

The use of VRAM frees the drawing engine from competing with display refresh for memory bandwidth. VRAM is, in effect, dynamic RAM that has been modified by the addition of a long shift register, giving separate ports for screen refresh and processor update of the frame buffer. The GSP architecture supports high-performance flexible graphics software, removing the barriers to using graphics standard interfaces (such as CGI and Microsoft Windows). The use of standard graphics interfaces will let more applications come to market, shorten development cycles, and increase applications portability.

Editor's note: As a service to BYTE *readers, the* TMS34010 *Graphics Design Kit will be available in late January for* $340. *The kit includes a* TMS34010 *Graphics System Processor, the* TMS34010 *User's Guide, and development software. The development software runs on* 512K*-byte* IBM PCs *and compatibles and includes the* TMS34010 *Macro-Assembler, Linker, Archiver-Librarian, Simulator, and a* ROM *utility. Interested* BYTE *readers should write Texas Instruments,* Dept. SPV04, P.O. Box 809066, Dallas, TX 75380-9066. ■

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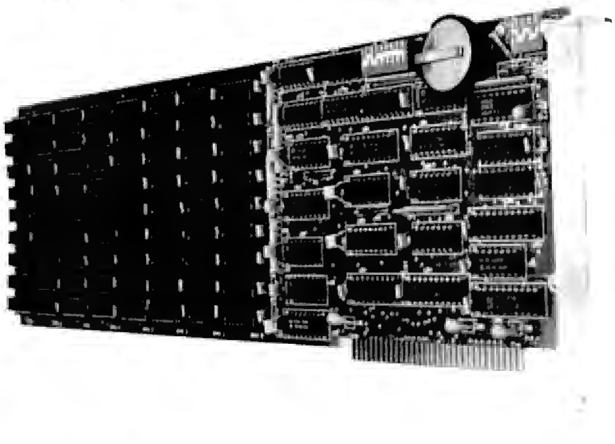

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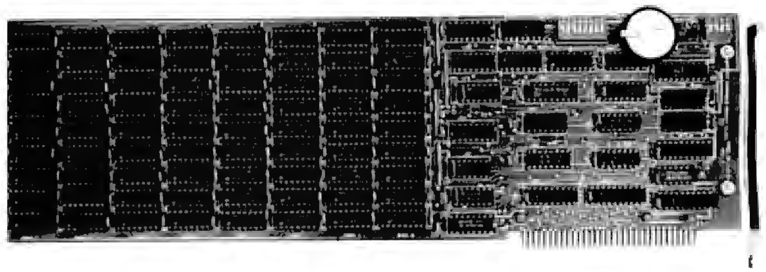

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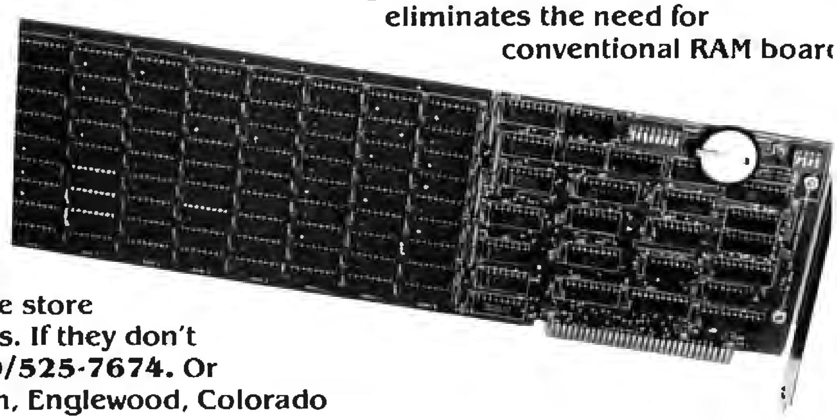

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PLOTTING THE MANDELBROT SET

BY PETER B. SCHROEDER

The more interesting the display, the longer it takes to generate

SOME PEOPLE CAN READ a musical score and in their minds hear the music more gloriously rendered than by any orchestra. Others can see, in their mind's eye, great beauty and structure in certain mathematical functions and number systems. Lesser folk, like me, need to hear music played and see numbers rendered to appreciate their structures.

The Mandelbrot set is one of the intriguing mathematical structures you can explore with the Commodore Amiga. In *The Fractal Geometry of Nature* (reference 1), Benoit Mandelbrot defines a fractal as "a set for which the Hausdorff Besicovitch dimension [fractional dimension] strictly exceeds the topological dimension."

You can use fractals to describe the fragmentary aspects of nature. Random fractals can simulate landscapes and objects in nature, such as trees and mountains. Mathematical modelers can use them to simulate shoreline decay and its effect on fisheries. Biochemists can use fractals to characterize the irregularity of protein surfaces and its influence on molecular interactions. You can use them to model climate and predict other apparently random and chaotic events (reference 2). You can use them to discover order where no order was previously believed to exist. Even processes of ontogeny—the course of an individual organism's development—that have proved elusive might be explorable using fractal geometry.

You need the definitions of complex, real, and imaginary numbers as a starting point. A complex number is any number of the form $a + bi$ where a and b are real numbers, and $i = \sqrt{-1}$. A real number is one in which there is no imaginary part, and an imaginary number is a complex number with b not equal to zero; some definitions require also that $a = 0$.

Engineers and others dealing with vector mathematics find imaginary numbers useful. For example, if vector b can be turned 180 degrees to point in the opposite direction by multiplying it by -1 so b equals vector $-b$, and there is a number, a, that turns the vector 90 degrees, then a^2 will turn the vector 180 degrees and be equal to -1. Thus, $a = \sqrt{-1}$.

WHAT IS THE MANDELBROT SET?

The Mandelbrot set is a set of numbers $z = c^2 + c$ where c is a complex number of the form $a + bi$ and z iteratively squared never produces a square root of $a^2 + b^2$ larger than 2. Note that since i^2 equals -1, $(a + bi)^2$ equals $a^2 + 2abi - b^2$, and that the iterative squaring of these numbers produces a jagged, nondifferentiable result. If the sum of the squares does grow beyond 4 within a large number of iterations, it will eventually approach *infinity* and, by definition, not be part of the Mandelbrot set.

If you take a matrix, a by b, and iteratively square every element in it until either the sum of their squares exceeds 4 or you reach 1000 iterations, you can determine a count of the number of iterations that each element in the array requires. Those elements with counts of 1000 are part of the Mandelbrot set; those elements with counts that are very large but still less than 1000 are near the Mandelbrot set; and those with low counts

(continued)

Peter B. Schroeder is president of Biosystems Research Inc. (11550 Southwest 108 Court, Miami, FL 33176). He is a biological consultant specializing in wetland and estuarine environments. He has a Ph.D. in biology from the University of Miami in Coral Gables.

are far from it. If you assign colors to each count or range of counts and color each pixel of the matrix display accordingly, you can graphically display the Mandelbrot set and its neighboring numbers. In a sense, the varying colors represent the fractal dimension distance from the Mandelbrot set for particular matrix elements.

SMALLER IS BIGGER

Fractal numbers have funny qualities. If you magnify areas near the Mandelbrot set, you will find minute imperfect replicas of the larger Mandelbrot set. If you increase the magnification even more, you find even more minute associated replicas, and so on ad infinitum. These components have great beauty and exotic structures, every one varying but always partially replicated at some smaller level.

The magnification you can attain is limited only by your computer's precision. In C, the Amiga stores double-precision floating-point numbers in 64 bits with a precision, therefore, of approximately 2^{63}. It does all its math in double-precision floating-point, and its range for long integers is from −2,147,483,648 to 2,147,483,647 and for double-precision floating-point numbers from $\pm 10.0^{-307}$ to $\pm 10.0^{308}$ with 15 to 16 decimal digits of precision. This precision lets you examine the Mandelbrot set in greater detail than an electron microscope can examine matter. An electron microscope can produce a photo of an object enlarged about 1,000,000 times. You need a magnification between 300,000 to 400,000 times to resolve the facets on the surface of the poliomyelitis virus. If the Amiga were a microscope, its magnification would let you examine the atoms making up those facets.

Areas of interest are those closely associated with the larger Mandelbrot set in photo 1, which represents the numbers from −2.0 to 0.5 on the x axis and from −1.25 to 1.25 on the y axis. Its range is therefore 2.5 along both axes. Photos 2 and 3 are successive enlargements of the small outlined area in photo 1, each with a range 1/20 that of the preceding photo. The rectangular outlined area in all the photos shows the area enlarged in the succeeding photo.

Photo 1: *One instance of the Mandelbrot set representing the numbers from −2.0 to 0.5 on the x axis and from −1.25 to 1.25 on the y axis.*

Photo 2: *An enlargement of the detail in the small box in photo 1.*

THE PROGRAMS

A. K. Dewdney provided the algorithm for describing the Mandelbrot set graphically in *Scientific American* (see reference 3). My programs implementing that algorithm are written in Lattice C; they produced photos 1 through 3. While they take a while to run, they seem brisk compared to a BASIC implementation I tried first. [*Editor's note:* DOSET.C *and* VIEWSET.C *are available in* Lattice C *source code on disk, in print, and on* BIX; *see the insert card*

Listing 1: *The program* DOSET.C, *which calculates the Mandelbrot set.*

```
#include <stdio.h>
#include <math.h>

main(argc,argv) int argc;char *argv[];
{
 int y,x,count,totct;
 float x_coord,y_coord,range,gap,size,a,b,ac,bc,b1;
 char ct[201][2];
 FILE *OutFile;
  /* Input x-y coordinates and range from keyboard   */
  printf("Input X_COORDINATE: ");
  scanf("%f",&x_coord);
  printf("Input Y_COORDINATE: ");
  scanf("%f",&y_coord);
  printf("Input        RANGE: ");
  scanf("%f",&range);
  gap = range / 200.0;     /* Increment per pixel      */
  y_coord += range;        /* Start at top of display */
  /* Open output file      (default or command line)  */
  if(argc<=1) OutFile = fopen("df1:ZOOM.DATA","w");
  else OutFile = fopen(argv[1],"w");
  /* Write coordinates and range to data file         */
  fprintf(OutFile,"%7.6f\n",x_coord);
  fprintf(OutFile,"%7.6f\n",y_coord);
  fprintf(OutFile,"%8.7f\n",range);
  /* Calculate count value for each pixel (200X200)  */
  for(y=1;y<=200;y++)          /* Each row            */
  {
   bc = y_coord - y*gap; totct = 0;
   for(x=1;x<=200;x++)         /* Each pixel per row  */
   {
    ac = x*gap + x_coord;
    a = ac; b = bc; size = 0.0; count = 0;
    while(size < 4.0 && count < 1000)
    {
     /* Do complex-number multiply                    */
     b1 = 2*a*b;
     a = a*a - b*b + ac;
     b = b1 + bc;
     /* Pythagorean theorem                           */
     size = a*a + b*b;
     /* Don't need square root                        */
     count++;
    }
    totct += count;
    /* Code count in two bytes to save disk space     */
    ct[x][0] = count/256;
    ct[x][1] = count % 256;
   } /* End x loop                                    */
   /* Show row number and average count to CRT       */
   printf("%5d  %5d\n",y,totct/200);
   /* Print coded pixel-values this row to data file */
   for(x=1;x<=200;x++)
   {
    putc(ct[x][0],OutFile);
    putc(ct[x][1],OutFile);
   }
  } /* End y loop                                     */
  fclose(OutFile);  /* Close data file               */
 } /* End main                                        */
```

following page 320 *for details. You will need Amiga's translator.library, intuition.library, graphics.library, and narrator.device, as well as the Lattice C compiler, to run these programs. Listings are also available on* BYTE*net; see page* 4.]

DOSET.C (listing 1) lets you pick the *x,y* axis—where you want to begin the display—and supply the distance you

(continued)

Photo 3: *An enlargement of the detail in the small box in photo 2.*

want to cover. The smaller this distance, the greater the magnification. These programs can take a long time—hours, even days—to generate a display. The closer you are to the Mandelbrot set, the longer it takes.

You should pick an *x,y* axis near the edge of the Mandelbrot set (colored red in the photos) for further exploration. If you pick a spot totally within the set, the display will seem to take forever—not literally, since the programs stop counting after 1000 iterations at each pixel—and the display will be a solid color. If you pick a spot where each pixel takes the full 1000 iterations (i.e., within the set proper) and you generate a 200- by 200-pixel display, the Amiga has to carry out 40 million iterations. If an iteration does approximately 20 double-precision floating-point operations, that's 800 million double-precision (64-bit) operations. And if each operation requires manipulating all the bits, that's 51 billion bit operations. On the other hand, if you start far away from the Mandelbrot set, you will finish a lot sooner, but you end up with a correspondingly uninteresting display. So choose a display that includes an area alongside, and maybe including a bit of, the set proper.

VIEWSET.C creates a 200- by 200-pixel graphics display from the data file created by DOSET.C. If you want to pursue this further, try changing the color separation in the program. With the proper color separation, you can find all sorts of interesting objects: trees, jabberwocks, maybe even a self-portrait—or millions of them. Since the Amiga can show up to 640 by 400 pixels, you can also create high-resolution displays. However, these displays take even longer to generate.

New Horizons

If you do look into the Mandelbrot set, happy exploring. The going may be slow, but the region is huge and will always remain largely unexamined. Because of the time involved, if you just want to look at the displays I have already generated, I will mail you a disk full of them at my cost ($10). You may share it as you wish. ■

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3. Dewdney, A. K. "Computer Recreations: A Computer Microscope Zooms in For a Look at the Most Complex Object in Mathematics." *Scientific American,* August 1985, pages 16–24.

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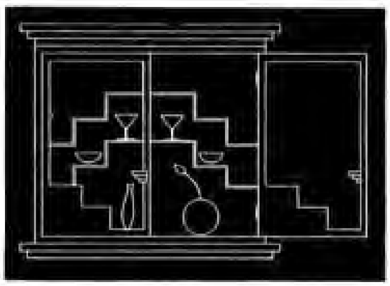

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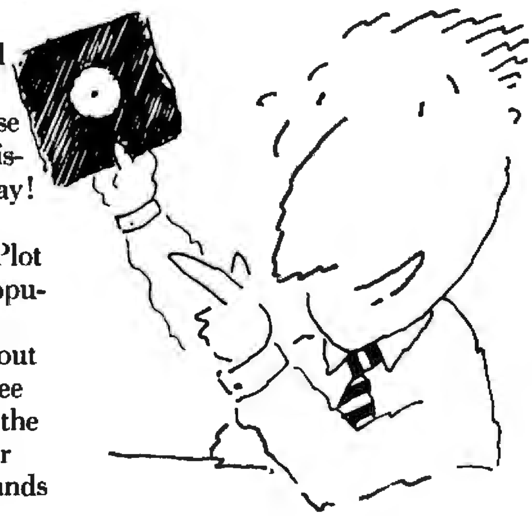

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GRAPHING QUADRIC SURFACES

BY GEORGE HARONEY

Methods of simulating 3-D graphics on a color display in BASIC

QUADRIC SURFACES are the graphs of second-degree equations in three variables. The solution set of the equation $x^2 + y^2 + z^2 = radius^2$, for example, is a familiar quadric surface: a sphere. In this article I present some simple techniques for displaying quadric surfaces. I've also provided a BASIC program as a tool for applying the techniques and exploring the subject of computer graphics and computer art.

The ideal method of plotting three-dimensional points would be on a stack of transparent planes, each filled with multicolored LEDs arranged in rows and columns. The LEDs would be transparent when off, so as not to obscure lighted LEDs on background planes. Such a display would represent illusorially real three-dimensional objects by illuminating selected LEDs on various planes within the structure.

Since such an ultimate system is not available, it is necessary to complicate matters by projecting three-dimensional coordinates onto a two-dimensional system: the computer screen. Nevertheless, it is often helpful to think of real three-dimensional graphics when making pseudo three-dimensional graphics.

PROJECTION TECHNIQUES

As an exercise in projection, draw a cube on a piece of paper, indicating hidden edges with dotted lines. Select a corner of the cube as the origin and label the three lines emanating from that point *X*, *Y*, and *Z*. You now have a system for projecting three-dimensional points onto two dimensions (see the sidebar "3-D Projection Onto 2-D" on page 216). For instance, to locate the point (5,8,3), start at the origin and move 5 units along the *X* axis. From that point, move 8 units in a direction parallel to the *Y* axis. Finally, move another 3 units in a direction parallel to the *Z* axis. By varying the orientation of three axes, you can rotate a projected figure in any way you choose.

To project 3-D data onto a computer screen, you describe the origin point and the axes in terms of the display's native horizontal and vertical coordinate system. The origin is defined by its horizontal and vertical coordinates h_0 and v_0. Each of the three axes is defined by the angle it forms with a horizontal line extending from the origin in a positive direction. I'll refer to such angles as A_X, A_Y, and A_Z.

Using these landmarks and some elementary trigonometry (see the sidebar), it is possible to project any point (x,y,z) onto the display in terms of the display coordinates h and v, as follows:

$$h = x \cos A_X + y \cos A_Y + z \cos A_Z + h_0$$
$$v = x \sin A_Y + y \sin A_Y + z \sin A_Z + v_0 .$$

PLOTTING A FUNCTION

Given a projection method, you are ready for some data points. Functions in three variables are a convenient source of data points, generating an unlimited variety of shapes and patterns with a little planning on your part. Unfortunately, there aren't any race car or dinosaur functions; almost all of them are stubbornly abstract.

The general method used is to con-

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George Haroney is a computer programmer working on software for a parallel computer system. He can be contacted at 2115 *Grayson Place, Falls Church,* VA 22043.

Ideally, foreground surfaces should cover background surfaces.

sider z as a function of x and y. For instance, given the equation

$$x^2 + y^2 + z^2 = 3$$

you rearrange things to get z as a function of x and y:

$$z = \pm\sqrt{3 - x^2 - y^2}$$

To plot a function, you scan the X-Y plane at regular intervals, selecting values for x and y, and calculate the resulting value for z.

Ideally, foreground surfaces should cover the background surfaces. Complicated hidden-line algorithms can provide this feature, but for the sake of brevity, my program simply draws the background before the foreground so that it obscures background points. The program also calculates foreground points closer together and assigns different colors to foreground and background surfaces. All of these techniques improve the apparent three-dimensionality of the rendering.

Figures 1 through 6 are the graphs of common second-degree equations in three variables, as found in any calculus text. I produced the images on a Chromatics CG 1999 microcomputer with screen resolution of 512 by 512 pixels.

PROGRAM NOTES

Listings 1 through 6 are Microsoft BASICA programs that will produce similar (but not identical) images on an IBM PC or PC compatible equipped with a color graphics adapter.

The main program (listing 1) starts by asking you to specify the orientation of the X, Y, and Z axes in degrees. You may enter a positive or negative number, with the understanding that positive angles are rotated counterclockwise around the horizontal axis and negative angles are rotated clockwise.

I created the figures using angles of 15, −15, and 90 for X, Y, and Z, respectively. To render a surface in another orientation, you simply change one or more of the axes. For example, to turn the "saddle" in figure 2 upside down, you specify angles of 195, 165, and 270 for X, Y, and Z.

Line 100 defines the function. The function definition includes two arguments, x and y; the function returns a value to be used for z.

Lines 110–120 specify the origin in terms of screen coordinates HC and LC. The position is calculated as a fraction of the number of points in each dimension. In listing 1, HC is

(continued)

3-D PROJECTION ONTO 2-D

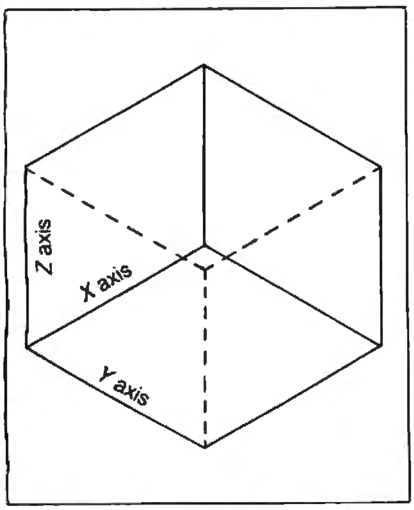

Figure A: *Drawing a cube onto a plane gives a system for projecting 3-D points onto a 2-D surface.*

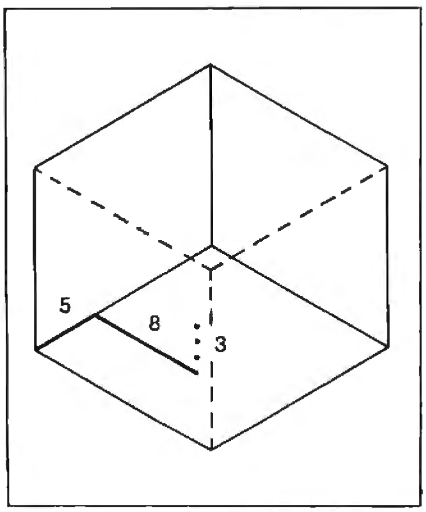

Figure B: *Finding the point (5,8,3).*

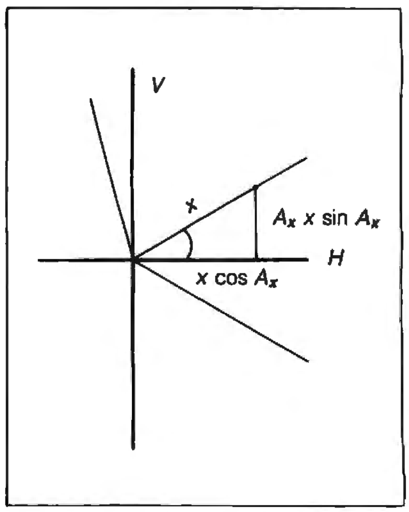

Figure C: *Calculating the horizontal and vertical coordinates of a point (x,0,0). When y and z are not zero, they must be calculated similarly using A_Y and A_Z; the horizontal and vertical coordinates are summed:*

$$h = x \cos A_X + y \cos A_Y + z \cos A_Z$$
$$v = x \sin A_X + y \sin A_Y + z \sin A_Z.$$

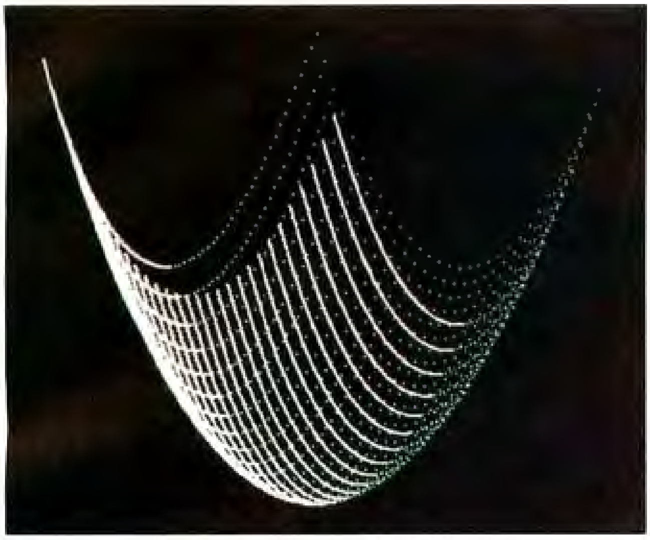

Figure 1: *Paraboloid.* $x^2/A^2 + y^2/B^2 - Cz = 0.$

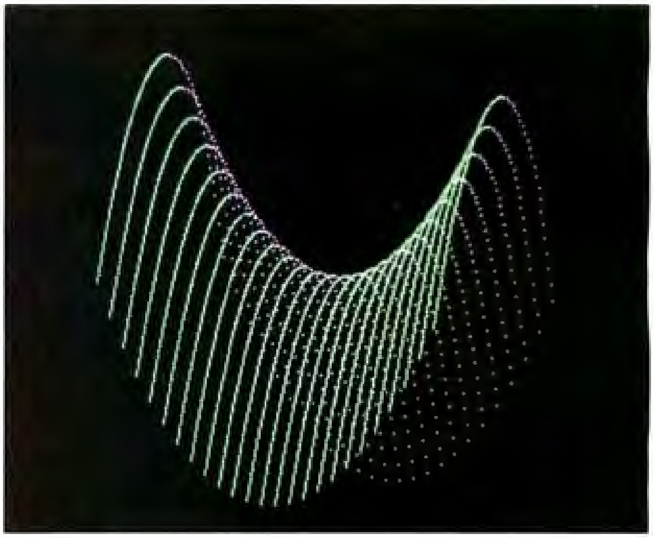

Figure 2: *Hyperbolic paraboloid.* $y^2/A^2 - x^2/B^2 - Cz = 0.$

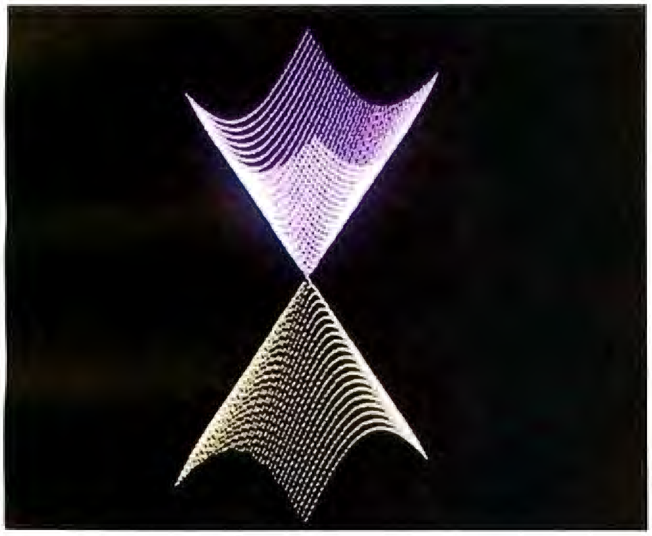

Figure 3: *Cone.* $x^2/A^2 + y^2/B^2 - z^2/C^2 = 0.$

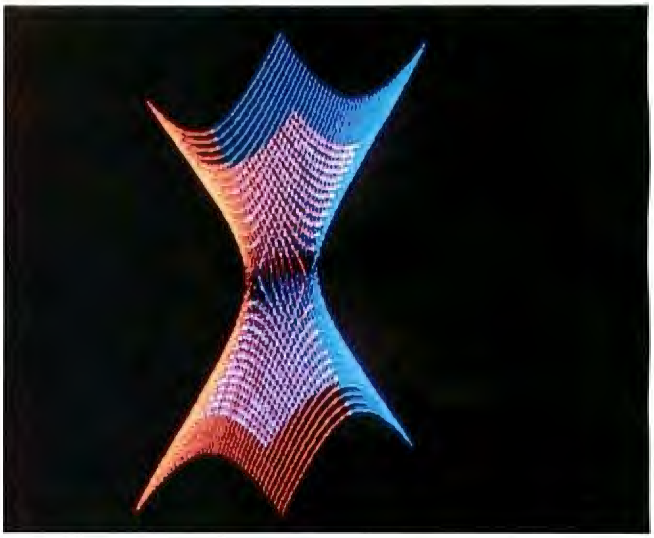

Figure 4: *Hyperboloid of one sheet.* $x^2/A^2 + y^2/B^2 - z^2/C^2 = 1.$

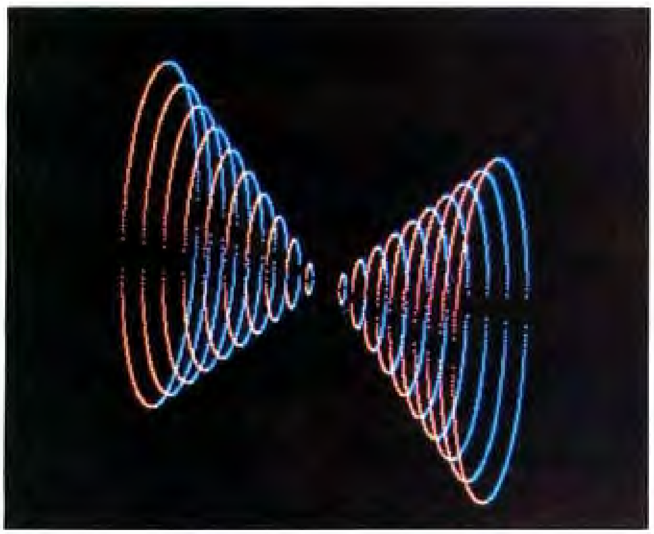

Figure 5: *Hyperboloid of two sheets.* $x^2/A^2 - y^2/B^2 - z^2/C^2 = 1.$

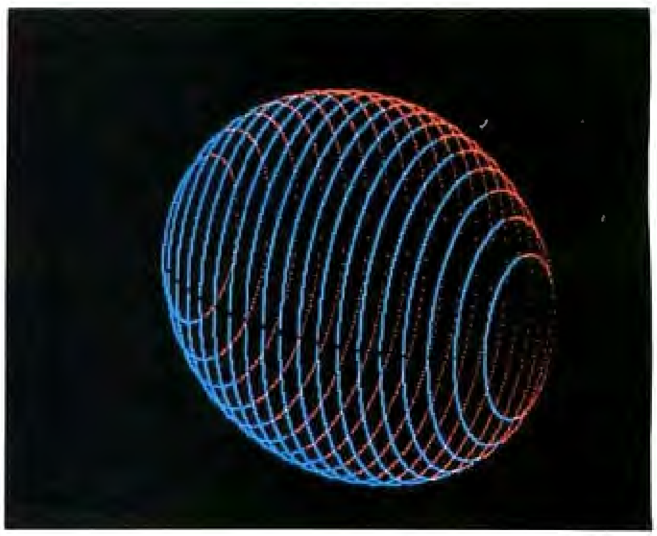

Figure 6: *Ellipsoid.* $x^2/A^2 + y^2/B^2 + z^2/C^2 = 1.$

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Listing 1: *The main program (written in Microsoft's* BASICA *for the* IBM PC) *generates a paraboloid.*

```
10 SCREEN 1                  :REM 320 H by 200 V, 3 colors
20 DEFINT H-N
30 PI=4*ATN(1)
40 DR=PI/180         :REM Converts degrees to radians
50 BLUE=1: PURPLE=2: WHITE=3
60 HMIN=0: HMAX=319
70 LMIN=0: LMAX=199
80 HRES=HMAX-HMIN: LRES=LMAX-LMIN
90 REM -------Define function and set parameters ---------
100 DEF FNF1(X,Y)=X*X+Y*Y                       :REM Paraboloid
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(19*LRES/20)
130 SCALEH=12
140 SCALEV=2
150 REM -------Find Angles from center to corners --------
160 C1=ATN((LC-LMIN)/(HMAX-HC))                 :REM to NE
170 C2=PI-ATN((LC-LMIN)/(HC-HMIN))              :REM to NW
180 C3=PI+ATN((LMAX-LC)/(HC-HMIN))              :REM to SW
190 C4=2*PI-ATN((LMAX-LC)/(HMAX-HC))            :REM to SE
200 REM ----------------- X Y Z axes ---------------------
210 KOLOR=WHITE
220 INPUT "Angles for x,y,z axes "; DEGX,DEGY,DEGZ
230 CLS
240 DEGREES=DEGX
250 GOSUB 1080       :REM Convert degrees to radians A
260 SINXA=SIN(A): COSXA=COS(A)
270 REM GOSUB 1010: REM Draw the axis
280 DEGREES=DEGY
290 GOSUB 1080
300 SINYA=SIN(A): COSYA=COS(A)
310 REM GOSUB 1010
320 DEGREES=DEGZ
330 GOSUB 1080
340 SINZA=SIN(A): COSZA=COS(A)
350 REM GOSUB 1010
360 REM -------------- Plot the surface ------------------
370 FOR TY=-6 TO 6 STEP .4
380 KOLOR=PURPLE             :REM To show points s.t. x>=0
420 FOR TX=0 TO 6 STEP .4
430 TZ=FNF1(TX,TY)
440 GOSUB 1230               :REM Project and scale
450 PSET (MH,MV),KOLOR
460 NEXT TX
470 KOLOR=BLUE               :REM To show points s.t. x<0
510 FOR TX=-6 TO 0 STEP .15
520 TZ=FNF1(TX,TY)
530 GOSUB 1230               :REM Project and scale
540 PSET (MH,MV),KOLOR
550 NEXT TX,TY       :REM Next point on current tracing
560 END
1000 REM ---- Extend a line through center to borders ----
1010 TANA=TAN(A)             :REM Save tangent
1020 GOSUB 1170: H1=HZ: L1=LZ        :REM Get one endpoint
1030 DEGREES=DEGREES+180: GOSUB 1080:
1040 GOSUB 1170: H2=HZ: L2=LZ        :REM Other endpoint
1050 LINE (H1,L1)-(H2,L2),KOLOR
1060 RETURN
1070 REM -- Converts degrees to radians, 0 <= a < 2*pi ---
1080 WHILE DEGREES<0
1090 DEGREES=DEGREES+360
1100 WEND
1110 WHILE DEGREES>=360
1120 DEGREES=DEGREES-360
1130 WEND
1140 A=DEGREES*DR
```

(continued)

```
1150 RETURN
1160 REM Find endpoint (hz,lz) of ray at (hc,lc), angle a
1170 IF A<=C1 OR A>C4 THEN HZ=HMAX: LZ=LC-(HMAX-HC)*TANA:
     RETURN
1180 IF A<=C2 THEN LZ=LMIN: HZ=HC+(LC-LMIN)/TANA: RETURN
1190 IF A<=C3 THEN HZ=HMIN: LZ=LC+(HC-HMIN)*TANA: RETURN
1200 IF A<=C4 THEN LZ=LMAX: HZ=HC-(LMAX-LC)/TANA
1210 RETURN
1220 REM --------- Project tx,ty,tz onto mh,mv ----------
1230 PX=TX*COSXA+TY*COSYA+TZ*COSZA
1240 PY=TX*SINXA+TY*SINYA+TZ*SINZA
1250 MH=INT(HC+PX*SCALEH)
1260 MV=INT(LC-PY*SCALEV)
1270 RETURN
```

Listing 2: *Replacement lines to generate a hyperbolic paraboloid.*

```
100 DEF FNF1(X,Y)=Y*Y-X*X   :REM Hyperbolic paraboloid
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(LRES/2)
130 SCALEH=15
140 SCALEV=3.5
370 FOR TY=-5 TO 5 STEP .4
380 KOLOR=PURPLE
390 FOR TX=0 TO 5 STEP .4
400 TZ=FNF1(TX,TY): GOSUB 1230     :REM Project and scale
420 PSET (MH,MV),KOLOR             :REM Deleted line 410
430 NEXT TX
440 KOLOR=BLUE                :REM To show points s.t. x<0
450 FOR TX=-5 TO 0 STEP .1
460 TZ=FNF1(TX,TY)
470 GOSUB 1230                     :REM Project and scale
480 PSET (MH,MV),KOLOR             :REM Plot a point
490 NEXT TX,TY
500 END
```

Listing 3: *Replacement lines to generate a cone.*

```
100 DEF FNF1(X,Y)=SQR(Y*Y+X*X)*2 :REM Cone
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(LRES/2)
130 SCALEH=8
140 SCALEV=4
370 FOR TY=-6 TO 6 STEP .75
380 KOLOR=PURPLE
390 FOR TX=0 TO 6 STEP .5
400 TZ=FNF1(TX,TY)
410 GOSUB 1230              :REM Project and scale
420 PSET (MH,MV),KOLOR      :REM Plot a point
430 TZ=-FNF1(TX,TY)
440 GOSUB 1230
450 PSET (MH,MV),KOLOR
460 NEXT TX
470 KOLOR=BLUE
480 FOR TX=-6 TO 0 STEP .2
490 TZ=FNF1(TX,TY): GOSUB 1230
510 PSET (MH,MV),KOLOR               :REM Deleted line 500
520 TZ=-FNF1(TX,TY)
530 GOSUB 1230
540 PSET (MH,MV),KOLOR
550 NEXT TX,TY
560 END
```

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Listing 4: *Replacement lines to generate a hyperboloid of one sheet.*

```
100 DEF FNF1(X,Y)=SQR(Y*Y+X*X-2)*2 :REM HB of 1 sheet
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(LRES/2)
130 SCALEH=8: SCALEV=7             :REM Deleted line 140
370 FOR TY=-4 TO 4 STEP .5
380 FOR TX=-4 TO 4 STEP .2
390 IF TX*TX+TY*TY<2 THEN 460 ELSE TZ=FNF1(TX,TY)
400 GOSUB 1230                     :REM Project and scale
410 IF TX<0 THEN KOLOR=BLUE ELSE KOLOR=PURPLE
420 PSET (MH,MV),KOLOR             :REM Plot a point
430 TZ=-TZ: GOSUB 1230             :REM Deleted line 440
450 PSET (MH,MV),KOLOR
460 NEXT TX,TY
470 END
```

Listing 5: *Replacement lines to generate a hyperboloid of two sheets.*

```
100 DEF FNF1(X,Y)=SQR(Y*Y-X*X-1) :REM HB of 2 sheets
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(LRES/2)
130 SCALEH=3: SCALEV=3             :REM Deleted line 140
370 FOR TY=-20 TO 20 STEP 2
380 FOR TX=-20 TO 20 STEP .3
390 IF TX*TX+1>TY*TY THEN 460 ELSE TZ=FNF1(TX,TY)
400 GOSUB 1230                     :REM Project and scale
410 IF TX<0 THEN KOLOR=BLUE ELSE KOLOR=PURPLE
420 PSET (MH,MV),KOLOR             :REM Plot a point
430 TZ=-TZ: GOSUB 1230             :REM Deleted line 440
450 PSET (MH,MV),KOLOR
460 NEXT TX,TY
470 END
```

Listing 6: *Replacement lines to generate an ellipsoid.*

```
100 DEF FNF1(X,Y)=SQR(1-X*X-Y*Y)   :REM Ellipsoid
110 HC=HMIN+INT(HRES/2)
120 LC=LMIN+INT(LRES/2)
130 SCALEH=50: SCALEV=50           :REM Deleted line 140
370 FOR TY=-.99 TO 1 STEP .15
380 KOLOR=PURPLE
390 FOR TX=.01 TO 1 STEP .03
400 IF TX*TX+TY*TY>=1 THEN 460 ELSE TZ=FNF1(TX,TY)
410 GOSUB 1230                     :REM Project and scale
420 PSET (MH,MV),KOLOR             :REM Plot a point
430 TZ=-TZ
440 GOSUB 1230  :REM Project and scale
450 PSET (MH,MV),KOLOR             :REM Plot a point
460 NEXT TX
470 KOLOR=BLUE
480 FOR TX=-1 TO 0 STEP .015
490 IF TX*TX+TY*TY>=1 THEN 550 ELSE TZ=FNF1(TX,TY)
500 GOSUB 1230
510 PSET (MH,MV),KOLOR
520 TZ=-TZ
530 GOSUB 1230
540 PSET (MH,MV),KOLOR
550 NEXT TX,TY
560 END
```

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Figure 7: *Wavy paraboloid.*

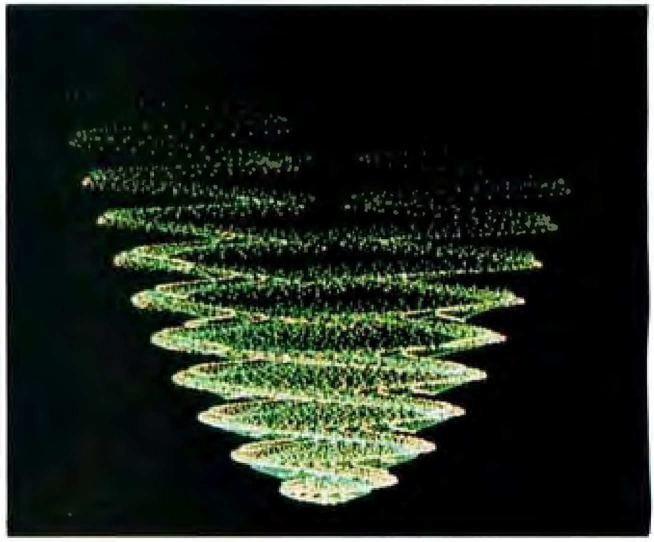

Figure 8: *Swirloid.*

Figure 9: *Comet.*

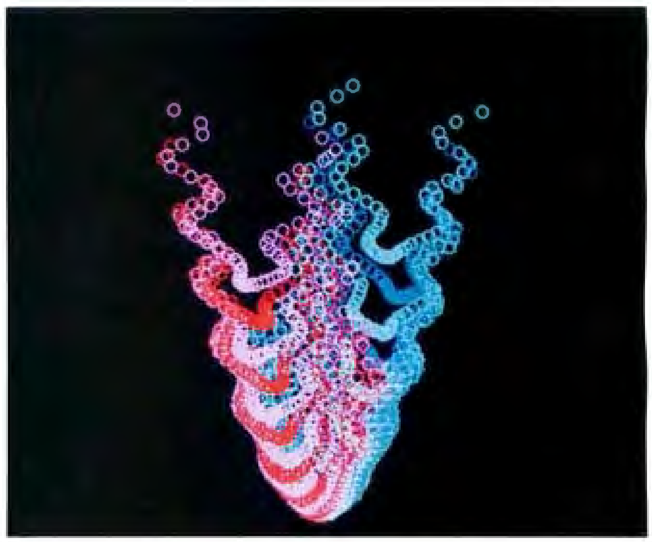

Figure 10: *Bubbling paraboloid.*

halfway across the screen (HRES/2) and 19/20 of the way down the screen (19*VRES/20).

Lines 130–140 set the horizontal and vertical scaling factors, which you can use to scale a surface so that it fits within the plotting area.

Lines 270, 310, and 350 draw the axes on the screen; in the listing, they are made inoperative by the REM keyword. To make the program draw the axes, simply remove the first REM from these three lines.

Lines 360–560 make up the plotting routine. The program steps through a domain of x and y values, calculates a z for each x and y, and plots the point. The program changes colors for points for which x is negative; this helps in the simulation of three-dimensionality.

You might find it interesting to tinker with the plotting domains for X and Y and with the increments used to step through these domains. You might also change the function definition, the screen center point, and the scaling factor.

In general, graphing a different function will require minor changes to lines in the ranges 90–140 and 360–560. Listings 2 through 6 consist of all the changes that you will need to make to listing 1 to generate figures 2 through 6.

You can further explore computer-generated art by using quadric shapes as building blocks and combining and intersecting them to produce intricate figures. Figures 7 through 10 illustrate some of the possibilities. The general idea is to apply an extra transformation to one or more of the coordinates before each point is plotted (for example, multiply a coordinate x by sin x).

Editor's note: The program listings in this article are available on disk, in print, and on BIX; *see the insert card following page* 320. *Listings are also available on* BYTEnet; *see page* 4. ■

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FREE-FORM CURVES ON YOUR MICRO

BY STEVE ENNS

Implement Bézier and B-spline curves for interactive graphics

EVEN THOUGH microcomputer graphics have become increasingly sophisticated, free-form curves have been largely confined to mini- and mainframe computers. Yet some microcomputer graphics applications seem to cry out for a method of creating free-form curves.

You could, of course, create several types of curves using an x,y coordinate system. But most microcomputer displays tend to be of the $y = f(x)$ type. For those systems the y coordinate is determined by some operation on the x coordinate. These curves are best suited to the mathematical sciences, where the graph or curve of the function is usually not as important as its numerical properties. In your graphics applications you may be more concerned with what the graph looks like than whether it has, say, a vertical asymptote at $x = 3$. Fortunately, there are ways of accessing free-form curves on your microcomputer.

Two types of curves that are particularly well suited to computer graphics and that you can define visually are Bézier curves and B-splines. You can define either with a small set of points, and you can intuitively discern their appearance from the positions of these defining points.

THE BÉZIER FORM

The French engineer Pierre Bézier developed the curves that bear his name for the car designers at Renault. Cubic parametric Bézier curves are defined by a set of four control points P_1, P_2, P_3, and P_4. The curve contains the first and last control point and traces a smooth path between the intervening points (see figure 1). The curves can be shown in matrix form as

$$C(t) = |t^3\ t^2\ t\ 1|B \begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix}$$

where

$$B = \begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

The parameter t varies from 0 to 1. At $t=0$, the curve is on point P_1. As t is increased in small increments, the curve approaches and passes points P_2 and P_3, ending at P_4 when $t=1$ (see figure 2). The curve will always remain within the convex hull formed by joining the four control points (figure 3). Different choices for points P_2 and P_3 result in more gentle or more severe curves (figure 4). The shape of the resulting curve becomes predictable after a little experience. This predictability, along with the relative speed at which the curves can be calculated, makes Bézier curves a popular choice for interactive design applications.

Going from the general matrix equation above to a method for plotting the curve in two or three dimension is not difficult. Depending on whether you're using two or three dimensions, each P_i is defined in terms of (x,y) or (x,y,z) coordinates. Matrix multiplication from the preceding equation gives one polynomial

(continued)

Steve Enns is a research assistant in mathematics at the University of Saskatchewan. He can be contacted at 2425 Haultain Ave., Saskatoon, Saskatchewan, Canada S7J 1R2.

equation for each of the coordinates. For instance, the x coordinates of the Bézier curve are given by:

$$x(t) = (-t^3 + 3t^2 - 3t + 1)P_1^x + (3t^3 - 6t^2 + 3t)P_2^x + (-3t^3 + 3t^2)P_3^x + t^3P_4^x.$$

(The notation P_i^x represents the x coordinate of point P_i.) The equations for the y and z coordinates are the same, except that P_i^y and P_i^z are substituted for P_i^x.

Any number of control points could be specified for a Bézier curve, but this requires the calculation of polynomial functions of higher degree.

THE B-SPLINE FORM

The B-spline is another popular curve form that is slightly more versatile than the Bézier form. The B-spline tends to follow the control points more closely. And while the Bézier description above used only four control points to describe a single curve, the B-spline form lets you use an arbitrary number of control points. (You can, of course, join several curve segments together to produce one larger curve, using either type.)

Mathematically, the cubic-parametric B-spline resembles the Bézier form. Given n control points, the curve around each control point is defined:

$$C(t) = [t^3 \; t^2 \; t \; 1] B \begin{bmatrix} P_{i-1} \\ P_i \\ P_{i+1} \\ P_{i+2} \end{bmatrix}$$

where $2 \leq i \leq n-2$ and

$$B = \frac{1}{6}\begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 0 & 3 & 0 \\ 1 & 4 & 1 & 0 \end{bmatrix}$$

The curve is calculated around each of the points P_2 to P_{n-2}, letting t range from 0 to 1 for each control point.

Matrix multiplication gives a parametric equation for each coordinate (x,y) or (x,y,z). Here's the equation for x coordinates around the point P_i:

$$x(t) = (-\tfrac{1}{6}t^3 + \tfrac{1}{2}t^2 - \tfrac{1}{2}t + \tfrac{1}{6})P_{i-1}^x + (\tfrac{1}{2}t^3 - t^2 + \tfrac{2}{3})P_i^x + (-\tfrac{1}{2}t^3 + \tfrac{1}{2}t^2 + \tfrac{1}{2}t + \tfrac{1}{6})P_{i+1}^x + \tfrac{1}{6}t^3P_{i+2}^x .$$

The B-spline winds among the control points in a fashion similar to the Bézier—it will not usually pass through any of them but will curve close to them, producing a smooth curve as opposed to an exact but less than "regular" fit (see figure 5). Like Bézier curves, you can change the influence that a particular point has on the overall B-spline. If the same control point is used twice, for example, the curve will be more attracted to that position.

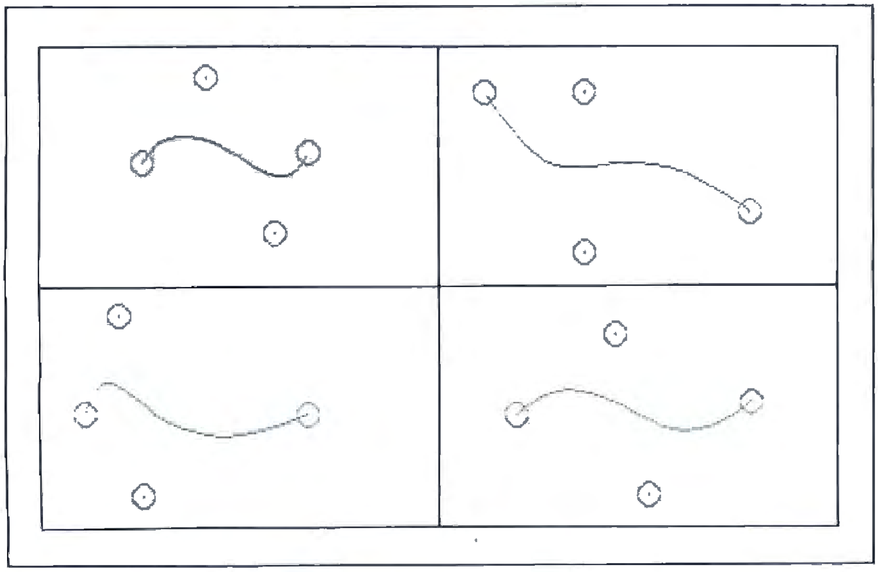

Figure 1: *Various Bézier curves and their corresponding control points.*

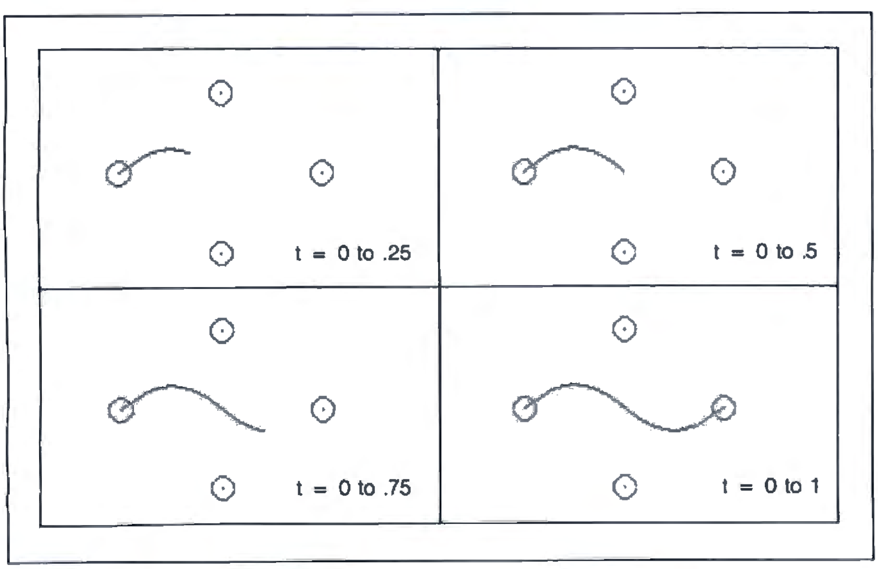

Figure 2: A *Bézier curve at various values of the increasing parameter, t.*

IMPLEMENTING FREE-FORM CURVES

The actual implementations of the Bézier and B-spline forms are very similar to their mathematical descriptions. In fact, the process involves little more than evaluating the polynomial equations at the given control points using each value of the increasing parameter t (see listings 1 and 2).

The only differences in the two algorithms are the number of control points used to produce each segment of the curve (the first loop in each algorithm) and the type of polynomial calculated (the third step in each case). Listings 3 and 4 are direct implementations of the algorithms as BASIC subroutines.

Let's say you need to create some rolling hills for the background of a graphic display. To produce gently rolling hills, choose four points (more if you use the B-spline routine) that describe the curve. To make the hills two-dimensional, set XBS23 to 0 so that the program calculates only *x* and *y* values. To have the curve drawn directly on the screen, set XBSDR to 0. Store the control points you've chosen in the arrays XC and YC.

Since these are the only control points you are using, set XNC (the index of the control points) to 1 and XNB (the number of points used) to 4. If this is the only curve you will be calculating, the points can occupy the first space in the curve storage arrays (X and Y), so set XNP to 1. To get a

(continued)

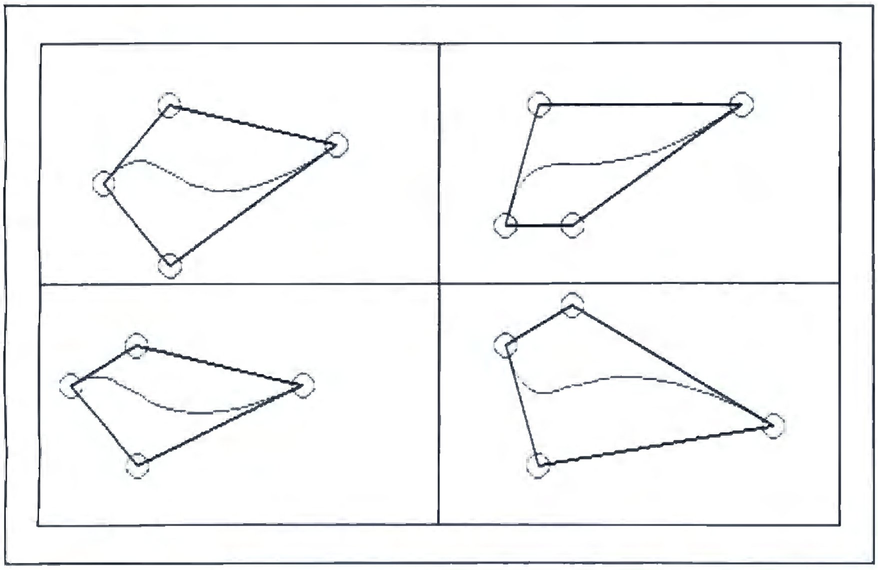

Figure 3: *Various Bézier curves and the corresponding "convex hulls," formed by connecting the curves' control points.*

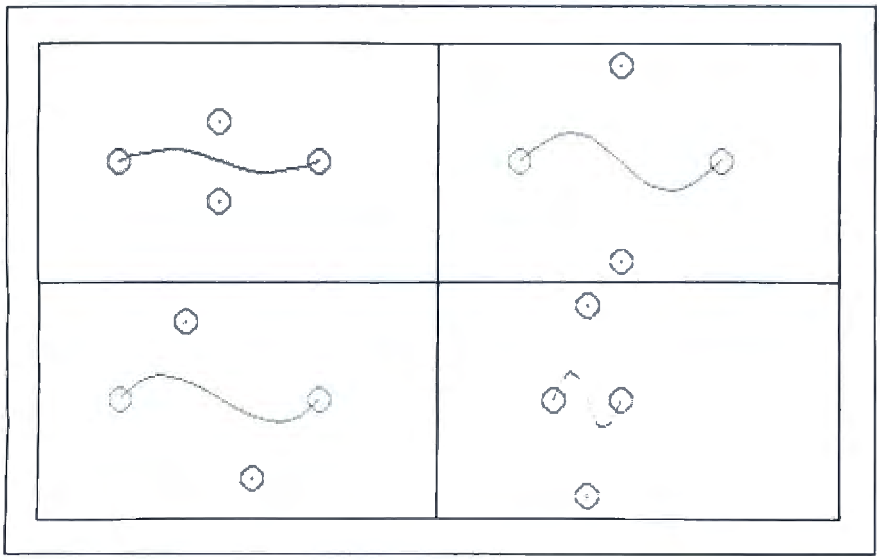

Figure 4: *Different choices for the two intermediate (disconnected) control points result in more gentle or more severe curves.*

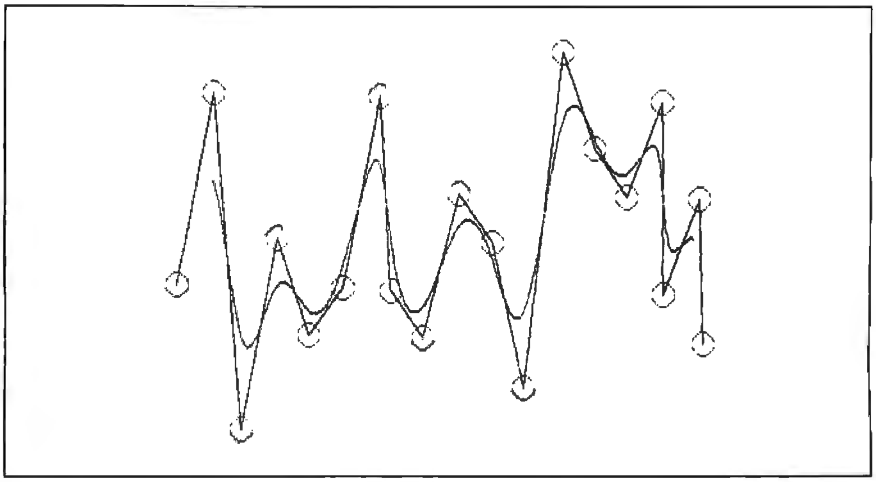

Figure 5: *An exact but irregular graph as opposed to a smoother B-spline curve.*

Listing 1: *The Bézier algorithm.*

```
Procedure Bezier
  for each group of four control points do
    for t = 0 to 1 by an increment do
      evaluate the Bezier polynomials x(t),y(t)
        and optionally z(t) (for a 3-D application)
    end
  end
end Bezier.
```

Listing 2: *The B-spline algorithm.*

```
Procedure B-spline
  for each of the control points do
    for t = 0 to 1 by an increment do
      evaluate the B-spline polynomials x(t),y(t)
      and optionally z(t) (for a 3-D application)
    end
  end
end B-spline.
```

Listing 3: *The Bézier subroutine in* BASIC.

```
16960 ' Bezier2.SUB
16962 ' From Fundamentals of Interactive Computer Graphics
16964 '
16966 ' Calculates cubic parametric free-form Bezier curves
16968 ' XBS23=1 for 3-D else 2-D
16970 ' XBZDR=0 if the curve is to be drawn (2-D only)
16972 ' XC(),YC(),[ ZC() ] are the hull points (4 per curve)
16974 ' XNC is the index of first control point
16976 ' XNB is the number of control points to be used
16978 ' XNP is the index for the first curve point
16980 ' NBS is the step size (default provided)
16982 ' QBZ is the color if drawn
16984 ' Returns X(),Y(),[ Z() ] as the points
16986 ' Returns XNS as the index of the last curve point
16988 '
```

```
16990 IS=XNP:XXS=XNC+XNB-1
16992 IF NBS=0 THEN NBS=.1
16994 IF XBS23 THEN 17016
16996 FOR IIS=XNC TO XXS STEP 4
16998    FOR T=0 TO 1+NBS STEP NBS
17000       T2=T*T:T3=T2*T
17002       NC1=1-3*T+3*T2-T3:NC2=3*T3-6*T2+3*T:NC3
             =3*T2-3*T3:NC4=T3
17004       X(IS)=NC1*XC(IIS)+NC2*XC(IIS+1)+NC3*XC(IIS+2)
             +NC4*XC(IIS+3)
17006       Y(IS)=NC1*YC(IIS)+NC2*YC(IIS+1)+NC3*YC(IIS+2)
             +NC4*YC(IIS+3)
17008       IS=IS+1
17010    NEXT
17012 NEXT
17014 GOTO 17036
17016 FOR IIS=XNC TO XXS STEP 4
17018    FOR T=0 TO 1+NBS STEP NBS
17020       T2=T*T:T3=T2*T
17022       NC1=1-3*T+3*T2-T3:NC2=3*T3-6*T2+3*T:NC3=3*T2
             -3*T3:NC4=T3
17024       X(IS)=NC1*XC(IIS)+NC2*XC(IIS+1)+NC3*XC(IIS+2)
             +NC4*XC(IIS+3)
17026       Y(IS)=NC1*YC(IIS)+NC2*YC(IIS+1)+NC3*YC(IIS+2)
             +NC4*YC(IIS+3)
17028       Z(IS)=NC1*ZC(IIS)+NC2*ZC(IIS+1)+NC3*ZC(IIS+2)
             +NC4*ZC(IIS+3)
17030       IS=IS+1
17032    NEXT
17034 NEXT
17036 XNS=IS-1
17038 IF XBZDR THEN 17048
17040 PSET(X(XNP),Y(XNP)),QBZ          ' Pixel at x,y color QBZ
17042 FOR II=XNP TO XNP+XNS
17044    LINE -(X(II),Y(II)),QBZ       ' Line from last X,Y to
17046 NEXT                             ' X1,Y1 color QBZ
17048 RETURN
```

Listing 4: *The B-spline subroutine in* BASIC.

```
16850 ' BSpline.SUB
16852 ' From Fundamentals of Interactive Computer Graphics
16854 '
16856 ' Calculates cubic parametric free-form splines
16858 ' XBS23=1 for 3-D else 2-D
16860 ' XBSDR=0 if the curve is to be drawn
16862 ' XC(),YC(),[ ZC() ] are the control points
16864 ' XNC is the index of first control point
16866 ' XNB is the number of control points to be used
16868 ' XNP is the index for the first spline point
16870 ' NBS is the step size
16872 ' QBS is the color if drawn
16874 ' Returns X(),Y(),[ Z() ] as the points
16876 ' Returns XNS as the index of the last spline point
16878 '
16880 IS=XNP:XXS=XNC+XNB-3:NSA=1/6:NSB=2/3
16882 IF XBS23 THEN 16904
16884 FOR IIS=XNC+1 TO XXS
16886    FOR T=0 TO 1 STEP NBS
16888       T1=T/2:T2=T*T:T2A=T2/2:T3=T2*T:T3A=T3/2
16890       NC1=-NSA*T3+T2A-T1+NSA:NC2=T3A-T2+NSB:NC3
             =-T3A+T2A+T1+NSA:NC4=NSA*T3
16892       X(IS)=NC1*XC(IIS-1)+NC2*XC(IIS)+NC3*XC(IIS+1)
             +NC4*XC(IIS+2)
16894       Y(IS)=NC1*YC(IIS-1)+NC2*YC(IIS)+NC3*YC(IIS+1)
             +NC4*YC(IIS+2)
```

(continued)

```
16896         IS=IS+1
16898      NEXT
16900 NEXT
16902 GOTO 16924
16904 FOR IIS=XNC+1 TO XXS
16906    FOR T=0 TO 1 STEP NBS
16908       T1=.5*T:T2=T*T:T2A=.5*T2:T3=T2*T:T3A=T3/2
16910       NC1=-NSA*T3+T2A-T1+NSA:NC2=T3A-T2+NSB:NC3=-T3A
             +T2A+T1+NSA:NC4=NSA*T3
16912       X(IS)=NC1*XC(IIS-1)+NC2*XC(IIS)+NC3*XC(IIS+1)
             +NC4*XC(IIS+2)
16914       Y(IS)=NC1*YC(IIS-1)+NC2*YC(IIS)+NC3*YC(IIS+1)
             +NC4*YC(IIS+2)
16916       Z(IS)=NC1*ZC(IIS-1)+NC2*ZC(IIS)+NC3*ZC(IIS+1)
             +NC4*ZC(IIS+2)
16918       IS=IS+1
16920    NEXT
16922 NEXT
16924 XNS=IS
16926 IF XBSDR THEN 16936
16928 PSET(X(XNP),Y(XNP)),QBS    ' Set pixel, x,y color QBS
16930 FOR II=XNP TO XNP+XNS-1
16932    LINE -(X(II),Y(II)),QBS ' Line from last X,Y to
16934 NEXT                       ' X1,Y1  color QBS
16936 RETURN
```

very smooth curve you'll need a small increment for *t*, so set NBS to .05. The last variable to set is QBZ (for color), which you can set to 2. The subroutine is now initialized and can be called by the main program.

I've also written a curve-fitting practice program, called CURVTEST.BAS, that allows you to choose control points on your computer display with a cross-hair cursor. The program then uses either BEZIER.SUB or BSPLINE.SUB to calculate and draw the curve on the screen, letting you compare the Bézier and B-spline curves. The program will give you the feel of how placement of the control points determines the shape of the curve. The program and the subroutines are written in Microsoft BASIC for the Texas Instruments Professional Computer. To work with another computer or language, you will probably have to add a graphics screen initialization routine and so forth. [*Editor's note:* CURVTEST.BAS, *which includes listings 3 and 4, is available on disk, in print, and on* BIX; *see the insert card following page* 320. *It is also available on* BYTEnet; *see page* 4.]

THE TRADE-OFFS

As opposed to calculating the points on a straight line, curves take a relatively long time to calculate. The points on a simple line can be calculated with only a few adds and compares, without any floating-point arithmetic. At best, using mathematical techniques that have been ignored here, the calculation of any free-from curve of this type involves many floating-point multiplications. The most effective use of Bézier and B-spline curves involves interaction and several calculations of the same curve, and using a personal computer, you'll have to be patient.

You can use several methods to speed things up. If you are interactively designing and require a particular curve, set the increment for *t* to a larger value for the initial curves. When you are fine-tuning the curve, the increment can be reset to a smaller value, for a smoother curve. An assembly language implementation that made use of a numeric coprocessor would squeeze more performance from a small computer. ■

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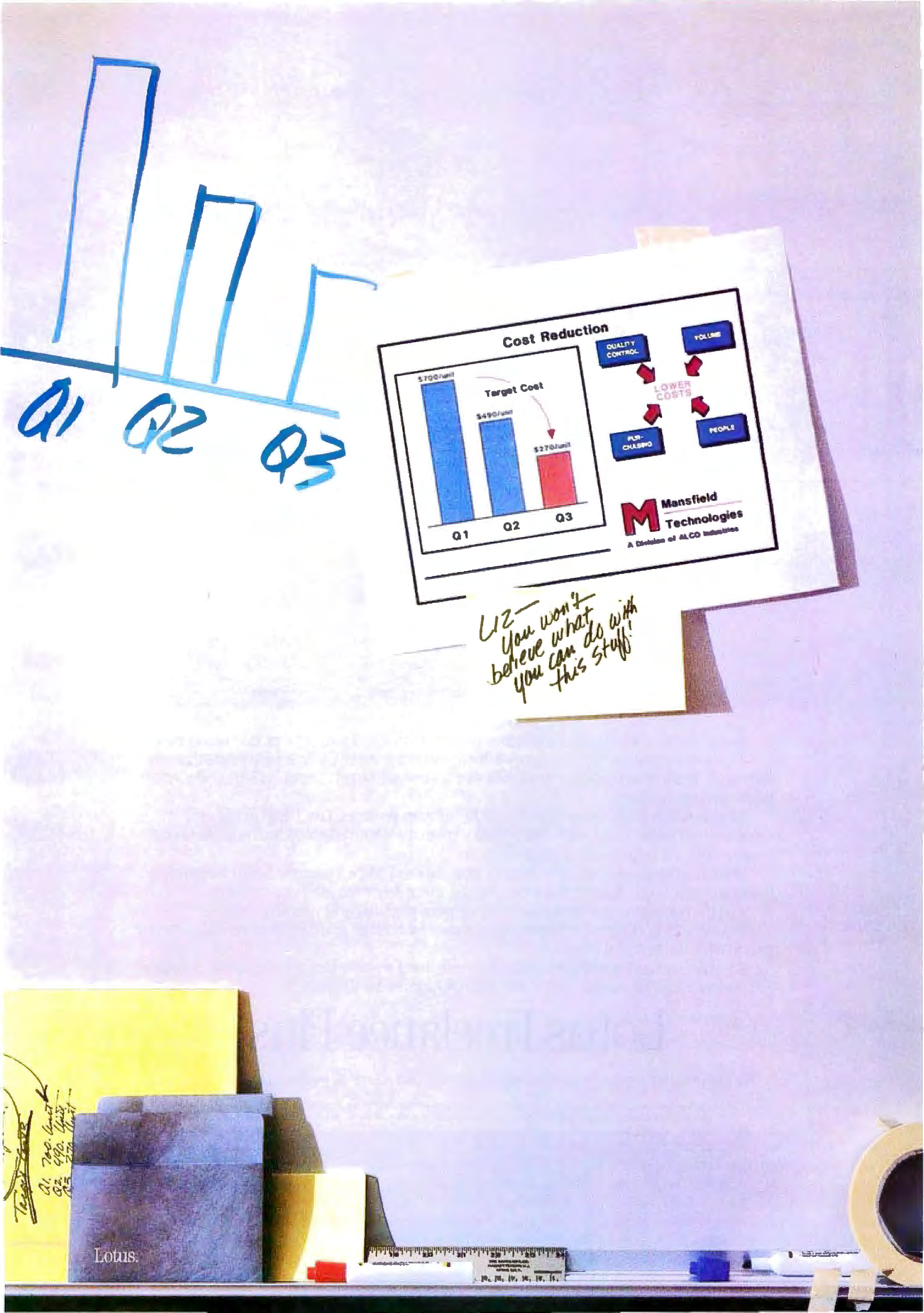

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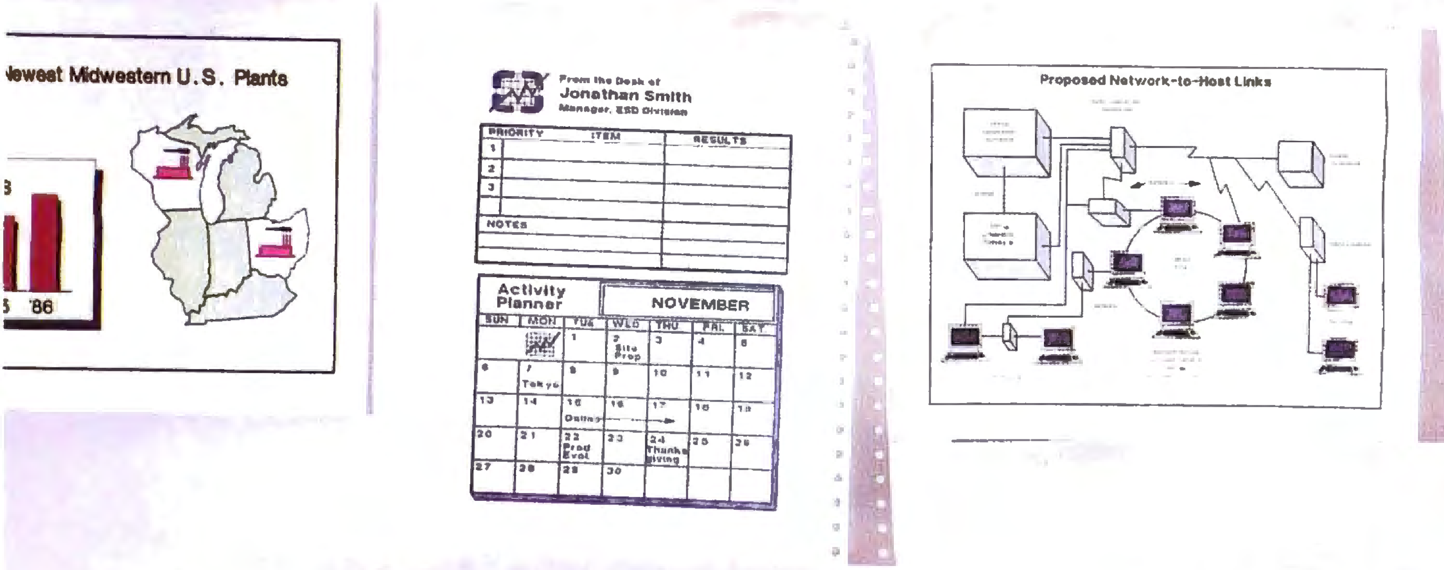

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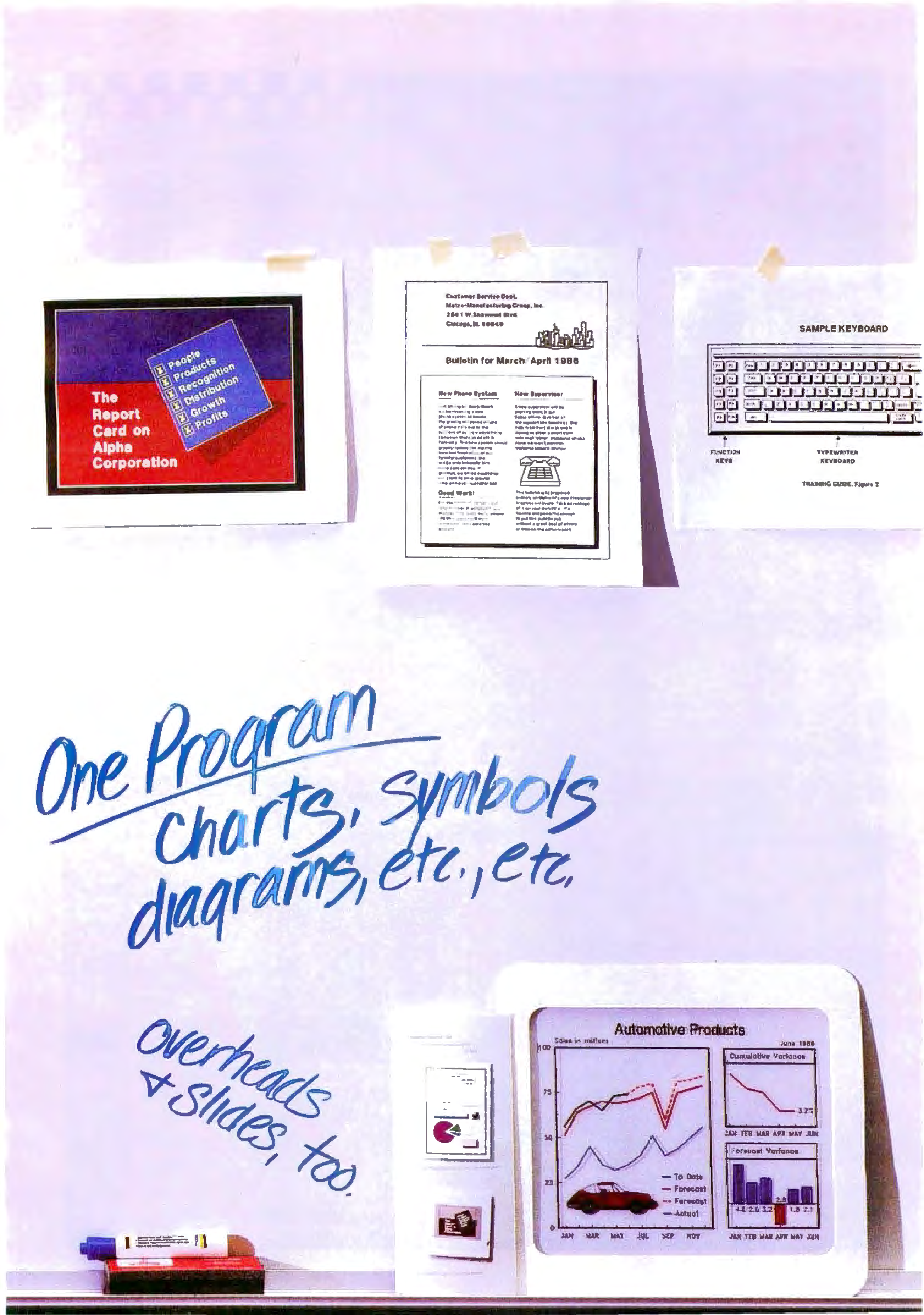

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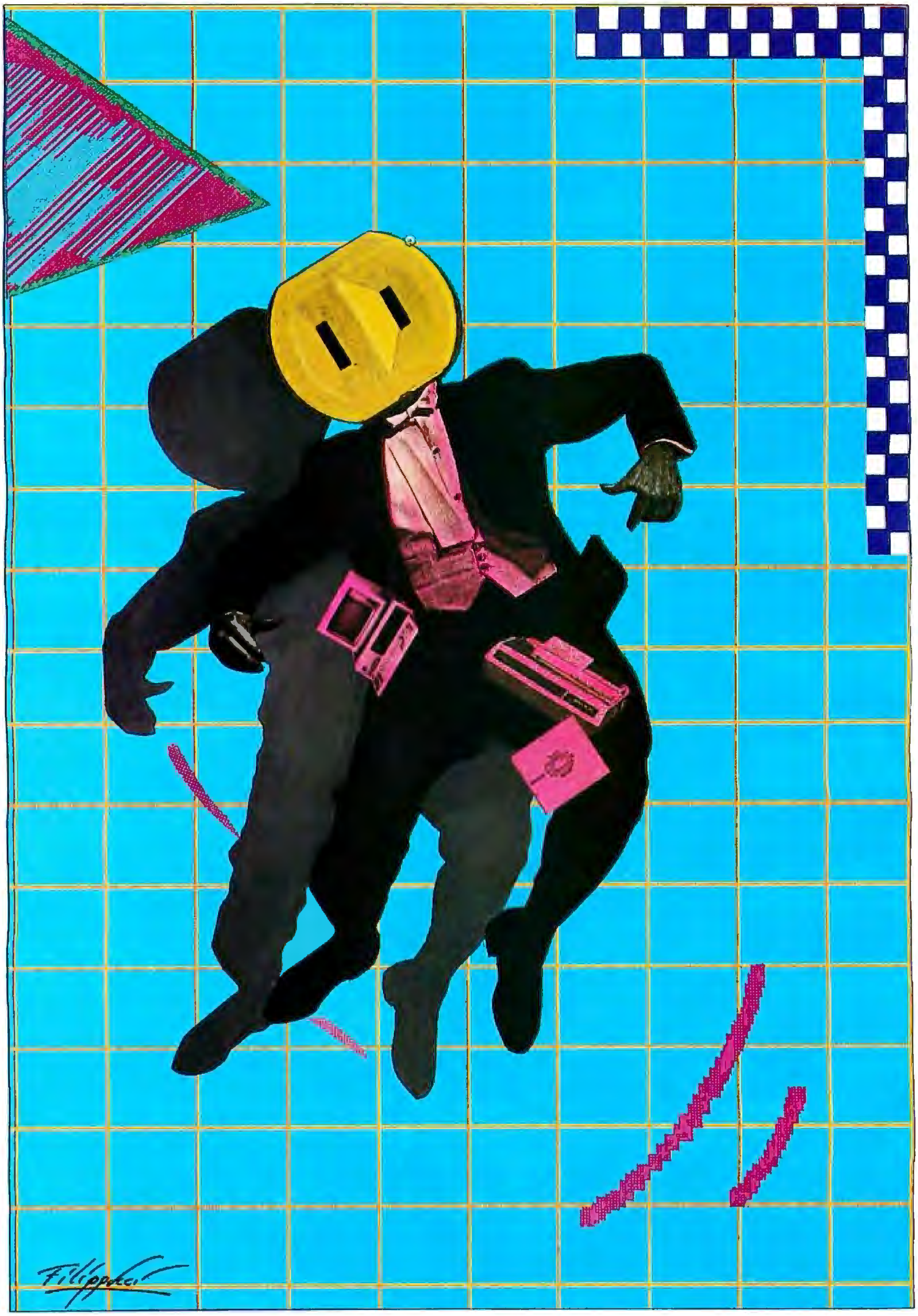

Reviews

WAYNE RASH JR. has reviewed four IBM PC AT clones: the Epson Equity III, the Western AT, and the Zenith Z-241 and Z-248. All are fast and relatively easy to use, but Wayne shows that the differences are important and well worth considering.

Rich Malloy examines the Hercules Graphics Card Plus, which may set a new standard for monochrome graphics. Its enhanced text graphics will allow you to use alternative character sets far more easily than before. The board also enhances the performance of a number of applications including Lotus 1-2-3 and Microsoft Word.

Stephen Satchell has compared 23 modems. The evaluation tests were extensive; the results are fascinating. The AT&T Model 4024 and the Ven-Tel 2400 Plus fared well, although many of these modems can well serve your needs. Stephen welcomes your comments on his testing methods.

Namir Clement Shammas surveys four Pascal implementations for IBM PC compatibles: Microsoft's MS-Pascal, Pecan Software Systems' UCSD Pascal, Pro Pascal from Prospero Software, and MetaWare's Professional Pascal. The comparative tables also bring in the results from Mark Bridger's February review of Turbo Pascal 3.0. As you might expect, there is a tremendous range in terms of price and performance. Perhaps of these compilers will meet your exact needs.

This month we present two applications software reviews. Stephen B. Robinson examines STELLA, an unusual application that provides what some might call a graphic spreadsheet. This modeling and simulation program allows you to build structural diagrams. With it you can gain tremendous insight into how organizations function and how various subsystems act and interact.

Finally, Brock N. Meeks reviews Flash-Com, an electronic mail and communications software system. The software is powerful and its uses are diverse, but Brock reveals that the application is not without its troubles.

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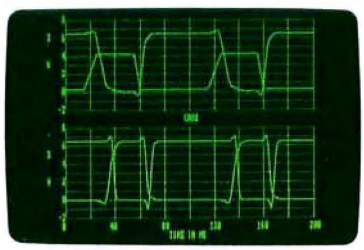
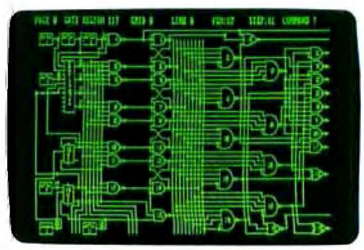

"Typical MICROCAP Transient Analysis"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MICROCAP and MICROLOGIC are available for the Apple II (64k), IBM PC (128k), and HP-150 computers and priced at $475 and $450 respectively. Demo versions are available for $75.

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IBM's new PC XT 286 certainly caused its share of excitement here. It was immediately obvious that the case is too small to accommodate conventional IBM PC AT expansion boards, and it appears to be more difficult than usual to install an 8087 coprocessor, owing to the location of the socket. At least one company will benefit from the size of the XT 286's case, however. Trade Ventures (512A Herndon Parkway, Herndon, VA 22070, (703) 435-3800) claims to have the only EMS memory board that will fit in the XT 286. [*Editor's note: At least two other manufacturers have just released* EMS *boards for the* XT 286. CSS *Laboratories* ((714) 540-4141) *has* TurboRAM, *and Boca Research* ((305) 997-6227) *has* BOCARAM.]

The benchmarks all ran quickly. The Calculations test took 21 seconds; the Sieve took 60. The Disk Write and Read tests took 25 and 26 seconds, respectively. The keyboard is IBM's new standard; it will take some getting used to.

I always enjoy looking at ways to enhance my working environment. This month I tried RapidWriter from Quixote (One East Wacker Dr., Chicago, IL 60601, (312) 467-6755). This special keyboard/software combination for IBM PC compatibles allows you to input commonly used words, phrases, and sentences by typing "chords" on the special keyboard. After loading in the sample dictionary, for example, you can press the *s* and *y* keys simultaneously to get the phrase *sincerely yours.*

In addition, you can create nested chords in which you can enter new text in the middle of a predefined macro. Pressing the Shift key with a chord will capitalize the first letter of the definition. Pressing Caps Lock will capitalize all the characters in the definition. Dictionaries can store up to 250 chords, with up to 16,000 characters of text per chord.

It is fairly easy to define new chords. I also found it comfortable to type chords, and the product worked with all the nonresident applications I tried. Unfortunately, RapidWriter is incompatible with Borland's SuperKey and SideKick, and Revolution Software's Cruise Control would not function with it, either. You may find the only other disadvantage to be the keyboard itself, which is slightly nonstandard. The function keys are located across the top, and the Alt, Ctrl, and backslash keys are only a few that are in nonstandard locations.

Another tool is Word for Word (formerly Mirrors/PC) by Mastersoft (4621 North 16th St., Suite A-108, Phoenix, AZ 85016, (602) 277-0900), a utility for IBM PC compatibles that allows you to convert files from one format to another without requiring much cleanup. Version 1.0 supports WordStar 3.30 and 3.31, WordPerfect 3.0 and 4.1, Volkswriter, PFS:Write version C, MultiMate 3.3, IBM Writing Assistant, and straight ASCII. Word for Word reports all items that do not convert to the target format.

Two new products tap the color graphics capabilities of the Amiga and the Atari STs. We were obviously impressed by Aegis Animator (see the review in the November BYTE) by Aegis Development (2210 Wilshire Blvd. #277, Santa Monica, CA 90403, (213) 392-6445), and I am much more impressed now that it has introduced the Aegis Art Pak, a series of utilities that, when used in conjunction with Aegis Animator, will allow you to create desktop videos much more easily.

The Art Pak contains a variety of backgrounds and objects, all created with the same color palette to facilitate your cutting and pasting. Aegis Development also supplies a player that allows you to distribute your videos with no copyright infringements. Even if you don't plan to get an Amiga, it is worth going out of your way to see the Art Pak's introductory video.

For the Atari ST, Activision (P.O. Box 7287, Mountain View, CA 94039, (800) 633-4263) has released Audio Light Incorporated's Paintworks, an elaborate paint program. The user interface is effective, and the program has three individual drawing screens. With them, you can cut and paste more effectively or expand the scope of your painting. There are over 70 features, including three levels of magnification, fine *x,y* coordinate control, and color-cycling animation. You can also incorporate music created with Activision's Music Studio for elaborate slide presentations. Unlike many of the other similar applications for the ST, you can create Paintworks pictures in all three ST modes. Files are compatible with both DEGAS and NEOchrome.

Last month I promised to report on WildFire from Software Wizardry (1106 First Capitol Dr., St. Charles, MO 63301, (314) 946-1968). WildFire is a speed kit for the Zenith Z-151/-152/-161. Stan Wszola and I installed the new chip set in my Zenith Z-151. The installation procedure was very simple, but we were unable to get the computer to boot. We were disappointed, particularly because Zenith users on BIX have reported excellent results. I suspect that the problem has to do with the dated BIOS on my Zenith. I'll discuss this problem in more detail in the future.

Next month I plan to report on Fall COMDEX, the largest show of the year.

—Jon Edwards
Senior Technical Editor, Reviews

FOUR IBM PC AT CLONES

BY WAYNE RASH JR.

These machines offer good value but may also present problems

Most IBM PC AT work-alikes promise combinations of greater speed, more functionality, and lower price than the PC AT. With these claims in mind, I evaluated four PC AT clones: the Epson Equity III, the Western AT, and the Zenith Z-241 and Z-248. [*Editor's note: The photo does not show the Z-248, which is identical in appearance to the Z-241. For the original* IBM PC AT *review by* Alan Finger, *see the* May 1985 BYTE.]

I tested the computers with a variety of IBM PC business software and other software commonly used to test compatibility. I also tried each unit with a variety of multifunction boards and peripherals. The systems that I reviewed were all off-the-shelf models—they were identical to what a purchaser would receive. BYTE did, however, request that each manufacturer install a video board, even if one is not normally included.

THE ZENITHS

Both of the Zenith Z-240 series computers that I reviewed follow the Zenith practice of not having a motherboard. The entire computer exists on plug-in boards that attach to a system bus. The Z-241 and the Z-248 both include a serial and parallel port as standard equipment. The enhanced versions, which I tested, also have a 20-megabyte hard disk drive, a 1.2-megabyte high-capacity floppy disk drive, and 512K bytes of RAM. Zenith's version of MS-DOS 3.1 was included with each machine.

The Z-248 comes with an enhanced graphics adapter card and Microsoft Windows. The EGA card will support special high-resolution monitors in addition to standard color graphics and monochrome monitors.

Both Zenith machines are notable for their speed. The Z-241 runs at 6 MHz, and the Z-248 runs at 8 MHz. Unlike the other two PC AT clones that I reviewed, neither machine has a wait state added to slow its operation. A wait state is a period of time during which the computer waits before it executes another instruction. This slows the computer down to allow the use of slower, less expensive peripherals such as memory boards.

The absence of wait states means that the 6-MHz Z-241 carries out operations at about the same speed as most 8-MHz machines, while the Z-248 is much faster than most other 8-MHz machines. You can anticipate the computing time of the Z-248 to be about half that of the IBM PC AT.

The extra speed also means that some peripherals may not work unless you slow the Zenith machines down. The expensive but fast Cheetah multifunction and memory cards were the only ones I found that were guaranteed to keep up with the Z-248.

EPSON EQUITY III

The Epson Equity III is a dual-speed machine. A high/low switch lets you select 6-MHz operation for maximum compatibility with peripherals and software or 8 MHz for maximum computing speed. To change the microprocessor speed you turn the system off, flick the high/low switch, and turn the computer on again.

In other respects, Epson has designed this computer along traditional lines. The motherboard resembles the one on the IBM PC AT and has the same number of expansion slots.

Two areas in the construction of the Equity III concerned me. One is the power supply cable, which exits from the supply itself through the unprotected edge of the sheet-metal power supply shield. Although the cable has an extra layer of insulation, it does not have the heavy grommet of the other systems' power supplies.

The other area of concern is that

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Wayne Rash Jr. is a member of the professional staff of American Management Systems Inc. (1777 North Kent St., Arlington, VA 22209), *where he consults with the federal government on microcomputers.*

Epson Equity III

Company
Epson America Inc.
OEM Division
23600 Telo St.
Torrance, CA 90505
(800) 421-5426

Size
6½ by 21½ by 17 inches

Components
Processor: Intel 80286, switchable between 6 and 8 MHz
Memory: 640K bytes, expandable to 16 megabytes
Mass storage: One half-height 1.2-megabyte 5¼-inch floppy disk drive or one 360K-byte floppy disk drive and one 20-megabyte hard disk
Display: 12-inch amber or green monochrome or EGA or RGB color; 80 characters by 25 lines
Keyboard: 84 keys; 10 function keys; indicator lights on Caps Lock, Scroll Lock, and Num Lock keys
Expansion: Eight slots; three IBM PC–compatible
Communications: One serial and one parallel port

Software
MS-DOS 3.2; GW-BASIC

Documentation
User's guide; MS-DOS operator's guide; GW-BASIC manual

Price

With one floppy disk drive:	$2495
With one floppy disk drive and hard disk:	$3195
Color monitor:	$549
Monochrome monitor:	$149

Western AT

Company
Western Computer
1381 Warner Ave.
Warner Corporate Park, Suite B
Tustin, CA 92680
(714) 553-1611

Size
6½ by 21¼ by 16½ inches

Components
Processor: Intel 80286, switchable between 6 and 8 MHz
Memory: 2 megabytes, expandable to 16 megabytes
Mass storage: One half-height 1.2-megabyte 5¼-inch floppy disk drive or one 360K-byte floppy disk drive and one 30-megabyte hard disk
Display: 12-inch amber or green monochrome or EGA or RGB color; 80 characters by 25 lines
Keyboard: 84 keys; 10 function keys; indicator lights for Caps Lock, Scroll Lock, and Num Lock keys
Expansion: Eight slots; three IBM PC–compatible
Communications: One parallel port

Software
None

Documentation
User's and service manual

Price
$2395

Zenith Z-241

Company
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 699-4800

Size
6½ by 21 by 16¾ inches

Components
Processor: 6-MHz Intel 80286
Memory: 512K bytes, expandable to 16 megabytes
Mass storage: One half-height 1.2-megabyte 5¼-inch floppy disk drive or one 360K-byte floppy disk drive and one 20-megabyte hard disk
Display: 12-inch amber or green monochrome or EGA or RGB color; 80 characters by 25 lines
Keyboard: 84 keys; 10 function keys; indicator lights on Caps Lock, Scroll Lock, and Num Lock keys
Expansion: Ten slots; three IBM PC–compatible, four Zenith-compatible (expanded PC AT), and three PC AT–compatible
Communications: One serial and one parallel port

Software
MS-DOS 3.11

Documentation
Owner's manual; MS-DOS manual

Price

With one floppy disk drive:	$3499
With one floppy disk drive and hard disk:	$4499

Zenith Z-248

Company
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 699-4800

Size
6½ by 21 by 16¾ inches

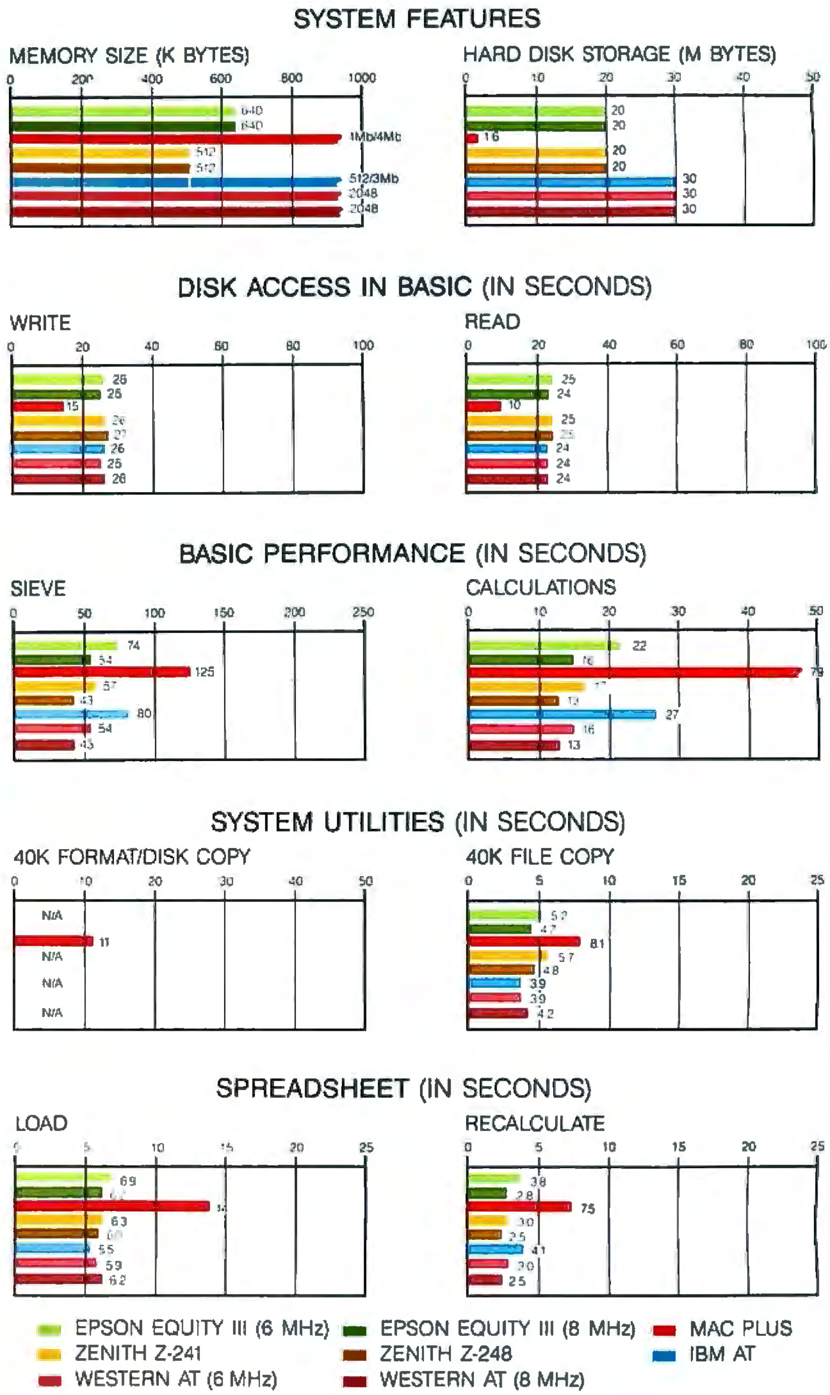
Components
Processor: 8-MHz Intel 80286
Memory: 512K bytes, expandable to 16 megabytes
Mass storage: One half-height 1.2-megabyte 5¼-inch floppy disk drive or one 360K-byte floppy disk drive and one 20-megabyte hard disk
Display: 12-inch amber or green monochrome or EGA or RGB color; 80 characters by 25 lines
Keyboard: 84 keys; 10 function keys; indicator lights on Caps Lock, Scroll Lock, and Num Lock keys
Expansion: Ten slots; three IBM PC–compatible, four Zenith-compatible (expanded PC AT), and three PC AT–compatible
Communications: One serial and one parallel port

Software
MS-DOS 3.11; GW-BASIC; Microsoft Windows

Documentation
Owner's manual; MS-DOS manual; GW-BASIC operator's guide; Microsoft Windows user's guide; Microsoft Windows user's guide

Price

With one floppy disk drive:	$2999
With one floppy disk drive and one 20-megabyte hard disk:	$4399
With one floppy disk drive and one 42-megabyte hard disk:	$5699



The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the capacity of the hard disk available with each system. The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graphs show how long it takes to copy a 40K-byte file using the MS-DOS COPY command. The Format/Disk Copy test was omitted since all four systems were single floppy disk systems. The Spreadsheet graphs show how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The spreadsheet used was Microsoft's Multiplan. All BASIC benchmark programs were run using GW-BASIC.

most of the integrated circuits, including the memory chips, are soldered onto the motherboard. While this method reduces the original cost of the unit, it increases the cost of replacing an integrated circuit. IC sockets are preferable.

WESTERN AT

Like the Epson Equity III, the Western AT is a dual-speed machine. A toggle switch on the back of the case allows you to set the speed for 6 or 8 MHz while the computer is turned off.

The Western AT that I reviewed was equipped with a 30-megabyte hard disk—the largest of the four. Like the Equity III, the Western AT has eight expansion slots. The Western AT is supplied with 2 megabytes of memory, also the largest in this group.

Two points about the Western AT concerned me during the course of the review. The first is the front-panel lock, which locks the case and the keyboard. This lock seemed to be of low quality, and it moved in its mounting when the key was turned.

The second item of concern is the video card that was supplied with my review machine. Although this card is an option, it should still work properly. The card is said to emulate the Hercules card and to provide graphics capability on a monochrome monitor. It is supplied with a special version of BASIC for this purpose. I could not get this version of BASIC to work at all, nor could I get the machine to display graphics using GW-BASIC graphics commands.

SETTING UP

IBM PC AT-compatible computers generally require a more involved setup routine than do earlier microcomputers. This is because of a wider selection of equipment configurations, disk drives, memory, and the like. As a result, you have to know more about your computer than before to get things started.

Normally you have to know the technical details of the hard disk such as the size of the drive and the number of sides to perform an initial formatting. This information is not always readily available. Once you get the information you need, you run a setup program that stores it in a battery-powered section of memory in which the clock and calendar information is also stored.

With the two Zenith computers I reviewed, the low-level format was already done and the proper parameters were recorded in the section of memory reserved for the setup information. A setup program is contained in the Zenith machines' extensive ROM diagnostics, eliminating the need to run the setup program from disk.

Setup is a little more involved on the Equity III than on the Zenith machines. You must run the disk-based setup routine before you can prepare the hard disk. Fortunately, Epson's instructions are clear and the appropriate choices for most users are in-

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dicated. Once you have run the setup program, you can proceed to run the low-level format program. This takes about 20 minutes.

The Western AT, by contrast, should not be set up by the faint of heart. You can change the configuration of this system only by running DEBUG and loading an address from ROM. Other setup steps depend on the details of the version of MS-DOS you purchase. The operating system is not included with the Western AT.

USING THE CLONES

All of these machines are a pleasure to use. They run quietly and much more quickly than the IBM PC clones that preceded them. Since any of these machines can be ordered with essentially the same video equipment, about the only individuality is in the four systems' keyboards.

The Western AT follows the IBM PC AT layout closely, even down to the bezel-mounted LEDs. The Epson Equity III is nearly the same, although the LEDs are located on the keys themselves. The two Zenith keyboards closely resemble those on other Zenith products. The primary difference between any of the keyboards is the location of the Escape key. Epson and Western place this key above the 7 on the keypad; Zenith places it in the more traditional location above the Tab key.

Operating these machines is straightforward. Since they are all equipped with a hard disk, you need only turn them on and they run. The Western AT and the Epson Equity III display the amount of memory present while they perform their memory checks. The two Zenith computers perform the checks, but the screen remains blank.

Once MS-DOS is loaded, you will be told the status of the RAM disk if there is one. Any RAM in excess of the 640K bytes used by MS-DOS can be used as a RAM disk. Since the 80286 microprocessor in the PC AT clones can address up to 16 megabytes of memory, you can have a very large RAM disk. Later versions of MS-DOS are supposed to make all this memory available to programs. The latest version of Concurrent PC DOS already does this.

Most of the popular business-related software will run very nicely on any of these machines. The only types of programs that I encountered problems with were ones that looked specifically for the IBM ROM and ones that were copy-protected. PC Focus, for example, would not work on either of the Zenith machines until the copy-protection scheme was changed.

COMPATIBILITY

All 80286-based computers including the IBM PC AT have some compatibility problems with products developed for the IBM PC and other 8086-based machines. Many programs simply will not run, or they will not run properly. The most notable is one of

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the favorites of compatibility testing, Microsoft's Flight Simulator. The program would start running, but it would always lock up on all four machines shortly after loading.

Most of the other compatibility problems I encountered had to do with copy protection. A variety of copy-protection schemes seem to have trouble with the faster microprocessor speed of most of the PC AT clones and with the high-capacity disk drives. However, many of the software companies I spoke with during the course of this review said that their copy-protection schemes will be changed to work with most IBM PC AT-compatible machines.

High-capacity disk drives can also cause disk compatibility problems between PC AT clones and other MS-DOS computers. All the manufacturers warn that the 360K-byte disks written by these drives may prove to be illegible to computers using standard double-density drives. The reason for this is the very narrow track created by the head of the high-capacity drive.

Nevertheless, I had no such problems when I created disks with each of these computers and attempted to read them with a variety of double-density drives.

Nearly any circuit board designed to function within an IBM PC AT will work in the clones that run at 6 MHz with one wait state, but faster machines may have problems. For instance, some memory boards will not work with the Zenith Z-241 unless you remove a jumper to make the machine add a wait state to its operations.

The 8-MHz machines had even more problems with speed-sensitive hardware. This was most noticeable in the Zenith Z-248, which requires a very fast board for things to run properly.

DOCUMENTATION

The manuals for these systems range from awful to excellent. The manual for the Western AT was clearly the worst of the lot and is one of the worst system manuals I've seen in some time. On the other hand, the Epson and Zenith manuals are quite good, although they are quite different.

The Western AT manual appears to be photocopied from the manual for another machine. The words *Western AT Turbo* were apparently pasted in prior to the copying process. The photographs are of such poor quality that they are virtually useless. The manual has no index.

Once you get past this unfortunate production quality, you may find some useful information in the Western AT manual. Complete configuration instructions are included as well as items such as a description of the system's memory map, error trapping, and physical arrangement. The manual even provides such rare information as I/O port addresses, timer channels, and interrupts.

Epson includes a nicely written hardware user's guide and MS-DOS

Deciding which of these computers is best for you depends greatly on your specific requirements.

operator's guide in a single binder along with a manual for GW-BASIC in another binder. The user's guide is clearly written and has excellent line drawings for illustration. The normal choices for factory-installed equipment are indicated, which allows you to make an intelligent selection when setting up the computer.

The Epson MS-DOS guide is an improvement over the standard Microsoft offering that most manufacturers use. Epson has rewritten the explanations and added examples of screens.

Zenith has continued in the company tradition of having the most complete manuals in the business. The hardware owner's manual resembles the Epson manual in the use of drawings and clear explanations. It continues beyond the Epson manual, however, in its descriptions of advanced items such as disk drive and memory installation.

Zenith's MS-DOS manual is easily twice as thick as any other that I've used. This is partially because Zenith adds a number of utility programs to its MS-DOS disks. Most of the increased length is due to the expansion of the description for each command and utility program.

BENCHMARKS

All of these machines are fast (see page 241). All except the Epson Equity III running at 6 MHz were faster than the IBM PC AT by a significant margin. The Zenith Z-248 was nearly twice as fast in computing speed. The difference is due mostly to the higher microprocessor speeds of the four machines. Some of the difference can be assumed to stem from slightly faster hard disk drives. The floppy disk drive benchmark times were about the same as those for the IBM PC AT.

The benchmarks show the importance of wait states in the speed of operation. For example, the Sieve calculation time for the 6-MHz Zenith Z-241 was nearly the same as for the Western AT at 8 MHz. The difference is that the Zenith Z-241 has no wait states while the Western AT has one.

CONCLUSIONS

As is always the case, deciding which of these computers is best for you depends greatly on your specific requirements. You may have to consider cost as the primary factor. If performance is the primary factor, however, the Zenith Z-248 is the obvious frontrunner. This machine is significantly faster than the competition and is well built and well supported.

Of course, all that speed is not without a price. Add-on memory boards will cost more than they otherwise would, and some may not work at all because they cannot keep up with the machine. In addition, the higher speed may prevent some software, notably programs with copy-protection schemes, from working. Selecting the slower Z-241 will overcome some of these speed-related problems.

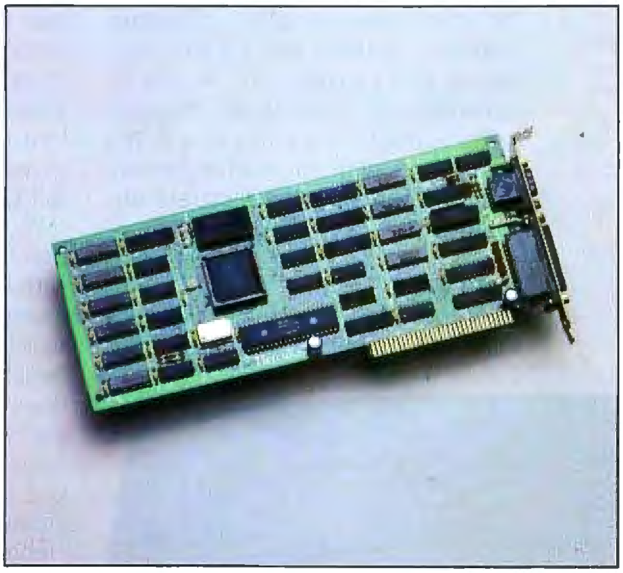
The Western AT and Epson Equity III, with their choice of speeds, give you the best of both worlds. If you have software that will not operate at 8 MHz, you simply throw a toggle switch and it runs at 6 MHz. This should satisfy the requirements of almost any software. Unfortunately, support for the Western AT in your area may be limited. Support for the Equity III should generally be more widely available. In addition, Epson computers are frequently discounted and should be quite inexpensive. However, the soldered-in memory chips and the power supply construction could present problems.

All of these machines are fast and highly compatible with the IBM PC AT. Based on features and price alone, all of them give more value than the IBM computer that they emulate. Provided the dealer and service arrangements satisfy you, any of them should provide satisfactory use. ■

The Hercules Graphics Card Plus

BY RICH MALLOY

An inexpensive general-purpose display card for the IBM PC



The Hercules Graphics Card (see the review by Tom Wadlow in the December 1983 BYTE) quickly became the standard for monochrome graphics. Hercules has now replaced its popular Graphics Card with its new Graphics Card Plus. In addition to having its predecessor's 720- by 348-pixel monochrome graphics capability and a lower price ($299), it also has enhanced text capabilities. With this board and the software that comes with it, you will be able to use alternative character sets and enhance the performance of applications such as Lotus 1-2-3 and Microsoft Word.

Hardware and Installation

The Graphics Card Plus is only 10 inches long. Such a small size is possible because Hercules combined the functions of many of the chips from the old card into a smaller number of chips. For example, the entire logic circuitry for the parallel printer interface now fits on one chip. The board's short length would seemingly make it suitable for use in the Tandy 1000. However, Hercules informed me that unfortunately there is no way to disable that computer's internal display adapter. It should, however, work with the new Tandy 1000 SX.

The back panel of the Graphics Card Plus has two connectors: one for the IBM monochrome display (or compatible) and one for a parallel printer. The printer port appears to be hardwired as LPT1. If this designation conflicts with another printer port, you must either rename the other port or remove the Hercules port by pulling the chip. That will most likely be your only inconvenience during installation, since there are no DIP switches or jumpers to set on the board itself. If your IBM PC is already set up for a monochrome display adapter, all you need to do is pull out the IBM board and insert the Graphics Card Plus.

RamFont

RamFont is a unique hardware feature that allows you to use one or more alternate character sets in the display adapter's text mode. On the old Graphics Card, as well as on the original IBM monochrome display adapter, the only way to change the character set was to install a new ROM chip. Some programs like Microsoft Word instead used the graphics mode to draw characters. Unfortunately, graphics mode did not include certain text-oriented capabilities such as line-by-line scrolling. In many cases, the result was very slow performance.

With RamFont you can completely and easily replace the text characters used in text mode with a new character set. RamFont thus combines a good part of the flexibility of graphics mode with the fast text-handling capabilities of text mode.

RamFont comes in two forms: 4K and 48K bytes. In 4K RamFont mode, a new character set replaces the standard character set. This mode seems to be compatible with almost all existing text-based software, and it allows you to use, for example, italic letters with your spreadsheet or mathematical symbols with your word processor.

In 48K RamFont mode, a program can access a total of 12 character sets. To do this, Hercules uses four of the bits in the attribute byte of each screen character to indicate which set is being used. The other four bits in-

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Rich Malloy is a senior technical editor for BYTE. *He can be reached at* BYTE/McGraw-Hill, 1221 *Avenue of the Americas*, New York, NY 10020.

Graphics Card Plus

Type
Combination text/graphics display adapter for the IBM PC

Company
Hercules Computer Technology
2550 Ninth St.
Suite 210
Berkeley, CA 947210
(415) 540-6000

Features
720- by 348-pixel resolution
Downloadable text fonts

Price
$299

dicate attributes. To use the 48K RamFont mode, software has to be specially coded.

RamFont's capabilities are impressive, but the board cannot display proportionally spaced text as, for example, the Macintosh or Microsoft Windows Write can. Also, the size of the text is variable, but only within certain limits. The standard IBM character is drawn inside a 9- by 14-pixel matrix that includes all the intercharacter spacing. On the Graphics Card Plus, you can vary the vertical dimension of this matrix from 14 pixels to 1 pixel. The horizontal dimension, however, is limited to either 8 or 9 pixels. Thus, the maximum number of characters per line is 90.

Note that a larger character matrix (e.g., 24 by 28 pixels) can be simulated by combining smaller character matrices (in this case, six matrices, each 8 by 14 pixels). The horizontal dimension of these large character matrices has to be a multiple of 8. The card comes with impressive demonstration programs that illustrate this technique.

Software

Like the older Hercules Graphics Card, the Graphics Card Plus comes with several programs. HBASIC allows you to write BASIC graphics programs that can access the Hercules screen. Another program, HGC, permits you to dump the Hercules graphics image to an Epson printer, and it helps to avoid wearing out the screen phosphors by blanking out the screen after a specified time. Programmers who want to access the graphics screen and control RamFont can order an optional set of assembly language routines.

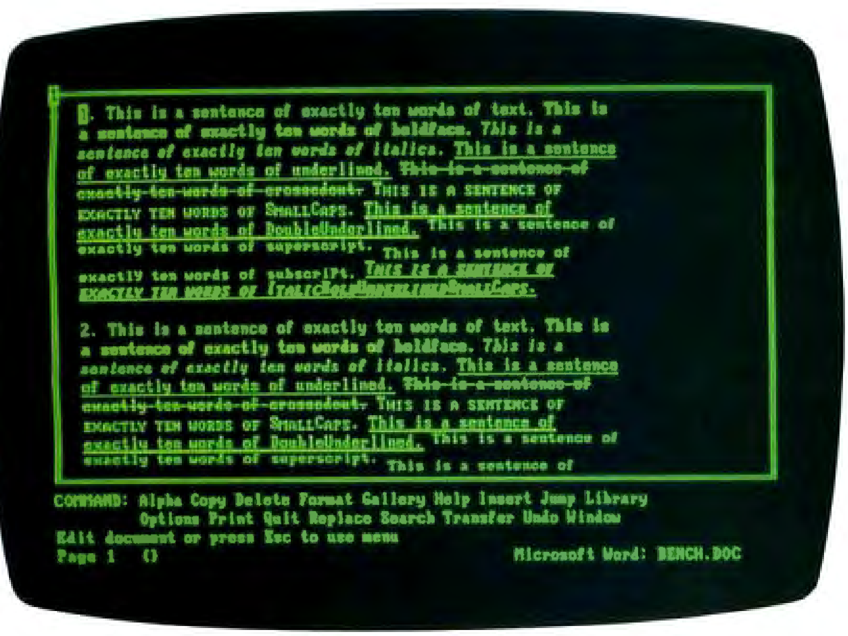

Photo 1: A *Microsoft Word screen showing a sample of the fonts that are included with the new* Hercules *driver for* Word.

Using Different Fonts

My favorite feature of the Graphics Card Plus is its ability to use a number of prepared fonts with most software (see photo 1). In addition to the standard IBM monochrome font, the board comes with approximately 15 new fonts including italic, sans serif, script, and a medieval font. My favorite of the prepared fonts is "bigserif," which is similar to the standard IBM font but is slightly larger and easier to read. Another interesting font is the full Greek alphabet.

You can easily modify any of these prepared fonts or create a new font with Hercules' FontMan program. For example, I altered the letters in the word "BYTE" to make it look like the familiar logo. More practical applications might involve special mathematical or scientific symbols. You can map each of the IBM keys to the characters you create. You could, for example, create fonts for phonetic Japanese, Hebrew, or Arabic. (For more information about implementing foreign languages on the Graphics Card Plus, contact Max Weinryb, S&B Electric, 2415 Grant St., Berkeley, CA 94703.)

Printing RamFont Characters

RamFont's new characters will appear on the screen, but your printer will still see them as the standard characters. Fortunately, some printers provide the capability for handling downloadable fonts. Others offer plug-in font cartridges. You could also use software packages such as Fontrix or Fancy Font that allow you to change the look of printed characters. Unfortunately, Hercules does not provide drivers to print out RamFont characters on standard printers. This would have enhanced the value of the Graphics Card Plus considerably.

USING 1-2-3 AND WORD

The board enhances the performance of Lotus 1-2-3 (release 2.0) and Microsoft Word. I tested these programs with the new board using both the standard Hercules drivers and the new RamFont drivers. Scrolling speed increased within both programs, and it increased dramatically with Word (see tables 1 and 2). The new driver scrolls through 50 lines of Word text approximately 70 percent faster than the old driver.

In 90-character-per-line mode, comparisons between the two drivers for Word are a little complicated. The older Microsoft driver displays 43 lines of text; the new RamFont driver displays only 35 lines. Screen repainting, measured by the time required to page down two screens, was 33 percent faster for the new driver, but, naturally, that driver had to display fewer lines during each repainting. After adjusting the time for an equal number of lines, I found that the new RamFont driver was still 17 percent faster.

Not apparent in the timings is the very readable quality of the characters produced by these versions of 1-2-3 and Word. In addition, with 1-2-3, the board allows you to display graphics in a window on the same screen as the spreadsheet. Of course, the graph is fairly small and is drawn at a fairly low resolution (probably 320 by 200 pixels). Symphony and Framework also provide special drivers. Hercules will not produce drivers for any other programs. It hopes that software developers will provide their own, as was done with the older Graphics Card.

Table 1: *Test results of Lotus 1-2-3 release 2.0 running on an IBM PC. The spreadsheet used was a standard 25- by 25-cell spreadsheet in which each cell equaled 1.001 times the cell to its left. The first test involved moving the cursor from column A to column Y. The second test was a simple recalculation. Note that in the 90-character-per-line mode, 1-2-3 appears to buffer cursor keystrokes and then jump to the final desired position.*

	Move 25 columns	Recalculate
80- by 25-line mode		
Standard Lotus driver	35.70	4.03
New RamFont driver	33.70	3.99
Improvement (percent)	5.60	1.00
90- by 38-line mode		
Standard Lotus driver	45.60	5.27
New RamFont driver	42.70	4.56
Improvement (percent)	6.40	13.50

Table 2: *Tests results of using the Graphics Card Plus with Microsoft Word with both the standard Microsoft driver and the new Hercules driver. The benchmark document consisted of 10 paragraphs of 10 sentences containing 10 words each in 10 various character formats. To ensure that a standard number of scroll-down keystrokes was used, a SuperKey macro was used with the smallest delay possible.*

	Scroll down 50 lines	Page down 5 pages
80- by 25-line mode		
Microsoft driver	24.60	14.30
New RamFont driver	7.21	9.47
Improvement (percent)	70.70	33.80
90- by 43-line mode		
Microsoft driver	7.41	20.50**
New RamFont driver*	6.52	13.70**
Improvement (percent)	12.00	33.10

*Note that the new RamFont driver for Microsoft Word's 90-character-per-line mode supports only 35 lines, not 43 lines as in the original driver.

** The time for five page-downs was extrapolated from the time for two page-downs.

PROBLEMS

The user's manual includes a pamphlet that lists approximately 100 compatible graphics software packages. It also states that the card works with all text-only IBM PC software. However, I had trouble with Borland's SuperKey. When I called SuperKey while using the special drivers for 1-2-3 and Word, I had unpredictable results. Sometimes the attributes of various characters would be shifted, and occasionally the system locked up. I would advise caution until perhaps a new version of SuperKey appears.

If you use a graphics program that is not on the list of compatible software, you may run into a problem. For example, I loaded a RamFont font and then used a graphics program to draw a graph. When I returned to text mode, everything suddenly went blank. To get the screen back, I had to leave the graphics program, go to the appropriate subdirectory, and cancel RamFont, all of which is pretty hard to do when the screen is blank.

RamFont stores its text information in page 0 of the Hercules graphics mode. I suspect that if a program uses

(continued)

Until faster processors become more prevalent, the RamFont approach may be the only way to display a large number of text styles and fonts.

page 0 for graphics, it will blank out this information. Programs using page 1 should not have this problem, and as more drivers are written for the Graphics Card Plus, the problem will diminish. Even Hercules' own program, HBASIC, uses page 0 and is not compatible with RamFont.

Another potential problem is that you cannot use the Hercules board while an IBM Color Graphics Adapter (CGA) card, or almost any other CGA card, is also in the system. You can, however, have a Hercules CGA card present.

CONCLUSIONS

Perhaps the best way to represent text is via a bit-mapped display, as on the Macintosh. But until faster processors become more prevalent for the IBM family, the RamFont approach may be the only really workable way of displaying a large number of text styles and fonts.

The Graphics Card Plus accomplishes well what it attempts to do. The card does an excellent job of handling Hercules-style graphics, displaying new custom character sets, and enhancing programs such as Lotus 1-2-3 and Microsoft Word. I advise caution due to the card's lack of complete compatibility with some older Hercules-compatible software and the lack of any easy way to print out RamFont characters. But at only $299, I recommend it as a very competitive general-purpose display card. For anyone involved in multilingual work or certain scientific applications, it may be indispensable. ■

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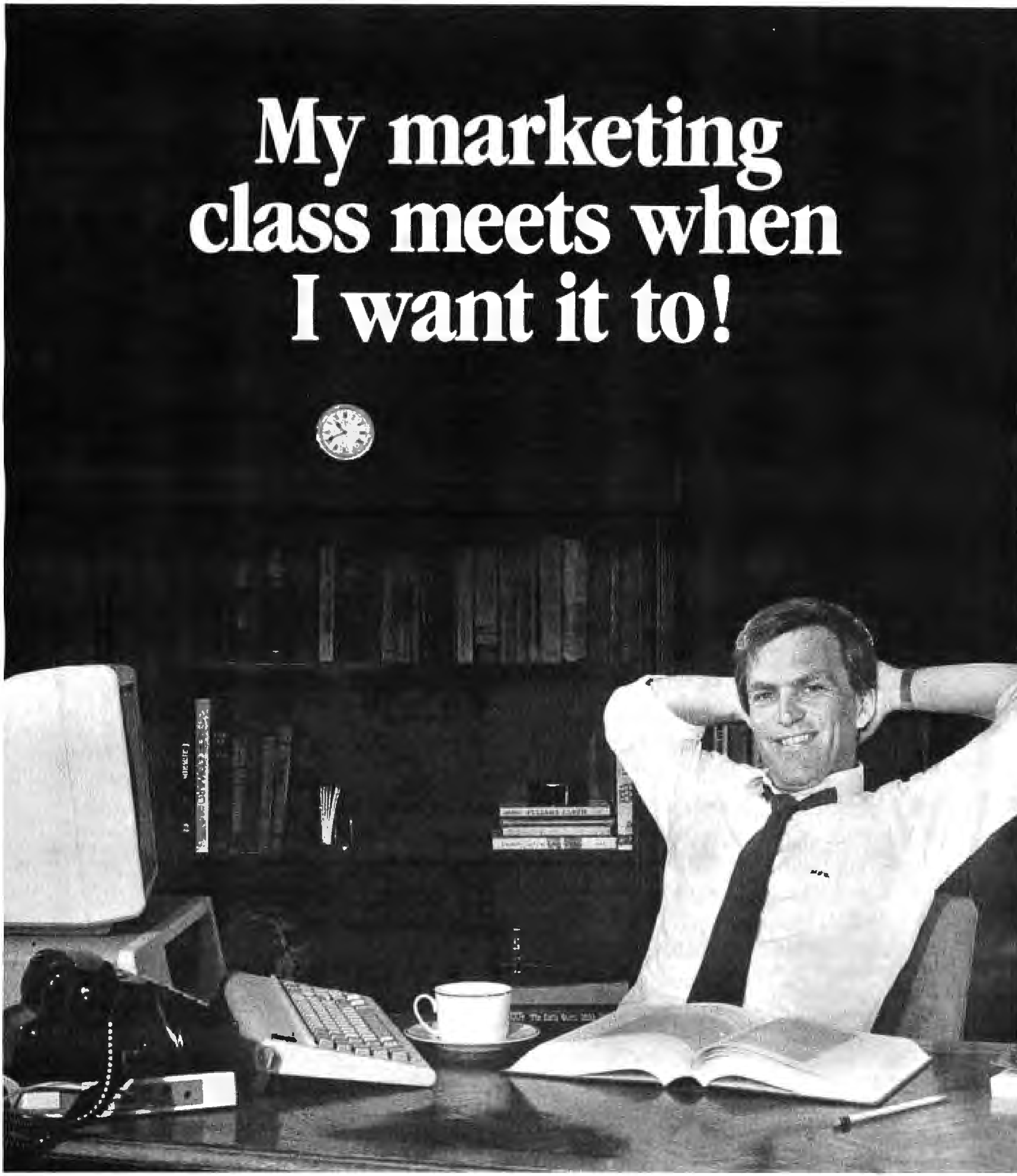

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23 Modems

BY STEPHEN SATCHELL

An evaluation of modems and their ability to handle impairments

All modems are not the same. To find out how much the current crop of modems differ from one another, I took 23 modems from 16 manufacturers and tested them head to head.

Modem Basics

The word *modem* stands for modulator demodulator. At one end a modem accepts signals and converts, or modulates, them to a form suitable for transmission. At the other end, the modem takes the modulated signal and converts it back to the original signal.

The modems I tested for this review convert digital signals to specific tone patterns, send them over an audio (telephone) channel, and reconstruct the digital signal at the other end. All the modems included here are full-duplex modems; that is, they can send information in both directions at the same time. This is done by splitting the available audio channel bandwidth in half; one modem generates tones in the lower half and the other generates tones in the upper half.

Depending on the modulation method, the modem takes 1 to 8 bits of information and modifies the carrier tone in some specific way. Each group of bits is called a symbol. The data rate is defined as the number of symbols transmitted per second. Note that the true data rate of a modem is some percentage of the bit rate, since a symbol can contain several bits.

The three modulation methods currently in use with asynchronous modems are the Bell 103 standard (0–300 bps), the Bell 212 standard (1200 bps), and the CCITT V.22bis standard (2400 bps).

The Bell 103 method uses frequency-shift keying to send up to 300 bits per second in each direction. This system sends two tone frequencies: a lower-frequency tone for a one bit and a higher-frequency tone for a zero bit. The data rate is equal to the bit rate and can be any speed from 0 bits to 300 bits per second. The bit rate may differ in each direction, although this is unusual.

The Bell 212 method uses differential phase-shift keying to send 1200 bits per second. Each symbol consists of 2 bits. For each symbol, the carrier wave is shifted four different amounts for each of the four possible dibit (2-bit) values: 00, 01, 10, and 11. The data rate is fixed at 600 symbols per second, or 1200 bps.

The CCITT V.22bis method uses quadrature amplitude modulation to send 2400 bits per second. Four bits define each symbol, and the system uses both 12 values of phase shift and three amplitude levels to encode a symbol. As with the Bell 212 method, the data rate is fixed at 600 symbols per second and the bit rate is 2400 bps.

What Goes Wrong

Almost all modems work without error when the communications channel makes no changes to the modulated signal. Unfortunately, no telephone line is absolutely perfect. Moreover, the farther the signal has to travel, the greater the possibility of transmission imperfections. How modems cope with these imperfections separates the good modems from the not-so-good ones.

A number of specific imperfections, called impairments by the telephone industry, have been identified, and methods have been developed to measure their magnitude. Impairments introduce errors by making the receiving modem's job of decoding the correct symbol difficult (or impossible). As the symbols become more complex, symbol corruption becomes easier. Thus, a connection that passes 300-bps data without error can completely destroy 2400-bps data.

To understand the source of particular impairments, you must take a look at the telephone connection. When you make a call to a phone in the same or a neighboring telephone exchange, a simple circuit is created. The connection between the two phones and the telephone company's central office consists of a single pair of wires from each phone to the switches inside the central office.

When you have to call a significant distance—100 miles or more—the telephone company will split your call in two. Instead of carrying both sides of the conversation on one pair of wires, the call goes on two pairs of wires. This simplifies amplifying the signal and improves the quality of long connections. Also, the two halves of the connection can be sent via long distance coaxial, microwave, satellite, or fiber optics with far fewer technical difficulties.

Since the call is split, it is possible to have defects in one direction and not the other. This is especially true with calls that get routed into trans-

(continued)

Stephen Satchell (Satchell Evaluations, 16 Searing Ave., Morristown, NJ 07960) has been active in computer product development and evaluation since 1971.

mission systems that multiplex many calls into one very high-speed channel. Digital transmission systems alleviate the problem a bit, but they introduce problems of their own.

The main problem with modem testing in this type of environment is that you cannot depend on getting exactly the same call routing from call to call. Thus, it is virtually impossible to apply exactly the same test conditions to each modem that you are testing. Even if you could, that does not help someone else decide which modem to buy, since they might have a completely different set of impairments with which to contend.

To combat this problem, I built a telephone connection simulator using a Bradley Telcom Corporation 2A/2B line simulator, a reference modem (an AT&T Dataphone II Set 2224B modem in loopback mode), a Hewlett-Packard 4437A attenuator, passive hybrid splitters, and a Ramsa 8210 recording mixer (used to synthesize two line amplifiers). I generated test data using a BASIC program running on a Compaq Portable (see figure 1).

By using the impairment generators in the 2A/2B line simulator and checking for errors on the Compaq, I was able to stress the modems to discover just how much impairment they could take. For each modem, I took 79 measurements per speed supported; that's 237 measurements for a 2400-bps modem. The results are summarized in figures 2, 3, and 4. [*Editor's note: Figures 2, 3, and 4 use numbers to denote the 23 modems tested. See the box on page 257 for the product name, company name, and price of each modem.*]

As a final check, I used the 1982/83 End Office Connection Study (*AT&T/Bell Laboratories Technical Journal*, volume 63, number 9, November 1984) to set up a reasonable worst-case connection that would test how the modems handled a mixture of impairments.

Modem companies use equipment like this to check out new modem designs. According to applications notes provided by Bradley Telcom, you loop back the modem through the 2A/2B line simulator during testing so that the modem is sending itself data. No one really uses a modem this way, so a more realistic condition was to duplicate the user/server relationship, with the server being an AT&T 2224B modem.

For impairments involving frequency, I focused on 20 Hz, 60 Hz, and 120 Hz in the tests. The most common frequency used by telephone operating companies to ring the telephone bell is 20 Hz. The power-line frequency in the U.S. is 60 Hz, while 120 Hz is the frequency you get from a 60-Hz power line after you convert it to pulsating DC using a full-wave rectifier, as many electronic appliances do. (If I wanted to be international in scope, I would have also used 50 Hz and 100 Hz.)

I conducted each impairment series four times. The first three times I used no filtering and three different signal levels: −5 dBm (decibels referenced to 1 milliwatt), −15 dBm, and −25 dBm. The fourth time I used a great deal of filtering at −5 dBm. The tests are described below.

SENSITIVITY

Sensitivity indicates the signal level required for the modem to recognize the initial connection protocol and to make an error-free connection on a clean line (i.e., one with no impairments). The results are shown in figures 2a, 3a, and 4a. The lower the result, the better; that means the modem can maintain the connection with a weaker signal.

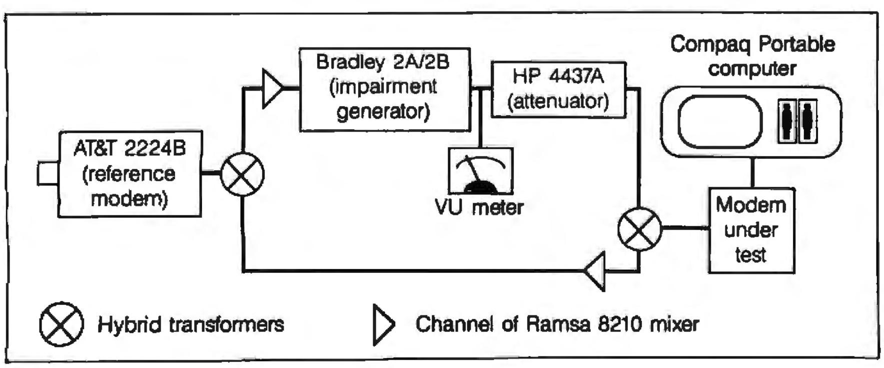


Figure 1: *The setup of test instruments used in this review.*

PHASE MODULATION

If you look at an oscilloscope displaying a sine wave that is experiencing phase modulation, the waveform will wiggle back and forth. Moderate amounts of phase modulation should not affect 300-bps operation. Since a 1200-bps or 2400-bps symbol uses phase offsets, however, a certain amount of jitter will cause symbols to be decoded incorrectly.

In this test I measured the amount of phase modulation that the modem could tolerate before it began introducing errors. I performed the test at the impairment frequencies of 20 Hz, 60 Hz, and 120 Hz and recorded the minimum and maximum tolerances (see figures 2b, 3b, and 4b). In this case (and in all the following tests except Error Count), a modem with high ratings was able to tolerate greater amounts of phase modulation before introducing errors. (In this test and the following test, the maximum modulation that the line simulator could produce was 90 degrees.)

AMPLITUDE MODULATION

Amplitude modulation tests how the modem rejects periodic fluctuations in signal level. It is the same as turning the volume control on the signal back and forth at a specific frequency. I checked how far I could go at the three frequencies of 20 Hz, 60 Hz, and 120 Hz and recorded the minimum and maximum tolerances, as shown in figures 2c, 3c, and 4c. A modem with high ratings could tolerate more amplitude modulation without introducing errors.

WHITE NOISE

White noise is the hiss you hear on long-distance telephone calls. As this gets louder in relation to the signal, the receiving modem may confuse the noise for part of the signal. I

(continued)

PRODUCT INFORMATION

The numbers preceding the products correspond to the numbers in figures 2, 3, and 4. All modems are 300/1200 bps except those marked with an asterisk, which also support 2400 bps.

*1. Model 2233 $445
Codex Corp.
20 Cabot Blvd.
Mansfield, MA 02048
(800) 446-6336

2. 212AHC $295
3. 212AH* $295
CTS Fabri-Tek Inc.
Datacomm Products Division
6900 Shady Oak Rd.
Eden Prairie, MN 55344
(800) 328-6104

4. FasTalk 1200 $450
Universal Data Systems Inc.
5000 Bradford Dr.
Huntsville, AL 35805
(800) 663-2252

5. KM1200S $299
Kyocera International Inc.
8611 Balboa Ave.
San Diego, CA 92123
(800) 235-1222

6. Smartmodem 1200 $599
Hayes Microcomputer Products
P.O. Box 105203
Atlanta, GA 30348
(404) 441-1617

7. Maxwell 1200V $295
Racal-Vadic
1525 McCarthy Blvd.
Milpitas, CA 95035
(800) 482-3427

8. MultiModem $399
*9. MultiModem224 $699
Multi-Tech Systems Inc.
82 Second Ave. SE
New Brighton, MN 55112
(800) 328-9717

10. Smart-CAT Plus $495
Novation Inc.
20409 Prairie St.
Chatsworth, CA 91311
(818) 996-5060

*11. 2400 Plus $695
Ven-Tel Inc.
2342 Walsh Ave.
Santa Clara, CA 95051
(408) 727-5721

*12. Courier 2400 $699
USRobotics Inc.
8100 McCormick Blvd.
Skokie, IL 60076
(312) 982-5010

13. Rainbow 1200SA $199
INCOMM Data Systems Inc.
115 North Wolf Rd.
Wheeling, IL 60090
(312) 459-8881

*14. Model 2400V $595
Racal-Vadic
(See address at number 7.)

15. OZ Guardian Model 533 $750
Tri-Data
505 East Middlefield Rd.
Mountain View, CA 94043-4082
(415) 969-3700

16. IntelliModem EXT $499
BIZCOMP Corp.
532 Mercury Dr.
Sunnyvale, CA 94086
(408) 733-7800

*17. Smartmodem 2400 $899
Hayes Microcomputer Products
(See address at number 6.)

*18. MultiModem224E $749
Multi-Tech Systems Inc.
(See address at number 8.)

19. OmniTel 1200 $299
OmniTel Inc.
5415 Randall Place
Fremont, CA 94538
(800) 654-2785

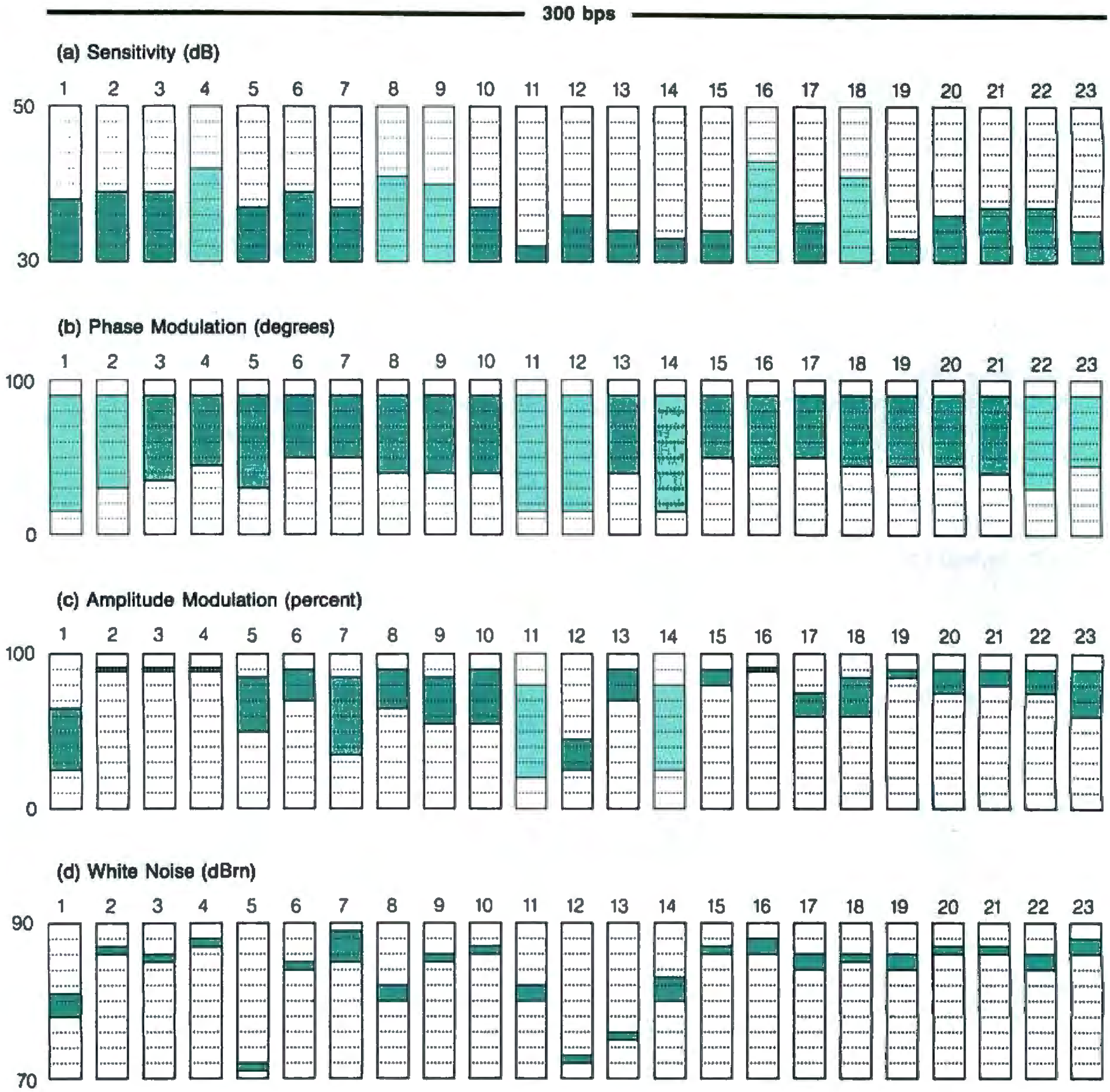
20. Model 4000 $499
*21. Model 4024 $750
AT&T Information Systems
225 Littleton Rd.
Morris Plains, NJ 07950
(800) 247-1212

22. Cermetek Security Modem $595
Cermetek Microelectronics Inc.
1308 Borregas Ave.
Sunnyvale, CA 94088
(800) 862-6271

*23. 2424AD $395
CTS Fabri-Tek Inc.
(See address at number 2.)

* Since this review was completed, the manufacturer has discontinued this model.

Figure 2: *Results of the tests performed on the 23 modems operating at 300 bps. See text for description of the tests. Generally, the higher the rating, the better, except for the Sensitivity and Error Count tests, in which the better modems have the lowest ratings.*



tested how much white noise each modem could tolerate at the various signal levels and recorded the point at which the modem began introducing errors. The results are shown in figures 2d, 3d, and 4d. A modem with high ratings could tolerate white noise better than one with low ratings.

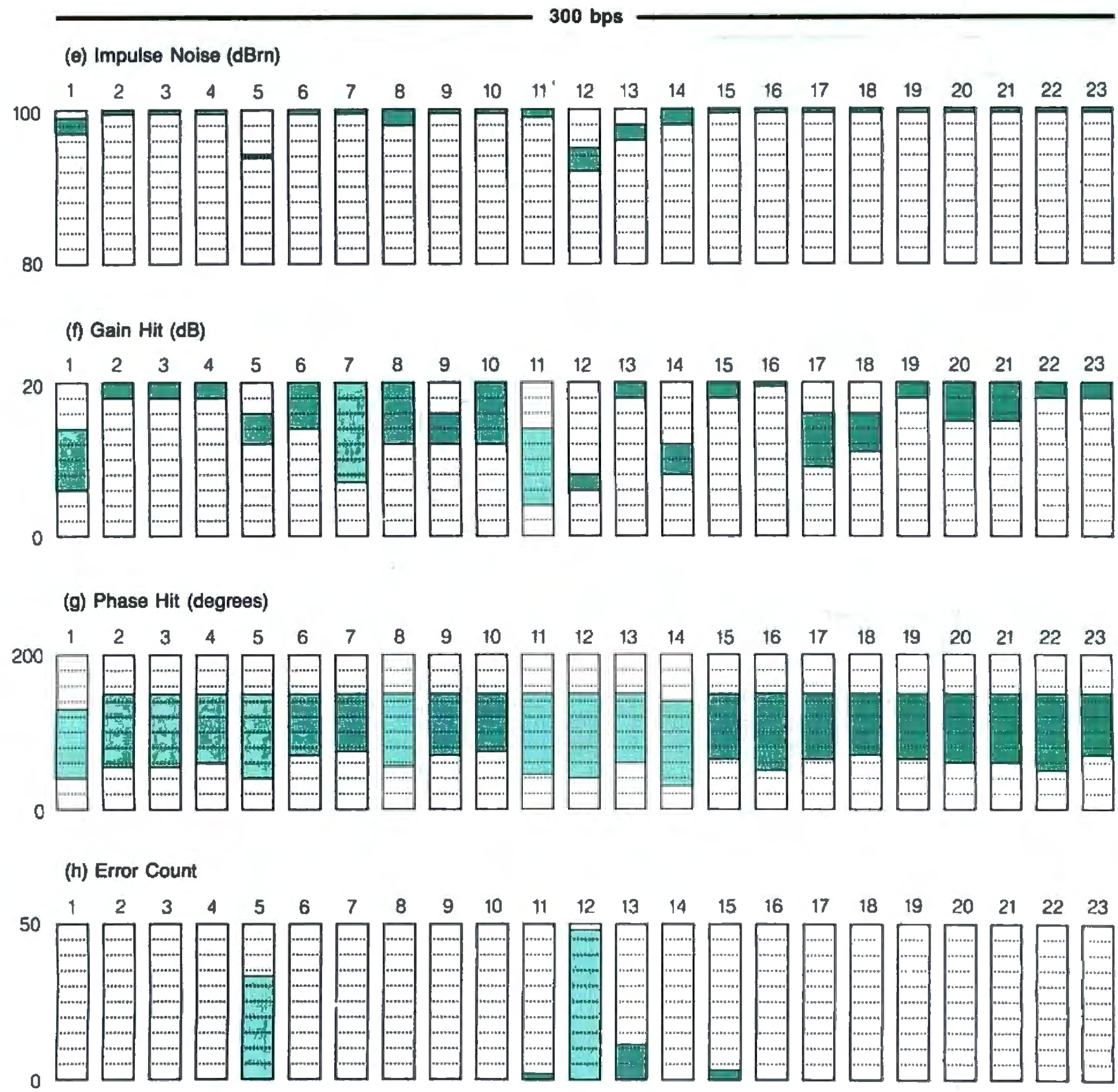
IMPULSE NOISE

Impulse noise is a transient pulse or spike caused by lightning, relays, or repairs, among other causes. You hear this as a short "pop" on long-distance calls.

I generated an impulse 5 times per second and measured the impulse level the modem could tolerate at the various signal levels. The test results are shown in figures 2e, 3e, and 4e. Once again, the higher the rating, the better. Note that 100 dBrn (decibels above reference noise) is the maximum that the 2A/2B can generate. This measurement is equal to 10 dBm.

GAIN HIT

A gain hit is a change in the level of the received signal for anywhere from 4 milliseconds up to hours. On a long-distance call, a gain hit sounds like someone has turned down a volume control and (maybe) brought it back up. I measured the maximum dip the modem could stand before it began



introducing errors by using two different rates of change in gain. In the first test I effected the gain change in 20 milliseconds; in the second I took 2 milliseconds to go from one level to another. Duration of the hit was 100 milliseconds, and I started a hit every 200 milliseconds.

The results are shown in figures 2f, 3f, and 4f. The maximum gain hit that the 2A/2B could generate was 20 dB (decibels). Modems that rate highly in this test are more likely to continue working reliably in situations where gain hits are common.

Phase Hit

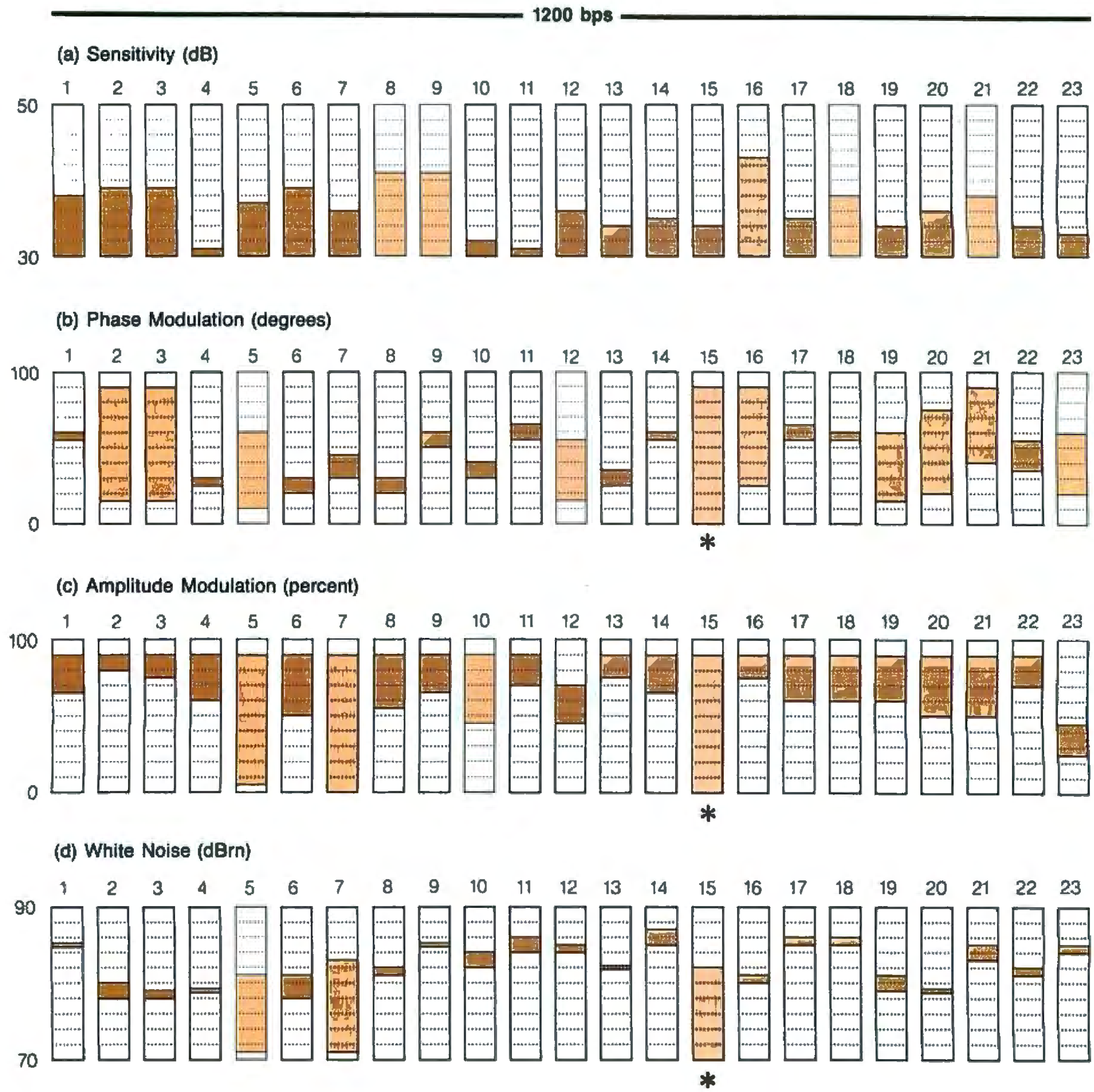
A phase hit is a change in the phase of the received signal, similar to the change in level of a gain hit. I used the same intervals as in the tests for gain hit and recorded the maximum and minimum amount of phase shift that the modem could stand before introducing errors (see figures 2g, 3g, and 4g). The maximum phase hit that the 2A/2B could generate was 150 degrees.

Error Count

Error count is the number of errors recorded for each speed the modem supports. I set up the line simulator for filtered frequency response, a signal level of −15 dBm, 10 degrees

(continued)

Figure 3: *Results of the tests performed on the 23 modems operating at 1200 bps. See text for description of the tests. Generally, the higher the rating, the better, except for the Sensitivity and Error Count tests, in which the better modems have the lowest ratings. An asterisk indicates that a modem was unable to maintain a connection at some impairment levels, as reflected in the minimum value reported.*

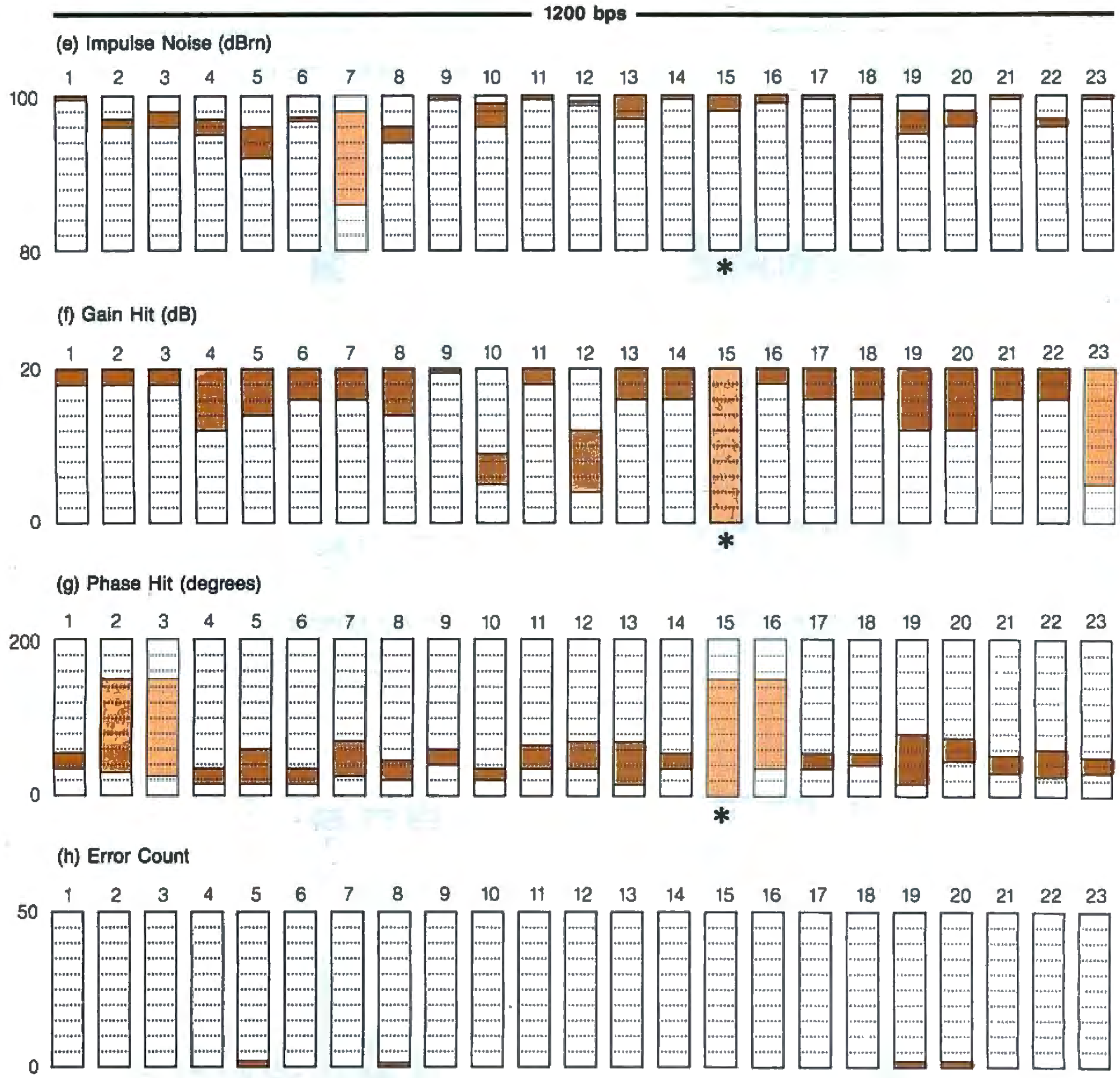


of phase modulation at 60 Hz, 2 percent (−33 dB) of second- and third-order harmonic distortion, white noise output of 55 dBrn (a signal-to-noise ratio of 35 dB), and gain hits of 2 dB and phase hits of 10 degrees at 5-second intervals with a 2-millisecond rise and a 100-millisecond duration. I counted errors for 2 minutes. When an error occurred, the test program stopped and waited for no bits for about ½ second before resuming pattern transmission. This ensured that the modem had recovered from the last error. The results are shown in figures 2h, 3h, and 4h. In contrast to most of the other tests, the lower the rating here, the better.

CONCLUSIONS

The rigorous testing I employed revealed differences between modems that simple "use testing" did not find. For example, when I tested the USRobotics Courier 2400 modem for another publication, I didn't perceive that 300-bps operation was more sensitive to line impairments than 1200-bps operation. This proved to be true for four other modems I tested.

The AT&T Model 4024 stood out clearly as the top modem. Although



the Model 4024 fared well in most of the tests, the bottom line in data transfer is the error count, and the Model 4024 showed the lowest error count at 2400 bps, as shown in figure 4h. The Ven-Tel 2400 Plus came in with the next lowest error count.

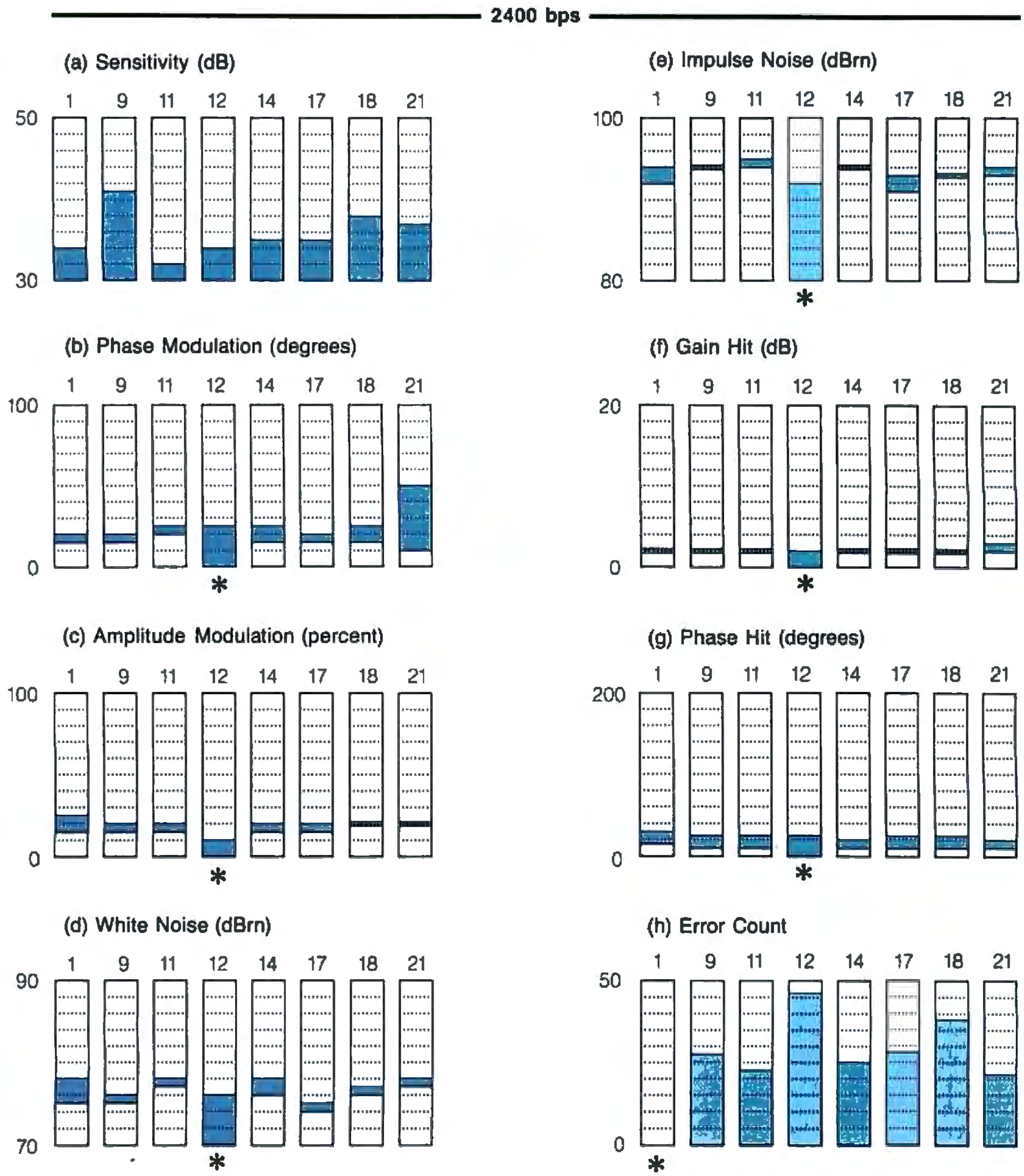
At 1200 bps, a number of modems ignored the simulated bad connection and had no errors at all (see figure 3h). I then looked to see how each modem stood up to impairments. On this basis, I selected these as the top five modems for 1200-bps transfers: the AT&T Model 4024, the Ven-Tel 2400 Plus, the AT&T Model 4000, the Multi-Tech MultiModem224E, and the IntelliModem EXT. All five modems were able to withstand the more severe impairments and excelled at ignoring at least one.

The error count results also add fuel to the controversy over whether CCITT V.22bis (2400-bps) modems can work. According to my test setup, the CCITT V.22bis modems performed miserably. (The CTS 2424AD, for example, could not make a clean connection at 2400 bps with any attenuation of the signal.)

Still, users report having good luck using these modems at 2400 bps over

(continued)

Figure 4: *Results of the tests performed on the 23 modems operating at 2400 bps. See text for description of the tests. Generally, the higher the rating, the better, except for the Sensitivity and Error Count tests, in which the better modems have the lowest ratings. An asterisk indicates that the modem was unable to maintain a connection at some impairment levels, as reflected in the minimum value reported.*



significant distances. The 1982/83 End Office Connection Study, upon which I based the worst-case Error Count test, analyzed 6500 directly dialed long-distance calls among 20 locations. In that study, over 95 percent of the medium-distance connections had better measurements (i.e., fewer impairments) than my setup.

Had I selected values such that 50 percent of the connections showed better measurements, I suspect the 2400-bps modems would have had lower error counts. This conclusion is based on the single-impairment stress tests.

This survey did not test sensitivity to radio frequency interference (RFI) from AM, FM, TV, CB, and other transmitters. Depending on how bad the RFI problem is, it can be extremely tedious trying to trace down an intermittent problem.

I make no claim that this is the perfect evaluation for modems. I welcome advice from all quarters to improve my methods.

Editor's note: If you would like more details on the setup of these tests, please send all comments and questions directly to the author. ■

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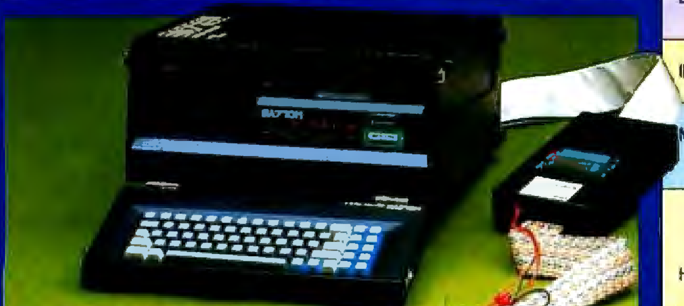

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	Z8 (Z8601/03/11/13-12R)	DIP40P	○
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	8048 (8035/39/40/49/50AH)	DIP40P	○
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PASCAL FOR THE IBM PC

BY NAMIR CLEMENT SHAMMAS

Which one you choose depends on your specific needs and experience

In this review I will survey four Pascal packages for the IBM PC: Microsoft's MS-Pascal, Pecan Software Systems' enhanced version of UCSD Pascal, Prospero Software's Pro Pascal, and MetaWare's Professional Pascal. Information on Borland's Turbo Pascal is taken from "Turbo Pascal 3.0" by Mark Bridger (February BYTE) and is included only in the comparative tables and in the benchmarks.

MS-PASCAL

The three-pass MS-Pascal version 3.31 compiler from Microsoft lets you include compiler directives in the source program or type them on the DOS command line while invoking the first pass. There is no built-in editor in the system. The second and third passes are invoked from DOS without any parameters and use files created by previous passes. You can initiate the compile and link process from a DOS batch file.

The current versions of Microsoft's C, FORTRAN, and Pascal compilers allow the interlinking of object code files among them. The linker comes with its own set of directives that affect such linking and code-generation processes as memory allocation, overlay manipulation, and the use of a default library name. If you are linking programs that have considerable floating-point operations, you can select from a number of floating-point support libraries to consistently use or avoid the 8087 chip, the IEEE floating-point standard, or an alternative representation (see table 1).

MS-Pascal supports the standard data types (boolean, char, integer, and real). It has five integer subtypes: short integer (−127 to 127), byte (0 to 255), standard integer (−32,768 to 32,767), the unsigned integer word (0 to 65,535), and the long integer4 (from minus to plus 2 billion). Floating-point types include the standard real, the explicit single-precision real4, and the double-precision real8.

The single and multidimensional super array data types have undefined upper bounds. When you declare a variable in the var section, you must specify the upper array bound. Pointers to super arrays, however, might delay specifying the upper limit until the new( ) procedure is called. This procedure allocates dynamic data structures and should define the upper array limits. The predefined functions upper( ) and lower( ) allow program access to these limits.

There are two types of strings: string variables, which may vary in length from 1 to 32K bytes (no default), and lstring variables, which may contain up to 256 characters. The difference between them is due to their internal data structures: a string is simply an array of characters, while an lstring contains a length field followed by a string of characters.

Numeric constants in MS-Pascal can be of any base from 2 to 36, enabling the use of binary, octal, decimal, and hexadecimal constants. You can also define constants by using expressions that involve other previously declared constants or as array or record structures (see table 2).

MS-Pascal also implements the value section, a program area in which you can initialize defined variables and assign each of them one or more attributes to instruct the compiler on how to handle and store them and how to define their status between routine calls.

The compiler supports the standard Pascal for . . . do, while, and repeat . . . until loop constructs as well as two additional loop control statements. The break statement provides an exit from the current loop, while cycle lets you skip the rest of the current loop iteration and resume processing at the next iteration.

MS-Pascal also supports the standard if and case constructs, and case is extended by the catch-all otherwise clause. Conditional (Boolean) expressions are evaluated sequentially. The tested expression is written as a series of and then or or else subtests. Once an and then subtest is found to be false, the remaining subtests are not evaluated. Similarly, once a subtest in an or else clause is found to be true, further evaluation is terminated.

Functions and procedures can contain attributes that direct compiler-generated code. These include forward (for forward referencing), extern and public (for external referencing), origin (for subprogram addressing), fortran (for multilanguage interfacing), interrupt (for hardware interfacing), and pure (for optimizing). MS-Pascal also contains a large library of functions and procedures that provide such services as data-file system access, dynamic variable allocation, data conversion, mathematical functions, extend- and system-level intrinsics, string manipulation, heap man-

(continued)

Namir Clement Shammas (4814 Mill Park Court, Glen Allen, VA 23060) is a freelance writer and columnist for several microcomputing magazines.

agement, and semaphore routines. There are no routines to support high-resolution graphics, cursor and screen control, or windows, but such support is available elsewhere.

The language supports readable ASCII and binary data-file structures. MS-Pascal has three file access modes: sequential, direct (random access), and terminal (similar to sequential but used with printers and terminals).

MS-Pascal provides support for modular program development through modules (programs that have no body but contain functions and procedure declarations) and units (more evolved libraries composed of the interface and implementation sections). The interface section declares the exported routines by the unit. It also contains the constants, types, variables, procedure and function headings, and optional unit initialization. The implementation section contains the complete routine's definition as well as those of local routines (see table 2).

MS-Pascal version 3.31

Type
Language compiler

Company
Microsoft Corporation
16011 Northeast 36th Way
P.O. Box 9097017
Redmond, WA 98073-9717
(800) 426-9400

Format
Two double-sided, double-density 5¼-inch disks

Computer
IBM PC, PC XT, or PC AT with PC-DOS 2.0 or later, 256K bytes of memory, and two floppy disk drives; 8087 math coprocessor chip optional

Documentation
Two three-ring manuals: a 359-page user's guide and a 392-page reference guide

Price
$300

Pro Pascal version 2.14

Type
Language compiler

Company
Prospero Software
190 Castelnau
London SW13 9DH, U.K.
Telephone: 01-741 8531

Format
Two double-sided, double-density 5¼-inch disks; PC-DOS 2.0–compatible disk format

Computer
IBM PC, PC XT, or PC AT with a minimum of 80K bytes of memory and 200K bytes of disk storage; 8087 math coprocessor chip optional

Documentation
220-page three-ring manual

Price
$390

UCSD Pasçal version 4.2.1

Type
Language compiler and environment

Company
Pecan Software Systems Inc.
1410 39th St.
Brooklyn, NY 11218
(800) 637-3226 (outside NY)
(800) 457-3226 (NY only)

Format
Three double-sided, double-density 5¼-inch disks; PC-DOS 2.0–compatible disk format

Computer
IBM PC, PC XT, or PC AT with a minimum of 128K bytes of memory, two double-sided disk drives, monochrome or color display, graphics adapter, and PC-DOS 2.0 or later; 8087 math coprocessor chip optional

Documentation
594-page bound manual

Price
$99.95

Professional Pascal version 2.5

Type
Language compiler

Company
MetaWare Inc.
412 Liberty St.
Santa Cruz, CA 95060
(408) 429-6382

Format
Seven double-sided, double-density 5¼-inch disks

Computer
IBM PC, PC XT, or PC AT with 227K bytes of memory, a minimum of 1.5 megabytes of hard disk storage (2.5 megabytes recommended), and PC-DOS 2.0 or later; 8087 math coprocessor chip optional

Documentation
500-page three-ring manual

Price
$595

UCSD Pascal

UCSD Pascal version 4.2.1, with its environment and operating system, runs on top of the MS-/PC-DOS operating system. You use the PSYSTEM.COM file to boot the p-System; however, the MS-DOS DIR command won't catalog the contents of p-System volumes. The environment consists mainly of the built-in editor, compiler, linker, filer, DOS files, assembler, debugger, monitor, and program driver.

The Edvance editor is a single-file built-in editor. Beyond the normal cursor movement, text modification, and text formatting capabilities, the editor has two buffer-management commands to extend the file buffer and write parts of it to a disk file. The editor lets you create a new function or macro by recording a sequence of keystrokes. Moreover, the program can read such functions from the text. Nested editing is also permitted.

The UCSD Pascal compiler translates source code into either p-code (by default) or native code (by using a compiler directive). You can include a number of directives in the source code to permit actions such as conditional compilation, I/O checking, index range checking, determination of single- or double-precision floating-point representation, or quiet compilation to prevent displaying compilation progress information. Other versions of the compiler produce code using the 8087 chip and a library that supports BCD math. When the compiler detects an error, you can choose from a number of alternate courses of action such as resuming compilation to catch more possible errors, halting the compiler, invoking the editor to point to the offending text location, and sending the error messages to the printer.

The linker enables you to link assembly language routines into a UCSD Pascal compilation. You can also link native code routines together. When you compile a source program into executable code, you need not explicitly invoke the linker; the compiler will automatically call it (see table 1).

The standard scalar data types (boolean, char, integer, and real) are supported. Long integers are available and can be defined as integer[*n*], where *n* is an unsigned integer representing the number of digits to a maximum of 36. You can use real data types as single- or double-precision numbers, depending on the compiler directive invoked. UCSD Pascal also has predefined string data types with default and maximum lengths of 80 and 255 characters, respectively (see table 2).

Procedures and functions can use the forward attribute for forward referencing, passing parameters by value or reference. The language supports conformant single- and multidimensional arrays. The lower and upper range of each array dimension is assigned to variables whose type is indicated after the range expression in the form array [*low . . . high;type*] of *type*. Within the functions and procedures, you access the array limits through the upper( ) and lower( ) special variables. The language also implements loops and decision-making constructs without language extensions.

UCSD Pascal supports single microprocessor pseudoconcurrent processes. These processes must be global to the program and cannot be declared within other procedures and functions; nested processes are not allowed. You use the procedure start to initialize each concurrent call. Each process triggered must have a processid, priority, and stack size assigned to it. Process synchronization is carried out by using the predefined type semaphore and a number of predefined procedures. A semaphore monitors the number of processes waiting in a queue and an integer count. The seminit procedure initializes the semaphore and the count number. You use the procedures signal and wait for interprocess synchronization; both take a semaphore as an argument. A concurrent process can associate hardware interrupts with a semaphore using the procedure attach.

Table 1: *General information about the four compilers discussed, as well as Borland's Turbo Pascal.*

	MS-Pascal	UCSD Pascal	Pro Pascal	Professional Pascal	Turbo Pascal
Version	3.31	4.2.1	2.14	2.5	3.0
Native code	Yes	Yes	Yes	Yes	Yes
P-code	No	Yes	No	No	No
Number of passes	3	1	3	1	1
Linker	Yes	Yes	Yes	No	No
Assembler	No	Yes	No	No	No
Debugger	No	Yes	Yes	Yes	No
Built-in editor	No	Yes	No	No	Yes
Syntax-oriented editor	N/A*	No	N/A*	N/A*	No
Requires hard disk to run	No	No	No	Yes	No
Price	$300	$99.95	$390	$595	$69.95

*Not applicable.

The compiler allows both sequential and random access binary-formatted I/O operations, but only sequential ASCII-formatted file structures are permitted. Untyped file I/O is supported, block I/O is performed through blockread and blockwrite, and device I/O is also implemented.

UCSD Pascal contains five units that perform a variety of important tasks including advanced screen control, I/O redirection and program chaining, turtle graphics, accessing IBM PC hardware features, PC-DOS file access, and data segment access.

Pro Pascal

Of the four packages reviewed, Pro Pascal version 2.14 adheres most closely to the ISO standard Pascal, but with a number of language extensions. The main package components include a compiler, linker, symbolic debugger, and librarian; the compiler's components include two utility programs, a cross-reference generator, and a configurator. It has no built-in editor.

To select a library for inclusion in a compilation, you must first make a copy of it and name that copy PASLIB.OBJ. The three-pass Pro Pascal compiler automatically chains to the linker if it finds the PASLIB.OBJ library. Otherwise you must explicitly link the object code file with a selected library. You use a linker switch to perform selective linking with only those routines that are referenced in the program. You can invoke the linker—or the compiler—in its interactive mode by not entering an object filename. In addition to prompting for the object filename, the linker will also ask you a number of questions concerning stack size, creation of a module map, a public and external routines map, a segment map, and overlays. The four available run-time libraries correspond to the four possible combinations of supporting small or large memory models and running with or without 8087 support (see table 1).

Pro Pascal supports the following basic data types: boolean, char, integer, real, long real, and string. The integers are implemented as long integers with values ranging from minus to plus 2 billion. Long reals have a wider value range (1.1^{-308} to 3.6^{308}) and use 16-digit precision; reals have 7-digit precision and range from 5.9^{-39} to 6.8^{38}; strings have a maximum size

(continued)

Table 2: *A comparison of the various available data types, program components, and special features.*

	MS-Pascal	UCSD Pascal	Pro Pascal	Professional Pascal	Turbo Pascal
Binary constants	Yes	No	No	Yes	No
Octal constants	Yes	No	No	Yes	No
Hexadecimal constants	Yes	No	Yes	Yes	Yes
Structured constants	Yes	No	No	No	Yes
Short integers (−127 through 127)	Yes	No	No	No	No
byte (0 through 255)	Yes	No	No	No	Yes
Unsigned integers (0 through 65,535)	Yes	No	No	Yes	No
Long integers	Yes	Yes	Yes	Yes	No
address	Yes	No	Yes[1]	Yes[1]	Yes[1]
Absolute variables	Yes	No	No	Yes	Yes
Double-precision reals	Yes	Yes	Yes	Yes	No
8087 support	Yes	Yes	Yes	Yes	Yes[2]
BCD reals	No	Yes	No	No	Yes[2]
Extended reals	No	No	No	Yes	No
Enumerated types	Yes	Yes	Yes	Yes	Yes
Subrange types	Yes	Yes	Yes	Yes	Yes
Set types	Yes	Yes	Yes	Yes	Yes
Open arrays	Yes	Yes	No	No[3]	Yes[4]
Conformant arrays	Yes	No	No	No	No
Procedural types	No	No	No	Yes	No
Functions return structures and arrays	No	No	No	Yes	No
Maximum string size	32K	255	255	64K	255
Bit/byte manipulation	Yes	No	No	Yes	Yes
Byte/character manipulation	Yes	No	No	Yes	Yes
case with else clause	Yes	No	Yes	Yes	Yes
Concurrent processes	No	Yes	No	No	No
DOS call	Yes	No	Yes	Yes[5]	Yes
High-resolution graphics	No	Yes	No	No	Yes
Iterators and extended for loops	No	No	No	Yes	No
In-line machine code	No	No	No	No	Yes
Interrupts	Yes	No	No	Yes	Yes
Labeled loops	No	No	No	Yes	No
Macro preprocessor	No	No	No	Yes	No
Procedure/function parameters	Yes	Yes	Yes	Yes	No
Screen/cursor control	No	Yes	No	No	Yes
String manipulation	Yes	Yes	Yes	Yes[5]	Yes
User-definable operators	No	No	No	Yes	No
Window support	No	Yes	No	No	No
64K-byte code/data limit	No	No	No	No	Yes
Chaining	No	Yes	Yes	No	Yes
Export abstract data types	No	No	No	Yes	No
Modules	Yes	No	No	Yes	No
External routines	Yes	Yes	Yes	Yes	Yes
include files	Yes	Yes	Yes	Yes	Yes
Overlays	Yes	No	Yes	Yes	Yes
Segmentation	No	Yes	Yes	Yes	No
unit libraries	Yes	Yes	No	No	No

[1] As a function.
[2] Option available through a special version.
[3] Feature available through pointers.
[4] Limited to strings.
[5] Imported from external available libraries.

of 255 characters. Pro Pascal uses the usual string-manipulation routines and supports the FORTRAN-like common declaration to make variables available to other segments (see table 2).

Functions and procedures follow ISO standard Pascal. Thus, you can pass parameters by value or by reference; Pro Pascal also supports functional and procedural parameters. The compiler contains the forward and extern directives and has additional procedures and functions including routines to chain programs, link overlays, PEEK, and POKE. It also supports standard loops and decision-making constructs. The case statement allows the otherwise clause.

A special library of external routines performs port I/O, makes calls to the operating system, and lets you perform error handling. The compiler has procedures that help a "parent" program start executing a "child" program. While the child program is running, the parent program is on hold. When the child program terminates, the parent program can resume execution. You can have nested child processes, and there are procedures to terminate those processes and free the memory space they used.

Like other Pascal implementations, Pro Pascal supports ASCII and binary file structures and has random and sequential access for binary-formatted files and sequential access for text files. It also allows an applications program to append data to the end of an existing sequential file. Other routines let an applications program rename and delete a file, return a file's file-control-block address, and verify a filename.

PROFESSIONAL PASCAL

Professional Pascal version 2.5 has some interesting language extensions influenced by Ada and Modula-2. It supports the 8087 chip and includes a number of utilities to handle various tasks such as console I/O, heap management, interrupts, sorting, string-manipulation procedures, and operating system services. It requires a hard disk and has no built-in editor.

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(continued)

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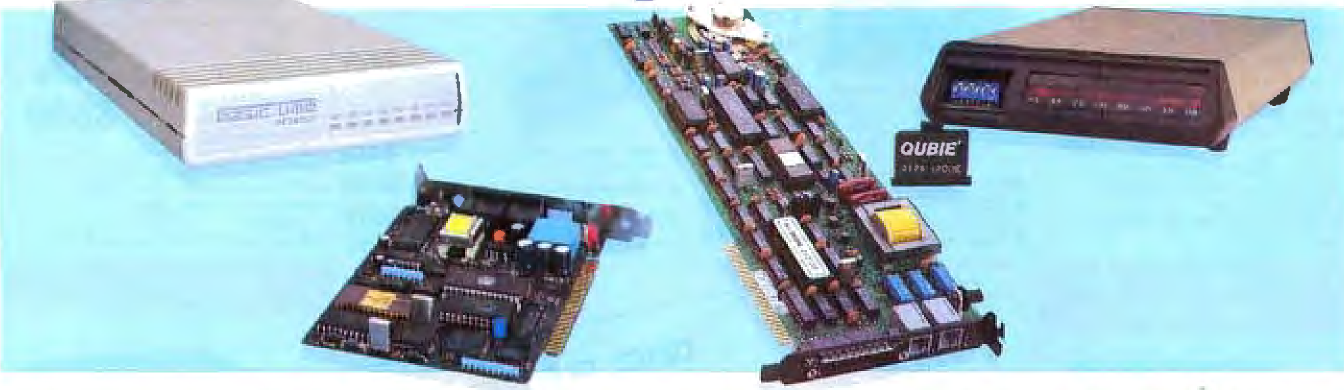

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models of the compiler, depending on the size of your source programs. You can invoke compiler directives either directly from the DOS level or as Ada-like pragmas (directives embedded in the source text). Professional Pascal has no linker of its own and uses Microsoft's; however, a macro preprocessor is available (see table 1).

Professional Pascal supports all the standard Pascal data types as well as the following scalar types: cardinal, or unsigned integer (inspired by Modula-2), long integer, and long and extended real. Thus, three floating-point types are provided. While their actual precision is machine-dependent, it can be expressed as real <= longreal <= extreal. Strings have a maximum size of 65,535 characters. When you declare string variables, you must define their corresponding sizes in parentheses. This requirement is dropped when you declare string-typed parameters in the formal argument lists of procedures and functions. Thus, routines can handle strings of varying lengths.

Numeric constants can be represented in nondecimal bases: The available range is from 2 to 16, thus enabling the use of binary, octal, and hexadecimal in addition to decimal and constants. You can also use constant expressions wherever constants are expected (see table 2).

You can initialize variables in a value section, which is similar to MS-Pascal's. The compiler offers typecasting, a C feature, to direct the data type of an expression. It is useful for controlling the results of expressions involving different types of integers. You can retype variables with an external pseudofunction that helps to get around Pascal's strong typing. Expressions can contain the assignment operators, thus permitting multiple assignments such as x := y := 1.23 among compatible types. There are also many operators for pointers and addresses including addition, subtraction, and a set of logical comparison operators (=, <>, <, >, >=, <=). The declaration block is borrowed from Ada and allows you to declare temporary variables inside the body

(continued)

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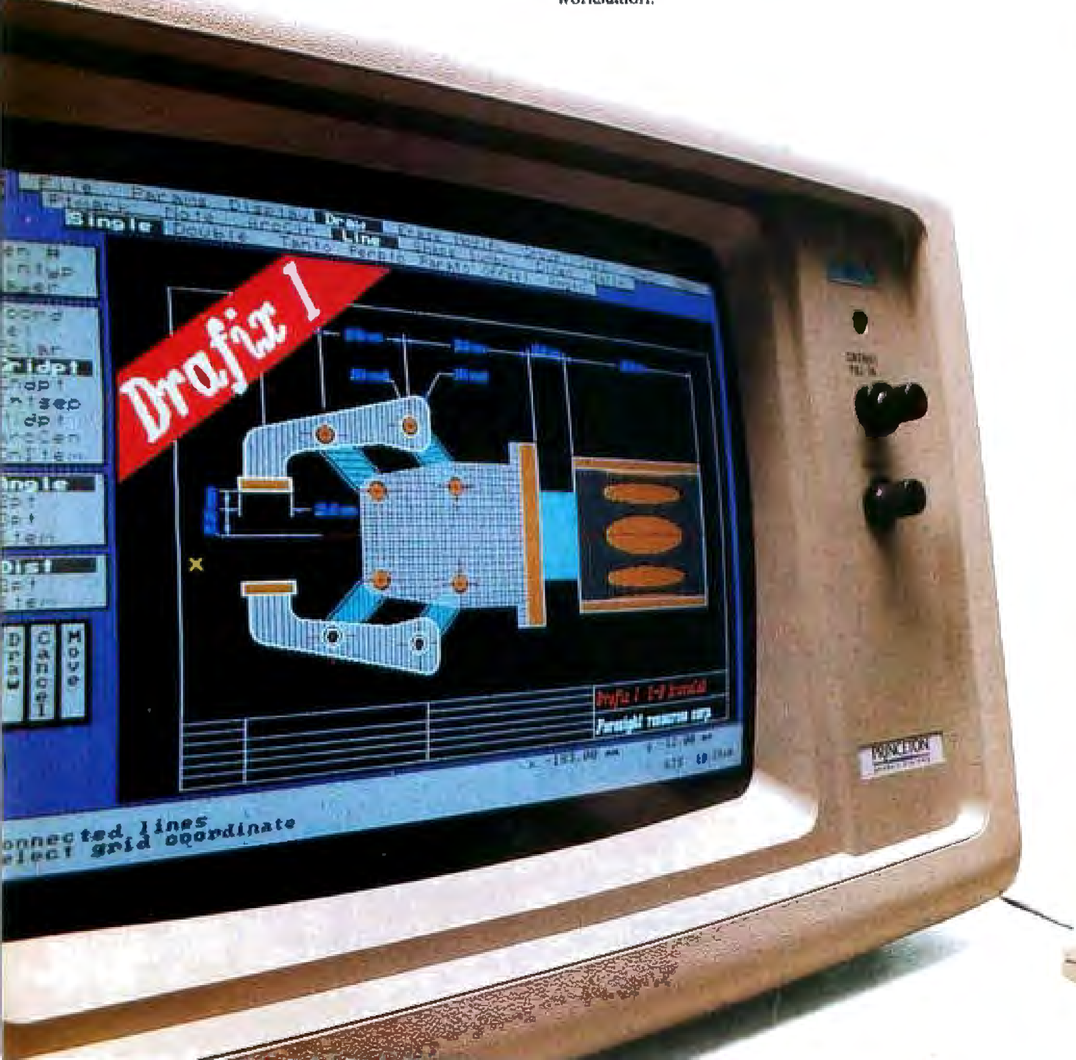

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of the program or routine.

Professional Pascal supports standard Pascal loops and two loop-control statements. The first statement, cycle, is used in the for, while, repeat, and iterator loops to bypass the remaining portion of the loop and continue with the next iteration. The second, break, is used to exit a loop altogether. Loop and block statements can have names that may follow the break statement to indicate where the program resumes. This is useful in providing nested loops with a single exit.

The case construct is similar to standard Pascal's except that it can contain the otherwise clause. You use the and then construct in sequential logical tests so that the right operand is not evaluated unless the left one is true. By contrast, the or else construct does not evaluate the right operand unless the left is false. You can use these operators to avoid error-prone expressions; for example, i < > 0 and then j/i > 5 avoids the division-by-zero problem.

The compiler implements a powerful Ada-like feature: user-defined unary and binary operators. A set of symbols lets you create a new operator symbol; it can include as many symbols as you wish. Professional Pascal also introduces a new kind of routine called the iterator, which is a very powerful extended for loop.

The language supports the Modula-2 procedure type and allows functions to return any data type. It has a special syntax to distinguish between intermediate function values appearing on the right-hand side of an assignment and recursive function calls. It also performs parameter association during routine calls by using either positional association or the Ada-like named-parameter association. Procedures and functions can handle arrays of varying sizes. To accomplish this, Professional Pascal uses a different approach than that of the other packages reviewed: Procedures and functions access the arrays with pointers.

Professional Pascal supports all the standard Pascal intrinsics except pack and unpack in addition to the

(continued)

Table 3: *Sieve of Eratosthenes benchmark results. Code sizes are in bytes (except where indicated), and times are in seconds.*

Compiler	Source code size	Compiled code size	Compile and link	Run time	Comments
MS-Pascal	768	29,600	54	11	
UCSD Pascal	4 blocks	2 blocks	19	129	p-code
		3 blocks	50	18	native
Pro Pascal	768	11,008	42	29	
Professional Pascal	768	21,646	74	12	
Turbo Pascal	768	11,495	2.7	13	

Table 4: *Floating-Point benchmark results. Code sizes are in bytes (except where indicated), and times are in seconds.*

Compiler	Source code size	Compiled code size	Compile and link	Run time	Comments
MS-Pascal with 8087	384	36,894	64	4	PASCAL.LIB
		29,708	63	4	8087.LIB
		36,878	66	4	MATH.LIB
MS-Pascal without 8087	384	31,946	65	12	ALTMATH.LIB
		29,954	65	10	DECMATH.LIB
UCSD Pascal	4 blocks	2 blocks	17	36	p-code
		3 blocks	43	4	8086/8087 code
Pro Pascal	384	5120	43	4	with 8087
		5888	47	10	without 8087
Professional Pascal	384	16,782	75	2.5	with 8087
		21,566	86	18	without 8087
Turbo Pascal	384	10,334	2.0	7	with 8087
		11,485	2.6	33	without 8087

Modula-2 increment, decrement, and set-include and -exclude procedures. The maximum and minimum functions can take more than two arguments. The lower and upper bounds of an array are returned by the lowest and highest functions, respectively. These functions also work with types and sets.

The compiler supports both ASCII- and binary-file structures and allows random and sequential access for binary files but only sequential access for ASCII files. The random access record-seeking procedure permits long integers to be used as record numbers, thus extending the range of allowable records from 65,535 to 2 billion.

Professional Pascal implements Ada-like library units, called packages, which can export constants, data types, variables, procedures, and functions to other programs. You can export abstract types in which the detailed structures are kept hidden from other programs, a feature from Ada and Modula-2. There is a special syntax to specify the items exported, thus localizing all others. Client programs (those being exported to) can also be selective of the items they import, just as in Modula-2.

Benchmark Testing

I carried out the Sieve and Floating-Point standard BYTE benchmarks on all four Pascal compilers using an IBM PC XT with a 10-megabyte hard disk, 512K bytes of memory, an 8087 chip, and PC-DOS 3.1. I used batch files to compile and link those implementations running under PC-DOS, except Turbo Pascal, and timed them accordingly. All compile and run times, except those for UCSD Pascal, were based on using a hard disk; UCSD Pascal was run on floppy disks. All the compilers processed the benchmark programs without error. (Some minor listing modifications were made.)

Pro Pascal generated the smallest fully compiled programs, followed by Turbo Pascal; MS-Pascal yielded the largest programs, with Professional Pascal in second place. UCSD Pascal generated a very small amount of code, which may be attributed to the presence of I/O routines in the UCSD kernel.

In compile and link speed, Turbo Pascal maintained a marginal lead. UCSD Pascal, while producing tight p-code, is the second fastest—and on floppy disks, not a hard disk like the others. Professional Pascal was the slowest.

The execution speeds indicate the strong and weak points in the compilers examined. MS-Pascal is fastest in the Sieve, with Professional Pascal and Turbo Pascal a close second and third, respectively (see table 3). In the Floating-Point test with the 8087 chip, Professional Pascal comes in first, with Turbo Pascal last (see table 4).

Conclusion

As you can see, there is no single best choice among these compilers: They all have their merits. As with most choices in the computer industry today, it all depends on your needs and on your skill level. MS-Pascal is suitable for large software projects and for intermediate and advanced programmers; UCSD Pascal puts program execution speed at practical and desirable levels. Pro Pascal's adherence to the ISO standard makes it easy to learn and use for novices and intermediate-level users; Professional Pascal appeals to language fans who enjoy features from other languages and it is suitable for large software projects. Turbo Pascal, even with its 64K-byte limitation, is practical and attractive to programmers at all levels of expertise. The comparative tables within this review can help you to weigh the options and determine which of these compilers is the best one for you. ■

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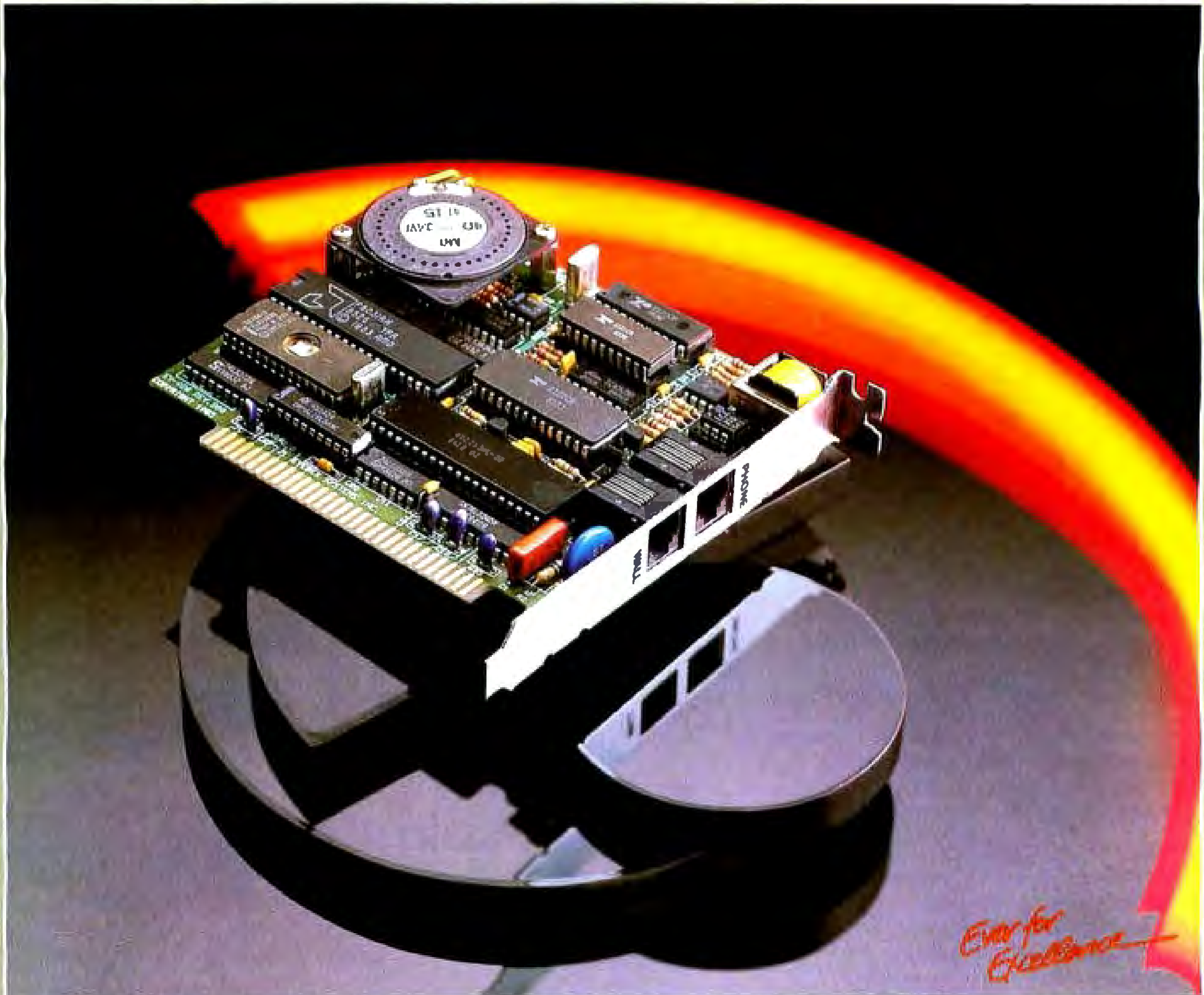

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STELLA

BY STEPHEN B. ROBINSON

Modeling and simulation software for use with the Macintosh

STELLA is a modeling and simulation program for the Macintosh developed by High Performance Systems Inc. STELLA, which stands for Structural Thinking Experiential Learning Laboratory with Animation, lives up to its name in an outstanding manner.

STELLA allows you to take your ideas about the way something works and make these ideas concrete, understandable, and testable. The program transforms general thoughts into a simple, logical, structural diagram. The user's guide refers to STELLA as a conceptual Lego set, which is an accurate description.

You can easily test and modify models in a variety of ways to obtain more refined models as well as a better understanding of the models. In this sense, STELLA is better than a Lego set because the model doesn't have to be torn apart to be tested and improved.

STELLA's Animation feature allows you to watch the parts of a structural diagram change and develop during a test run. This gives you a good feel for how the parts work in relation to each other. STELLA also has useful graphing features. The graphs, tables, and animation provide you with a variety of ways for gaining an understanding and intuition for a model.

FEATURES

STELLA is designed to model and simulate dynamic systems, that is, systems that move or change with passing time. This includes a very broad range of problems, particularly in the physical and social sciences. Some examples might include epidemics, soil erosion, effects of management policies, and population growth. One example included in the user's guide that I found particularly interesting because it dealt with some abstract concepts in very concrete terms was a case study in which a previously successful company was losing its most talented managers to competing firms. Using STELLA, the firm was able to recognize the contributing factors and make changes that encouraged and retained talent. In this situation, STELLA's abstract concepts, called converters, were used to build an accurate model of the company and its policies.

AUDIENCE

You don't have to be a mathematician or a programmer to create a useful model with STELLA because the program handles all the difficult mathematics on its own.

STELLA is menu-driven and is no more difficult to use than MacWrite or MacPaint. The commands are straightforward, and only the most technical commands require a complete explanation in the user's guide.

STELLA models are quite lucid. If one user develops a good system model, then it is easy for other users to understand and test that model. The logic of the structural diagram and the visual appeal of the graphs and animations make a model very easy to follow. In this sense, STELLA is a wonderful tool for workbooks, lectures, or presentations. Just as a word processor can enhance productivity, STELLA can help you deal with problems more productively by fleshing out a useful working model of a dynamic system.

Unfortunately, the current version of STELLA will not let you export structural diagrams, tables, graphs, or equation lists for use in other applications. With these features, STELLA would attract a more general audience. [*Editor's note:* A *preliminary version of a* STELLA *update has these features. In the future, therefore, it may be possible to use tables in your spreadsheet programs or transport structural diagrams to* MacPaint. *High Performance Systems also plans to add more built-in features to future versions. These may include net present value, delay, integer, linear projection, percent, and other statistical functions.*]

MODELING AND SIMULATION

STELLA has four basic building blocks: stocks, flows, converters, and input links. The stocks and flows represent the skeleton of a structural diagram. Stocks represent places where items accumulate, and flows determine how quickly items pass into and out of a stock.

Imagine a model of population growth in America. You might start with one stock and two flows: The stock would represent people, the inflow would represent the birthrate and immigration into the U.S., and the outflow would represent the death rate and emigration out of the U.S.

Converters and input links provide the logical connections that complete a structural diagram. Converters represent factors that might affect flows, while input links are simply arrows that show how the other building blocks are related. Using the population-growth model, two useful con-

(continued)

Stephen B. *Robinson* (2874 *South Palisades Ave.,* Santa Cruz, CA 95062) *is a graduate student at the University of California at Santa Cruz.*

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Documentation
A User's Guide to STELLA, 115 pages

Price
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verters might be Average_Family_Size or Average_Lifetime. If Average_Lifetime is determined by the number of people and available resources, then there should be an input link from the stock, People, to the converter, Average_Lifetime, and an input link from Available_Resources to Average_Lifetime.

STELLA makes very good use of the Macintosh system to draw these structural diagrams. Using the mouse, you can easily move and connect the parts of a simple or complex diagram in various ways. Several useful features help with the picture-making. Pinning helps keep input links from crossing other parts of the diagram. Using this feature is similar to using pushpins and yarn on a map. Ghosting is another helpful feature. You can create a ghost image of an important model part, move it to a less cluttered area, and enhance the structural diagram around the model part.

After drawing the structural diagram, you must define the basic relationships between diagram parts. STELLA will then arrange the more difficult computational mathematics in the background. You can define relationships in several ways: You can draw them on a graph, write them in an equation, or define them using conditional statements with IF, THEN, ELSE, AND, OR, or NOT as keywords. STELLA even checks to make sure that the definitions are consistent with the structural diagram that you draw. For example, in the population-growth model, Death Rate might be defined as People/Average_Lifetime. Before allowing this definition, STELLA would require that you draw input links from People and Average_Lifetime to Death Rate. If you draw an input link from Available_Resources to Death Rate, then STELLA requires you to include Available_Resources in the definition of Death Rate. This definition could be refined as you understand the system better and take more factors into account.

The combination of a structural diagram and the basic definitions of its parts constitutes a complete model. Now you are ready for simulation and testing.

The first step, creating graphs and tables, isn't difficult. All you have to do is choose the variables to be graphed, set the scale or approximate limits of the graph values, and then run the simulation. Any one or several of the variables can run against time or each other.

STELLA has several very helpful features for simulation. Autoscale puts the model through all or part of a test run to determine the best limits for values on a graph. In the Specs menu, the Computation Method and Simulation Time features let you adjust accuracy and speed according to the needs of the model.

Also in the Specs menu is Animate What. This feature allows you to select which parts of the structural diagram will be animated. Setting the scale for the animation is identical to setting it for a graph. Animated stocks look like tubs that fill and empty as items flow in and out at different rates. The other animated model parts resemble dials with little arrows that move inside the model part as values change. Watching these during a test run is helpful, although the graphs are more reliable for exact information.

To test the stability and realistic qualities of a model further, the Built-Ins list has features such as Pulse and Step. These features let you introduce disturbances in the model to see how it will react. For example, in the population-growth model, if in one particular year the U.S. had an influx of one million unexpected war refugees, how would that affect future population? Also, what if the government decided to double the immigration limit permanently? These would be Step increases. These testing features make STELLA a versatile and powerful laboratory for testing your model.

The process of building, testing, and modifying a model has two major results. First, the model can become an increasingly accurate and sensitive tool. Second, you gain an extended intuition and understanding of the system.

LEARNING STELLA

Learning to use STELLA well is mostly a matter of practice. Fortunately, STELLA's manual, *A User's Guide to STELLA*, is reasonably well written and provides an opportunity for sufficient practice. It contains a handful of good modeling workshops; guidelines for conceptualization, equation formation, and testing; a list of useful generic flow structures (basic model shapes that are used frequently); and some friendly advice. For me, learning to use STELLA became a short course in systems dynamics.

CONCLUSIONS

With practice and ingenuity, STELLA can become a remarkably flexible tool. STELLA's writers even mention not having used some of STELLA's built-in functions for defining relationships between model parts, but they were included for those interested modelers who may one day need them.

I expect that STELLA will become a valuable tool in a variety of situations for businesses and organizations that want to understand and improve their own operations, for education as a laboratory and a workshop for ideas, and for users with good ideas that they want to test and improve upon. ■

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TGA	Ultra-high resolution (640x400)
EGA	IBM standard (640x350)
CGA	Double-scanned, high-quality image

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Model 840	16-inch, large-screen CAD/CAM graphics. 0.39mm dot pitch
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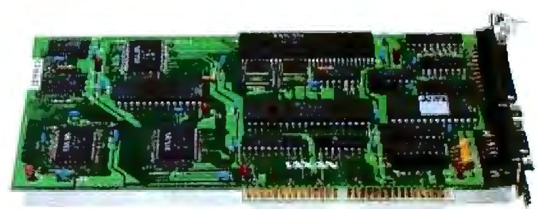

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FLASH-COM

BY BROCK N. MEEKS

An electronic mail and telecommunications software system

Flash-Com by Omni Computer Systems is an electronic communications system that contains four separate applications modules and two utilities. The program is copy-protected, but you can copy it and run it from a hard disk. The only requirement is that a master disk must always be in drive A.

The program's four applications are communications, a mailing list manager, a Store and Forward module, and a forms manager. The two utilities consist of a group of conversion programs for creating Flash-Com–compatible files and a large range of prepared business forms and form letters. For users who don't do much online work, this program seems overqualified. It is more suitable for a corporate setting.

OPERATION

Once you boot Flash-Com's main disk, you can run all its functions from the main menu.

You handle all setup procedures with menus, prompts, and function keys. Novice users will appreciate the extensive use of menus, but advanced users may find them annoying. There is no way to shortcut these menus; no command mode is provided. Once you overcome the menu hurdle, you must get past the program's slow built-in "sloth" mode.

You must sit through a long wait after choosing any function from the main menu until the application appears on the screen. For example, Flash-Com took a full 12 seconds to enter the communications module from the main menu on my floppy-disk-drive-based system.

However, once the desired function is on-screen, the program shines. Flash-Com wasn't built for speed; it was instead built to be a workhorse, which it does well.

COMMUNICATIONS

Flash-Com's emphasis is on electronic mail (E-mail) transfer. The program comes configured for use with many electronic message transfer systems including MCI Mail, EasyLink, The Source, Delphi, CompuServe, Instant Yellow Pages, and more. For most of these services, Flash-Com runs you through a step-by-step procedure for setting up what it calls a dialogue file, which stores all your unique information such as passwords and ID numbers. By using these dialogue files, your computer and modem execute an automatic log-on procedure.

For services that don't come preinstalled, such as Lockheed's Dialog, Flash-Com lets you set up a custom dialogue file. You can also define custom macro files. These macros permit the program to automatically manipulate the desired service in several ways, and they are an excellent means of handling redundant on-line tasks. For example, if you always read the same conferences on BIX, you could set up a dialogue file to first get you logged onto BIX. Then you could set up macros to automatically download all your BIX mail and any new comments that have been added to conferences you belong to. In addition, Flash-Com lets you send prepared text to these same services with its Post Batch Mail mode.

The Post Batch Mail mode is perhaps the most sophisticated application of Flash-Com. After creating your text in batches (following a special format outlined in the documentation), you then assign a specific time when each batch-mail file is to be delivered. You can also stack batch mailings for delivery to several different on-line services.

At the appropriate time Flash-Com dials the service, starts the log-on procedure, and proceeds to deliver your batch mail. If you want to immediately deliver your batch-mail files, Flash-Com handles this as well. To send batch-mail files, your computer must be powered up for the entire time.

You can also set Flash-Com to a Receive Messages mode. In this mode your computer will accept incoming calls from a remote comptuer while it waits to send your batch-mail files. However, Flash-Com has no security measures for its mail modes. No passwords or account ID numbers are necessary.

The program's Traffic Log monitors all incoming and outgoing message activity and stores the results on disk. A quick scan of the Traffic Log confirms delivery of your batch-mail files and notifies you of any incoming E-mail.

If you don't need all this high-powered E-mail management, Flash-Com also offers a Terminal mode. This mode lets you interact with any type of system just as if you were using a generic telecommunications program. From Terminal mode you can download and upload files or type in comments from the keyboard. Both ASCII

(continued)

Brock N. Meeks (8383 Center Dr., Suite C, La Mesa, CA 92041) is a contributing editor for Profiles *magazine. He is the winner of a Computer Press Association award for outstanding writing.*

Flash-Com

Type
Electronic mail and telecommunications package

Company
Omni Computer Systems Inc.
Hearthstone Plaza
P.O. Box 162
Chestnut Hill, MA 02167
(617) 522-4760

Format
Three 5¼-inch floppy disks

Computer
IBM PC, XT, AT, or compatible

Features
Automated send/receive electronic mail, mass-mailing manager, forms generator, report generator, telecommunications package

Documentation
111-page hardbound user's manual

Price
$299

and XMODEM transfers are available.

A curious hitch in the communications module is Flash-Com's inability to handle transfer rates above 1200 bits per second. My calls to Omni Computer Systems to confirm this were never answered. Transfer rates above 1200 bps are not discussed in the user's manual.

STORE AND FORWARD

The Store and Forward module sets up all the correct header and address information for your batch-mail files. Because telex and E-mail formats differ from service to service, formatting messages for several different services can be confusing. One mistake in syntax could cause your whole batch file to bomb. Flash-Com eases the confusion by providing input templates for setting up message headers for the services it is configured for.

You can prepare text using either your regular word processor or Flash-Com's built-in word processor. A limited text editor is also available for use with each input template. This editor allows you to enter text in small amounts: up to 60 lines with up to 68 characters per line.

Flash-Com defines three different message files: an address message (SAM), a common text message (COT), or a text-insertion message (TIM). A SAM is a message that you write for one person only. A COT is a message designed for mass mailings; each addressee receives the same letter with information you insert that is personal for that individual. A TIM allows you to insert variables into the common text of a letter designed for mass mailings; this is useful for form letters.

MAILING LIST MANAGER

The Mailing List Manager module gives you a versatile way to handle several different mailing lists. You can use it with any previously created mailing list, or you can use it to create your own. An extensive data-entry template included for creating new mailing lists contains all the standard features of list management such as Add, Edit, Browse, Delete, and Sort.

A useful tool of the list manager is the Extract feature. Using Extract, you can pull out all the names from your master mailing list that meet a certain search criteria, for example, names in a particular zip code. You can store the resulting file to disk as a unique mailing list. You can then use this list with batch mailings that you set up with the Store and Forward module.

FORMS MANAGER

The Forms Manager lets you create forms that you can merge with text or send separately. Using the keyboard, you can draw horizontal and vertical lines or insert graphics characters with a few keystrokes. Forms can be up to 150 lines with a maximum of 80 characters per line.

You can set up forms with data fields, such as account numbers or invoice numbers. You can merge the created forms with an existing database using a utility function. This allows you to send out filled-in forms without having to enter the data by hand.

UTILITIES

The program's utilities can process any prepared text into Flash-Com format (an ASCII file), merge unlimited document and data files to form a single file, convert existing mailing lists to Flash-Com–compatible format, and create reports.

Most of these utilities are simple to use. Instructions are included for handling data files from dBASE II, Lotus 1-2-3, PFS:File, and more. I easily transformed dBASE III files, although this is not mentioned in the user's manual. Flash-Com also easily handles combining different files into a single one.

Another handy feature is the program's ability to generate reports either from forms filled in via the Forms Manager or from any of the Flash-Com data files. Reports are limited to a single format and have no tabulation features. You can, however, specify report width and column titles and designate the order of column headings. This feature might be used by field representatives sending sales forms to the home office via modem. After the forms were received at the home office, someone could compile the results taken directly from the forms into a report format for quick perusal.

FORMS AND LETTERS

Flash-Com comes with over 30 different forms and letters on disk. You get everything from a client billing estimate letter to a Valentine's Day card. Each of these forms can be customized with your word processor or with the Forms Manager.

DOCUMENTATION

Flash-Com's documentation is sketchy in most places, disorganized, and not well written. Only the barest of details are given for most applications. Although a hard-core telecommunicator shouldn't have any trouble making sense of the material, the package doesn't belong in the hands of a novice.

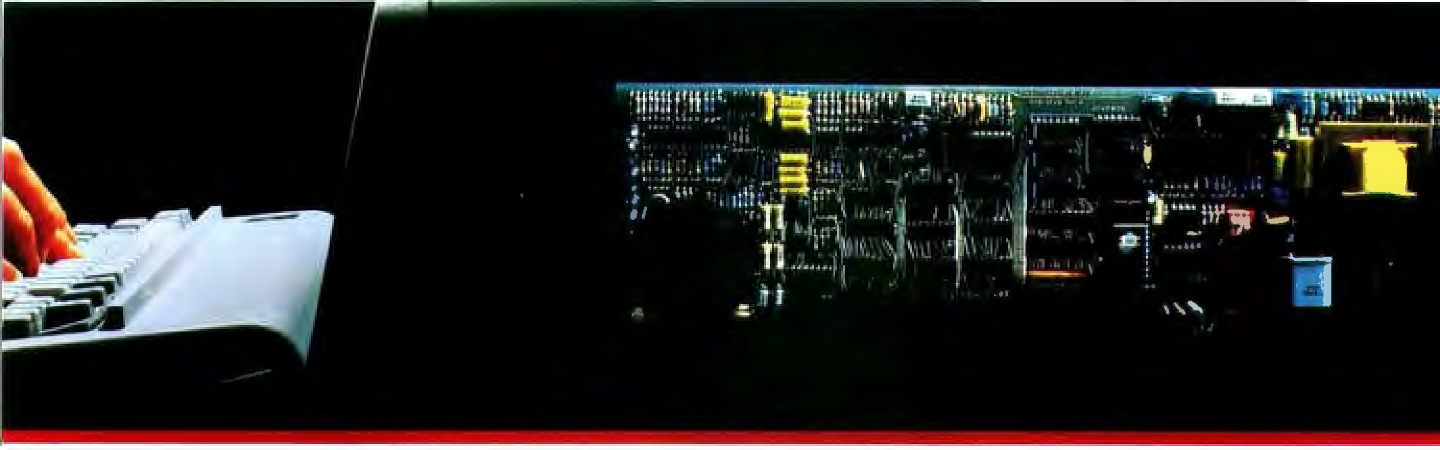
PROBLEMS

Here's a list of some of Flash-Com's problems:

- Although this program is great for batch-mail functions, it is less than desirable as a stand-alone communications package.
- To handle the various functions, you really need a hard disk. Using a floppy-disk-based system requires a disk caddy just for all the work disks required.
- Omni Computer Systems' telephone technical support, which costs $100 to register for, is handled poorly. When I talked to the technical support people, I couldn't make any sense out of their answers. It seemed like they were bothered by the whole process and simply wanted to get off the telephone as soon as possible.
- The program's learning curve is steep. To build a well-oiled E-mail machine, you have to do some pretty extensive planning and experimenting. The payoff for your efforts, however, is tremendous.
- Error trapping was acceptable, but not fantastic. During one run my modem wasn't connected, and when the program was informed of this it simply locked up, refusing to recognize the modem. I couldn't break out and reset; a cold boot was necessary.

CONCLUSION

Flash-Com doesn't promise to make your communications problems disappear overnight. However, in the right hands and under the right set of applications, this program can do great things for a company or organization (and, in limited cases, an individual) that wants to make the best of the benefits of electronic message transfer systems. Although Flash-Com requires more investment in terms of your time than other communications packages, your efforts are well rewarded. ■



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TURBO PROLOG

Namir Clement Shammas's delight as a Pascal programmer with the typing of variables in his review of Turbo Prolog (September) does not change the fact that a typed Prolog can hardly be called a Prolog at all, for at least two reasons. First, the unification algorithm is the very heart of the language, and the typing of variables reduces that mechanism to a somewhat glorified value assignment. Second, and even more important, the basic idea of Prolog is the implementation of first-order logic as a programming language.

To do this, you somehow must deal with quantification. The Prolog solution is to assume universal quantification for all clauses and to substitute the existential quantifier by a naming convention called the Skolem function. Evidently, this works only if every variable can be instantiated with an arbitrary logical function of any item that is allowed as its value. Eliminating this possibility, Borland succeeded in implementing a logic without existential quantification.

This is only one of several severe faults with Borland's attempt to hack up some scraps and pieces of its Pascal implementation to some fifth-generation contraption, for example, the impossibility to assert rules, or the introduction of a clumsy string type instead of Prolog's elegant manner of representing strings as character lists.

If you or Borland should object to my calling this product "hacked up," I know of no other expression appropriate for a language implementation that hides the more interesting parts of its messages beyond the limits of a tiny window.

PETER SCHNUPP
Munich, West Germany

LEADING EDGE MODEL D PC

I own a Leading Edge Model D PC with a 20-megabyte hard disk drive and, for the most part, I agree with everything that Stan Miastkowski mentioned in his review (September).

Unfortunately, I have discovered a darker side to Leading Edge Hardware Products Inc. that is not mentioned in the review.

I agree that the company has produced a good machine at a superb value. The problem is that the company's infrastructure is set up for sales with little time for service or support. It is perhaps misleading to point out that the company has an impressive 15-month warranty when minor repairs such as replacing a clock/calendar battery can take over two months.

There is more to a product than simply its hardware and software features. As I said in a letter to Leading Edge, I am using my Leading Edge Model D, but I fear the day that I have another hardware problem with my computer.

ROBERT S. WEBB
Providence, RI

FIVE LABORATORY INTERFACING PACKAGES

The review "Five Laboratory Interfacing Packages" by Patricia Wirth and Lincoln E. Ford (July) overlooks some of the capabilities of both Labtech Notebook and ILS.

Labtech Notebook is identified in table 2 as having no data manipulation or statistics capabilities, yet version 2.5 can perform both to some degree. An FFT option in the main menu will perform forward and inverse fast Fourier transforms on stored data. A curve-fit option allows the user to fit discrete data to linear, polynomial, exponential, and trigonometric models.

The table also indicates that only one graphics channel can be displayed at a time by the ILS package. In truth, data from several channels can be displayed simultaneously in separate windows as long as the data for each channel is available in sequentially numbered files.

NANCY A. WINFREE
Ann Arbor, MI

EXPEROPS5

Thank you for the review of ExperOPS5 (July). I thought that it was well written and accurate, given that it reviewed a 13-month-old version of the program. Most of the problems that William Jacobs mentioned were corrected in the August 1985 version of the program. For example, ExperOPS5 now offers standard use of the (^) operator, availability of ppwm and matches, time tags with wm, and the full functionality of the strategy command. In addition, ExperOPS5 now has the build function.

ExperOPS5, as Mr. Jacobs states, is implemented on top of ExperLISP by ExperTelligence Inc. Mr. Jacobs correctly points out that the version of ExperOPS5 with ExperLISP that he reviewed was incapable of supporting large expert systems. This shortcoming was due to a limit of 32K bytes of print-name and string space in earlier versions of ExperLISP; with version 1.51 of ExperLISP and the new large-memory Macintoshes, ExperOPS5 can indeed support large expert systems. Since ExperOPS5 uses the Rete algorithm, run-time performance remains acceptable for systems with large numbers of production rules.

As with most artificial intelligence tools, ExperOPS5 is under continuous development. A version of ExperOPS5 that is now being tested supports the development of distributed expert systems using multiple Macintoshes and a local area network; synchronously executing expert systems can add facts to the working memory of other expert systems. This version of ExperOPS5 also supports multiple working memory areas called perspectives; an expert system's production rules can reason with uncertain data by creating and maintaining separate hypothetical data areas.

MARK WATSON
La Jolla, CA

SPERRY PC/IT

I was truly impressed with Frederick D. Davis's review of the Sperry PC/IT (August). I was particularly impressed with the PC/IT's benchmark results. After reading the review, I became convinced that the Sperry PC/IT was the system for me. Kudos to Sperry, BYTE, and Mr. Davis for a job well done.

J. D. MILLER
Bath, ME ■

REVIEW FEEDBACK *is a column of readers' letters. We welcome responses that support or challenge* BYTE *reviews. Send letters to Review Feedback,* BYTE, *One Phoenix Mill Lane, Peterborough,* NH 03458. *Name and address must be on all letters.*

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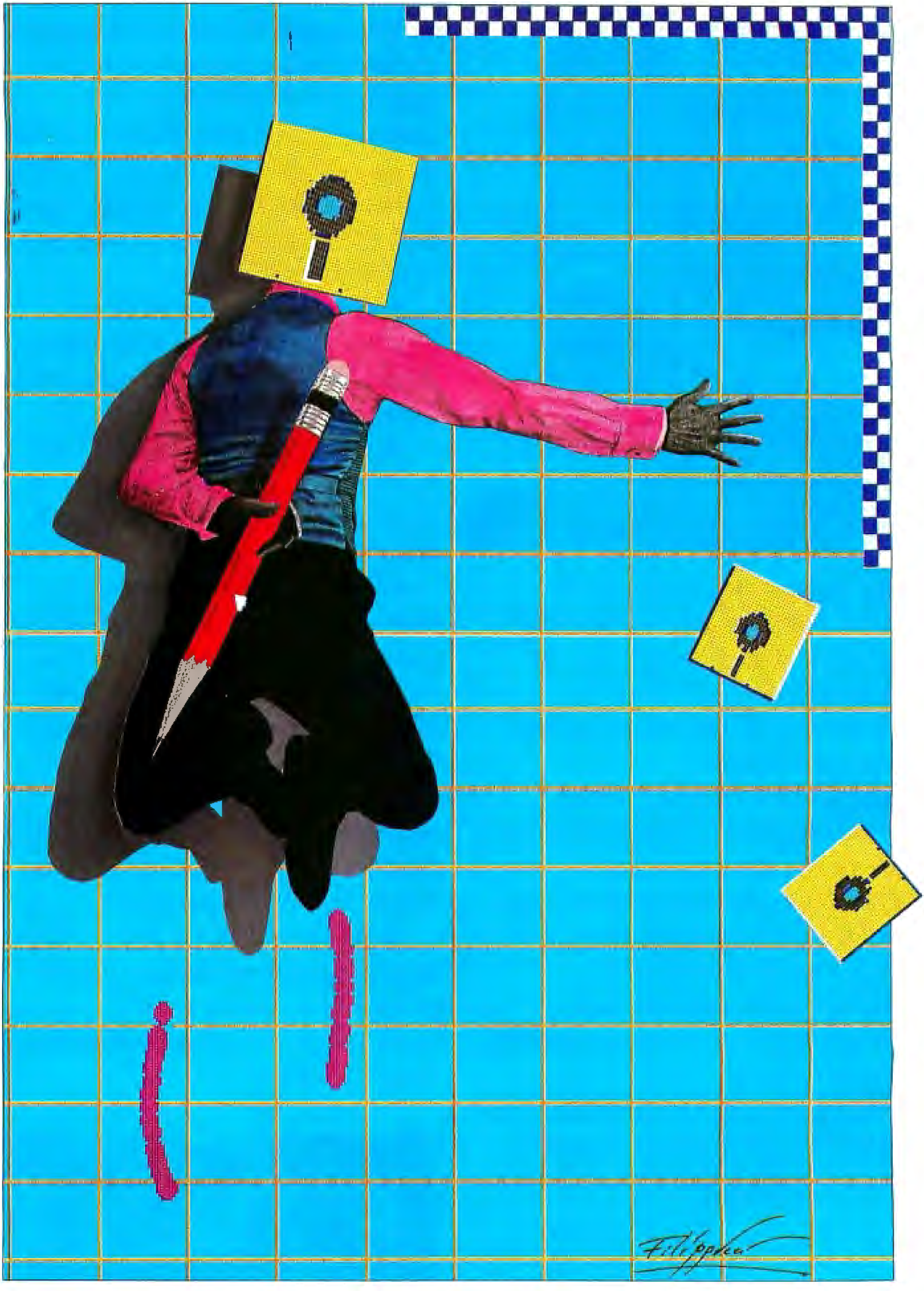
Or better still, just amble on down to your computer products retailer to see who's offering what.

And get your backup system while the gettin's good.

 Inquiry 398



Kernel

JERRY POURNELLE ENDED UP having another normally busy month. This one was highlighted by his involvement in the preliminary discussion of an academy for space cadets. BIX was a major component in this discussion. Jerry also paid a visit to Silicon Valley, where he saw the latest CompuPro equipment. What CompuPro is doing may enable Jerry to link up a number of computers and be able to run both IBM PC and CP/M software. This could help him solve the problem of computer proliferation at Chaos Manor.

Bruce Webster experienced a feeling of disorientation writing his Christmas column in August. But the lack of snow didn't stop him. He persevered and came up with a column in which he looks at some products for the Amiga: the Alegra memory expansion box, the MAS-20 hard disk, and Instant Music. Bruce also begins a periodic review of public domain/shareware programs and makes some gift suggestions.

Ezra Shapiro's mission this month is clearly spelled out in the title of his column ("Stocking Stuffers"). He looks at a number of programs that would make good gifts. These programs are not too expensive and are nothing you can't live without, but they are all great fun. This does not mean that they aren't useful products. Being fun to use doesn't mean a program is frivolous.

In BYTE U.K., Dick Pountain returns to his beginning as an organic chemist. He discusses the U-MAN 1000, a computer built around the 68000 microprocessor that is targeted at scientific and engineering users and designed for high-performance I/O. Dick borrowed the U-MAN to look at CHEMMOD, a color, three-dimensional molecular modeling system of a power that until recently would have been available only on a mainframe.

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THE FINAL FRONTIER

BY JERRY POURNELLE

BIX is the scene for a discussion of an academy for space cadets

Every month I start with reasons why this wasn't a normal month. I suppose one day I'll admit there *are* no normal months—or rather, that even in a normal month something unusual happens to consume my time. Not, you understand, that these activities aren't important. This month it was the Space Academy conference, and that might be the most important thing I've done this year.

The Space Academy is another idea from General Daniel O. Graham's Project High Frontier shop. The notion is to investigate the possibility of setting up an academy whose mission is to do for the space frontier what West Point did for the settlement of the west: to produce the engineers and technicians and officers capable of making the frontier inhabitable. There are, however, two major differences from the early West Point of Superintendent Sylvanus Thayer: Graham conceives this as nongovernmental, and it will admit women from the beginning.

The notion looked worth investigating, anyway; so General Graham set up a conference to include academics, space enthusiasts, journalists, and financiers. We couldn't all get together in the same city, so we used electronics: there are conference rooms linked by television. Meetings would take place in Los Angeles, Colorado Springs, and Melbourne, Florida, with Dr. David Webb of the National Commission on Space participating by telephone from the University of North Dakota. This was all arranged through a commercial electronic conferencing service.

Next thing I knew, I was supposed to chair and organize the Los Angeles part of the meeting, while G. Harry Stine was to do the Colorado Springs part of the job. The instant I heard that, an idea came: let the commercial TV conference people do their thing, but simultaneously link up through BIX as well.

BIXING THE SPACE ACADEMY

BIX, for those who tuned in late, is the BYTE Information Exchange, a computer-assisted conferencing system that I truly believe is the first step into what will be the normal communications pattern of the future. No doubt you'll find more about it, including how to sign up, elsewhere in this issue.

BIX has several different kinds of computer-assisted conferences. Most are open, meaning that anyone can find them and join up. Others are closed: you have to be invited in. A few are hidden, meaning that you can't find them even if you're looking for them; and of course you'd have to be invited to join if you did stumble across one of those. The Space Academy conference is like that, not because there's anything to hide, but to keep the chatter down to a minimum; most of the people involved in this have about 90 other things to do. Eventually we'll bring all the information out to a public conference. Meanwhile, we used BIX to plan and set up the televised conference.

It all went well. Barry Workman and my son Alex brought Barry's ancient CP/M Lobo computer; Barry still finds it both versatile and reliable. They connected to BIX with MITE, the communications software package I used to use and may go back to. Barbara Clifford (bjc on BIX) came down from Silicon Valley to serve as moderator and editor. With all that help I could concentrate on the conference essentials, and indeed we got a lot done.

Now that the TV conference is over, the discussion continues on BIX. It will be interesting to see what comes of it. With luck, the whole world will see the results.

100 PERCENT COMPATIBLE

Another reason I was away from my desk this month was a trip up to Silicon Valley. The actual reason I went was to confer with Dr. Stefan Possony about the new edition of *Strategy of Technology* we're writing with Barbara Clifford's editorial assistance; but while I was up there I spent a day with Bill Godbout finding out the latest about Viasyn's CompuPro equipment.

There's a lot going on.

First, they were all excited about the new service contracts they've signed with Sperry. You remember *Sperry*? It's odd how many old-timers look puzzled when you ask if they remember Sperry. If you say Univac, their eyes light up. Anyway, Sperry is providing service support for CompuPro systems. Coincidentally, about the time you read this, I'll be in the south of France giving a talk to a group of managers of the European divisions of Sperry. Tough duty. . .

Anyway, I've always had mixed emotions about CompuPro systems. There's a sense in which CompuPro has no competition: they have just

(continued)

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.

about the best (microcomputer-based) development hardware packages on the market today. CompuPro is always out at the edge of technology, always pushing the envelope of state-of-the-art "small systems." The Golem, my big CompuPro 286/Z80 Dual Processor system, is still the most powerful machine I have.

That's the good part.

The bad part is that you'd better know what you're doing or have a darned good dealer handy. CompuPro equipment is adequately documented for technoweenies, but there's still a tendency to think "support" means reading the spec sheets, very slowly, over the telephone. With the right dealer that doesn't matter. For example, Steve Rose, a systems distributor on Maui in the Hawaiian Islands, always prefers to install CompuPro because, done right, the systems are trouble-free and the customers are happy. However, if you don't have a good dealer and you don't know much about small computers, you might have your work cut out.

Another problem with CompuPro systems is IBM PC compatibility. Dr. Godbout always had mixed emotions about that. To get real PC compatibility would require compromises in hardware performance and speed, and of course performance and speed are CompuPro's main selling points.

I'm pleased to say that CompuPro has solved those problems. You can get 100 percent PC compatibility, plus multiuser capability, plus file sharing, plus the enormous speed of a CompuPro system. You can not only have SideKick and SuperKey and Ready!, you can share your SideKick calendar and phone dialer files with another user a hundred feet away.

They achieve this in the simplest possible way: CompuPro recommends that you use cheap PClones as workstations. Since you can get a minimum clone for less than a thousand dollars, you aren't paying much for the compatibility: any decent terminal will run you at least half that much. Of course, you can also attach normal terminals to the CompuPro system.

The purpose of the clone is to run memory-resident software. Big jobs, like multiuser database applications, are done in the central CompuPro unit, which operates at speeds considerably higher than an AT.

The clones are networked through Arcnet. CompuPro provides cable, network boards for the clone, and the network board for the CompuPro system. Inside the CompuPro box they follow Pournelle's rule: "One user, at least one CPU." Each user has a block of memory and a CPU, all internally linked, in addition to the CPU in the workstation clone.

The result is something wonderful: at least, I saw it work something wonderful. Steve Rose demonstrated a big CompuPro system linked with three PClones, a TeleVideo terminal, and a Wyse terminal. Big spreadsheets are calculated in the CompuPro at lightning speed. Results can be called up by other users. SideKick files and suchlike are callable in the workstation but are kept in the CompuPro so that other users can get at them when needed.

It all looked wonderful, but now comes the usual note of caution: I saw this in Hayward. As always, I reserve final judgment for when I have things operating here at Chaos Manor. That happens next month. They tell me I'll be able to link up Zeke II, the ancient CompuPro Z80 I'm writing this on; the Golem; Big Kat, the Kaypro 286i PC AT clone; Lucy Van Pelt, our old fussbudget genuine IBM PC; and the Zenith Z-150, all working together with the new CompuPro; and then I'll be able to run both PC and CP/M software.

There are terrific advantages to this. For one, I can save text from any station onto the Golem's 8-inch floppy disk drives. This is important because I don't think anything is truly safe until it has been saved on two separate 8-inch disks, and one of those disks is no longer in the house. Tapes, hard disks, small disk drives, are all very well, but I don't, deep down in my heart, trust anything but those 8-inchers. That may change in future, but it hasn't yet.

We'll also be able to share printers and hard disks. All stations will be able to shuffle stuff off for archiving on the Golem's tape backup unit. And so forth.

CompuPro tends to use me as a test site for new stuff. I've promised to keep a log of any problems. Moreover, I'm beginning to collect neat tricks to use in networking PClones; when I'm done, Barbara Clifford is going to edit the stuff into a manual of user tips that CompuPro will ship with the networking systems.

When I left CompuPro, Bill Godbout, Mark Garetz, and Steve Rose were arguing: what is a fair statement of the actual speed of a system that has many CPUs all going at once? Just how many MIPS (millions of instructions per second) does this system execute? It's a good question. Anyway, I'm sending my CompuPro systems up to Hayward in the morning; and I can hardly wait to try this. Maybe, just maybe, I'll have solved the problem of computer proliferation at Chaos Manor.

ELECTRONIC MUSIC

A couple of issues back I talked about the coming revolution in electronic music. Bill Godbout saw that column and sent me some copies of a magazine, *Electronic Musician*, that has some claim to be the BYTE of the electronic music world. Formerly called *Polyphony*, *EM* specializes in MIDI (musical instrument digital interface).

There's a reason for Godbout's interest in the magazine: it was one of the first products of desktop publishing, and Craig Anderton, *EM*'s editor, has always been a big CompuPro fan. The magazine is now produced on a large multiuser (one user, at least one CPU) CompuPro machine, which produces IBM-compatible disks that go directly to the typesetter.

Electronic Musician (2608 Ninth St., Berkeley, CA 94710) is organized like a thinner issue of BYTE, with reviews, how-to articles, columns, what's new, and lots of ads. The ads were the most interesting part for me: it's amazing what you can buy, from keyboards and mixers to programs with a wide variety of synthesized sounds. Me, I'm not very musical, and my wife is oriented to classical opera and thus

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not terribly interested in things you can synthesize; but I found it intriguing to go through the dozen sample copies Bill Godbout sent me. I'm more convinced than ever that small computers are going to do at least as much for music as they have done for writing.

FASTREAD

Years ago, for my sins, I was a professor in a fairly good college. One thing I consistently noticed about my students: they didn't seem to be as widely read as my generation had been. Perhaps it was television. Whatever the cause, they had a lot of reading to do to catch up to what I thought was an acceptable level.

Many of them had trouble doing that. They just couldn't read fast enough. After giving that some thought, I encouraged the slower ones to take the Evelyn Wood Reading Dynamics course. I'm not sure how I selected that particular course; it may be that outfit offered our college a special deal, or just that their institute was close by. Anyway, I kept some statistics on performance of students who I thought read too slowly and who did or didn't take the course, and I continued to recommend it.

There may be a better way. Note I said "may."

Fastread is a program designed to teach you to read faster. It runs on an IBM PC, XT, AT, or close clone, and it works by running the cursor across the text at a speed you can control with the + and – keys. While it's doing that, it counts how fast you're reading. At least sort of: the count is apparently keyed to the speed of your computer, and the program documents warn you that the absolute speed as reported may not be accurate. Anyway, you turn on Fastread, adjust the cursor speed to a bit faster than you're comfortable with, and practice reading.

That's about all there is to the program. The documents consist of a folded sheet of paper, but that's all you need to make things work. In the lessons themselves are some hints and tips on fast reading, but the program isn't really long on theory; the authors clearly think the best way to learn to read faster is to do it, and the most interesting stuff for you to read are files you load on yourself through your word processor.

Whether that will teach you to read faster or not is debatable; certainly it can't hurt, and I have some reason to believe it would help. Indeed, there is a lot to like about this program.

There's also considerable to hate. For one thing, it has a miserable user interface. It starts with one of those menus in which you pick numbers to tell the system what you want to do, including exit the program. At every other level you type a "Q" to exit to the previous menu, but here the program just beeps at a "Q"; it wants a number and nothing else. If, in fury, you type several irrelevant commands, you can fill the type-ahead buffer with them, and thus get a long and perfect cacophony of beeps.

You're supposed to use your own files for most of your lessons. The instructions don't say what kind of files it will accept. I was going to try some downloaded from BIX, but the silly program runs only from the A drive—naturally it's copy-protected—and if you try to give it a subdirectory name from your hard disk, it won't take it. Filenames must be eight letters or fewer; anything more than that gets the dreaded beeps. I don't keep BIX files on the root directory of my hard disk, and I wasn't really in much of a mood to transfer some over there just to accommodate this program. Also, Fastread has no provision for getting a directory of files from inside the program: you'd have to write down the exact names of candidate files before invoking this program.

Fastread, in other words, is one of those programs that might be fun to play around with, but it would be a lot more useful if the publishers had done more testing and editing and hadn't been so paranoid. I'd probably have put it on the hard disk for more attention if they hadn't copy-protected it. As it is, I doubt I'll ever see it again. Pity.

Sometimes we win one, though. Fifth Generation systems has announced that they've dropped all

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copy protection on Fastback (no relation to Fastread), a hard disk backup program I talked about in July.

POURNELLE'S LAW

I can see a church by daylight, although I may be a bit slow. That is: I log on to BIX a lot, and after months of doing that, it came to me that I didn't need to sit here waiting for the phone to ring, answer, get the local net prompt, respond to that, get the BIX prompt and respond, enter my password . . . Crosstalk, after all, has a script command capability that will take care of everything from dialing to entering my password. Or so I was persuaded.

Doing it was another matter. The Crosstalk manual tells all; but it does it without examples. Actually, it's worse: many of the critical commands *have* examples, but the examples are ambiguous or even wrong. Now what I mean by "wrong" is that if you use the example, as shown in the book, it will *not* produce the result you're after. That's because they have inserted or omitted some key item like a quotation mark in the document text. It's not a real example, it's a virtual example. I hate virtual examples.

Some of the descriptions of what the commands do are masterpieces of minor deception, too.

The only salvation is that they do supply you with a few workable scripts on the disk that the program comes with. Examining those while studying the manual will, eventually, produce enlightenment.

All in all, I'm still satisfied with Crosstalk, and I still use it for communications despite having a dozen or more competitors around. That's partly inertia, of course, but it does say I have no serious complaints about the program; except that I wish they'd followed the rule: "You can't have too many examples, but the examples must *work*." On the other hand, I wish *everyone* would follow that rule.

INTERIM REPORT

I have a lot of memory-resident utilities in Big Kat. I don't want to give any up, but I'd sure like to get some of them up into extended memory. I've been trying to install the Orchid ECCELL error-correcting extended/expanded memory board in Big Kat.

I'm still trying.

My first attempts failed. I called Orchid, was asked what version of the installation software I had, and was asked to wait until a new version came. That arrived promptly, but by then I was off on trips. When I returned I started in again.

It all seemed clear. I went through the installation program, setting the system so that it would have both RAM disk and expanded memory. Some of the options didn't seem very clear, so I used my best guesses on them. Finally I rebooted the machine.

Blooey.

Big Kat trundled for a moment, then reported that I didn't have a valid

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command processor file; and nothing I could do would change that. Furthermore, since I couldn't bring the system up at all (maybe I could if I'd removed the board?), I couldn't even get at the file to edit out the CONFIG.SYS file that the ECCELL installation procedure had generated and put on my hard disk.

Fortunately Big Kat, like most clones, will boot off a floppy disk if there's a floppy in drive A. I got out the original IBM PC-DOS disk. Then I called Orchid.

I can't say I'm totally fond of Orchid Technology's documents, although they are much improved from a year ago, and the company listens; but I sure am impressed with the technical support people. It took an hour of careful step-by-step logical procedure, but eventually we found the problem. It seems that something in the Kaypro ROM BIOS and the Orchid installation procedure have a fatal clash. Once the symptoms were all noted, the Orchid people went to work; I'm told they'll have the problem fixed in a few days, and I'll get yet another copy of the installation software.

I have no doubt that the board will eventually work. ECCELL (the name is symbolic of the board's standout feature, error-correcting code capability, meaning that if you get a memory error it not only warns you but fixes it) works fine on a genuine PC AT; at least, I know half a dozen colleagues who've made theirs work. There's no reason why it won't work on the Kaypro.

When it does, I'll set it up with the optional parallel port, so that I can finally put in an EGA color card; at the moment, my only parallel port is on the Hercules Graphics Card, but the Orchid ECCELL has both serial and parallel ports if you want them.

PARADISE

Last month I reported that I had a problem with the *Paradise Hi-Res* Graphics Card. This is a card that is said to give you the highest resolution your system can use. It's capable of both monochrome and color (you have to throw a switch on the card to change over) and has a parallel port

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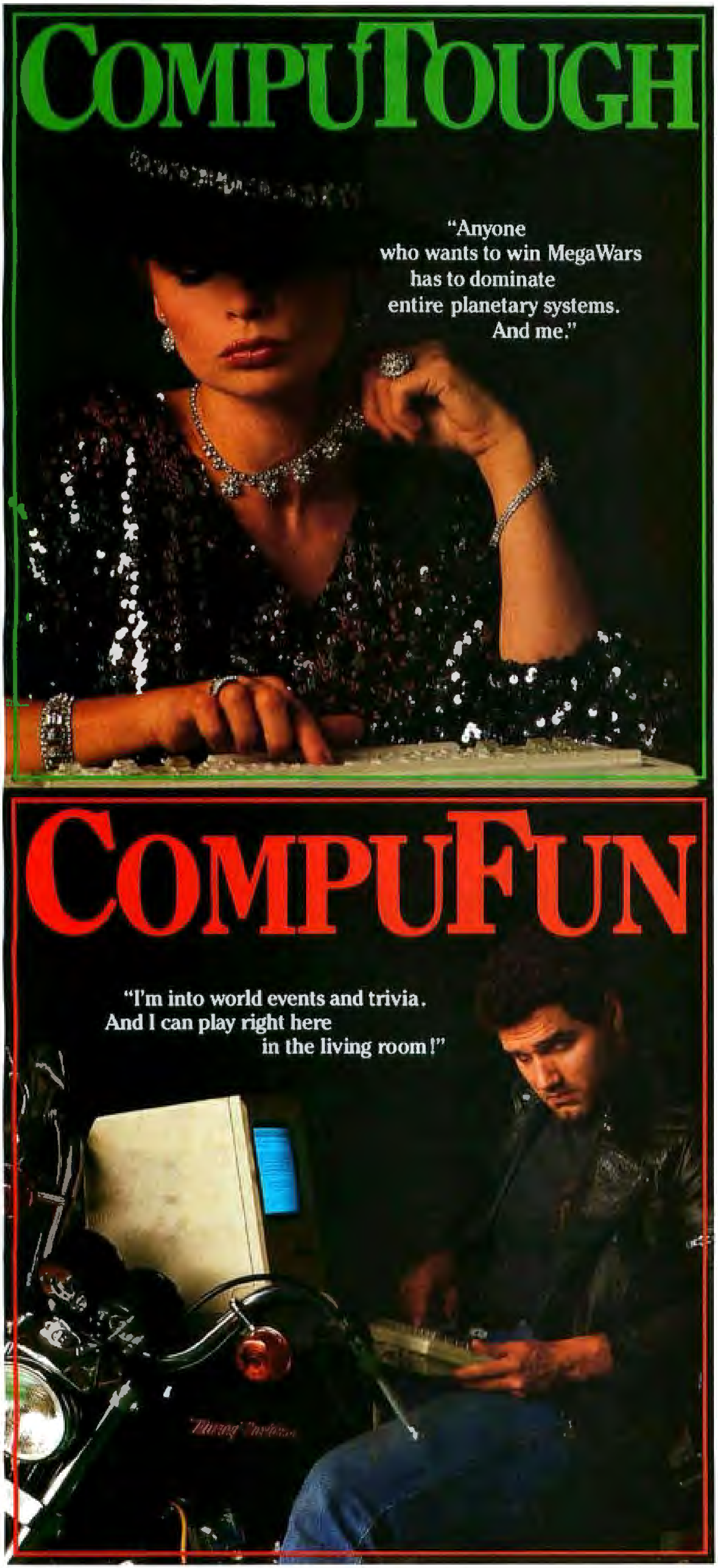

on it. It looked like what I needed.

The problem I had was that all the text was jammed over against the left side of the Zenith 19-inch High Resolution Color Monitor I use with Big Kat.

After I wrote that, two things happened: Paradise sent another board, and Ken Sheldon, my technical editor at BYTE, told me that one of the other editors had asked why I didn't try the MODE command in MS-DOS. MODE, it seems, can shift the image over to the right by a space or two.

I tried both. First, the new board: it had the same problem. Since that board seems to work fine on Lucy Van Pelt, I can only conclude that there's some interaction with either the Kaypro AT or the Zenith monitor. Whatever it is, I remember when they'd have put a horizontal control on either the board or the monitor, or both. One tweak would have solved the problem.

Instead, though, they seem to be relying on MODE.

The MODE command, I discover from reading the fine print in MS-DOS manuals and books, not only tells your machine whether you're using monochrome or color and 40 or 80 characters per line, it will also, in theory, shift the screen image over, thus accomplishing what you'd want from a horizontal control.

In theory. In fact, it doesn't, at least not on a Kaypro 286i. What it does is lock things up to the point where you have to reset the machine. I haven't the foggiest notion why. I don't have a genuine IBM PC AT, so I can't tell if MODE CO80,R would do the job on that. I do know that MODE CO80 or MODE CO40 will work on the Kaypro as advertised, changing the display from color 80 columns to color 40 columns; but if you add the shift, or try to invoke the "T" for test pattern feature of MODE, you'll shortly after reset a Kaypro 286i.

Consequently, I'm back to the Hercules Graphics Card, which has always worked fine. MODE shift doesn't work with it, either, but it doesn't have to.

I find it all pretty discouraging. In order to save about five dollars' worth of parts on the video board, they're relying on software that will probably have to be invoked every time you reset the machine or turn it off. That makes no sense at all.

Short Shrift Time Again

I'm always looking for something new to write about. Believe me, it's no problem. Alas, books, programs, and hardware pour in here much faster than I can keep up. I've had to be pretty ruthless: if something can't get my attention in a couple of minutes, it goes. As late as last year I might have kept it around, but that clearly won't do any longer: there's just no room for it all.

Some stuff can go immediately. Things like silly games that arrive with neither documentation, packaging, nor cover letter, and turn out to be written in BASIC with a "choose a number" user interface; clearly hopeless stuff like that goes into the big barrel with a permanent magnet from an old telephone magneto. Eventually I reformat the disks. But even after eliminating the absurd I find the stacks grow higher all the time.

I'll never clear it all out; but much of it deserves mentioning. Thus, it's short shrift time again.

Intel Math Chip

Some weeks ago Intel sent me one of the 80287 math chips for the PC AT and clones. The chip comes in a lovely box with extensively detailed instructions. If you have a genuine IBM PC AT, I can't imagine anything simpler than installing it.

I had a bit more of a problem with the Kaypro 286i, but the relentless application of logic—there's only one slot on Big Kat's board that would take that chip, and all the notches face the same way—solved the problem. If you have a 286 machine and you do any number crunching, you *must* get a 287 math chip. It speeds up calculations something wonderful, and with most programs you don't have to do anything to get that extra speed. Much recommended for those who crunch numbers.

Excel

On the subject of number crunching: as I've said before, if I had to do much

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detailed spreadsheet work, I'd buy a Macintosh just so that I could use Microsoft's Excel. That is simply the most elegant and versatile spreadsheet I've encountered.

Comes now a really good book on using Excel.

Hands-On Excel by Danny Goodman (Scott, Foresman & Company, $21.95) is clearly written and filled with useful examples. The book is in an informal narrative style, the kind of writing I try for; I hope I don't sound arrogant by saying that much of it reads the way I'd have written it if I knew as much about the subject as Goodman obviously does.

If you're wondering why people get excited about Excel, this book will tell you; and if you use Excel, I expect this book will save you a lot of time. Recommended.

BRIEF

Brief is a programming editor for the PC. It was written by a company called UnderWare, which may or may not explain the name. It's extremely popular among hackers, and for good reasons.

Brief isn't all that simple to learn, but then no programming editor is. There are about a zillion commands, including, I suppose, Control-meta-cokebottle and Alt-coffeecup. The main thing is that it will do just about anything you want it to. It has windows—boy, does it ever have windows!—a good search and replace, macros, automatic indenting, buffers, and a partridge in a pear tree.

For the last few months, every time I've mentioned text editors I've got a raft of mail urging me to try Brief. Now that I've tried it I see why. If you need a general-purpose programming editor, look no further. Recommended.

SOLARSIM

Longtime readers will know of my addiction to Star Fleet I from Cygnus (now known as Interstel). If you like games based on *Star Trek*, you'll like that one, which is frankly better than the Star Trek game I wrote.

The latest from Interstel is Solarsim, "The Solar System Simulation Program." This PC program is a real gem for science fiction writers. You can get a simulation of the positions of the major bodies in the solar system—including about 200 asteroids—for nearly any given date. Find out what constellations will be in the sky, also for any given date and time. Look at the planets' positions as if viewed from earth. And so forth.

There's also a complete, if pretty dry, account of the theory, including Euler's method for approximations.

Recommended for astronomy buffs, science fiction writers, and anyone who likes to play around with computer simulations.

IT'S GENERIC

I've mentioned this program before, but it's more than worth bringing up again; they're always improving it. If you have a PCompatible and any interest at all in CAD, you need Generic CADD. While not quite as elegant as Autodesk's AutoCAD, Generic CADD will, I'd guess, do about 75 percent as much, for 10 percent of AutoCAD's price. It's not copy-protected, either; and the license agreement makes sense. They don't guarantee it will work, but if you don't like it you have a 60-day period during which you can get your money back. How can you go wrong?

Generic CADD comes with a thick, well-written manual (the writing style is informal, and the language is simple English; quite refreshing after all the documentese I've had to digest lately). Not only is it easy to understand, but it's complete, with both analytic table of contents and lengthy index.

In other words, it's pretty hard to find anything to criticize. This is one heck of a program.

Generic CADD works with a PC or close compatible, including the Kaypro 286i AT. It will work without a mouse, but you're better off having one. If you want a paper copy of your designs, you'll need a plotter. Generic CADD supports all the popular microcomputers. You can also get Generic CADD through Logitech, bundled with the LogiMouse. Works fine, and the documents are better bound.

If you've been wondering what CAD is all about, here's your chance to find out at a reasonable cost. You may never need any other CAD program. Highly recommended.

DESKTOP PUBLISHING

Tony Bove and Cheryl Rhodes are near geniuses at making complex ideas understandable. Now they've done it again.

The Art of Desktop Publishing (Bantam, 1986, $20.95) shows Wes Thomas, a "High tech PR Man," as formal coauthor and three more people as contributors, but it's not hard to see the hand of Bove and Rhodes all over the book. It's clearly written and doesn't assume you know much.

I like this book, and it isn't out of line with the industry standards, but I sure don't understand why it costs so much. This book has illustrations, glossary, and a good index, but it's only 300 pages of large type in a "trade paper" binding; why the daylight should it cost more than, say, the hardbound edition of Niven and Pournelle's *Footfall*, which ran more than 1000 manuscript pages? The fact is, though, computer books *do* cost that much, and there doesn't seem to be anything to be done about it. It sure isn't Tony and Cheryl's fault.

If you're at all interested in desktop publishing and you're looking for a survey of what can be done with existing hardware and software combinations, this is the book to start with. On the other hand, things *flow* in the micro world; the book is almost up to date now; will be a little out of date by the time you read this; and by next year one hopes they'll have a new edition.

POLYNOMIAL

Polynomial is a PC program designed to let you play about with polynomial functions. Take any polynomial function, plug it in, and out comes a graph. Not the kind of program everyone needs, but more useful than you might think: I wish it had been available when I took high school algebra. By taking the tedium out of numerical calculations, programs like this can make it fun to play with math, so that you can get a feel for just what complicated mathematical functions model. Just what shape *is* a fifth-order polynomial curve, anyway? Now you can find out, painlessly.

ONE SCREWY NEWSLETTER

I have for months been intending to mention *DTACK Grounded*. This is billed as a "junk mail flyer" from Digital Acoustics, 1415 East McFadden, Suite F, Santa Ana, CA 92705; and it consists of the sometimes outrageous and surprisingly often well-reasoned opinions of an odd composite personality who can't decide whether he's real or fictional. If you've no interest in 68000+ systems, don't bug the man; but if you have a passionate interest in what's going on in that part of the computer world, you don't hate compiled BASIC, and you believe that assembly language is better than Pascal, then by all means write and

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ITEMS DISCUSSED

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Hayward, CA 94545
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FASTREAD $59.95
Achievement House
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Danbury, CT 06811
(203) 748-0277

GENERIC CADD $99.95
Generic Software
8763 148th Ave. NE
Redmond, WA 98052
(206) 885-5307

INTEL 80287 MATH COPROCESSOR CHIP ....$217 to $385
Intel Corporation
3065 Bowers Ave.
Santa Clara, CA 95051
(408) 987-8080

LITTLE COMPUTER PEOPLE..$35–$50
Activision
P.O. Box 7287
Mountain View, CA 94039
(415) 940-6044

POLYNOMIAL $27.50
Computer Services
RR 1
Wolfville, Nova Scotia
Canada B0P 1X0
(902) 542-5253

SOLARSIM $29.95
Interstel Corporation
P.O. Box 57825
Webster, TX 77598
(713) 333-3909

beg for a copy.

DTACK Grounded used to be available by subscription. Now it's available at the whim of its editor, FNE, who is sometimes known as Hal W. Hardenbergh. You can't bribe him. Try pleading. It's probably worth the effort.

WINDING DOWN

I'm out of space, and just about out of time: day after tomorrow I'm off to Atlanta for the World Science Fiction Convention, where *Footfall* has been nominated for a Science Fiction Achievement Award, otherwise known as a Hugo. By the time you read this, we'll all know if Larry Niven and I won, but just now I don't.

The book of the month is *The Education of Julius Caesar, A Biography, A Reconstruction* by Arthur D. Kahn (Schocken Books, 1986). The flyleaf says he was 12 years writing it, and I believe that. He sure doesn't like Cicero much.

The computer book of the month is Jeff Duntemann's *Complete Turbo Pascal* (Scott, Foresman & Company, 1986). This is about the best introduction to the Pascal language I've yet seen. It's keyed to Borland's Turbo Pascal and has complete, specific, and compilable programs. If you've been thinking of learning Pascal, this is probably the most painless way to start.

The game of the month has to be Activision's Little Computer People. That's not strictly a game, but it sure has consumed all the game time around here this month. We had Little Computer People running on both the Amiga and the Atari ST. The Amiga's graphics are preferable. I also learned something about multiple-screen systems: there's no easy way to handle error messages, because where do you display them? The program you're running may have covered up the "workbench" screen. That's Amiga's explanation for what happened, which was that the program blew sky-high whenever it tried to write to a disk with the write-protect window open. The programmer is supposed to handle such problems.

I've been pondering that, and we'll look at the problem next month. It isn't a simple one, but I don't think the current version of Amiga's operating system has the answer.

I've been playing with Activision's Music Studio program, and all I can say to that is wow! again. It's sure fun to play around, spraying notes about, then listening to what I "composed." If I'd had an Amiga and this program back when my parents were making me take piano lessons, who knows, maybe I'd have learned something. Anyway it's fun.

There's no point in your wishing me luck in Atlanta. See you on BIX. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, *One Phoenix Mill Lane, Peterborough, NH 03458. 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.*

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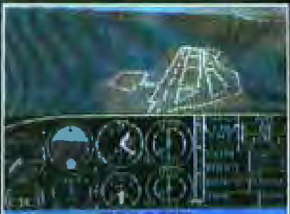

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SEASON'S GREETINGS

BY BRUCE WEBSTER

New products for the Amiga highlight Bruce's Christmas column

I find that it's strange to be writing a Christmas column in late August, but such are the vagaries of a three-month lead time. At least I am finally settled into my new office in my new home: boxes are unpacked, papers sorted (more or less), desk organized.

Most of the products discussed this month are for the Amiga. I didn't plan it that way; that's just how it happened to work out. But the Mac and the Atari ST are well represented, so there is something for just about everyone. What? You say there are folks out there who own other machines? Hmm, I'm going to have to look into this.

MEMORY FOR THE AMIGA

When the Amiga made its appearance last year, I—like many others—commented favorably on its open architecture and the free space (8.5 megabytes) in the memory map. Unfortunately for Amiga owners and Commodore, the third-party manufacturers have been slow to release reliable products that take advantage of those features. I would guess that as of this writing, less than 1 percent of all Amigas have more than 512K bytes of RAM. Since the Amiga is a graphics-intensive machine—even more so than the Mac—it eats up RAM quickly and that 512K bytes disappears fast. So the ideal peripheral for the Amiga would be a cheap RAM expansion box, and I expected to see them flooding the market within weeks of the Amiga's introduction.

No such luck. Some RAM boxes have come out, but they've been expensive and often unreliable. To be fair to the manufacturers, part of the problem is the expansion bus itself. In order to pass the bus through for other peripherals, you've got to deal with a number of headaches, including the protection of your own components should the next box down the line do things wrong.

Access Associates decided that the simplest solution was not to pass the bus through at all, and that's how they built their Alegra memory expansion. The unit is a slim grayish-brown box. It's about ½-inch wide and hugs the side of the Amiga. The top, bottom, and rear of the box are flush with the Amiga's main unit, and the front starts about ¼ inch back from the second mouse/joystick port. Installation is simple, though not necessarily easy. I found the best way to get the box to sit firmly on the expansion bus was to stand the Amiga on its side and push down on the Alegra.

The Alegra comes with 512K bytes of RAM, implemented using 256K-bit dynamic RAM chips. On boot-up under version 1.2 of the operating system, the RAM is automatically added to the memory map; you don't have to worry about anything. For systems running version 1.1, Alegra has supplied the necessary utilities for system configuration—but if you're still running 1.1, shame on Commodore! The Alegra's DRAM sockets are set up so that you can pull all the 256K-bit DRAMs and replace them with 1-megabit DRAMs. That gives you 2 megabytes of extra RAM, instead of just another 512K bytes.

Does the extra 512K bytes make the Amiga nicer? Very much so. First, you can now use more RAM for your RAM disk. My boot disk copies all the command files (in directory DF0:C/) into RAM:C/, then assigns that as the command directory (ASSIGN C: to RAM:C). That way, both floppy disk drives are free for work disks, and I avoid the eternally annoying "Please replace volume WHAZIT in any drive" messages. It also speeds up system response significantly.

Second, applications can now run in the "fast RAM" memory space, that is, memory outside the bottom 512K bytes (which is known as "chip RAM"). Running your program in fast RAM has two advantages. First, it frees up more space for bit planes (graphics images) and any other data that has to be read by the Amiga's custom chips, since those chips can access only chip RAM. Second, it prevents bus contention from slowing down your application. Admittedly, you'd have to be doing a lot of chip work (high resolution with multiple bit planes, etc.) in order to cause bus contention, but it's nice not having to worry about it.

Not passing the bus through isn't as much of a limitation as you might think. If you want to add other expansion-bus peripherals to the Amiga, you simply unplug the Alegra, plug in the peripheral, then plug the Alegra into the peripheral that we're assuming does pass the expansion bus through. If it doesn't, then you're out of luck.

What's the cost of the Alegra? As of mid-July, it was $379. It might be cheaper by the time you read this. Even at $379, though, it's worth the price for the added power.

(continued)

Bruce Webster, a consulting editor for BYTE, *can be reached c/o* BYTE, P.O. Box 1910, Orem, UT 84057, *or on* BIX *as bwebster.*

I know that I'm hooked; I don't think I could stand a 512K-byte Amiga now.

MicroBotics MAS-20 Hard Disk

The other peripheral the Amiga has lacked is a fast, cheap hard disk. Unfortunately, cheap hard disks may be slow in coming for the Amiga, just as they were for the Mac. Two problems crop up here: first, the bugaboo of the expansion bus again; and second, the perception by manufacturers of a small, soft marketplace. The former has already been discussed; the latter means that manufacturers aren't willing to commit to produce more than, say, a thousand units (into an installed base of about 90,000 Amigas as of mid-August). Because of that, the manufacturers can't get a great price on the drives, and that keeps the price relatively high.

However, high-quality hard disks are finally coming out for the Amiga. One such drive is the MAS-20 (20 megabytes) from MicroBotics. The unit is about 2 inches high by 5 inches wide by 12 inches long, and it is the same beige shade as the Amiga. The MAS-20 avoids the problems of the expansion bus by plugging into the parallel port. This allows you to place it wherever is comfortable (within the reach of the cable, of course).

The first time you set up the MAS-20, you must format it and create a boot disk. To do this, you make a copy of your regular Workbench or CLI boot disk, since the setup program will modify portions of the disk (like the Startup-Sequence file). You then run the setup program (provided with the MAS-20). This updates the boot disk with the proper drivers, creates the needed start-up file, and does the formatting (which takes about 40 minutes). After that, you use your modified boot disk when you start up or reset, and the MAS-20 does the rest. All the command files (your C directory) were copied onto the hard disk during the setup process, so commands operate more quickly; likewise, setup copies the device and library files to the hard disk.

Having a hard disk on the Amiga was nice; as was the case with the extra RAM, it spoiled me. It makes a big difference in what I accomplish when I have Aztec C, Lattice C, CSI MultiFORTH, and TDI Modula-2 all on-line at the same time. Twenty megabytes, while not as much as it sounds (about equivalent to 23 floppy disks), still can go a long way. And the access time—about three times faster than a floppy disk—helps a lot, too.

I didn't have time to really wring out the MAS-20. MicroBotics has just started shipping them and could lend me a unit for only a week or so. During that period, though, the unit was trouble-free: no crashes, no lost files, no mysterious happenings. The only major grievance I've heard is that printing and disk accessing tend to interfere with each other since both are using the parallel port. Unfortunately, I don't have a printer cable for my Amiga, so I haven't been able to verify how much of a problem this is.

My only complaint with the MAS-20 is its price: $1495. Unfortunately, the dynamics of the Amiga marketplace will keep that price up for quite a while. I'm not sure if that

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price is low enough to entice someone who has already spent $2000 or so on the Amiga system to buy a hard disk. But if you can afford it, the MAS-20 is a great addition to the Amiga.

Product of the Month: Instant Music

Speaking of power, a new package from Electronic Arts shows off the capabilities of the Amiga. Instant Music, written by Robert Campbell, truly provides "the triumph of technology over talent" (to quote BYTE's Gregg Williams). Briefly put, Instant Music turns the Amiga into an intelligent electronic instrument that even an untalented hack like me can play. It allows me to jam by moving the mouse up and down and pressing the button. What's more, it plays three other voices while I jam, forming the musical background for the piece. And what comes out sounds like real music.

The secret is in the "musical intelligence" of the program. By moving the mouse up and down, I pick the relative pitch of the music I want to play, and Instant Music generates accompanying chords. This can be limiting at times—it's disconcerting to hold the mouse button down and get only occasional notes or chords—but the result is pleasing to the ear (usually).

To play, you select the piece of music you want to hear. There are more than 40 different selections from 4 to 24 measures long, ranging in style from rock to classical. A given piece has four voices, though often only three (the ones the computer usually plays) are actually scored. Each voice represents an instrument: electric guitar, flute, organ, and so on. A total of 19 instruments are available, including a "DoVoice" instrument that allows "do wah" vocals for songs. You start the piece and play your part while the computer plays the others. A graphical display shows the entire piece, so you can see what each voice will be doing. You can switch voices and take over another part; you can change instruments; you can change the tempo; you can even make the program do less for you and gain greater control over chords and rhythm.

Once you've gotten comfortable with all that, you can start creating and editing pieces of your own. Composition is almost as easy as playing; in fact, it's just like playing. First, decide how many measures long the piece will be (up to 64). Second, pick the instruments for each of the four voices. Then pick a given voice and use the mouse and button to play what you want the track to be. Pick the next voice and lay down the next track. When you're done, you can play back your composition. You can also "step in" for a given voice and play it yourself.

My only complaint with Instant Music is that it's copy-protected. True, it's the key disk method, which does allow for installation on a hard disk, and, also true, you can buy an unprotected version for another $20, but it's still a pain. Copy protection seems to be a dying trend in the industry; maybe Electronic Arts will see that and follow the other firms that are dropping protection from their products.

I've enjoyed having Instant Music to use, and my kids have been fascinated by the ability to sit down and play

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real music without much effort. It's an outstanding program, and Robert Campbell should be commended.

THE HACKERS CORNER

Every few weeks, I receive some piece of software that a solitary programmer working long hours has feverishly pieced together. Sometimes the programmer sends it to me; sometimes I get it by other means (downloaded from bulletin boards, etc.). In either case, the software itself is either public domain (i.e., free) or it's shareware (i.e., free unless your conscience bothers you enough to compel you to send some amount of cash to the author). I plan to periodically review some of the PD/shareware programs out there, calling attention to the fine efforts of kitchen-table hackers everywhere.

The two programs I'd like to mention this month are, at first glance, frivolous, but both illustrate the strengths of the computers they run on. The first is a public domain desk accessory for the Macintosh, known simply as Talking Moose. It was written by Steve Halls, a doctor in Canada, who apparently had a great deal of fun putting the program together. When you activate the desk accessory, it installs itself in the system heap, then allows you to go back to whatever you were doing. However, if an interval of time (user-adjustable) goes by with no activity, a small window with a moose's head in it appears near the upper left corner of the screen. The moose then makes some smart-aleck remark, usually (but not always) having to do with your lack of work, and the window goes away. The moose head—somewhat reminiscent of Bullwinkle—is animated while it talks, moving its eyes, ears, nose, and mouth.

At any time, you can bring up the desk-accessory window again, which allows you to adjust the rate and pitch for the voice, as well as the delay between comments. You can also click a box to remove the moose from the system, in which case the moose appears and makes some sort of plea or threat ("Oh, no! Don't do that!"). If you then turn the moose back on, it replies with some expression of gratitude ("Splendid decision!"). The desk accessory requires two support files: MacinTalk, Apple's speech synthesizer program; and Moose Phrases, a resource file full of comments converted to MacinTalk phonetics.

Halls was offering the assembly language source code for the price of a disk and postage (or for a disk with sufficient return postage). I don't know if the offer is still in effect; you might want to write him (with a self-addressed envelope and money for postage) to find out. The last address I have for him is Steve Halls, M.D., 11135 50 Ave., Edmonton, Alberta, Canada T6H 0J1.

The other program is for the Amiga, and it arrived in the mail with a pair of the old red-and-blue three-dimensional movie glasses. The program, 3-D Breakout, was written by Tim Kemp of Columbus, Ohio. As you might guess, it's a variant of the old Breakout game in which you keep bouncing a ball off a paddle back toward a group of bricks. In this version, the "bricks" (one layer thick) line the ceiling and three walls of a room, with the screen forming

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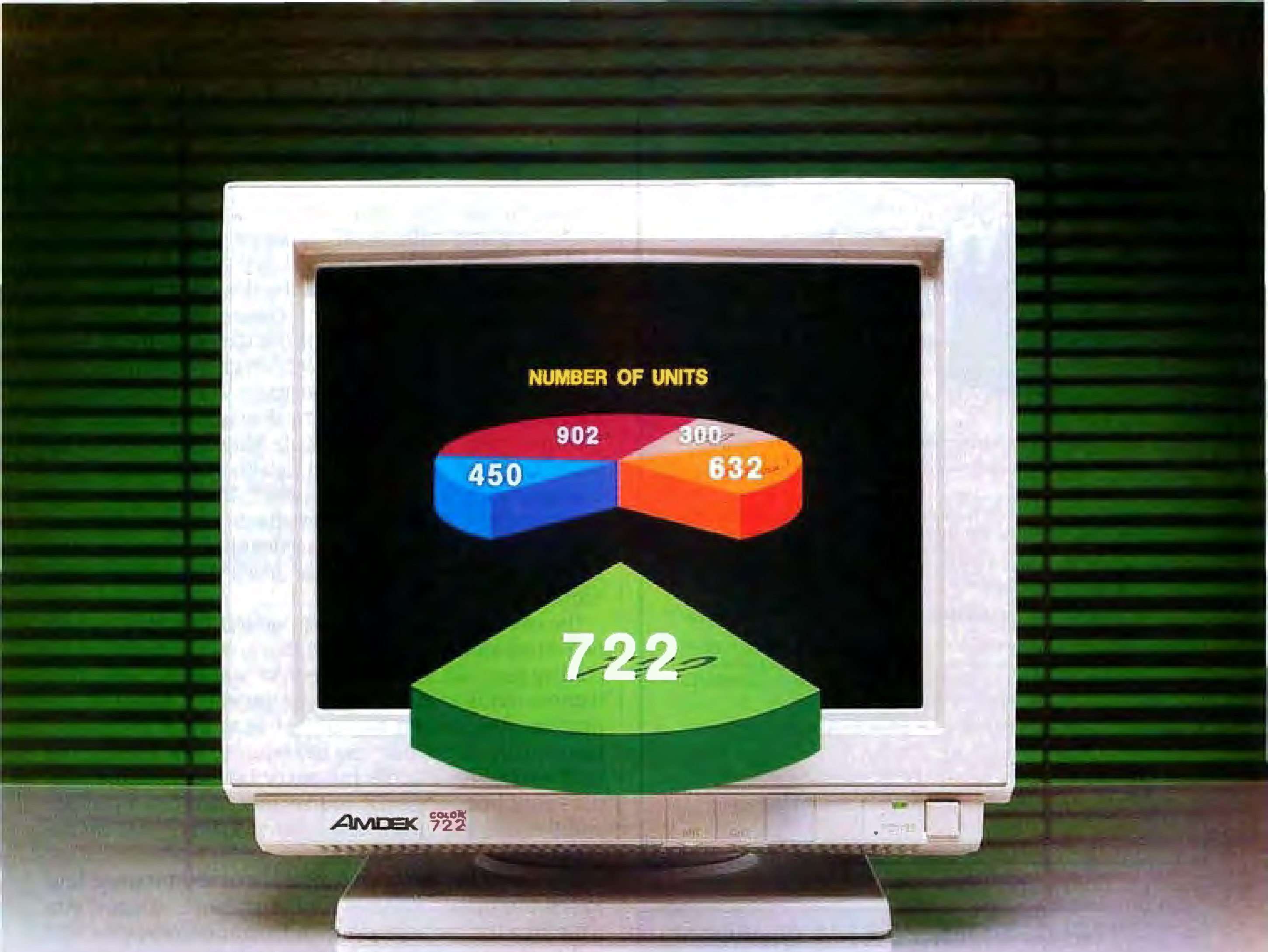

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the fourth wall. The "ball" (which is square) bounces off the ceiling and walls. It will, however, sink into the floor and disappear unless you bounce it off your paddle: a square that you move around the floor with the mouse.

The three-dimensional effect is quite good. The program actually draws two versions of the game on the screen, one in red and one in blue. Each version corresponds to what each eye would see if the scene were truly three-dimensional. For the eye looking through red plastic, the pale red looks gray and the pale blue looks black; vice versa for the eye looking through the blue plastic. The background is a light purple, which looks gray through either color of plastic. The net effect is that the left and right eyes see two different two-dimensional images and your brain fuses them together into a three-dimensional scene.

The effect, while good, is not perfect. The "ball" is only two-dimensional, a flat square that grows and shrinks according to its distance from the front wall (the screen). That flatness tends to nullify some of the effect. Likewise, the program needs some adjustment as to when the paddle has actually hit the ball; the ball tends to sink through the back end of the paddle but easily bounces off the paddle's very front edge. Of course, that hasn't stopped me and the kids from putting in a fair amount of time on the game.

Tim was willing to correspond about the program and to sell the plastic material for the glasses. I suggest you write him (with a self-addressed stamped envelope and sufficient money to cover his time and effort) at Tim Kemp, P.O. Box 23101, Columbus, OH 43223.

Stocking Stuffers

By the time you read this, there won't be too many more shopping days until Christmas, and you may be wondering what to get for the computerphile in your life (even if that's just you). I don't talk much about games in this column, but I hope you won't mind too much if I make some recommendations for your last-minute Christmas shopping. Since computer games are something of a passion in this household, we've had a fair amount of experience.

My favorite game this year has been Major Motion, written by Philip MacKenzie and Jeffrey Sorenson for the Atari ST and published by Michtron. It was inspired by the video arcade game Spy Hunter and involves car-to-car combat. Your mission is to travel as far as you can, destroying enemy (blue and/or black) cars and helicopters as you go along while avoiding injury to civilians. Your car starts out armed with just guns, and they work only against some of the enemy. As you drive along, a red semi appears from time to time; if you drive into it, you come out with a new weapon (oil, smoke screen, repulsor, missiles for the helicopter, or turbo boost). Each new weapon is good for only three attempts, and you lose one of those weapons each time you crash. You start out with six cars and get a new one for each 10,000 points.

The enemy, of course, is not idle during all of this. One

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type of enemy car is equipped with tire slashers; if it bumps into your side, you're gone. Other enemy cars will try to run you off the road while the enemy helicopters drop oil spots in front of you. If you go far enough, you'll encounter your "evil twin"; if you get past him, you'll soon run into two of them. Somewhere past that you'll find the bridge is out, but. . .well, that would be telling.

The car, controlled by the mouse, handles very nicely, and the graphics are smooth and colorful. Also, the game plays background music (themes from *James Bond*, *Batman*, etc.) from time to time as you drive; a nice touch. The game has other features, like an abort key, pause and music toggles, and the ability to reassign the weapons keys. And, best of all, it keeps a "Top Ten" list that provides solid documentation for bragging rights.

I'm not sure why I like this game more than the others I've played. I think it has to do with the way I drive or, more precisely, the way I'd like to drive. And Major Motion had one welcome feature over the other two: it is not copy-protected. That helps, because my kids have already creamed one working disk, and it took me just a few minutes to make a new working disk from the master. I'd hate to think what would happen if they messed up the master disk for one of the other games.

Nevertheless, those two other games gave Major Motion serious competition. Both are superior in one way or another; I just didn't happen to get as hooked playing them. One is Time Bandit, written by Bill Dunlevy and Harry Lafnear for the Atari ST and also published by Michtron. This is easily the finest all-around arcade game to come out on a home computer to date. It is actually a collection of 16 different arcade games, 15 of which follow the same basic pattern: Once you get into it, you can't get out until you find the key(s) and unlock the gate(s) that bar your way. In the meantime, of course, all sorts of nasty creatures are trying to kill you by running into you. You can run, fire, or fire as you run. In an interesting twist, the points you get for each creature you destroy vary according to your "bravery": If you just sit in a corner and blast away, the points-per-creature value drops; if you run at the things, the PPC value goes up. Each game has 16 levels, which get tough fairly quickly.

Interwoven into all this is an adventure game that lets you solve puzzles, find (and use) objects, and generally work toward an eventual goal. This adds a depth to the game that holds your interest even when the arcade elements grow old. Other features include a pause function (press P) and a "Time Lord" list that keeps track of the top six scores—the top five, actually, since it includes "Krazy Kev," who (allegedly) racked up more than 500,000 points. The only complaint I have is that there is no "Save Game" function, which is a significant shortcoming given the time it would take to completely solve the game. Even so, all the great features, as well as the outstanding graphics, make this game a must if you have an Atari ST (with color monitor).

The other competitor to Major Motion is Marble Madness, written by Larry Reed for the Amiga and published by Electronic Arts. This is a licensed port of the Atari video arcade game, and the graphics are really amazing. The basic theme is guiding a marble through a downhill maze. You have so many seconds to complete each maze; any time left over is then added to the time you have for the next maze. Various obstacles and enemies confront you as you proceed, the mazes get tougher, and the time for each maze gets shorter. You can use either the mouse or a joystick; for that matter, the game is designed to let you use a trackball if and when one becomes available for the Amiga.

I do have some gripes with Marble Madness. There's no pause function, so once you start a game, there's no way of stopping even for a second until the game is over. Even less forgivable, there is no "top scores" list, and once

(continued)

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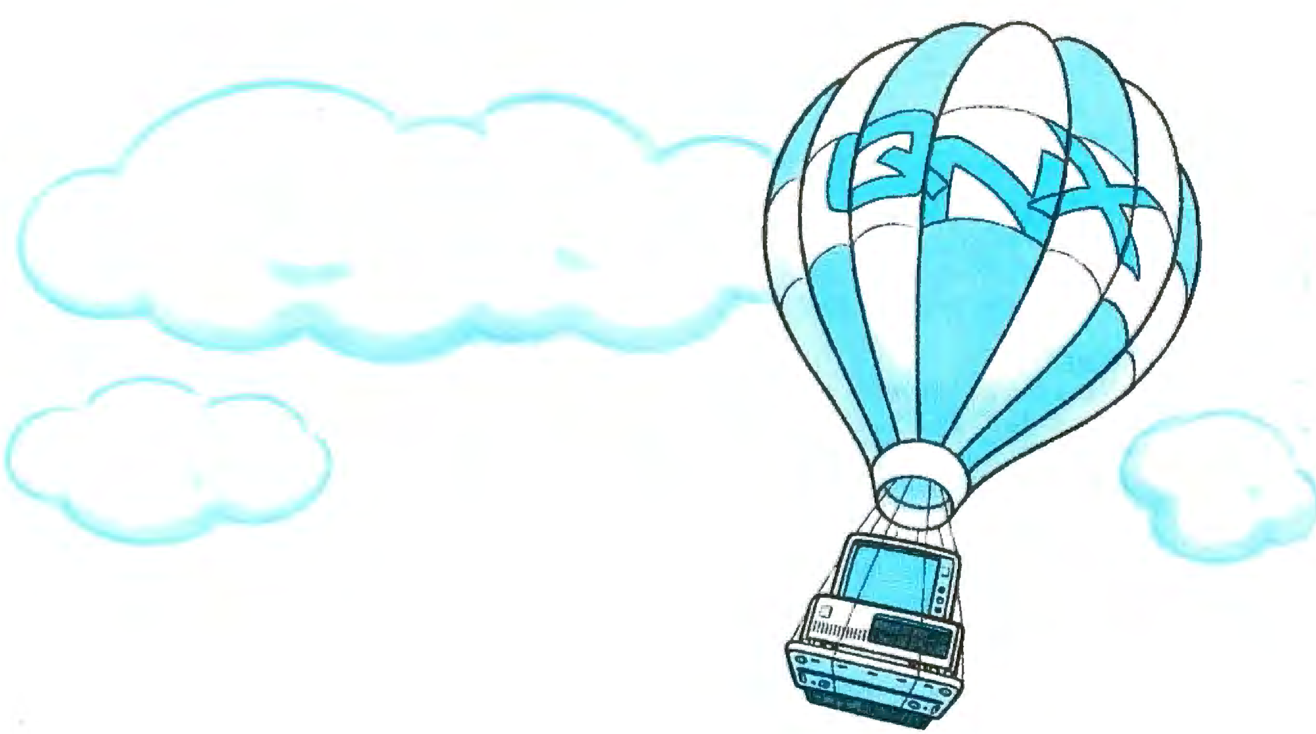
QNX

you've run out of time, the game goes back to the starting screen after a second or two, making it difficult to even see what your final score was. Even so, Marble Madness is definitely worth having if you own an Amiga.

OUTLINING AND MORE

The success of a product can be judged by the number of imitators. By that standard, ThinkTank from Living Videotext has done very well. The Winer brothers, Dave and Peter, managed to create an entirely new category of software: outline processors (also referred to as idea processors). In doing so, they've managed to pull in no little amount of money while spawning the type of competition that forces products to get better and better. Two results of that competition: Acta and More, both for the Macintosh.

Acta, written by David Dunham and published by Symmetry Corporation, is your basic no-frills outline processor. "No frills" doesn't mean limited, though: You can quickly create outlines, rearrange the topics, add and delete items, cut and paste text, and generally do most of what you'd want to do with an outline.

What makes Acta different—dare I say unique?—is that it's not an application: It's a desk accessory. Once you've installed it in your system file, you can call it up from within any application that supports desk accessories, which is to say 95 percent of all Mac applications. You can be working in, for example, MacProject, Excel, or Microsoft Word, and you can pull down the Apple menu, select "Acta," and there you are. Acta brings up its own window and appends its menu to the end of the current menu bar. You then create a new outline or load in an existing one. You can change it as you please, then save it out in one of three formats: Acta, MacWrite, or Text. And if you're using it within Microsoft Word or MacWrite, you can copy (or cut) part of the outline, exit Acta, and then paste it into your document, where it will appear properly indented and with bullets at the start of each line.

Acta is larger than most desk accessories—about 37K bytes—but smaller than you'd expect for a program this complete. I've found it very useful for doing outlines of documents that I'm writing using Microsoft Word. I get into Word and open the document (or start a new one). I then bring up Acta from the Apple menu. Having done that, I can now switch between the two programs by just clicking on their respective windows. Cutting (or copying) and pasting works in both directions, so that I can insert text from my Word document into the Acta outline and vice versa. And at only $59.95, Acta can provide all the outlining capabilities that the majority of Mac users need.

At the other end of the spectrum is More, the new package from Living Videotext. Written by Peter and Dave Winer and Doug Baron, More picks up where ThinkTank left off and runs like crazy. You can convert outlines to bullet and tree charts, then print the charts if you desire. You can create documents (letters, memos, etc.) under a given line of the outline, then print them out (independent of the line) as needed. You can open multiple windows, then ask More to tile them (lay them out with no overlap) the way you want them. You can set up a series of screens as items in a "flip chart"-style presentation. You can have More do math for you, time-stamp text, and sort entries. In short, you can do just about anything you'd like (or expect) to be able to do.

More has features and aspects that you may never use; on the other hand, its capabilities may lead you to try things you might never otherwise attempt. The price is somewhat full-featured, too—$295—but if you have any serious outlining needs, More may well be the way for you to go.

IN THE QUEUE

You would think that I'd learn not to predict what I'm going to cover next month, since I'm so often wrong. Well, I'm a slow learner. Next month, I hope to review the predictions for 1986 made in last January's column and make some new predictions for 1987. I'll also pick some products of the year. These are meant more to reflect my personal preferences than any objective standards of what the most significant products of 1986 were. I'll also have a first look at the Apple IIGS, the newest offering from Cupertino, as well as whatever additional software products I can squeeze in. Until then, Merry Christmas, and I'll see you on the bit stream. ■

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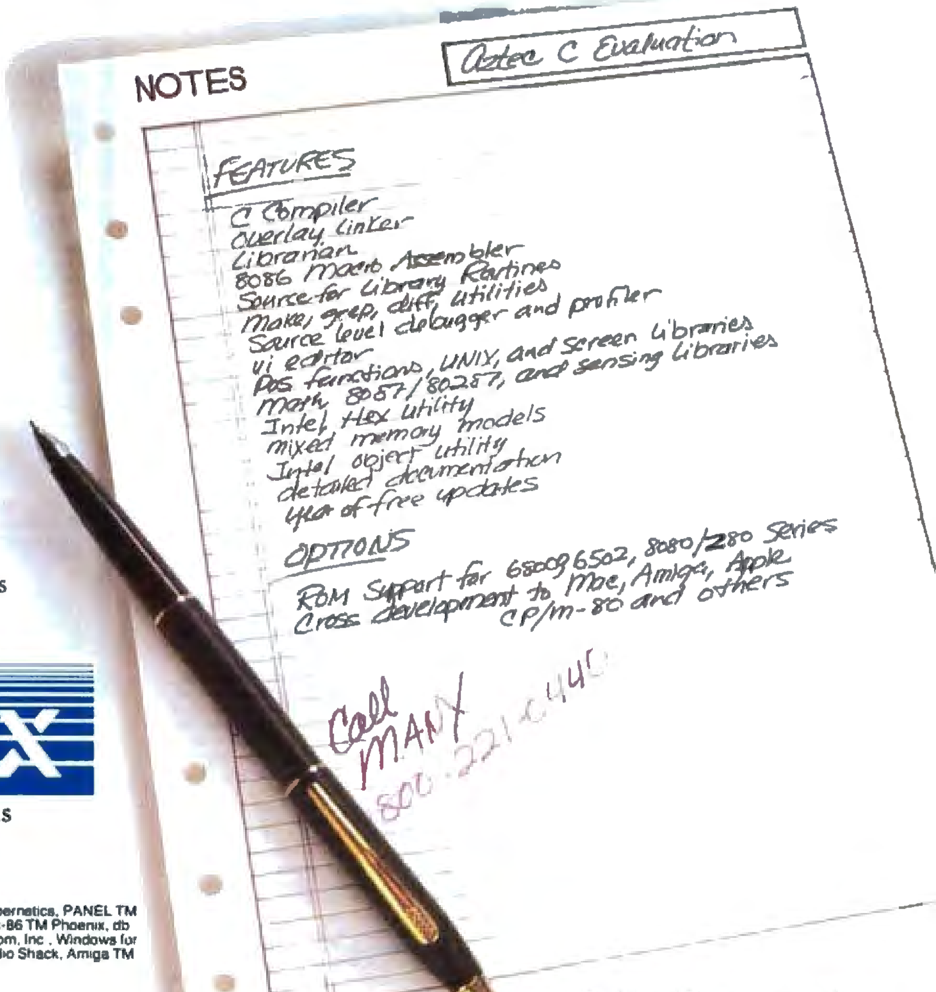

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STOCKING STUFFERS

BY EZRA SHAPIRO

Some simulations, a paint program, a mouse, and even a game

Time for a little holiday cheer. This month I've put together a batch of programs that would make terrific gifts. Nothing too expensive, nothing that you can't live without, but all great fun. That's not to say that they aren't useful products; they are—some of them spectacularly so. Being fun to use doesn't mean a program is frivolous. I'd argue that *all* software should be as entertaining as the packages in this collection.

If I weren't receiving this stuff because I write this column, I'd be hoping that someone would catch the spirit of the season and gift-wrap the lot for me.

NOT A JOKE

ComicWorks (Mindscape, $79.95) is yet another giant step in the evolution of Macintosh art. The program starts from the basic toolbox offered by MacPaint, then adds object orientation, sophisticated airbrush and masking techniques, text handling, and layout options that make it a topflight illustrator's kit. Although the name and the promotional literature suggest the program is merely a toy for cartoonists, you can do some amazing—and serious—things with ComicWorks.

Object orientation lets you build a painting piece by piece and then overlay the pieces into a finished work. In a pixel-based program like MacPaint or FullPaint, once a section of art or text is moved into position, it obliterates anything underneath. With ComicWorks, you create each section on a separate layer, so you can edit and rearrange to your heart's content. This strategy is the basis for many CAD programs; it's new in a paint package. You can construct a scene the same way you would decorate a room or dress a Barbie doll.

A ComicWorks object can be a graphics image or a block of text (usually enclosed in a border, like the standard speech balloon in comics). You can work either on an opaque background or on a transparent plane that lets you see what's underneath. When you're through, you can decide whether the overlay should mask the lower layer, or you can add to it, reverse the color of the underlying pixels, and so on.

Most of the MacPaint tools have been preserved in this package; a couple have been enhanced. FatBits (blowing up a section to edit it a pixel at a time) has become SmallBits, MediumBits, and LargeBits, so you can zoom in step by step down to the pixel level. ThinBits is an editable full-page view that allows easy repositioning of objects.

The airbrush tool is a thing of wonder; you can adjust its diameter from 1 to 96 pixels in 1-pixel increments, control the rate of spray, and toggle between black and white by pressing the Backspace key. Coupled with the masking options, you can use this electronic tool much as you would a real airbrush.

Layout and nomenclature are geared to the comic-book artist—you build "balloons" (text) and "easels" (graphics) in "panels" located on "pages"—but I can see no reason why you should be limited to producing comic art. The program comes with three disks, of which two are libraries of comic-book objects. However, the authors have also snuck in some eye-opening teasers: two greeting cards, a restaurant menu, a newsletter, and a blank TV storyboard for advertising people. Mindscape is currently talking about releasing a companion product, sold only through the mail, called GraphicWorks. It will come with libraries of business art (whatever that is) instead of spaceships and monsters. The basic program will be the same, as will the price.

You can work on only one file at a time, but because of the structure, that file can include many individual pictures. A browse option lets you scan other files for objects you might want to import to your current project. Finished illustrations can be stored as ComicWorks files (which preserve the independence of objects) or as MacPaint files for exporting to other programs.

The program takes a while to learn. It's complex and not intended for the weekend doodler. And several things annoyed me. First, text attributes were hard to control, as they were in the early days of MacWrite. Second, when I had half a dozen panels open on the screen, each with a few easels, screen updating was disconcertingly slow. Mindscape's technical support person commented that ComicWorks was pushing the Mac's poor 68000 to its limit, and I'm sure he was right. (This should be better on 1987's Macs.) Finally, I missed the enhancements of FullPaint (see September's Applications Only), like free rotation, precise mouse control, and exotic distortions.

But on the whole, I was enchanted with this program. At a price of

(continued)

Ezra Shapiro is a consulting editor for BYTE. *He can be reached at* P.O. *Box* 170040, *San Francisco*, CA 94117-0040.

$79.95, ComicWorks is worth the money it costs.

MEDICAL MARVEL

Surgeon (ISM, $60) is an excellent graphics simulation for the Macintosh that lets you operate on a "patient" to remove an aortic aneurysm and replace the defective artery with a length of Dacron tubing. You start by diagnosing and prepping the patient, then you perform the surgery using a mouse to select and manipulate icons representing various instruments. An EKG scope in the upper left corner of the screen tracks the patient's vital signs.

Deviation from correct medical procedure is dangerous. If you make a mistake, or leave out a step, or use the wrong medication, or cut in the wrong place, the program informs you in a polite dialog box; you can attempt to repair the damage, but this is delicate surgery and errors are costly. When the trace on the EKG goes flat, you know you've blown it. I suppose Surgeon has to be considered a game, but it's scary in its accuracy and detail (it was designed by a physician), and there's only one way to win: successfully completing the operation.

It takes half an hour, or less, to play Surgeon through to its conclusion, but the experience is unusually compelling; it's impossible not to take the operation seriously. This is not a program for the squeamish—you're as close to the heart as you can get without calling it "open-heart surgery"—and for once I'm glad the current Mac lacks color.

Surgeon could be a magnificent teaching tool; think what it could have meant in your high school health or biology class. And it sure beats the cryptic explanations you sometimes get from the medical community when someone you know is having similar surgery. I'd love to see hospitals and doctors using the program to educate, and calm, patients and their families. The people at ISM are currently thinking about turning Surgeon into a whole line of programs, each dealing with a different condition. I hope they do; there's a real need for software like this that demystifies the subjects of our darkest fears.

BOP ON THE PC

Good news for any geopolitical wizards out there—**Balance of Power** (Mindscape, $49.95) is now available for IBM PC–compatible machines. When I first wrote about it in March, I was ecstatic. I commented that Chris Crawford's simulation of superpower diplomacy and confrontation was the best game I had ever seen on any computer. But it was a Macintosh product, period.

Well, it's still the best game around, and owners of MS-DOS computers no longer need sigh longingly. The new version is one of the first software packages to use the Microsoft Windows interface as a way to achieve a Mac-like environment, and it's pretty

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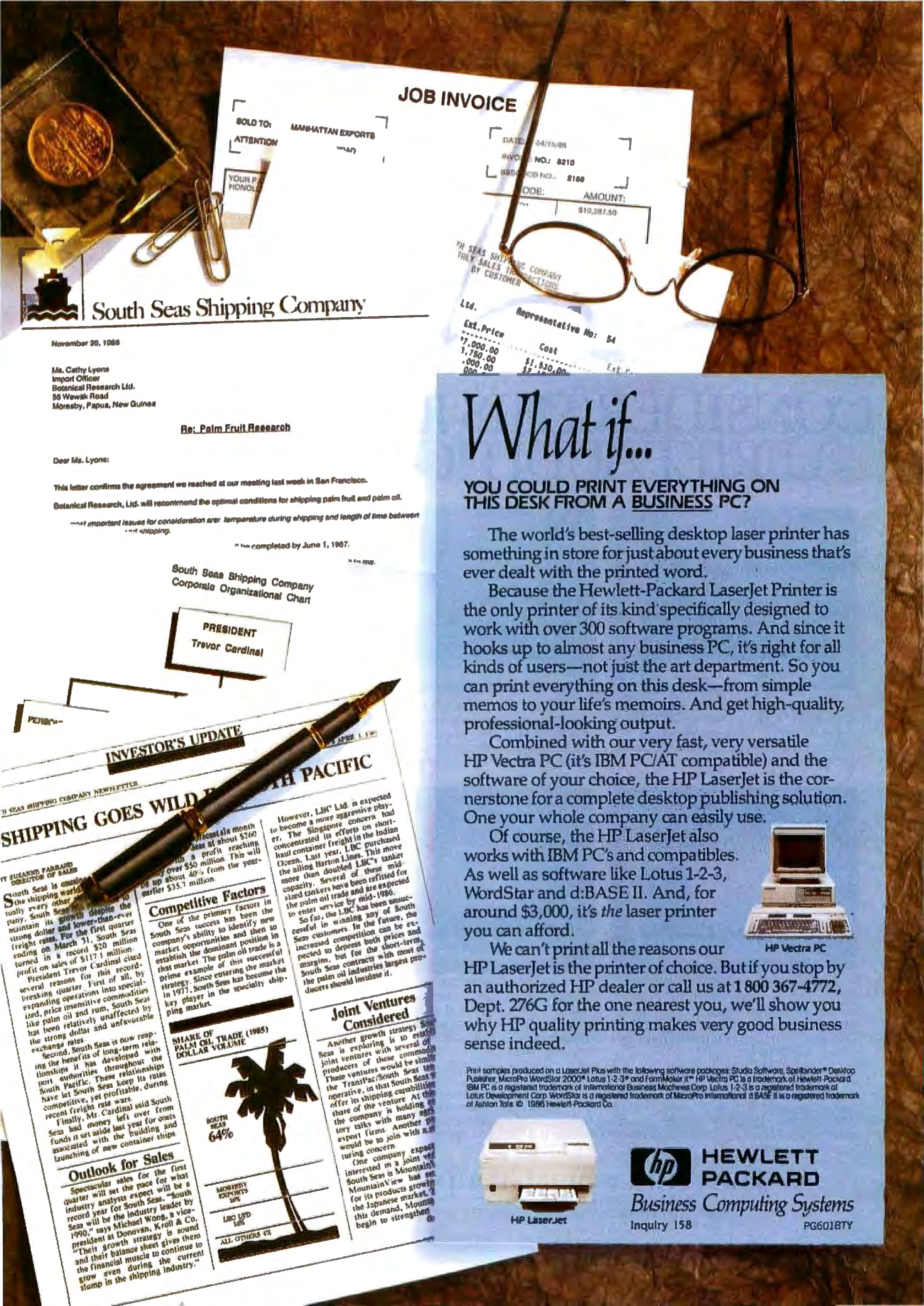
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good. You get three disks that enable you to install Balance of Power and Windows on either a floppy disk or a hard disk (you can make only one copy, but you can uninstall it if you want to make changes to your system). Of course, if you already have Windows running, you can avoid most of the installation procedure.

The MS-DOS version is a bit of a pain after using the program on a Mac. With a CGA card, the graphics are pretty rough-looking; they're better with an EGA card. You also have to take extra steps that you can avoid with the Mac. You can't just select a country on BOP's world map by pointing the mouse and clicking; you have to choose a continent from a menu bar and then pick the country from a pull-down menu. And I was surprised that the MS-DOS program seems no faster than the Mac version, even though it makes use of four times the memory (512K bytes versus 128K bytes).

Anyhow, I'm still raving about Balance of Power. If you've got an MS-DOS machine and a Macintosh, buy the Mac version of BOP. But by all means, get the program.

RAT REPORT

This isn't strictly software, but if you want to play Balance of Power, you'll need a good mouse, even if they tell you it's "optional." For the past month and a half, I've been testing mouse-based MS-DOS software using the **LogiMouse C7** (Logitech, $99), and it has made my life a lot easier. On the hardware side, the C7 is an opto-mechanical rodent that uses CMOS technology to get rid of the transformer module; you just plug the thing into your serial port and go. (Anything that cuts down on the jungle of wiring around my system is a real boon.) And resolution seems sharper than that of the optical mouse it replaced.

On the software side, the LogiMouse comes with a driver that doesn't interfere with most other resident software, a mouse driver compiler that's as good as anybody else's, and interfacing routines for BASIC, C, Modula-2, and Turbo Pascal. For an additional 20 bucks you can get Logitech's Plus package, which adds an excellent menu builder (with useful examples), a fast windowing text editor, and an outstanding Lotus 1-2-3 interface. Logitech also sells the mouse bundled with a variety of application programs, including PC Paintbrush, Reflex, and Generic CADD. Any one is a bargain.

Note that there are two models of LogiMouse, one with traditional mouse buttons and one that has three little raised bars in place of buttons. I got the mouse with the strange ribbed thingies. Beware—go with the standard-style buttons!

PRACTICAL PLAY

The last time anyone tried to teach me something about the way of the world was in my eighth-grade math class.

(continued)

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Red hot

Mr. Kebles took a couple of weeks to explain stocks, bonds, and how checking accounts are managed by banks. Since then, I've had to negotiate the minefield of personal finance entirely on my own, and there have been many moments when I've wished I knew more about what I was doing.

The first Blue Chip simulation I encountered was Millionaire. It's a stock-market model, and I played it on a CP/M-86 machine with 8-inch drives I'd rather forget. But I learned a lot about market trends, stock options, and portfolio strategy. You track performance of a particular stock, its industry, and the overall market by watching charts and graphs; read the business news; and invest accordingly. On my copy, the graphs were built out of standard text characters, but they were effective. A few years later, Millionaire became the first razzle-dazzle simulation on the Mac by using spreadsheet-like grids and full graphics.

Millionaire is still available from Blue Chip, as are Tycoon (commodities) and Baron (real estate), on a wide range of machines. MS-DOS and Mac versions cost $59.95; Apple II versions are $49.95; and Commodore 64 versions are $29.95. The newest offerings are Squire (MS-DOS and Mac)

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BALANCE OF POWER $49.95
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Northbrook, IL 60062
(312) 480-7667

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6744 Eton Ave.
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LOGIMOUSE C7 .... $99
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(415) 365-9852

SURGEON $60
ISM
2936 Paper Mill Rd.
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and Managing for Success (MS-DOS only).

Squire is a simulation of investing for retirement. You can choose among stocks, bonds, money-market funds, real estate commodities, tax shelters, and so on. The game period is 20 years; you get to reassess your portfolio monthly, for a total of 240 "turns." As with the other games, you watch charts, graphs, and news reports. The standard game is pretty dull. Being an overview, it lacks the richness and complexity of the other Blue Chip products. However, it does offer one significant plus: a "reality" mode that lets you configure the program for your own situation: age, current portfolio, cash flow, retirement age, etc.

This can be depressing. I fed in my personal statistics, went through the game, and was informed that I would spend my retirement years "leeching off relatives" (the program's words, not mine). Though any simulation of this sort is necessarily going to have to make some assumptions that hurt its long-term validity, Squire does make you think. Note that the Macintosh port doesn't make use of the Mac interface like the other Blue Chip programs; after clicking the game icon, you're dealing with characters only.

Managing for Success (originally sold as American Dream) is aimed at the professional business manager. You're the CEO of a manufacturing firm, facing decisions on personnel, marketing, production, R&D, materiel, sales, finance, and so forth. It's two disks of exhaustive stuff, far more sophisticated than the rest of the Blue Chip line. I wouldn't suggest it for an evening's entertainment; this baby is tough. However, if you've got aspirations in management, this one will force you to do some hard thinking.

DARK CASTLE

While I'm on the subject of fun software, I'm going to break from my standard policy and say a few words about an unabashed, honest-to-goodness *game* for the Macintosh. Set in medieval times, **Dark Castle** (Silicon Beach, $49.95) is a variation on the tried and true Lode Runner/Donkey Kong theme; you have to pilot your hero through 14 screens of obstacles, traps, monsters, and villains to an eventual confrontation with the extremely nasty Black Knight. There's nothing new about the basic concept, but the execution is impressive. Dark Castle is a wonderland of slick animation and realistic digitized sound. You're constantly confronting squeaking rats, clanking chains, cracking whips, sizzling lightning bolts, and the like.

The program comes on two 400K-byte disks and will really put any of the 512K Macs through its paces. Dark Castle is a perfect way to fritter away those long winter evenings when you should be doing something productive. ■

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THE U-MAN POTENTIAL

BY DICK POUNTAIN

A computer for scientific users and a molecular modeling system

1985 and 1986 have been appalling years for Britain's mass-market microcomputer manufacturers. All the big names of the early 1980s are either gone or survive in greatly reduced circumstances, with the exception of latecomer Amstrad. In the U.K., though, a number of smaller computer manufacturers never went after the volume market. Firms like Comart, Positron, and MicroConcepts found themselves niche markets, often in the scientific and technical arena, and in the main they thrive regardless of the cold winds blowing above.

I've recently been looking at a machine from one such firm called U-Microcomputers, U-Micro for short. The computer, the U-MAN 1000, is built around the 68000 microprocessor. It's targeted at scientific and engineering users and designed for high-performance I/O in applications like data logging and instrument and process control, while still retaining the capabilities of a general-purpose personal computer.

U-Microcomputers was founded in 1979 at Warrington by Dr. Bill Unsworth, who has a Ph.D. in chemistry, and it became one of the first Apple dealers in the U.K. Like many pioneering Apple dealers, U-Micro got into the business of designing and selling its own add-on boards that, given Unsworth's background, tended to be A/D converters and other I/O devices. This led to a series of full-scale Apple II–compatible desktop computers and finally to the U-MAN 1000. Recently, U-Micro has become part of the large VG Instruments Group of scientific instrument makers (U-Microcomputers Ltd., Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR, United Kingdom, (0925)-54117; in the U.S.: VG Instruments Inc., 300 Broad St., Stamford, CT 06901, (203) 325-4090).

INSIDE THE 68000 BOX

At first sight, the U-MAN looks much like any of the Stride-style multiuser 68000 machines that have sprung up in the business sector in recent years: a featureless box with a separate monitor and keyboard. The U-MAN, however, differs from the average business box in that it comes with bit-mapped color graphics. In addition to a 10-megahertz 68000 microprocessor, it contains a 6809 microprocessor to handle I/O and drive what amounts to a built-in graphics terminal. The two microprocessors communicate via a dedicated 4K-byte area of dual-ported static RAM.

Architecturally, the U-MAN is a clean machine. The standard model comes with 1 megabyte of no-wait-state RAM, which can be expanded to 5 megabytes of contiguous, linearly addressed memory internally and to 15 megabytes externally. The only firmware consists of a boot ROM that can discriminate between the various operating systems available, plus the operating firmware for the 6809 I/O microprocessor. The 6809's operating firmware doesn't reside in the 68000's address space and need not concern programmers (unless they are into heavyweight system building and want to modify it). Up to 512K bytes of user ROM can be supported if required.

The video subsystem provides 27 lines of 85 characters in 16 colors (or gray scale), along with flashing, underline, and reverse-text attributes. Bit-mapped graphics are supported at 680 by 288 pixels, but the number of colors in graphics mode is hard to summarize conveniently because of limitations on permitted color combinations in adjacent cells due to the way the video microprocessor works. Basically, you can put 16 colors on the screen—but not just anywhere you like. Two 32K-byte pages of RAM controlled by the 6809 are devoted to video and I/O buffers, and a standard character font is downloaded from EPROM into one of these buffers at boot-up time. Soft fonts (up to 16) can be stored here, and text can be mixed with graphics on the same screen. Any of this memory that's not being used for video or fonts (in text mode, that means most of it) gets allocated for print spooling and other I/O buffering.

The standard U-MAN includes a formidable array of I/O devices. In addition to two buffered serial ports (150 to 38,400 bits per second) and a Centronics printer port, the U-MAN has twin 8-bit general-purpose parallel ports and timers (controlled by a 6522 chip), four channels of 10-bit A/D conversion, a four-slot expansion system that brings out the full 68000 bus and an Apple-compatible bus, and a sound generator and speech synthesizer based on the Texas Instruments TMS5220. Apple cards can be used on the expansion bus, but, of course, any ROM software in 6502 code *will* not run on the 68000.

These goodies are packed into a

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, *One Phoenix Mill Lane, Peterborough*, NH 03458.

seemingly bombproof alloy case with a 100-watt power supply, two 800K-byte floppy disk drives, and the option of hard disks with 20- to 80-megabyte capacities. The keyboard is an OEM version of the Key Tronic KB 5151, and you supply your own monochrome or RGB monitor.

A number of add-on boards are provided for scientific I/O applications. A floating-point coprocessor board using the National Semiconductor 32081 fits piggyback-style into the 68000 socket and is supported by many of the compilers supplied by U-Micro. A 48-line IEEE-488 parallel interface is available, as is a serial expansion card containing eight RS-232C ports. For high-speed parallel data logging, a 16-bit parallel board operates at the full 10-MHz bus speed and can be configured as one to three channels depending on the protocol required. This board can acquire a 16-bit word of data in 500 nanoseconds. The system's A/D conversion capabilities can be enhanced with a range of 12-bit A/D and D/A boards with up to 16 channels. Finally, being a relatively small company, U-Micro will build special single-unit U-MAN configurations to order, with extra RAM or other features.

The prices for U-MAN 1000 systems start at £2760 for a machine with twin floppy disk drives and 1 megabyte of RAM and go up to £9250 for a 5-megabyte machine with an 80-megabyte hard disk.

A VARIETY OF OPERATING SYSTEMS

The biggest problem faced by any 68000-based system is that no single dominant operating system has emerged for the chip in the way that CP/M dominated the 8-bit Z80 world and that MS-DOS dominates the Intel 8086 family. UNIX enthusiasts might claim the chip as their own, but in truth the UNIX takeoff still hasn't happened, and applications are few by CP/M or MS-DOS standards. On an installed-units basis, the Apple Macintosh operating system could claim to be more important than UNIX, but it's supported only by one vendor and on one machine. Atari and Commodore have managed to further divide the market by choosing two other operating systems.

None of this is crucial to a specialized firm like U-Micro. It is not chasing the user of packaged business software; typical U-MAN users will probably write their own software, in FORTRAN, Pascal, C, or LISP. Alternatively, they may want to buy scientific packages like the Reduce 3 symbolic math system. Accordingly, U-Micro has chosen to offer no less than four operating systems for the U-MAN, none of which is UNIX!

The two basic operating systems offered are the UCSD p-System and Digital Research's CP/M-68K, both of which are single-user, single-tasking systems. In addition, the Mirage operating system (multiuser, multitasking, networking) and OS-9/68000 (real-

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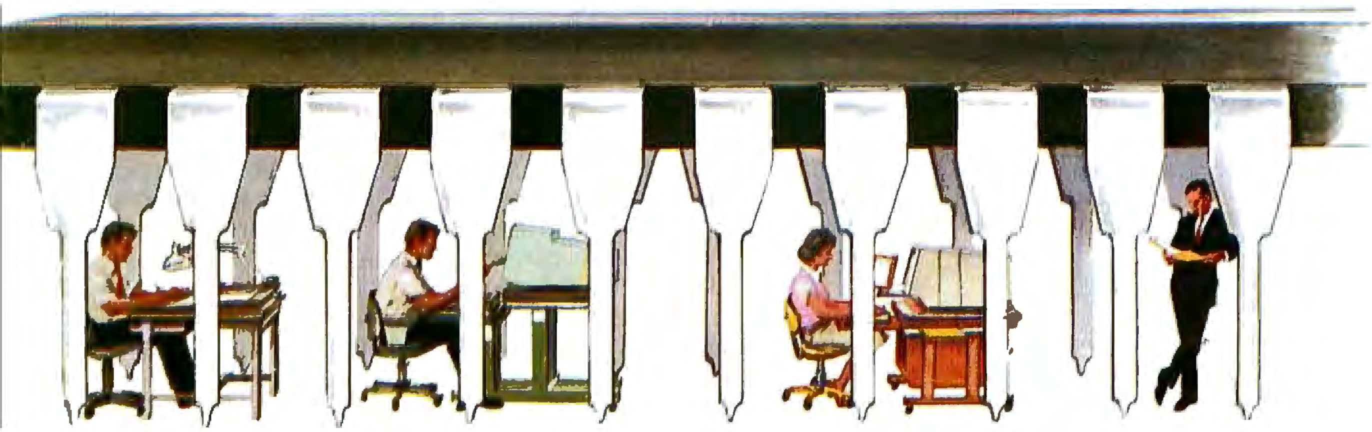

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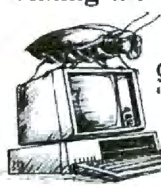

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time multitasking) are offered. I haven't the space, nor would I tax your patience, to describe all these systems in detail, let alone the myriad compilers that come with them. Some brief comments will suffice.

The UCSD p-System is well established among academic users, and its supporters like it a lot. Its Pascal compiler set the standard for extending the language into a useful form, and there is a fair amount of software available under it. Its principal attraction is portability of code across microprocessor families; its chief drawback is the slow speed of interpreted p-code (though you can choose native code and lose the portability).

CP/M-68K was Digital Research's attempt to repeat its Z80 success on the 68000. But it didn't quite come off. CP/M-68K looks much like 8-bit CP/M version 2.2, which is to say that it's crude and old-fashioned, but simple to program under and reasonably quick. U-Micro offers the high-quality SVS Pascal and SVS FORTRAN 77 from UniPress Software Inc. plus the C Compiler from Whitesmiths as development languages. Using CP/M-68K reminded me how awkward it is to manage a large hard disk without the benefit of a hierarchical directory structure; it has only "user areas," just like 8-bit CP/M. However, CP/M-68K is quite suitable for putting up quick-and-dirty one-time programs. U-Micro has written its own screen-oriented editor for CP/M-68K (called USE) that is powerful, easy to learn, and supports all the U-MAN's video options; it's almost a full-blown word processor.

Mirage was developed by the U.K. software house micro-APL, originally as a vehicle for the firm's APL compiler on 68000-based supermicrocomputers. It's a business-oriented, multiuser, multitasking system that features an indexed sequential-access method filing system with full file and record locking. Written in assembly language, it's small and fast, occupying only 40K to 60K bytes of RAM and requiring no memory management hardware. Mirage can also run CP/M-68K as a task. One of its strongest points is that system configuration is easy, well within the capabilities of the average user.

In addition to APL, Mirage supports, as development languages, FORTRAN, Pascal, C, and a heavily extended business BASIC reminiscent of the one in Pick. The system has a fairly Spartan user interface, which I found resembled VAX VMS. A certain amount of off-the-shelf business software is available under Mirage, including multiuser accounting, database, hotel management, currency arbitrage, and statistical programs.

An interesting extra to Mirage that I tried successfully is a package called MITS/PC. This program runs on an IBM PC and enables it to serve as a Mirage terminal via its standard RS-232C port. MITS is a memory-resident program. Thus, when you hit Ctrl-Shift, a SideKick-style window pops up in the middle of your current PC application screen, and you can access a multiuser database or run programs on the U-MAN under Mirage. Another keystroke and you're back to what you were doing before.

It's also possible to upload and download files between the Mirage system and the PC, to spool PC files to the U-MAN printer, and to access an IBM mainframe via Mirage. MITS/PC could provide a cheap and satisfactory way to share a moderately used database in a small office while keeping all the advantages of using individual IBM PCs and avoiding expensive network cabling. It might not be adequate for heavy sharing, like a travel bureau application, but since I have only one PC, it wasn't possible to test the package's real capacity.

OS-9, an operating system originally written for the 6809 microprocessor, inspires almost fanatical devotion among its followers; U-Micro put it onto the U-MAN in response to requests from users. It's a full 68000 version and doesn't run on the U-MAN's 6809. OS-9 provides many of the features of UNIX (indeed, its shell is almost indistinguishable from UNIX's), including multitasking and multiuser operation. However, OS-9 is capable of responding to peripherals in real time, a feat that UNIX's virtual memory system completely precludes:

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OS-9 is completely structured, the source code looking much like Pascal, and is modular to an extraordinary degree.

under UNIX you can never be sure that the servicing routine hasn't been swapped out in favor of another task. This feature makes OS-9 ideal for scientific applications where, for example, a background task might be continuously monitoring an instrument while the user runs programs to process and display the results in the foreground.

I had never played with OS-9 before and was pleasantly surprised at how nice it is to use. It provides all the better features of UNIX, like pipes, filters, and redirection (rather like a grown-up version of DOS 2.0), and includes a remarkable language called BASIC09. This is to Microsoft BASIC as Robert de Niro is to Sylvester Stallone (i.e., it approaches things with rather more finesse). It's completely structured, the source code looking much like Pascal, and is modular to an extraordinary degree, global data being forbidden altogether. Individually named procedures can be separately compiled and even run and tested from the command line, then called from a main program.

It's perfectly possible to have all four of these environments present on the same U-MAN hard disk. Booting without a floppy disk in the default drive gives you CP/M, and putting in a boot disk for the other operating systems causes them to be booted instead. Some fairly tricky code in the boot ROM was required, since they don't all share the same directory format.

CHEMMOD

The main reason I borrowed the U-MAN was to look at a remarkable molecular modeling system called CHEMMOD, for like Bill Unsworth I started out as an organic chemist. CHEMMOD is a color, three-dimensional molecular modeling system of a power that until recently would have been available only on a mainframe, and it makes all the other microcomputer systems I've ever seen look like toys.

For those of you who are not chemists, I should explain what a molecular modeling system does. It's in effect the research chemist's equivalent of a word processor, but it manipulates three-dimensional pictures of molecules instead of words. You will remember from school chemistry that molecules are represented by formulas like H_2O and NH_3. Nowadays, organic chemists work with models that depict the actual arrangement of the atoms of a molecule in space, known as its *conformation*. The atoms are represented as balls whose radius represents the comparative size of the atoms. To make large, complex molecules easier to recognize, arbitrary colors are assigned to different types of atoms; for example, oxygens might be white and hydrogens red.

When I was at college, we used to make these models out of colored plastic balls held together by bendy springs whose lengths represented the chemical-bond lengths. It's possible to learn things about the chemical properties of a substance simply by manipulating such a model, to see which atoms are near each other and how they collide as the model is twisted and rotated. This is especially true of large molecules found in living systems, like protein enzymes and peptide hormones; the biological actions of such molecules are largely determined by their shape.

Chemists in universities and pharmaceutical company laboratories spend much of their time manipulating computer models of molecules. In this way it's possible to investigate the probable properties of, say, a new drug molecule that hasn't even been synthesized yet. You can take the structure of a drug that does exist (and whose properties you do know) and modify it on-screen, just like cutting and pasting in a word processor.

CHEMMOD is a system of this sort that runs on the U-MAN computer under CP/M-68K and costs around £15,000 for the hardware and software. The U-MAN's built-in graphics are not capable of the required performance, so a separate raster-graphics processor, manufactured by Digisolve, is supplied in a slim box that sits under the monitor. This gives 512- by 512-pixel graphics in 64 colors and can write 1.5 million pixels per second. A separate high-resolution monitor is supplied to display molecular models, with all normal operating system output going to the U-MAN's text monitor.

The user interface to CHEMMOD is driven entirely by a light pen or mouse, and you need the keyboard only for entering the names of the files containing model descriptions. The version I used had a light pen, but a mouse might actually perform better. You choose options from on-screen menus by pointing with the pen, as you do with a professional CAD/CAM system. There are 20 predefined atom types (4 types of carbon, 5 types of nitrogen, etc.), 20 predefined amino acid molecules, and 20 ring structures to choose from, as well as a disk library of whole molecules. You can add new components of any sort (e.g., a new atom type) by building parameter tables using an ordinary ASCII editor.

Molecules can be shown either as stick models or fleshed out as colored balls (see photo 1); the transformation is accomplished by one command and happens almost instantly. The stick version makes it easier to see the whole molecule, whereas the ball version gives a feel for the actual molecular shape. Depth can be conveyed by making elements that are farther from the observer appear dimmer. If that still isn't realistic enough, you can display a red-and-green three-dimensional picture that's viewed through cardboard spectacles like those that used to be given away in comics.

Molecules can be rotated in any dimension, either as a whole or internally by using chosen bonds as axes, and can be edited by moving bits from one place to another or adding extra atoms. CHEMMOD scales the models automatically to make them fit the screen; you can also zoom them and pan across them. More than one molecule can be displayed at a time, but screen and model sizes will impose some limits here.

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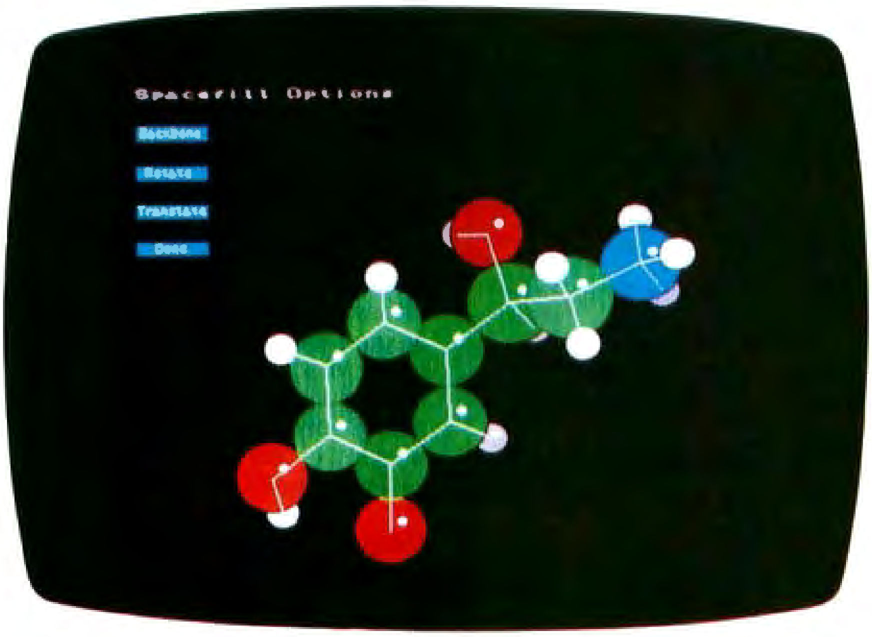

Photo 1: *As shown in this model of noradrenalin,* CHEMMOD *displays molecules as three-dimensional colored balls that can then be manipulated.*

Before now, CHEMMOD's modeling and computation features were available only on systems like a VAX with Tektronix terminals.

Most important to the serious chemist, though, are the computational facilities offered. It's possible to have CHEMMOD compute the minimum energy conformation of a molecule and to get an on-screen plot of the potential energy as a molecule rotates around various bond axes. Bond lengths, torsion angles, and interatomic distances can be measured. Vibrational energy levels can be displayed as a Ramachandran map using colored contours. The distribution of electric charge over a molecule can be computed, and *steric congestion* can be measured. This last measure is an extremely important one; it shows how the different atoms get in each other's way as the molecule bends and twists and can predict the probability with which reactions will occur. Hard copy of all these measurements can be obtained on a variety of plotters and printers.

£15,000 might sound like a lot of money to nonchemists, but the features offered by CHEMMOD have hitherto been available only on systems like a VAX with Tektronix terminals, for which you are talking hundreds of thousands of pounds. What's more, when several people are timesharing on such a system, the performance is probably a lot slower than on a single-user CHEMMOD system.

Of course, a CHEMMOD system can still be used as a general-purpose computer. It's possible that someone somewhere might even want to do hotel management during the day and design enzymes in their spare time! It almost makes me wish I were a chemist again. I hated those plastic balls and bendy springs. ■

C·H·A·O·S M·A·N·O·R M·A·I·L

Conducted by Jerry Pournelle

MIND MINE NO LONGER

I've been informed that Mind Mine, which had a clock and a memory upgrade for the Atari ST (October, page 288), is bankrupt. I have also heard from—and alas lost the letter from—the actual designers of the memory upgrade and clock kit furnished to me by Mind Mine.

Mind Mine no longer exists: I will do my best to find the real source of the products I recommended in the column. Apologies.—Jerry

FASTBACK

Dear Jerry,

Regarding "painless" copy protection à la Fastback (Computing at Chaos Manor, July, page 325): No! It has continually been shown that a quality product at a reasonable price is its own guarantee against excessive loss of revenue by illegal copying. Borland is the most obvious example, but I believe that Satellite Software International is another good example with WordPerfect. SSI has shown that its support is desirable to the user, so that no one wants to have an illegal copy and forego support.

Another problem, although perhaps not with this particular product, is speed. Hard disks were considered to be fast, but with the inexpensive price of expanded memory boards, I now dump all programs requiring repeated disk access to a logical drive in expanded memory and run them from the logical drive. Any copy-protection scheme that requires access to a floppy disk becomes a bottleneck to such a system.

And lastly, may I point out that you appear to be giving up when the battle is almost won? I took the pledge several years ago not to buy protected software, and, apparently, so did a significant number of others. If Fastback is a good idea, there shall soon be a competing product—and probably one without copy protection. Besides, as a proud owner of many floppies that eventually became garbage, I will not tolerate the time, effort, and delay involved in replacing a failed copy-protected original when the underlying premise for such protection is an affront to my integrity.

MARTIN E. VON LINDENBERG
Baltimore, MD

Fastback is no longer copy-protected. I may or may not have had anything to do with it; last time I talked to the Fastback people I was not polite regarding withdrawing the "send in for a nonprotected update" offer they used to have.

Theirs was not the worst copy-protection scheme I encountered, but all copy protection is a bad solution to a real problem.—Jerry

Dear Jerry,

I am sympathetic with your Fastback problems. After similar and worse (did you know that the old copy-protection scheme refused to allow you to restore on a machine with a different A drive?), we switched to DS Backup from Design Software and are delighted. The cost is a quarter that of Fastback, it is not copy-protected, it can handle all types of files (system, hidden), it uses the archive bit intelligently, and the publisher gave us a site license. DS Backup is 10 to 20 percent slower, but so what? Try it, you'll like it. The address is Design Software, 2 North 520 Prince Crossing Rd., Suite 16, West Chicago, IL 60185, (312) 231-4540.

HARVEY H. BUNDY III
Chicago, IL

Now that Fastback isn't copy-protected, speed and data recovery are the most important factors. I like Fastback for both of those.—Jerry

NEW COMMUNICATIONS NOT SO NEW

Dear Jerry,

While Donald L. Stoner's petition to create the Public Digital Radio Service (May, page 393) is attractive on the surface, his petition to the Federal Communications Commission fails to take into account several facts.

In the first place, a method for computers to be linked via radio already exists. Amateur radio operators have been working for a number of years with packet radio, to the point that most major metropolitan areas have one or more packet repeaters on the air. Direct computer-to-computer communication is also common. Many of the hams who operate radio teletypewriters are using computers to do so.

A second point is that the "underutilized" section of the 6-meter band that he proposes is currently designated for repeater service, including packet radio. As to lack of growth and utilization, I cite the American Radio Relay League's reply to the FCC. In 1971, there were 58 repeaters listed in this segment. In 1978, there were 169, and in the 1986 repeater directory, 250 were listed. This looks like utilization and growth to me. It should be noted that direct comparisons of numbers of repeaters in the other bands in which repeater operation is authorized is not applicable, due to the different propagation characteristics of the 6-meter band.

A third point is that the ham radio community has the technical capability and expertise and already has in place the structure and discipline to ensure the long-term growth of digital communications.

Since you presented his side of the argument, I would appreciate your making the opposite viewpoint also known. Ham radio operators have provided leadership in exploring new fields of communications and electronics. I invite you and anyone else so inclined to get in touch with a ham radio operator and find out more about this interesting hobby. Licensing requirements are minimal and information is readily available through your local club, on CompuServe (GO HAMNET), or through many of your local bulletin boards.

WILLIAM E. BUOY JR.
Houston, TX

Thank you. I have no strong views on the subject. I do think it would be nice to have a "computer CB," but I confess I haven't thought much about how hard/easy that would be to implement, nor even what I'd do with it if it existed. I use BIX a lot, and I presume that any decent computer communications system is go-

(continued)

ing to require that someone invest in a pretty big host machine and expensive software.—Jerry

Dear Jerry,

Mr. Stoner's intention is noble, and one not familiar with FCC actions might be enthused about reaching the status of a Rulemaking docket (RM-5241), but it's not an item to get ready to make use of next month—or even next year—or maybe ever. Reason: The radio spectrum is far more crowded than many "outsiders" might know at virtually all except its highest reaches. It is "open frontier," where ranges are short and technologies are expensive, even to give you short ranges.

Further, the FCC is not sovereign about controlling uses of radio frequencies, because whatever we do must be in accord with international treaty, which the FCC cannot make; that's the job of the State Department. Virtually every square inch of frequency allocation has been planned out and has to go around a loop from the FCC to international "suggestion," then be approved by the State Department before we can get licenses.

Finally, there are already uses of frequencies for data in Part 90, subpart K of the FCC rules. Indeed, some makers of radio modems have fielded products that claim up to a 37-mile range. Under such circumstances, one will have to convince the FCC that there is some overriding public need to do better than that, and if you want more range, you can bet the phone companies will be all over the case hollering that they can fill what small public need they say there is. One always has the phone industry to contend with, for they are *sure* everything is theirs!

As to amateur radio operators, they are not authorized to use ASCII code, so one way to get use of those nice, crowded (on HF, somewhat on VHF) frequencies is just to get a ham ticket and go to it! Remember that casual contact radio operations will probably do 100 bps maximum. Takes a while to transmit a 500K-byte file that way—and the longer you're on the air, the longer you expose your traffic to getting "hit" by somebody else. Transmitting data files by radio is a real trip!

There *must* be people doing it, for if you look in the appendices of Hayes manuals, you'll find a section on how to use the Hayes modems on radio—just be forewarned that it's not for the faint-at-heart Sunday dabbler.

DONALD E. KIMBERLIN
Safety Harbor, FL

Advising hackers to get a ham ticket is fine, but it requires that they learn the dreaded Morse code. Now, you and I and everyone else know that the only real reason the FCC requires Morse for a ham ticket is to limit the number of amateur licenses. I don't really complain about this; I suppose there needs to be some kind of limit, and the Morse requirement has been around a long time, so it might as well be that. On the other hand, thanks to the Army, I learned Morse a long time ago, and it wouldn't take me all that long to brush up on it.

Most hackers find Morse cruel and unusual punishment.—Jerry

Dear Jerry,

Concerning Donald L. Stoner's letter on the so-called Public Digital Radio Service, such a service already exists. It allows the direct or indirect connection of computers via the airwaves using a variety of codes such as ASCII, AMTOR, or even Baudot with baud rates up to 19.6 kilobaud! The

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service has also created Packet Radio, an integrated data communication system that allows local, regional, and even global communication using fairly simple radio equipment and computer interfaces. There are on-the-air bulletin boards, automatic relay stations ("digipeaters"), relay satellites, and even a message-delivery service that operates free of charge!

Best of all, this digital radio service is public-service-oriented, allowing even those not directly using the system to benefit from it. Groups and organizations that don't have the money for computer systems can still be helped by those many individuals who use the system for public service events and for emergency message handling during disasters. The service even allows the use of non-digital communication modes (just in case your system is down or your fingers get tired).

What does this service cost? At present, there is a one-time fee of about $5 for a special exam that the FCC requires to make sure that the user knows enough about the radio aspect of things so as not to cause interference to other users or the general public. The exam also requires the user to know a primitive code used for emergencies and for weak signal conditions. I got through the exam before I knew much about computers, so anyone who has mastered something as complicated as hooking up an RS-232 cable the right way can probably pass the test.

If you haven't guessed what the real name of this service is by now, go find the nearest amateur, and ask him or her about the Technician License. Better yet, how about doing an article in a future issue of BYTE on this fascinating digital communication service? If you need more information, write The American Radio Relay League, 225 Main St., Newington, CT 06111. Mention that you are interested in digital communications. I think you will find that most of the users will go out of their way to help you.

PS—A citizens band for personal computers would probably end up just like the present CB has, namely, a mess!

DAVID KNISELY
Beatrice, NE

Thanks. Since the Technical License does not require the dreaded Morse, it should serve for the computer-hacker types who want to play with remotes. —Jerry

V20 PROBLEMS

Dear Jerry,

In your June column, there was a lot of discussion about the merits of the NEC V20 chip and its compatibility, so the following may be of interest:

I installed a V20 in place of the 8088 in the IBM PC XT and attempted to copy a write-protected disk with the CopyWrite 2 program. Instead of the usual copy, I received an abort message with some remark about a batch file. After a quick switch under the hood to the original 8088, everything was working properly again. It seems that write-protected programs and the programs intended to copy them are very sensitive to the speed of the microprocessor. My machine had an 8087 coprocessor installed, but I doubt that this affected the results. It is, however, possible. I am sure other users can tell us more about this matter.

KEN AFFIAS
New York, NY

The major difficulties I've heard about the V20 are Z80 code and copy-protected software.

Z80 code can only be run by software emulation; the V20 chip does only hardware emulation of the 8080. Software emulation on the best PC gives about the equivalent of a 2-MHz Z80. Ezekial, my friend who happened to be my first computer, was a 2-MHz machine, but alas, I've learned to expect better since those days.

Copy protection is another matter. You go by trial and error. Worse, something that usually works may not always work. This is the case with both CP/M software and, worse, PC-DOS software that worked with the original 8088 chip but won't work with the V20. Short of breaking the protection scheme entirely, I have no sure remedy.—Jerry

THE RIGHT TOOL

Dear Jerry,

I would like to speak for what I think is probably a large number of your readers. While the creativity-versus-structure debate will undoubtedly continue (Chaos Manor Mail, March and June), I'm convinced that the point is moot. With the software firms going in their current direction (i.e., falling prices and innovative language implementations), it is becoming practical for hackers to own and utilize several different languages, each suited to different tasks.

For large tasks, or those requiring a great deal of "polish," I use Modula-2. It allows me to break tasks down into small chunks that I can concentrate on. This frees me from having to keep track of organizational skills, thus allowing a greater deal of creativity.

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On the other hand, if I need to knock off a quick Lagrange polynomial, I do it in FORTRAN (gasp!) because it is well suited to the "off the top of my head" style I use when I need something *now*. This lack of structure also helps my creativity flow.

It seems to me that the "best tool for the task at hand" approach is what the micro revolution is all about. While any group will have its factions, I think it is important to remember what we bought the little buggers for: They help us solve problems and allow us a little fun at the same time.

TIM NOLAN
Ypsilanti, MI

Oh, I have to agree. The Great Languages Debate began, after all, back when few of us knew much about computers and even less about what to do with them; and in those times, there were no decent Pascal or FORTRAN compilers. Also, most of us learned BASIC and then wondered what to do next.

With all the tools available now, the problem is to choose a couple; nobody can learn all the languages, or at least no one but a real computer professional, which I, at least, am not.

I still tend to use BASIC for my "quick and dirty, run it once" programs. I have a fascination with APL; I keep thinking I really ought to learn it, but I have never made the required modifications to my hardware so I could use it with its odd squashed boxes and bent arrows and other symbols. I may get to it Real Soon Now. I may not.—Jerry

CP/M Isn't Dead

Dear Jerry,

I read with delight your June column "Color and CP/M." For numerous reasons, I rely on a CP/M-based computer as my primary system. I have accumulated thousands of dollars worth of really good CP/M software that I couldn't bear to part with or afford to replace.

Last November, I put together an SB180-based system as featured in Ciarcia's Circuit Cellar starting with the September 1985 BYTE. I have found it to be very fast and powerful, and 100 percent compatible with all my existing CP/M software. It is very compact in size and efficient in its use of electricity.

It comes with Echelon's ZCPR3/Z-System operating system, which is CP/M upward-compatible, coded in Z80 (not 8080) assembly language, and configurable to handle different peripherals. It comes with dozens of powerful, useful utilities, and has fast, powerful, user-configurable video-oriented shells for operating system functions. You can easily bypass these, via Control-C, should the desire strike.

The whole system is greater than the sum of its parts. The added speed and the integral RAM disk, coupled with the flexibility and power of Echelon's operating system, make what I perceive as a superior tool compared to the Ampro boards that you've mentioned. It functions just like we always knew it was supposed to when we first started messing around with these machines.

I love demonstrating my little box to the MS-DOS crowd, mostly average first-time computer buyers who learn just barely enough about their machines to keep from crashing too often. They are jealous of the speed and ease of use. Even the MS-DOS whizzes are impressed. I suppose the moral goes something like: It's not so much what you use that matters, but how you use it.

I recently received a 44-page catalog

(continued)

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from Spite Software. These folks are dedicated to supporting the not-insubstantial installed base of CP/M systems. They have brought together hundreds of programs and a dozen or so vendors in an informative and tempting format. Everyone who plans to be productive with CP/M should be in contact with these folks:

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All this adds up to the fact that I see no reason to change computers just to "follow the fads."

R. Scott Truesdell
Corona Del Mar, CA

It always does amaze the MS-DOS people when you show what a good CP/M system can do, doesn't it? I say this as I write on my ancient Z80. Zeke may be a bit tired, but he hasn't failed me yet. —Jerry

Dear Jerry,

I can't believe I read what I think you wrote! I quote from the June issue of BYTE: "The spiral is deadly [to CP/M]" *and* "CP/M isn't dead."

I respect you as an author. I enjoy your science fiction and your scientific nonfiction. But Jerry, you have a blind spot! Allow me to illustrate:

Question: Why are Latin and Classical Greek dead languages?

Answer: Because no original thought has been written in these languages for at least a thousand years.

Question: Why haven't Italian and modern Greek become *the* languages of the modern world?

Answer: Because Italy and Greece haven't been the center of entrepreneurial innovation.

CP/M is dead because little or no new and original software is being written for the CP/M environment. CP/M is dead because the center of entrepreneurial innovation is MS-DOS and/or UNIX based. Jerry, recant!

There is a spectrum of microcomputer users from white-eyed new users to seasoned veterans who eat tech manuals for breakfast without salt. You (and I) are pretty far out on the latter end of the spectrum. Do not assume that because you write for a living and are farsighted that the whole spectrum will see the light about CP/M with the emergence of V Weapons.

The availability of mass-produced books did not resurrect Latin or Classical Greek. Until new and commercially innovative software is written for the CP/M environment, nothing can save CP/M!

CHARLES H. PORTER
Bothwell, WA

Well, we've had the other view too.... I'm sure you're right, CP/M will slowly vanish; but it will be useful for a long time anyway, and some will continue to love it.—Jerry

Dear Jerry,

I own two Radio Shack TRS-80s, a Model 4D and a 4P. Recently, I acquired a CP/M 2.2 operating system for them, so I could run KAMAS and Out-Think, by KAMASOFT. Previously I used Radio Shack's TRSDOS 6.2 exclusively, and I have a substantial number of TRSDOS applications.

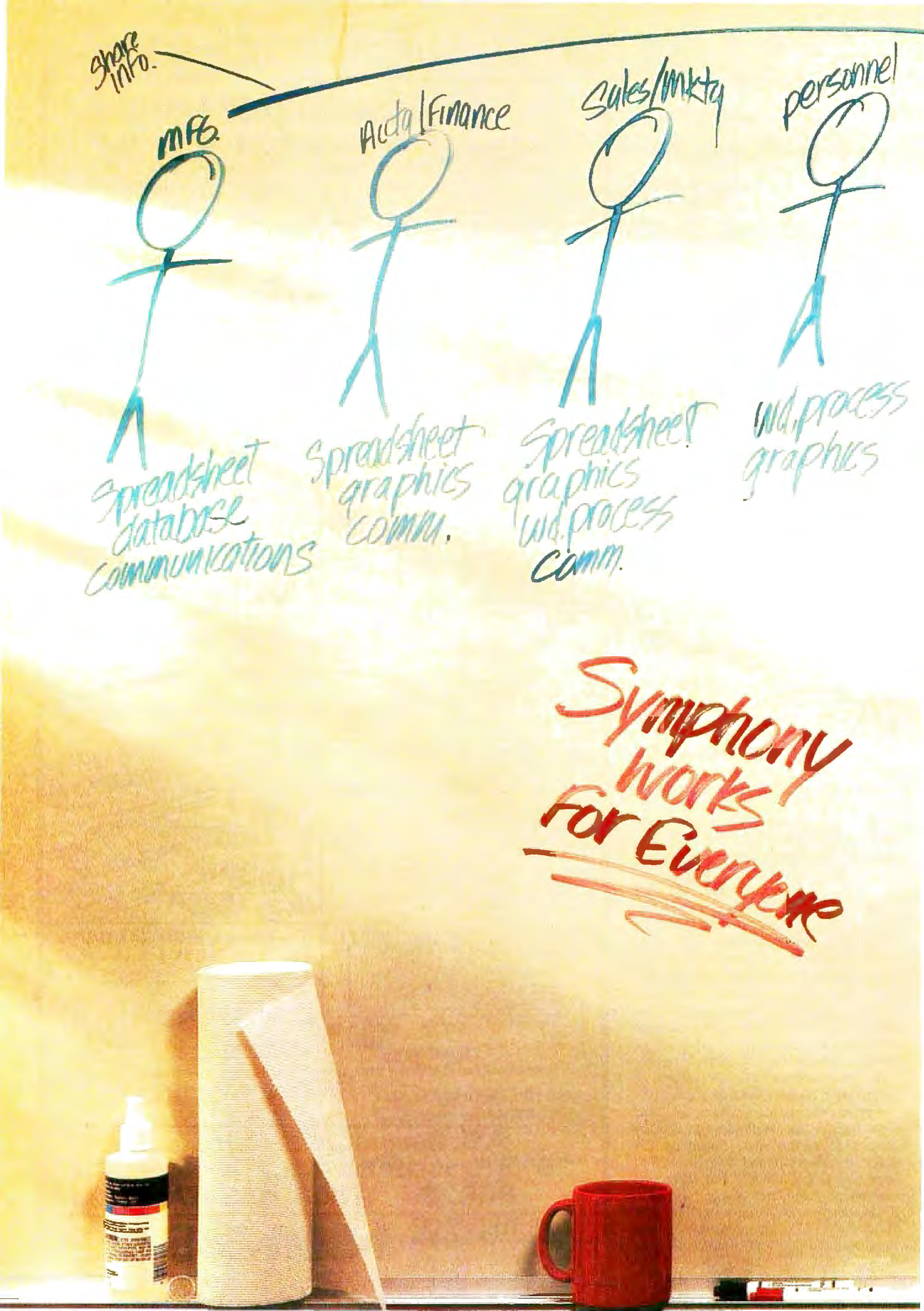
I must comment that CP/M as an operating system reeks when compared to my TRSDOS 6. I have found it to be very hostile to both users and programmers. (Perhaps I'm biased because TRSDOS lets me take more control of my hardware.) I know of ZCPR3, but this still doesn't stack up to TRSDOS. I know what you're thinking—TRASHDOS! The Model 4 seems to have inherited this reputation from Models I and III—undeservedly, I'll add. TRSDOS 6 was written by Logical Systems, unlike versions 1 and 2, which were rather poorly done by Radio Shack. TRSDOS 6 compares quite favorably with anything else, including MS-DOS. Logical Systems has even published the commented source code to it. You'll never see Microsoft do that!

Anyway, what's the deal with CP/M these days? Can you steer me toward more CP/M users groups or newsletters?

JEFF JOSEPH
Minot AFB, ND

I suppose that some day I'll forget TRASHDOS and the millions of "zaps" to patch it, but it won't be soon. I also remember LDOS, which is much better, and which, I gather, became TRSDOS 6. I recall Logical was an easy outfit to deal with and I was pretty impressed with what they were trying to do; that was in the days when I was still hoping to make something of my TRS-80 computer (which now gathers dust in a garage.)

A good place to start picking up CP/M software is from Workman and Associates, 112 Marion Ave., Pasadena CA 91106. I haven't heard from the CP/M User Group for a while but there are several of them still going. Software Toolworks (14478 Glorietta Dr., Sherman Oaks, CA 91423, (818) 986-4885) also publishes low-cost CP/M stuff.—Jerry ■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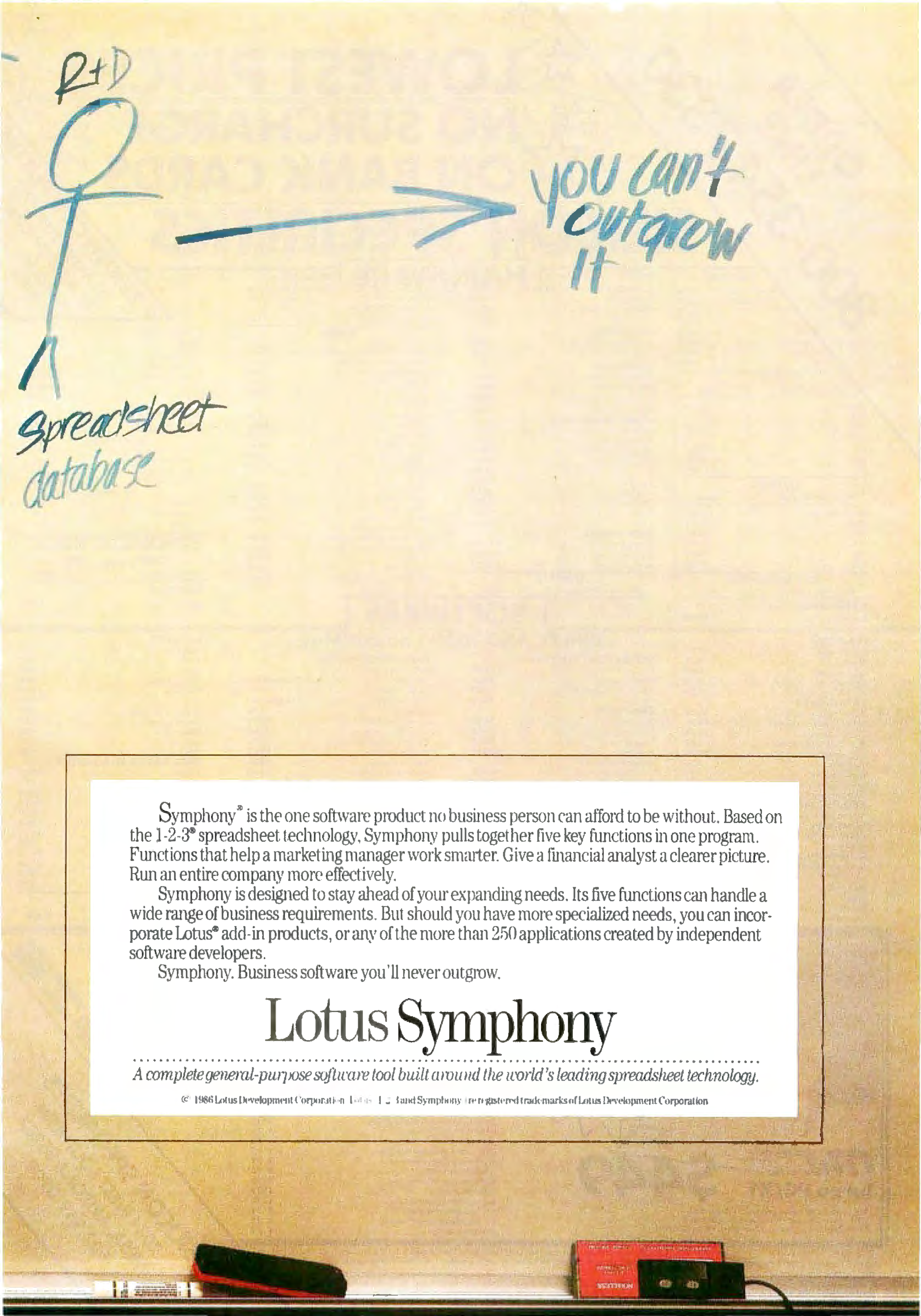
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AMIGA

The Amiga window begins with a question on how to rescue a disk that suddenly reads "unvalidated." Next is a discussion of a possible bug in the Trackdisk routine. Finally, there is a look at the possibilities within the Resident command.

UNVALIDATED DISK PROBLEMS

---

amiga/main #4488, from greggw (Gregg Williams, Senior Technical Editor, BYTE)

Help! During a normal disk access, something went wrong and now I have an unvalidated disk, which AmigaDOS won't recognize in any way. This is not the first time this has happened. I thought the file structure was robust enough to recover from such things. I've lost 880K of data!

Are there any programs or techniques to repair a disk that's been declared "not validated"? Surely AmigaDOS is not this fragile? Any help would be appreciated. Thanks.

(FYI--I was trying to "chop" a downloaded file using 'fixobj', which reads the file and writes to a new one. The disk was less than half full.)
--greggw

---

amiga/main #4489, from lnoland (Leslie Noland)
a comment to message 4488

There is a program called Disksalvage (some places shortened to Disksalv) that can rescue much, if not all, of your data. I believe it is in Listings, but if it isn't, BIXmail me and I'll put a copy up there.

It isn't a perfect program - sometimes it seems to recover data from past versions of a file and include those in the new file, or something like that. That's not too critical in a text file, but it could probably mess up an object file pretty badly. But it usually does a pretty good job.

There is an old Metacomco program (the name of which escapes me at the moment) that allows one to manually rescue the disk, but that is an abhorrent task. It's rumored that they've produced a new program, called DiskDoctor, which may well work better than Disksalvage but it is probably only available to developers.

The big question is why your disk failed to begin with. The only disks I've ever trashed myself were ones I popped out of the disk drive before it had finished writing to the disk. I've heard of Marauder (at least early versions) being capable of trashing a disk - but that obviously isn't your problem. If you aren't being a bit too quick to pop the disks from the drive, and you're consistently getting this problem, you may want to have your drive checked.

— Les Noland

---

amiga/main #4490, from jim_kent (Jim Kent)
a comment to message 4489

Software crashes during a write can also do this. It happened to my hard disk the other day in fact. But I still don't know if it was AmigaDOS or Aztec, or ... something else.

---

amiga/main #4491, from cheath (Charlie Heath)
a comment to message 4490

But odds are pretty good it was AmigaDOS, one way or another. I'd guess that 98% of disk crashes are caused by AmigaDOS, or perhaps Intuition in interaction with AmigaDOS. Argghhh.

---

amiga/main #4492, from rsimonsen (Redmond Simonsen)
a comment to message 4491

Does this mean that no matter what one does nor how skilled one is (editors, programmers, designers) that AmmoDOS [AmigaDOS] blows you away eventually if you put a disk in its path?

Eeewwwwhhhhhh!

--Redmond

---

amiga/main #4493, from cheath
a comment to message 4492

Well, I'd qualify that by saying I just got bit (had a disk get zapped). So I'm not in a particularly forgiving mood re: AmigaDOS. My disk got zapped after reading a file into TxEd. The disk was still spinning, I brought up an Open requester, and *bang*. Suffice it to say I am fairly familiar with the code being executed and there is nothing I could have done using published specs (and probably nothing I could have done, period) to avoid a disk crash. Most likely there is something happening at interrupt level which kills either Trackdisk or AmigaDOS.

---

amiga/main #4494, from cheath
a comment to message 4493

Also qualify that by two factors:
1) I was using V1.1 of DOS.
2) I have an old machine.

---

amiga/main #4496, from jim_kent
a comment to message 4493

I know I just WON'T have any other processes going while I'm compiling/linking anymore, 'cause this makes disaster happen about 10 times as often. Shouldn't be memory either, 'cause my favorite was to run my little itty bitty terminal program on BIX while compiling. Now I use the ST to communicate while programming on the Amiga and vice versa. Oh well, you're all quite tired of my AmigaDOS flames even if most of them are true.

---

amiga/main #4498, from althoff (Thomas Althoff)
a comment to message 4496

When I reboot the system, I have a habit of typing the date, time, and a program name just as soon as the window is ready to take text. I just typed Manx's DB and, as the drives were churning (20 meg MAS20 and DF0:), got "DH0:not validated." After about 30 seconds of hard disk activity, everything seemed normal again. Next time I say anything about disk problems, I'm going to "knock on wood"!

(continued)

A Bug in Trackdisk

amiga/softw.devlpmt #2541, from sjones (Scott Jones)

There seems to be a bug with the IOTDF_INDEXSYNC flag not working for ETD_RAWREADs from the Trackdisk device. *I have* been able to read in a track, but the track is read in starting at a random location. The flag doesn't seem to do anything at all. The way I understand it, in a synchronized read, the buffer should be filled in with undecoded data starting somewhere in the pre-index gap (before the software index address mark). I've been able to find and decode the index address mark, the sector I.D. fields, and the data fields from an IBM-format disk (it's not at all the same as Amiga format...), but the buffer is filled with data starting in a random location in the track (not sync'd to anything, apparently!). Can any insiders at Commodore-Amiga shed some light on this? (I am a registered developer - with 1.2 beta 4 software. (Where's my beta 7??)) Is this just a bug in beta 4? Thanks!
Scott Jones

---

amiga/softw.devlpmt #2543, from jdow (Joanne Dow)
a comment to message 2541

This is normal with all raw track reads. The sync has a several-byte slop in it due to interrupt service time lags and sweep time and some other factors. Commodore-Amiga can account for all but 3 microseconds of it, they think (at least that's what the docs say).
<^_^>

---

amiga/softw.devlpmt #2544, from sjones
a comment to message 2543

There is much more than a "several-byte slop." I haven't been able to see any difference between using and not using the IOTDF_INDEXSYNC flag. The slop is often 1/2 to 3/4 of a track. That is NOT 3 micro-seconds! (More like 1500 microseconds!) This is NOT sync'd. This is a bug. [Please C-A, if you haven't fixed this, fix it before you go ROM wild.]
Scott

---

amiga/softw.devlpmt #2545, from jdow
a comment to message 2544

Perhaps the TD_RAWREAD is the correct one to use with the INDEXSYNC request. The slop should be anywhere from a minimum of about 135 to 200 microseconds. 55 is software-interrupt service, 66 is one horizontal line as reads and writes are sync'd to this, and the last is the partial scan line to achieve the scan-line sync. This leaves 15 microseconds unaccounted for, unfortunately.

Oh - you are using IOTDF?? The flag is IOTDB_INDEXSYNC. I wonder how the IOTDF got by the compiler?
<^_^>

---

amiga/softw.devlpmt #2546, from sjones
a comment to message 2545

Sorry, but IOTDF_INDEXSYNC should be the right one. As with all other flags used in the ROM Kernel, there are 2 defines, one to define the bit POSITION (IOTDB_, or MEMB_) and another to use to actually test or set the bit flag (IOTDF_, or MEMF_). This is a standard convention that Commodore-Amiga has followed in all of the include .h and .i files. Sorry, Joanne - this is still a bug!
Scott

---

amiga/softw.devlpmt #2547, from jdow
a comment to message 2546

Let's check your value for IOTDB_INDEXSYNC. (I agree re: IOTDB/IOTDF convention - was grasping at straws and have head cold mashing my ability to think clearly.) My includes have IOTDB_INDEXSYNC as 4 and the "F" as (1<<4). Let me check the .i file for funsies....It agrees. Make sure your version agrees. Also, are you applying it to IO_FLAGS field? Refresh me which version of the Kickstart, Workbench, and includes you are using, please. (I wonder if anyone at Commodore-Amiga is having fun watching me semi-flounder here?)
<^_^>

---

amiga/softw.devlpmt #2548, from snow (Vic Wagner)
a comment to message 2547

Recently I found out from a nice person named Bob Burnes (who used to work for Commodore-Amiga) about

(continued)

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this IOTDF_INDEXSYNC problem. It seems that DoIO is really the culprit. It clears some flags. What you gotta do is

BeginIO/WaitIO

It works fine for me on both the 3.5 and 5.25 disks.

THE RESIDENT COMMAND

amiga/softw.devlpmt #2411, from cheath

Has anybody tried using the Resident command in v1.2? It is supposed to work with all the AmigaDOS CLI-type commands - but should also work with any programs that adhere to a couple of rules -

1) Code segment should not be modified.
2) Data segment must be addressed by relative addressing.

Apparently, it is possible to do this with Manx-compiled programs, at least most of 'em. Has anybody tried this? (Also, it would work with Lattice programs if their new linker will support relative addressing - which Alink doesn't.)

amiga/softw.devlpmt #2413, from w.volkaegis (William Volk, Aegis Development Inc.)
a comment to message 2411

Does Resident make the program stay in memory? This could be GREAT!

amiga/softw.devlpmt #2414, from cheath
a comment to message 2413

Resident loads the program into memory and then allows multiple invocations of the program to use the same code. So even if you run the program multiple times it only needs one copy to be loaded.

amiga/softw.devlpmt #2428, from jgoodnow (Jim Goodnow, Manx Software Systems)
a comment to message 2414

Bad news for the Resident hopefuls! The Resident command seems to work okay on Aztec-compiled programs. However, the CLI-resident version of the CLI doesn't make a copy of initialized data segments. This means that programs share both CODE and DATA. This means that if I have any initialized data that later gets changed, the next time you run it you get the last value before exiting.

Even worse, two invocations will use the same variables.

On the bright side, this is fixable in two ways. First, I can have some special start-up and exit code that allocates some memory and copies the data. Even better would be if I could know that the program is resident and, if so, only do the copy. The second way is to use a CLI replacement that is smart enough to make a copy of the data. Question: Doesn't BCPL have initialized data? Or does it always make a copy before using?? (Stay tuned to this station....)

amiga/softw.devlpmt #2443, from tking (Tim King, Metacomco)
a comment to message 2428

Let me explain what Resident does. It simply loads your program into memory using LoadSeg and then the Resident CLI uses that copy if it can find one in memory. If you write code that is both reentrant and reusable, then

(continued)

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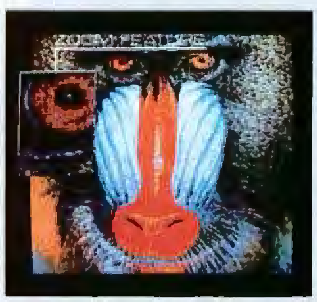

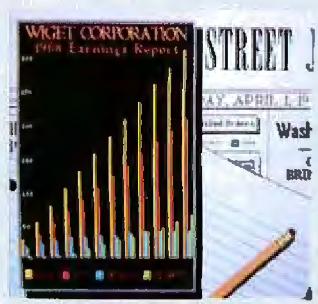

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this works fine (BCPL does this, which is why it works). If you are writing in C, then you must use PC-relative addressing and use a startup sequence that allocates a memory area for your BSS; you must not use any static initialized data because that makes your code nonreusable. Local variables are allocated on the stack; you get one of these for each invocation. If you don't use any global data then your code is OK; otherwise, you must use a compiler that can handle PC-relative addressing. [There is a big problem here in that the current version of Alink does not cope with the Xref(A5)-style of addressing so that Lattice users, at least, cannot use the two options that cause the compiler to produce position-independent code.]

If you think the problem through you will realize that simply copying the data area will, of course, not work because there are essentially absolute references in the code (created by the relocating of the code) to areas within the data segments. And altering these would mean that the code could still be used by only one user at a time.

The entire area of producing pure code on a 68K is complex; some systems (e.g., OS-9) require that all programs are position-independent, which I find very hard to take because the XXX(An) addressing mode limits one to 64K address bounds, which sounds a little too much like the dreaded 808x for me.

---

amiga/softw.devlpmt #2451, from jgoodnow
a comment to message 2443

Unfortunately, very few serious programs that do anything with windows or graphics can get by without some initialized data structures. That's what Crunch's gadget editor is all about.

---

amiga/softw.devlpmt #2455, from lnoland
a comment to message 2451

Though I know this is messy at best: How about if the initialized data were stored as a separate file, loaded by the program with LoadSeg and addressed via pointer de-reference. It's an awful way of doing things because it throws any concept of data hiding completely out the window, requires cooperation amongst all programmers on a project to a degree that goes beyond what is reasonable, and requires the programmers and compiler to perform a function that ought be performed by the linker and loader. It would, however, enable one to write code that could be used with the resident feature and, hence, would be much more valuable to the user. Just a thought.

– Les Noland

---

amiga/softw.devlpmt #2458, from jdow
a comment to message 2455

Lattice is experimenting with residency using standard Amiga methods. Perhaps some day soon. (BLINK seems to perhaps handle the necessary linking formats.)
<^_^>

---

amiga/softw.devlpmt #2476, from jmackraz (Jim Mackraz, Commodore-Amiga, Inc.)

a comment to message 2451

Question: If you don't _change_ your initialized data, isn't it OK to use it by multiple invocations?
Intuition has a reference copy of each system gadget, which it copies to a dynamically allocated gadget when it creates a window/screen. The only big-time reason for initialized data in Intuition users is probably image planes, and copying them to dynamically allocated chip-mem isn't all bad (unless their size is too large to duplicate). I think you can share image data that isn't going to change.
ramble ramble ...

---

amiga/softw.devlpmt #2460, from afinkel (Andy Finkel, Commodore)
a comment to message 2443

Actually, one user at a time is *fine* for compilers and editors, and...(the stuff you've been putting in your RAMdisks). Not keeping two copies around (one in RAMdisk, and one executing) is a win by itself (at least for me!). So only the static data has to go, right?

andy

ATARI

This month's look at the Atari ST conference begins with a thread of double-buffered animation techniques. The section continues with a question on controlling the RS-232 (serial) port and concludes with a comparison of graphics techniques for the Atari 8-bit and 16-bit computers.

DOUBLE-BUFFERING TECHNIQUES

atari.st/tech #706, from jim_kent (Jim Kent)

I was running some double-buffered animations on the ST, switching screens with Setscreen. This seemed to work pretty well except for a glitch that happened every minute or two. I wanted to clear this up without resorting to a wait for vertical blank, which could slow down the frame rate quite a bit. Well, if you make the high-order word of the start address the same for both screens (both screens in same 64K block of memory) then you don't get the glitch, which is apparently from the video register being half-updated when it latches. I had to shuffle around my memory management, but it seems to work, and no waits!

---

atari.st/tech #720, from cheath (Charlie Heath)
a comment to message 706

Ah, good idea. So you just store the low word?

---

atari.st/tech #732, from jim_kent
a comment to message 720

Actually, I still call Setscreen, but if you were talking to the chip yourself you'd just store the low word.

---

atari.st/tech #740, from mmallett (Mark E. Mallett)
a comment to message 732

Does the ST have memory reserved for an alternate screen buffer? The Abacus documentation sort of implies that it does, because its examples show default values for a current and an alternate page. If not (Jim), how did you go about allocating two 32K chunks of memory that were both within the same 64K block, and not waste some memory?
-mm-

---

atari.st/tech #744, from jim_kent
a comment to message 740

As far as I know, the ST doesn't have a reserved second screen. What do I do? Well, there are some routines I

(continued)

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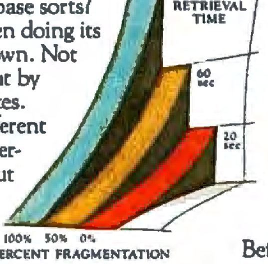

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posted in listings - alloc and mfree - that I use for my memory management. Basically I use Malloc((long)-1) to see how much memory is there. I leave 32K for GEM, and malloc the rest of it for myself. Then I play some games to extract two screens in the same 64K block out of the big continuous chunk Malloc has given me, and put what's left back on my free list. It is a bit of a pain 'cause you can't use the start-up screen (in high memory) as one of your double buffers. When Deluxe Eggbeater ST crashes, it means that GEM thinks the screens are in the middle of the memory that Megamax uses for a stack. Scrolling the stack for a printf isn't a good idea. So I have to reboot after crashing when I use this memory method. However, now that I've got it to work, I went back to the old way for development.

Anyway, if you're very interested I can post the source. It is a little kinky, but worth it not to put waits into my draw loop!

---

atari.st/tech #747, from mmallett
a comment to message 744

No, I was just interested in whether you had some really elegant way of getting aligned allocated memory. I've had to use the same method that you described for other things as well.
-mm-

---

atari.st/tech #749, from sgrimm (Steven Grimm)
a comment to message 740

You can point the screen anywhere on the ST by using Setscreen(). Just allocate 32K (I think it has to be on a 512-byte boundary) and away you go!

---

atari.st/tech #770, from jruley (John Ruley)
a comment to message 749

Does that work with GEM (i.e., can you change the screen pointer after GEM starts)?

---

atari.st/tech #777, from jim_kent
a comment to message 770

Yep, Setscreen works fine with GEM so long as you don't change resolution.

---

atari.st/tech #778, from jruley
a comment to message 777

Many thanks, Jim. That may just come in handy!

---

atari.st/tech #782, from mmallett
a comment to message 778

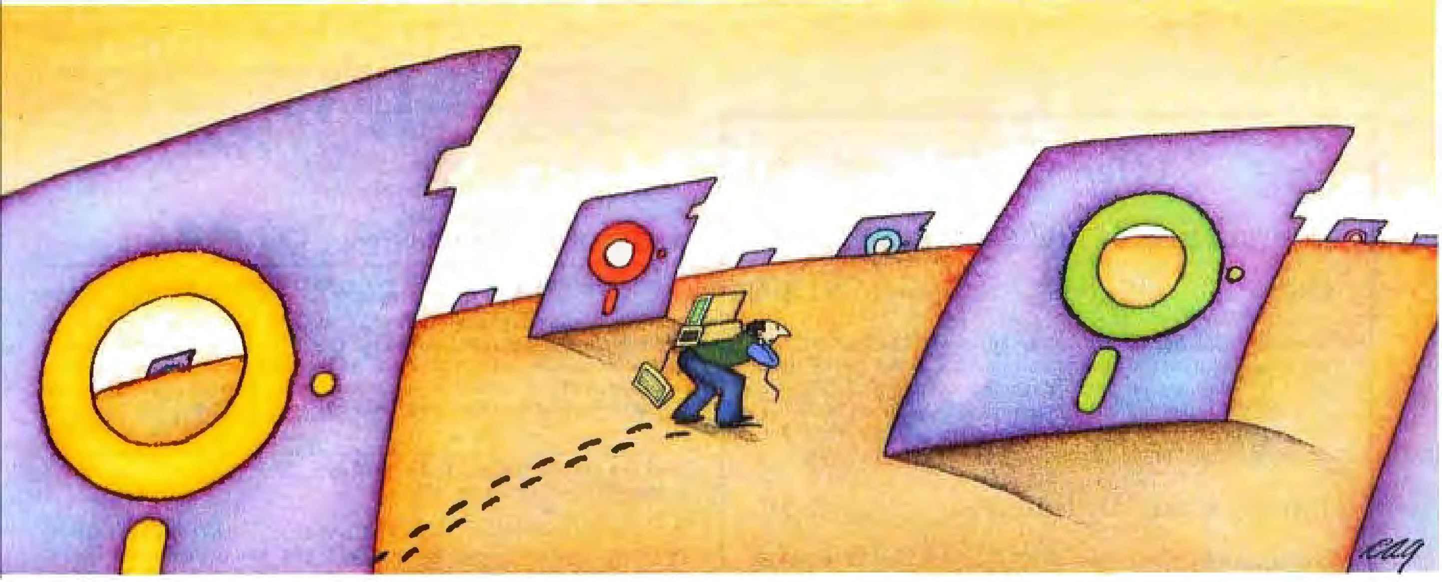
Does that imply that you cannot change resolutions in a GEM application, programmatically speaking? Why can you not do a Setrez, followed by appl_init, etc.? What happens? Doesn't this seem like a major deficiency? So what else is new?
-mm-

---

atari.st/tech #784, from jim_kent
a comment to message 782

Nope, can't change resolution with GEM about. It is maybe the biggest deficiency in this machine.

(continued)



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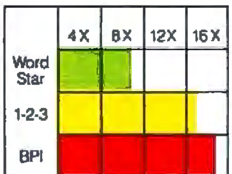

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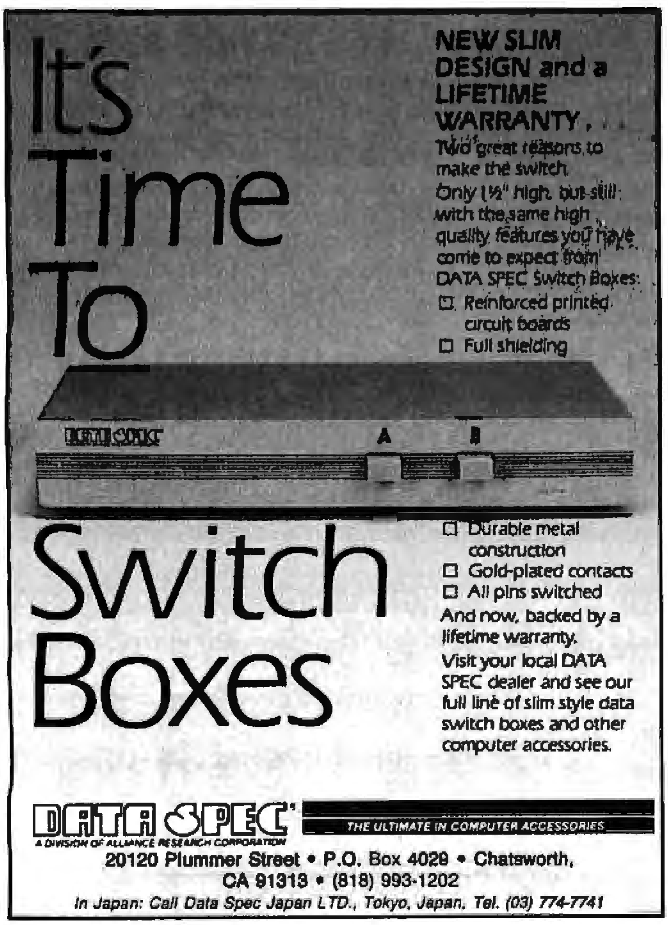

RS-232 HANDSHAKE CONTROL

atari.st/tech #802, from rcheckotts (Rick Checketts)

How do I control the Atari ST RS-232 handshake lines from an application, notably the RTS line to make the modem hang-up, etc.? I have tried using Giaccess, Ongibit, etc., without much success. Can anyone give me a function call that will work?

atari.st/tech #805, from jruley
a comment to message 802

Use the Rsconf(this,that,the_other)... this will let you turn handshaking on and off (it has a handshaking parameter) and will give you very tight control using the MFP registers. Hope that helps! —— John ——

atari.st/tech #811, from rcheckotts
a comment to message 805

I have looked up Rsconf and, while I can see how to set it up to do the handshaking for you, I still cannot see how to control the lines myself. How, for instance, do I turn DTR on or off? Thank you in advance. --Rick--

atari.st/tech #812, from sgrimm
a comment to message 811

```
To turn DTR on:
   Offgibit(0xfef);

and off:
   Ongibit(0x10);

   You have to #include <osbind.h>, of course.
```

8-BIT-TO-ST GRAPHICS

atari.st/tech #831, from stevesmith (Steve Smith)

As an avid fan of the old Atari 8-bit computers and a possible future owner of the new, I am particularly interested in the machine's graphics capabilities. I know basically that hi-res color is 640x200 with 4 colors, and that lo-res has 320x200 with 16 colors, but what else is there? Is any of the older hardware carried over, such as player/missile (sprite) graphics, etc.? Is there a 16-bit Antic display processor? How is the display memory configured? At a fixed location (like IBM) or can it be moved around anywhere in memory, like the old 800?

Please forgive all the ignorant questions, but I'm basically a video-game programmer who's been locked up in a Mess-DOS world for the last two years!

Any insightful comments would be most appreciated.

atari.st/tech #832, from bwebster (Bruce Webster, Consulting Editor, BYTE)
a comment to message 831

Steve:
I'm certainly not the most experienced ST graphics programmer (OK, guys, stop snickering), but I can probably give you the basics. No, there is no hardware assist (missile graphics, display processor) for graphics. There *are* a series of low-level graphics routines that you can call, which may save you the hassle of writing them yourself. Display memory can be configured on any 256-byte boundary and always takes up 32K. The graphics mapping is an interesting interlace approach. For hi-res (640x400x2), each bit represents one pixel on the screen, starting in the upper left corner and going across and down, i.e., the first 80

(continued)

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bytes represent the first row. The very first pixel (upper left) is the high-order bit of the first byte. For med-res (640x200x4), each pair of words represents 16 pixels; corresponding bits in those two words represent pixels. Confused? Well, if the screen is located at, say, $78000, then the upper left pixel is represented by the high-order bit of the words at $78000 and $78002. Those two bits yield a total of four values, which are looked up using a color table. For lo-res (320x200x16), groups of four words are used; the upper left pixel is represented by the high-order bits of the words at $78000, $78002, $78004, and $78006.
..bruce..
(Did I get it right, guys? Huh? Did I? :-) ..bfw..)

---

atari.st/tech #833, from jim_kent
a comment to message 831

Yes, we have no sprites, or no hardware sprites at least. There's no real equivalent of the Antic display processor. You can set up horizontal blank interrupts and do some of that stuff with the processor. Basically, the ST is just a real solid 68000 machine with 16 colors out of 512.

The display memory can be put on any 256-byte boundary. You can double-buffer. Scrolling is a little harder; in fact, you can only scroll horizontally 16 pixels at a time and vertically about 5 pixels at a time (or is it 8?). This is without moving data in memory. The 68000 will scroll vertically by moving memory at about 100 frames/sec, though.

The screen layout is "interleaved bitplanes." In 16-color mode this means that a pixel will be a bit in each of 4 consecutive words, 16 pixels in 4 words, the next 16 in the next 4 words. The color selection is 16 colors out of 512. The way this works is 8 levels each of red, green, and blue. Try to check out Neochrome and a couple of video games at a computer store.

---

atari.st/tech #834, from jsan (Jez San)
a comment to message 833

Jim -
How on earth do you hardware-scroll *ANY* amount on the ST!?
You say that you can scroll 16 pixels at a time, and vertical 5 pixels at a time?
I know how to do it in assembly code, but are you saying there is a hardware function that scrolls the screen!?
— Jez.

---

atari.st/tech #835, from jim_kent
a comment to message 834

Jez, I am sleepy. Come to think of it you can't scroll horizontally without moving memory, and even then you can only do it quickly 16 pixels at a time. To scroll vertically you have to figure out the least common multiple (or is it greatest common denominator) of 80 (bytes per line in the screen) and 256 (the screen alignment BS) and just set the screen pointer where you want. If I hadn't been up all night I'd figure out if this was 5 pixels or not.

---

atari.st/tech #836, from jim_kent
a comment to message 835

Actually in a color mode it's 160 bytes/line. 8*160 = 1280 = 16*16*5 = 256*5 ... so moving the screen pointer 8 lines down will also be on a 256-byte boundary, 16 lines in monochrome. Sort of course scrolling, but not much overhead. Lets see, 200/8 = 25 ... so 25 steps to scroll off the screen. If you timed it so it took less than a second it'd probably look pretty smooth even.

---

atari.st/tech #837, from mpack (Don Milne)
a comment to message 835

Aw, and I hoped you were going to give me a hardware method. Is there any quick way to scroll portions of the screen (i.e., without moving every word yourself)? Restricting it to byte or word boundaries is no problem.
--Don Milne.

---

atari.st/tech #841, from chriskuku (Christoph Kukulies)
a comment to message 837

There is no way to scroll by hardware on the ST. You have to do it all by yourself (MOVEMs) or use the appropriate GEM or bitblt line-A functions. See earlier discussions in this topic. There is also a way to manipulate the video controller register, but I haven't gone happy with that. You cannot scroll portions by this means and screen wraps are difficult to handle. I've written a VT100 emulator that also emulates the single- and double-width characters, three different fonts (one copied directly from the VT100-character ROM), and I did all scrolling, full screen and partial (in windows), by hand, by using assembler mixed with GEM, line-A and AES functions. The resulting scrolling in the windows still doesn't look overwhelming, so I wished we had a hardware scroll, too.
Chris

---

atari.st/tech #866, from dmichael (DeCarte Michael)
a comment to message 831

If you are into games, wait a little while until a bigger selection comes out. By then the prices may come down some more and there will be a bigger selection from programmers that have had the benefit of hacking on the ST for a year or two and can teach it to do some really nice things. (To see what I mean take a look at the old Atari 800 games, then look at the newer ones. There is a big difference, right? It comes from hacking a long time on a computer.)

---

atari.st/tech #869, from jimomura (Jim Omura)
a comment to message 866

Wellll. It also comes from the fact that memory got cheaper so more people started to buy bigger computers. Some of the early stuff for many of the early home computers were actually quite amazing when you look at them in detail. Just a couple of examples that I don't feel have *ever* been surpassed within the confines of the hardware they were designed for are the original Star Raiders, Tandy's Skiing for the Color Computer, and Tandy's DinoWars, also for the earliest Color Computer.

IBM PC AND COMPATIBLES

The IBM section begins with an unusual problem: A user finds that his IBM isn't compatible with his clones! BIXen quickly come to his rescue. The section continues with a look at the issue of "parking" the heads of hard disks. An assembly language program for parking heads, with instructions on compiling it from Debug, is included.

THE CLONE WARS

---

ibm.pc/hardware #1137, from jsprowl (Jim Sprowl)

I ran into an interesting headache today. A program that has been running happily for several weeks on

(continued)

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Inquiry 193

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*as reported in Micro Cornucopia, August-September 1985. Turbo Pascal is a registered trademark of Borland International.

Compaqs (8088 and 80286 models) and Zeniths (Z-151s and Z-158s) *suddenly* bombed at one point when tested on an IBM PC XT. The program accesses the screen exclusively through ROM BIOS interrupt 10h, doing such things as positioning the cursor, writing character + attribute, scrolling, and clearing windows (by using scroll and setting the number of lines to zero). Are there any "traps for the unwary" in INT 10h that might be tripping me up on the true-blue product but permitting me to run on the clones? I shall be tackling this one on Friday, and would welcome any suggestions.

---

ibm.pc/hardware #1138, from dmick (Dan Mick)
a comment to message 1137

One that comes to mind quickly, Jim, is the hardware scrolling of the Zeniths; but I don't know if the Compaqs do that or handle it gracefully or what. Make sure the "set scroll mode" isn't called, is all I can say (AH=100), though the IBM BIOS looks like it'd just ignore that call. Otherwise you got me.

---

ibm.pc/hardware #1141, from dondumitru (Donald Dumitru)
a comment to message 1137

It seems to me that there was a problem with the BIOS scroll function trashing the BP register. I haven't run into it personally 'cause I use Fansi-Console (which completely replaces the BIOS video functions). It should be easy to verify whether BP gets trashed or not from the BIOS listing in the Tech Ref.

Donald

---

ibm.pc/hardware #1145, from jsprowl
a comment to message 1141

>INT 10h problems on IBM PC
So scroll may clobber BP, eh? That is where C instructs me to save a pointer to the stack that is restored as the stack pointer after an assembly language program runs. That could very well be the problem. Thanks for the tip. I shall begin by checking for a clobbered BP register whenever the "scroll the window clear" function is called.

---

ibm.pc/hardware #1146, from dondumitru
a comment to message 1145

If you will look in the Tech Ref BIOS listing (for the older XT), you will see around line 3356 a bunch of pushes to save registers (BP being noticeably absent). Then around line 3858 (in a procedure that gets called by both scroll_up and scroll_down) you see BP getting stuffed with something useful (which gets used when the procedure returns to its caller). Nowhere is BP saved (or restored) by the scroll_up and scroll_down routines.

Oops.

Donald

P.S. This is particularly insidious because high-level languages almost always use BP to keep track of variables on the stack. If you trash BP, it will point to a "random" place in your stack segment. Just think how long it could take to figure out what's going on...

---

ibm.pc/hardware #1151, from dmick
a comment to message 1146

Yeah, I'd heard of this. Someone (perhaps even on BIX) wrote a little routine to intercept INT 10h and save BP locally, then pass on the call. Was that you, Don? Good idea for IBMs, anyway, it would seem, in particular if you're using some kind of driver anyway. I wonder if ANSI.SYS contains a BP save to isolate me from problems? I've used ANSI on the XTs almost since we unpacked them..

---

ibm.pc/hardware #1155, from jsprowl
a comment to message 1146

>BP clobbered by IBM PC INT 10h bug
Sure enough — that was the problem. Today I simply went through all the assembly language listings and searched for all calls to "int 10h." I simply inserted "push bp" ahead of "int 10h" and inserted "pop bp" following "int 10h" everywhere, and my IBM PC and XT problems disappeared completely.

This one "tip," which probably saved me 4 to 6 hours of debugging and testing, has more than paid me back for all the time I have spent helping others on BIX. I am really grateful for this assistance. Thanks to all of you.

(continued)

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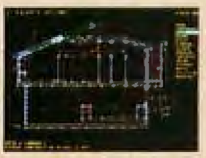

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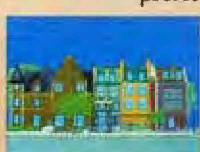

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Inquiry 194

A PARKING PROBLEM

ibm.pc/drives #367, from amaib (Andy Maib)

I was under the impression that the Seagate ST225 parked the heads properly on power-down and that this would not be a problem. Am I correct? If not, what would be a good way to park the heads before the system is turned off?
Thanks.
Andy

---

ibm.pc/drives #368, from barryn (Barry Nance)
a comment to message 367

Andy, the following assembler program will park the head of drive "C." You can enter it via Debug (do you need the procedure?) or you can assemble it with MASM.

```
;
; copyright (c) 1985 Barry Nance
;
code    segment para
        assume cs:code, ds:code
        org     100h        ;will be a .com file via
                            ;exe2bin
parkit  proc    far
;
start:  mov     ax, 1100h ;ah 11 = recalibrate
        mov     dx, 0080h ;select first hard drive
        int     13h       ;do the recalibration
        mov     ax, 0800h ;ah 08 = get disk parms into
                          ;CX/DX
        int     13h
        mov     ax, 0C00h ;ah 0C = seek
        mov     dx, 0080h ;select first hard drive
                          ;CX still contains max cyl,
                          ;max sector from get-disk
                          ;-parms
        int     13h       ;do the seek
        int     20h       ;all done...exit
;
parkit  endp
code    ends
        end     start
```

---

ibm.pc/drives #369, from mhaas (Mark Haas)
a comment to message 367

You might also try TIMEPARK.COM in the archive file called HAASUTIL.ARC in the IBM.ARC section of Listings. It'll park your drive's head automatically after a specified number of minutes (i.e., TIMEPARK 5 takes 5 minutes) of inactivity.

---

ibm.pc/drives #370, from petewhite (Pete White)
a comment to message 367

There are numerous programs available to park the heads on an ST225. If you have a problem, BIXmail me and I'll send you a few. What system? (Say "Leading Edge.")

---

ibm.pc/drives #371, from petewhite
a comment to message 369

Just be a bit careful on TIMEPARK. It says it doesn't interfere, but it could cost you keystrokes in certain applications if the timing is right. But use it with "TIMEPARK 1" and wait a minute. I like barryn's better.

---

ibm.pc/drives #372, from bbrown (Bob Brown)
a comment to message 370

Pete, I'd be interested in a discourse on head parking, in theory and in practice, as it applies to the ST225. My early experience is with mainframe-type drives, which unload the heads (i.e., move them completely off the disk surface and out of the way) when power is

(continued)

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Inquiry 356

removed. I think there are micro-sized hard disks that do this, too, but I think the ST225 isn't one of them.

As I understand "parking," it means moving the head assembly to a "landing area" on the disk so that when power is removed, the heads touch down there instead of wherever they happened to be. Does the ST225 have a dedicated landing area? If not, isn't it better to let the heads land in a random (more or less) place instead of in the same track every time?

---

ibm.pc/drives #374, from petewhite
a comment to message 372

There is a dedicated parking area. Leading Edge has a "park" program that handles several drives (believe it or not, "color coded" by a dot on the rear of the system). But they also had the "park" capability when they had the older systems, which were almost exclusively Seagate. Seems I remember seeing a "Debug" park command also. But let's not get too carried away with parking heads; it's usually necessary only when you're going to move a drive or move the system where it might get a bump. The "voice coil" drives park themselves on power-off, some by backing the heads to a platform so the heads NEVER come near the platter (and let's not play with the definition of "near"). I make it a habit to park the heads on two of my systems all the time as they are the ones most likely to be ripped apart at a moment's notice to test a board that "dropped by." I don't like the "did I or didn't I?" feeling when I have to backhand the sucker to get the cover off!

---

ibm.pc/drives #375, from skluger (Sigi Kluger, Definicon Systems Inc.)

Just thought I'd add my 5 cents' worth to the parking subject (insert nickel, turn knob).

Most low-cost Winchester drives do not have a landing zone or head retractors. They were designed not to get damaged when the head comes in contact with the surface due to power-down. High-quality drives these days have automatic head retractors, brakes, and spindle locks. When power is removed, a spring moves the heads to the landing zone, a brake slows down the spindle, and once it stops, the spindle is locked in place. Those drives clearly don't need a park utility.

If you don't cause any physical shock, there is no need to move the heads anywhere since, on the "cheaper" drives, they are designed and tested to do no harm to the media. It is, however, a good idea to move the heads into the least-used area on the disk (usually the innermost track) if the computer is to be moved.

As far as TIMEPARK and such utilities go, I'd rather see them all 'mv'ed to /dev/null since they serve no practical purpose other than to cause a significant delay in access time after they have done their evil deed. Harmless or not, I'd be wary of anything that installs itself in RAM and once in a while goes and moves the heads.

---

ibm.pc/drives #376, from mhaas
a comment to message 375

I think there may be some merit to parking disk heads if you leave your computer on all the time and don't want to worry about power glitches wiping out good data. I have been using TIMEPARK for many months without problems. I set it to the maximum time of 9 minutes. That way, if I'm doing anything remotely disk-intensive, it doesn't degrade performance. Most of what I do is not disk-intensive, even less so with the 2K buffer on the controller, so it's nice not to have to remember to move the heads manually every time I get up from the machine.

---

ibm.pc/drives #377, from mhaas
a comment to message 376

Let me clarify one thing about TIMEPARK. It parks the heads after n minutes of inactivity. Thus, TIMEPARK 9 will park the heads after 9 minutes of no accesses. If you haven't accessed your disk in 9 minutes, then the short delay to "unpark" the heads should not matter to you. If you do access the disk more often than once in 9 minutes, the heads will never park and you will not be inconvenienced.

---

ibm.pc/drives #378, from nickbaron (Nick Baron)
a comment to message 375

I know that the parking program I use with my Microscience 20-Mb drives parks the head on cylinder 639, which is the next-to-last cylinder on the inside track. The problem with generic parking programs is whether they can tell which track number is the inside track since this varies with different disk drive models. For example, the first program I used was parking my heads on track 305, which is fine if you have a 10-Mb drive but is right smack in the middle of my 20-Mb drive.

---

ibm.pc/drives #379, from geary (Michael Geary)
a comment to message 378

A park program that doesn't check the disk size is just sloppy programming. All it has to do is issue the "Request Drive Parameters" BIOS call and find out how many cylinders the disk has!

---

ibm.pc/drives #380, from barryn
a comment to message 379

The short program posted in message #368 does exactly that.

---

ibm.pc/drives #390, from amaib
a comment to message 368

Barry, I would appreciate the procedure to assemble your program. I've had limited experience using assemblers and the one in Debug just laughed at me. I currently have 7 Seagate ST225s in use and would feel much better if the heads were in their proper place when not in use. I have also downloaded TIMEPARK.COM and the doc file and will start experimenting with it soon.
Thanks for all the feedback!
Andy

---

ibm.pc/drives #392, from barryn
a comment to message 390

Andy, here's what you do. Capture this message as a disk file and use an ASCII-based editor to "cut out" the marked area. Name the resulting file "park.dbg". Then invoke the Debug program like this:

```
debug <park.dbg
```

The result will be a file PARK.COM that you can run anytime you want to park the head on the "C" drive.

(The blank line before the "R CX" line is important; leave it in.)

```
---------------- cut here ----------------
N PARK.COM
```

(continued)

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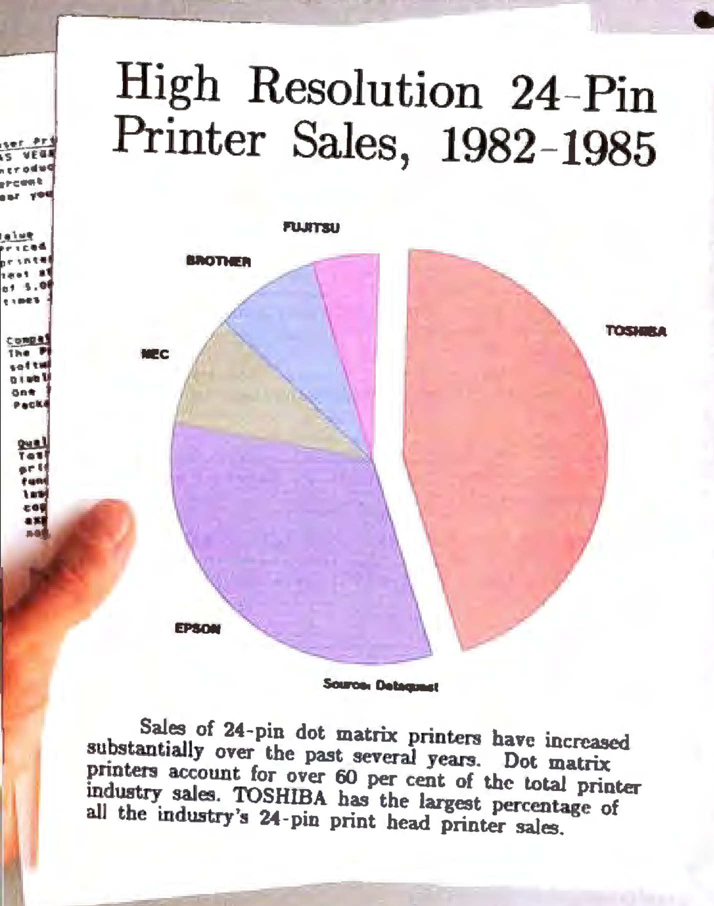

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The P351

The P351C (used to print sample shown)

In Touch with Tomorrow

TOSHIBA

Toshiba America, Inc., Information Systems Division

Inquiry 363

```
A 100
mov     ax,1100
mov     dx,0080
int     13
mov     ax,0800
int     13
mov     ax,0C00
mov     dx,0080
int     13
int     20

R CX
64
W
Q
------------------- cut here -------------------
```

ibm.pc/drives #393, from cdanderson (C. David Anderson)
a comment to message 392

Can this program be made to park the "D" drive as well?

ibm.pc/drives #394, from barryn
a comment to message 393

Sure. For a "D" drive parker (I've named it "PARK-D.COM" below), just give the following Automatic Response File to Debug, as outlined in message 392:

```
------------------- cut here -------------------
N PARK-D.COM
A 100
mov     ax,1100
mov     dx,0081
int     13
mov     ax,0800
int     13
mov     ax,0C00
mov     dx,0081
int     13
int     20

R CX
64
W
Q
------------------- cut here -------------------
```

ibm.pc/drives #395, from cdanderson
a comment to message 394

Thanks very much. Two questions. First, why does it take so much longer to execute the second time you invoke the program (1 second vs. 10 seconds). Second (I may be pressing my luck), can one version do both drives at once?

ibm.pc/drives #396, from barryn
a comment to message 395

1. It takes so long because the program does a "recalibrate" operation before actually sending the heads out to the last cylinder. Sometimes it's necessary to do the recalibrate; sometimes not. It's safer to leave it in.

2. Sure, one program could park the heads of all the drives. In fact, one of the drive parameters returned (the second call to Interrupt 13) is the "number of consecutive acknowledging drives attached..." So adding a little code to the program would make it work for any number of drives. (It already works for any size drive, (10 Meg, 20, or whatever.) It always sends the heads to the last cylinder, regardless of how many cylinders are on the device.)

THE MACINTOSH/ APPLE II

The Macintosh/Apple II window opens with a discussion of the effects (and desirability) of screen-blanking programs for the Macintosh. Moving into the Apple II world, the BI command parser and a problem with MouseWrite are discussed. Finally, there is a brief tutorial on communications programming.

SCREENBLANKERS

[Message #506 is an announcement that Autoblack, an automatic screen-blanking program, is now available on BIX.]

macintosh/news #507, from frankb (Frank Boosman)
a comment to message 506

What happens when you run software that uses the alternate screen buffer while Autoblack is installed? Crash-O-Rama?

macintosh/news #510, from dpallen (David P. Allen)
a comment to message 506

I just don't understand the need for screensaver/blanker programs. What's the trouble with just turning down the brightness control? That's what I do.
Uncle David

macintosh/news #511, from rschnapp (Russell L. Schnapp)
a comment to message 510

The same reason we have spring-closed doors: Why should you have to remember to do it? The computer can figure out when to blank the screen quite nicely. I've used a screen blanker on my (shudder) PC clone for years.
...Russ

macintosh/news #512, from tom_thompson (Tom Thompson, Technical Editor, BYTE)
a comment to message 510

What happens is this: I'm working away at my Mac when someone needs some tech help (usually a MacBinary download or something). I go help them, and someone jumps me about a desk accessory. That leads to someone I need to check a tech ref with on a manuscript, and... I've been away from the Mac for one-half to two hours. I had not planned to be away that long! No matter: the Mac's taken care of itself by neatly blacking away five minutes of activity. That's what screensavers are for.
---tom

macintosh/news #513, from tom_thompson
a comment to message 507

I don't know. Only thing I know that uses the alternate buffer is Megaroids. I'll try it out and see. (Hey guys, I use my Mac for serious work! :-))
---tom_thompson

macintosh/news #514, from dpallen
a comment to message 512

(continued)

My observation is that the fear of screen burn is *vastly* overblown, especially in black and white. I can remember, when I first got into this business thirty years ago, that the old Vidicon film chain would sit there for hour after hour on the same I.D. slide. We would comment how amazing it was that it did not burn in ... not in the monitor screen, but on the target of the Vidicon. We were real used to the sticky image Orthicon, which would burn in very badly in only a few seconds on a high-contrast scene. But I never recall _ever_ seeing any significant after-image retention on a Telecine monitor.

I sometimes go off and leave the Mac on the same image for hours and have yet to see _any_ sign of after-image. In the old days if you had after-image it was generally from the pick-up tube and not the monitor screen. The remedy was to defocus the camera on a high-brightness flat field for a couple hours. That would generally erase the image.

I am not denying raster burn on a picture tube; however, that takes years to produce and results from a general deterioration of the picture tube phosphor.
Uncle David

---

macintosh/news #515, from dwiner (Dave Winer, Living Videotext Inc.)
a comment to message 514

But monochrome PC screens are a different story. I have a PC that had ThinkTank left on so many nights that the two white bars at the bottom of the screen have become permanent. Now we just keep the monitor on a BBS machine and leave it turned off most of the time.

I've gotten into the habit of turning off monitors at night before I leave, but, like you, I don't worry about it during the day.

---

macintosh/news #516, from ccrawford (Chris Crawford)
a comment to message 514

My Lisa, which has automatic screen-dim as part of the hardware, clearly shows the menu bar for the editor when in other programs. My original Mac also shows the Apple, "File," and "Edit" items from the standard menu bar in just about every application that doesn't otherwise cover that section of the screen.

Of course, the mere fact that such burn is visible does not make it a problem.

ProDOS BI Command Parser

---

apple/software #302, from jtierney (John Tierney)

I have been trying to use the BI (BASIC Interpreter) from machine language and have run into a problem I can't explain. For example, let's say I want to do a catalog from assembly thru the BI. These are the steps that I thought I should follow:

1. Put the command 'CATALOG'+$8D in the input buffer ($200)
2. JSR to BI command parse ($BE03)
3. Check $BE0F for error (00 = no error)
4. CLC and RTS

The steps outlined above do actually produce a catalog but then I get a "Syntax Error" (sometimes two). Is there something else I must do before RTS? $BE0F is returning $00, so the error is after the routine is finished. Anybody have any insight on this problem?
John

---

apple/software #303, from mdavis (Morgan Davis)
a comment to message 302

I was going to plop onto my II+ to try out what you explained. I've done that exact same thing before, and successfully. But I did it from a BASIC program. Something like this:

```
CMD$ = "CATALOG"
BE03 = 48643
FOR I = 1 TO LEN(CMD$)
POKE 511+I,ASC( MID$(CMD$,I))
NEXT
POKE 511+I,13            :REM put C/R in there at end
CALL BE03
```

It worked just fine. The "Syntax Error" that you get is telltale. What this usually means is that Applesoft's text pointer has fallen upon something that it doesn't like. If, say, your routine that puts "CATALOG" into the input buffer and calls DOSCMD ($BE03) is at location 768 ($300) in memory, and you typed

```
]CALL 768
```

from immediate mode in order to execute it, guess where the text pointer is? Right, it is pointing right after the 768 (which is in the input buffer). BASIC happily goes out and jumps to $300 to execute your routine. Now, when your routine stuffs "CATALOG" into the input buffer, it just trounced the "CALL 768" (or even a 300G from within the monitor!), and probably the null terminator that BASIC puts at the end of your immediate mode command so that it knows when to stop parsing instructions. Also, if you have a clock card, ProDOS will poll it before each DOS command and stuff 17 bytes (or is it 16?) into the input buffer starting at $200 -- this would also munge your command and anything that followed it.

After the catalog is displayed, Applesoft returns to continue parsing commands at its text pointer which (if in immediate mode) is pointing somewhere inside the input buffer. Of course, you can guess the results: SYNTAX ERROR.

Try doing the call to your routine from deferred mode:

```
]10 CALL 768
]RUN
```

See if that works. If so, your problem is solved. And you might want your routine to save the first n bytes of the input buffer before calling $BE03, and then restoring them when done so that immediate mode usage is okay.

Of course, this was all "on-the-fly" speculation. So I could be very, very wrong about all this. But I've had this sort of thing happen before with DOS calls and such.

---

apple/software #304, from jerryh (Jerry Hewett)
a comment to message 303

You might also want to try sending low-order ASCII (bit 8 clear, including the C/R) to the input buffer -- BI or ProDOS might be fussy about that.

---

apple/software #305, from jtierney
a comment to message 304

I think you are right about the problem in the immediate mode. I still had a problem in the deferred mode and solved it by putting a 00 in $BE0F before calling DOSCMD. Thanks for your help.

---

apple/software #307, from mdavis
a comment to message 305

(continued)

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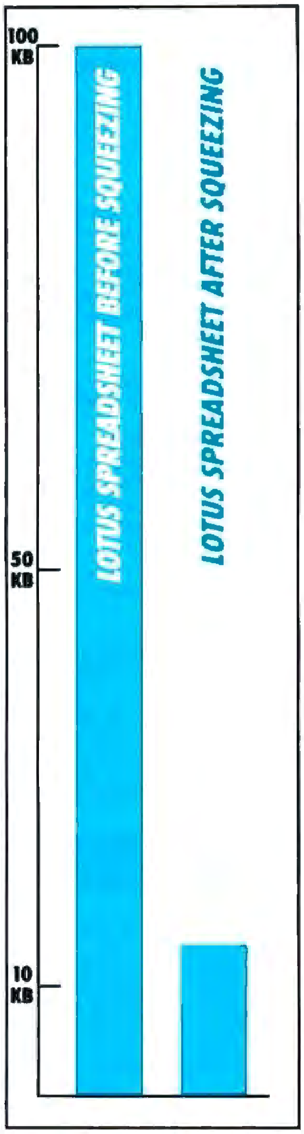

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That's interesting. I don't think the contents of $BE0F should be significant prior to making the call. If, however, you are testing that location after the call to DOSCMD, it would be. But I don't think you ought to do it that way. From what I've read about it, the carry flag is your indicator of an error occurrence after calling DOSCMD. That would make sense since ProDOS does the same thing. You might want to try:

```
JSR     DOSCMD
BCC     NO_ERROR
LDA     $BE0F            ;A-reg now has error code
```

If BASIC.SYSTEM is as consistent with errors as ProDOS is, I'll bet you don't even need to load the A-register with $BE0F after a JSR DOSCMD. If an error happens, the carry should be set, and the accumulator should contain the error code for you. (Might help to cut down on some of the code in your program to take advantage of this circumstance.)

---

apple/software #308, from jtierney
a comment to message 307

Well, I'm not sure, but I am beginning to think that $BE0F is not reset after an error occurs. Putting a 00 there before the call works fine. I will look into the carry flag. My primary source of info on this is Beneath Apple ProDOS (by Don Worth and Pieter Lechner, 1984, Reston Publishing) and they don't mention the carry flag to detect an error. Makes sense though.
John

---

apple/software #309, from mdavis
a comment to message 308

I'm sure that $BE0F will change *ONLY* if an error occurred, otherwise BASIC.SYSTEM probably leaves it alone. I've always used the carry flag status after MLI and DOSCMD calls to indicate an error. It seems to work flawlessly.

MOUSE AND MOUSEWRITE

apple/hardware #497, from rbracken (Rick Bracken)

Is anyone out there using MouseWrite? I have version 1.5.7 and the revision C of the Apple Mouse. Everything works fine execpt printing. When I go to print I only get part of my document prior to MouseWrite crashing. I have the Mouse in slot 4, a Super Serial Card in slot 2, and the FingerPrint Plus parallel interface in slot 1, connected to a Panasonic dot-matrix printer. Any help or suggestions would be appreciated.
Rick Bracken

---

apple/hardware #498, from jerryh
a comment to message 497

The problem might be the FingerPrint Plus card -- I was recently talking to a developer who was having trouble getting this card to work correctly with his program. You might want to try it with another card (borrow one from a friend, or try it at your local computer store) and see what happens.

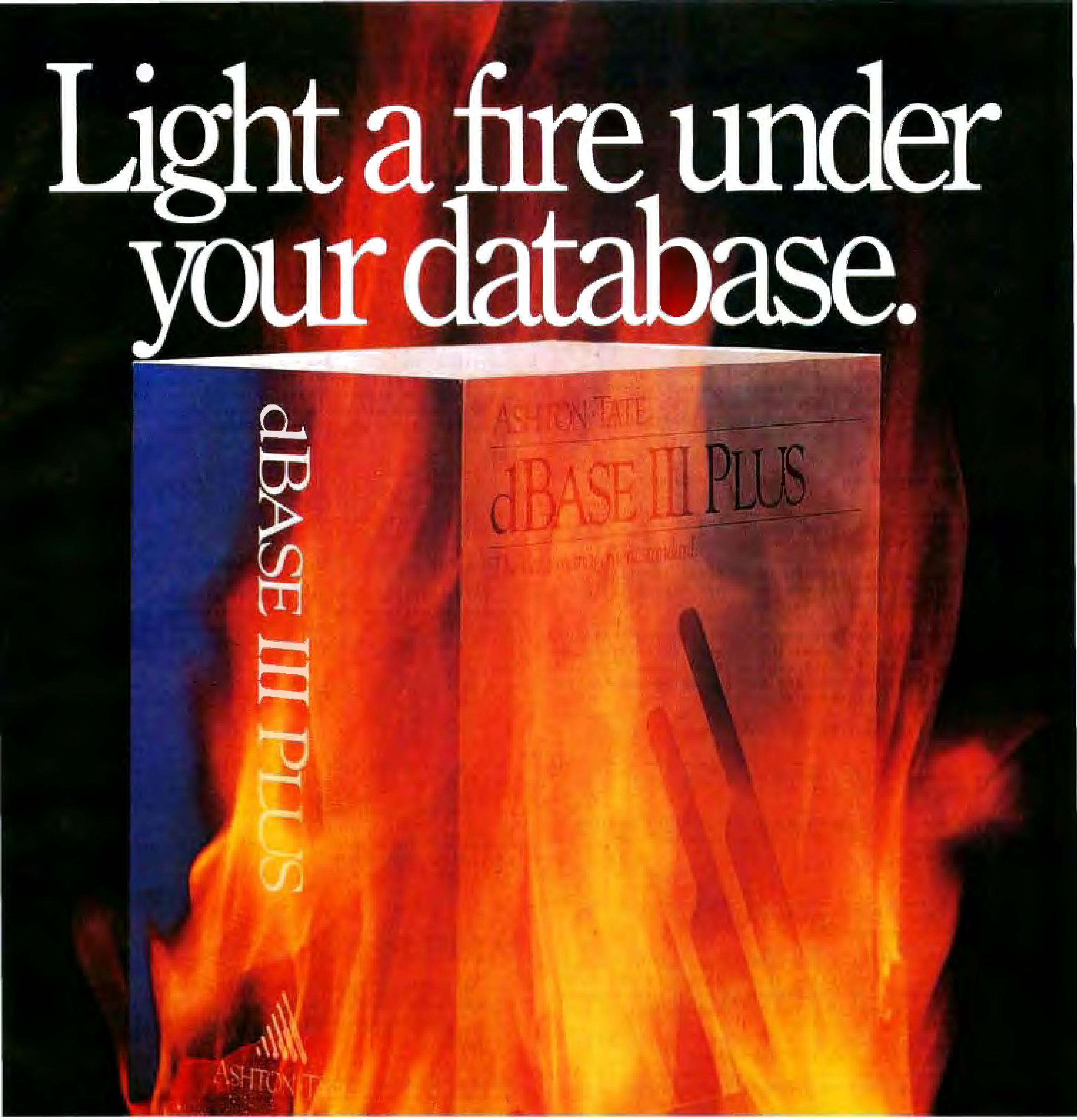
---

apple/hardware #499, from mdavis
a comment to message 498

Right. I could not get my version of MousePaint to print through Apple's parallel printer interface, though it worked great with the SSC and Imagewriter.

(Does it have a printer-install option or anything like that?)

(continued)



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Inquiry 393

apple/hardware #500, from rbracken
a comment to message 499

I can get MousePoint to function properly with my Panasonic printer and the FingerPrint Plus card but still no go with MouseWrite. I am borrowing an alternate card tomorrow.

apple/hardware #501, from rbracken
a comment to message 498

Back again. I think I have the solution to the FingerPrint card problem. Evidently the FingerPrint Plus does not handle interrupts properly. I'm going to call Thirdware Computers about a possible fix that I heard about. Will let you know.
Rick B

PS: MouseWrite worked great with a Grappler card.

apple/hardware #503, from mdavis
a comment to message 501

MouseWrite requires interrupts in order to print text?!? (hooo! heee! haawww! ooo! har har har!!!) Strike another point for old Roger.

You ought to ask them why MouseWrite's pull-down menus kind of "crawl" down the screen... "It's because we wanted to give the impression of the menus actually being pulllllllllled down the screen, so we put in some false delay loops to slow them down."

Jiminy Crickets, that's rich!

apple/hardware #524, from rbracken
a comment to message 501

Back again. Short update on my FingerPrint problem. Called Rafael Landers at Thirdware; he sent out a new ROM - no charge.
Rick B

apple/hardware #525, from jerryh
a comment to message 524

Did they tell you what the problem was in the first place? A brief description of the situation and what steps Thirdware took to correct it might help someone else down the road. ("Oh yeah! I remember seeing a solution to that on BIX!")

ACIA 6551 Technical Information

apple/long.msg #2, from jemurray (John Murray)

Writing communications programs for the Promodem 1200A

For anyone interested in writing a terminal program for the 1200A (Super Serial Card compatible) internal modem, here is a brief description of the 6551 ACIA used in the 1200A and Super Serial Card. In the following description, it is assumed that the 1200A is in slot 2. In register descriptions, bit 7 is the most significant bit.

The 6551 has 5 registers, which are mapped to 4 Apple memory locations. To write a program to control the 1200A, it is necessary to directly read and write these registers:

Receive/Transmit Data Registers: location: $C0A8

These registers contain the characters sent to and received from the modem. Writing to this location writes data into the Transmit Data register and reading from it reads from the Receive Data register.

Status Register: location: $C0A9

This register contains status information about the 6551. Bit 4 is set at 1 when the Transmit Data register is empty and cleared and at 0 when data is written into the Transmit Data register. Bit 3 is set when the Receive Data register has received data and cleared when the data is read from the Receive Data register.

Command Register: location: $C0AA

This register controls various transmit/receive functions. Normally, bits 0 and 3 should be set and bits 2 and 4 cleared. Bit 1 enables receiver interrupts and is set to disable interrupts and cleared to cause an IRQ' interrupt when a character is received. Bits 5-7 control parity checks as follows:

```
Bit 7 6 5
    - - 0 No parity
    0 0 1 Odd parity
    0 1 1 Even parity
    1 0 1 Mark parity
    1 1 1 Space parity
```

Control Register: location: $C0AB

This register sets the mode of the 6551. Bit 4 should normally be set. Bit 7 selects the number of stop bits, set for 2 stop bits and clear for 1 stop bit. Bits 5 and 6 control word length as follows:

```
Bit 6 5
    0 0   8 bits
    0 1   7 bits
    1 0   6 bits
    1 1   5 bits
```

```
Bits 0-3 set the baud rate as follows:
Bit 3 2 1 0
    0 1 1 0   300 baud
    1 0 0 0  1200 baud
```

I hope this is helpful to anyone writing a terminal program for the 1200A
- John.

APPLE IIGS

The IIGS section of the Apple conference has received a great amount of traffic from the day the IIGS was announced. The following are excerpts covering resets, sound, graphics and assembly language programming.

Reset Inconsistencies

apple/gs.compat #27, from rbradford (Rex Bradford)

Does anyone know why my OpenApple-Control-Reset only works some of the time? I cannot detect any pattern. Although usually if I bang on it a dozen times it seems to catch. This is on my Product Validation Unit; I don't know if this is me or real or what. Any comments from the guys at Apple?

apple/gs.compat #28, from ericeldred (Eric Eldred)
a comment to message 27

Yes, same thing happens in my PVU. I was told it is in programs that do not allow interrupts (the Control-Command-Escape uses an interrupt to call the classic Desk Accessory and won't work in a lot of programs in DOS 3.3, and even in one under the new ProDOS I saw today). But I thought that was hard-wired more than that in the IIe for copy protection reasons. (??)

apple/gs.compat #29, from gs.softteam (Apple Computer)
a comment to message 27

(continued)

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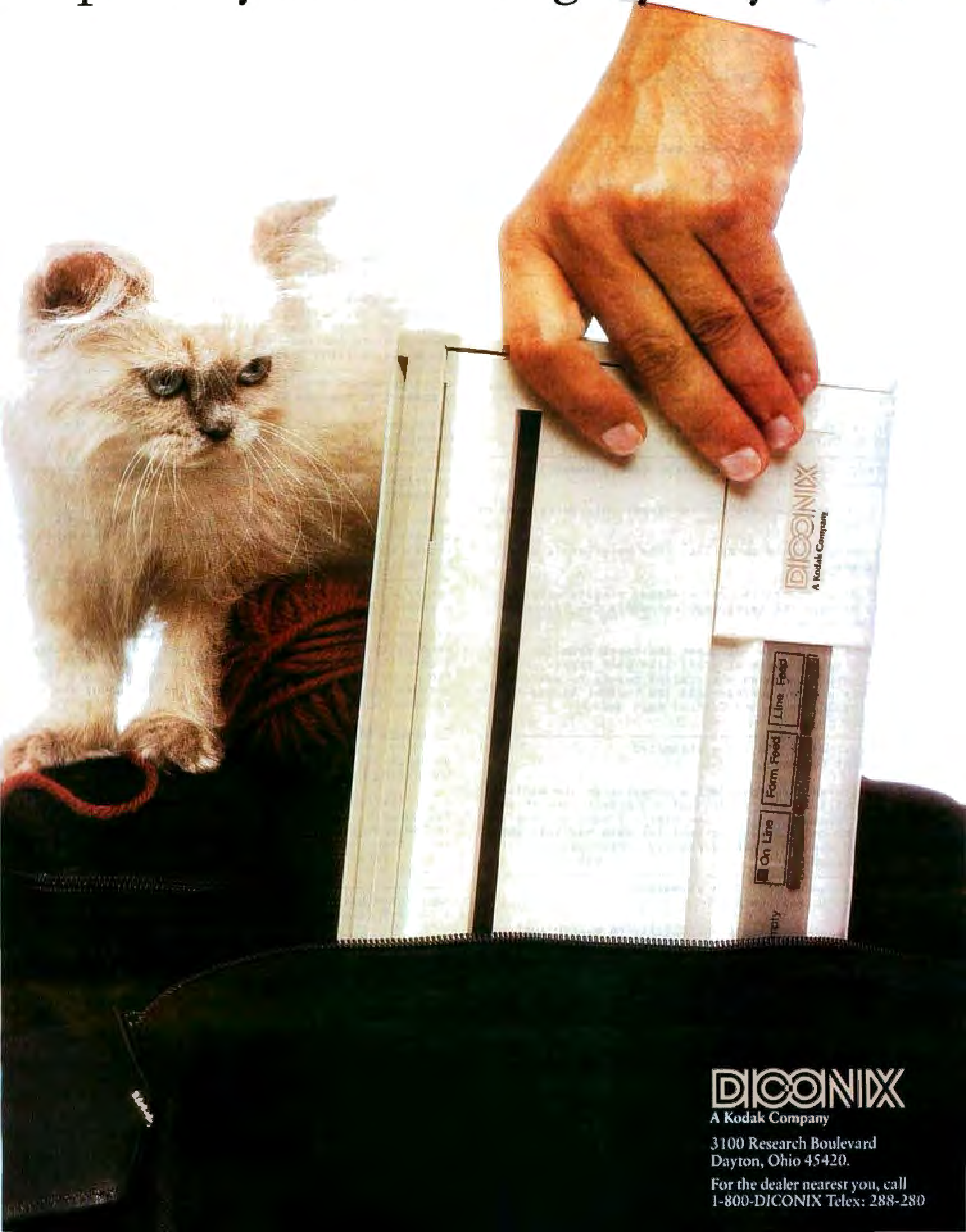


If you have a 1-meg memory expansion card, OpenApple-Control-Reset will cause all RAM not configured as a RAM disk to be zeroed. This takes some time. If you hit the reset again, it restarts the zero process. If this is the problem, be patient. If not, bring it up again and we'll try to find an answer.

R. Montagne (IIGS software)

---

apple/gs.compat #30, from gs.softteam
a comment to message 28

It is true that programs that disable interrupts also disable access to the control panel via OpenApple-Control-Escape. OpenApple-Control-Reset is not an interrupt, and should always work. See my comment to message 27.
R. Montagne (IIGS software)

---

apple/gs.compat #31, from gs.softteam
a comment to message 27

I would guess that you have keyboard buffering enabled from the control panel. There is a bug in the version of the keyboard micro used in the PVU units. Quite simply, Control-OpenApple-Reset is buffered. If you have anything in the keyboard buffer and try to reset, nothing will happen. A quick work-around is to flush the buffer if reset doesn't work. The keystroke for this is Control-OpenApple-Delete.
John Worthington (IIGS Software)

---

apple/gs.compat #32, from jerryh (Jerry Hewett)
a comment to message 27

> ...why my OpenApple-Control-Reset only works some of the time?

Same thing happens on my IIc. The solution is easy, thank ghu...

1) Press OpenApple-Control-Reset simultaneously.
2) Release the Reset key, but *NOT* the OpenApple and Control keys

Works every time. I guess the reset code is performing all sorts of stuff like bank resets, code swaps, etc., and when the routine checks to see what keys are pressed further into the routine it has to find the OpenApple and Control keys down.

---

apple/gs.compat #38, from rbradford
a comment to message 30

I just tried OpenApple-Control-Reset from the Monitor. The first two times I just got a] prompt; the third time it went to boot off the disk. I have no memory expansion and was very patient (it does hesitate about a second when it works correctly). Perhaps I'm still missing something... Rex

---

apple/gs.compat #39, from rbradford
a comment to message 31

Thanks for the information. Still, on my PVU just now I was inside a game called H.E.R.O. I hit Control-OpenApple-Delete followed by Control-OpenApple-Reset, and it took a few times. Perhaps the buffer-flusher keystroke is itself buffered or locked out?

---

apple/gs.compat #40, from rbradford
a comment to message 32

GREAT SCOTT!! It's true! Pressing OpenApple-Control-Reset and releasing the Reset before other keys makes it reset every time. Rex Bradford

---

apple/gs.compat #42, from mdavis (Morgan Davis)
a comment to message 27

Make sure you release the Open-Apple key *last* when doing a Ctrl-OA-Reset sequence. If you don't, the reset routine is called and it sees that the OA button is not down, and causes just a standard reset.

---

apple/gs.compat #43, from cheath (Charlie Heath)
a comment to message 39

H.E.R.O uses interrupts to synchronize the display - perhaps somehow the interrupt servicing is interacting with the reset function?

---

apple/gs.compat #44, from cheath
a comment to message 40

Then again, perhaps not.

---

apple/gs.compat #45, from gs.softteam
a comment to message 38

OpenApple-Control-Reset is a sequence-sensitive operation. Try holding the OpenApple and Control keys down. Then press Reset. Release Reset. Then release OpenApple and Control keys.
Ray Montagne (IIGS Software)

---

apple/gs.compat #46, from gs.softteam
a comment to message 42

The Reset key should be released first (before the OpenApple and Control keys).
Ray Montagne (IIGS Software)

---

apple/gs.compat #47, from gs.softteam
a comment to message 43

Reset is an independent function, and should not be affected by interrupts. See message 45 for the proper sequence of keys to reset.
Ray Montagne (IIGS Software)

---

apple/gs.compat #48, from ericeldred
a comment to message 47

Yes, on my PVU, I have had no trouble since I was careful to use the sequence described above. Actually, I gave it some thought and seemed to remember that I had to do that on my IIe as well; it was just a little more noticeable here. Thanks for the tip about the keyboard buffer disable.

GRAPHICS MAPPING

apple/gs.other #82, from bwebster (Bruce Webster, Consulting Editor, BYTE)

I got the impression from Gregg-and-Rick's preview that the super hi-res graphics screen is in a fixed location in RAM and (I may be misremembering, but I'm too lazy to go back and look) that there's only one. Is this true? I sure hope not.
..bruce..

---

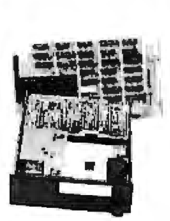
apple/gs.other #94, from rbradford
a comment to message 82

It appears from my reading of the docs that indeed graphics memory is fixed in memory. It's a shame because display double-buffering was invented (on micros anyway) in the Apple II. The display interrupts are helpful in synchronizing screen updates, but it's just not the same.

I am beginning to think that the 256 on-screen colors (with some layout limitations) from a palette of 4096 will make for quite nice displays. Has anyone seen the AT&T board that has resolution of only 256 by 256 but produces stunning displays because of its 32,000 colors?

Also, the byte layout (pixels contained within

(continued)



bytes) is much better for software than bitplane displays. Bitplanes are popular in high-end systems because fancy graphics hardware can cope with bitplanes easily, but software has a dickens of a time updating pixels which are spread across several bytes. Not too much fast animation seen on the Atari ST yet, for instance.
Rex Bradford

apple/gs.other #100, from cheath
a comment to message 94

Say it ain't so! A single video display area, in an 8-meg address space?

How fast can the 65816 copy an entire display screen? Make that: What is the fastest way to move a 16-bit word from one indexed location to another?

apple/gs.other #154, from rbradford

TITLE: Coping with the single video bank
Since the IIGS has only one hardware bank of display memory in super hi-res mode, it is of interest to know about writing to an off-screen "bank" and copying the results to the real screen. Quickdraw II does support writing to a "screen" anywhere in memory; next task is to copy it to the real screen memory. The MVN and MVP instructions will do block moves at 7 cycles per byte moved; since the screen is 32,000 bytes, this is 224,000 cycles. At 2.8 cycles per microsecond, this is 80,000 microseconds, or 80 milliseconds. This is 5 video fields at 60 Hz, which does not exactly make for a clean screen update. Anybody have any thoughts on this matter?
Rex Bradford

apple/gs.other #155, from cheath
a comment to message 154

That sounds about like the speed to copy a screen on the original IIe, except of course the IIe does have an alternate bank. That is about five times *slower* than Atari ST and Amiga's; and both of them *do* allow bank switching.

apple/gs.other #163, from gs.softteam
a comment to message 154

Actually, the block move instruction is not the best way to move data onto the screen. The block move does a false read of the destination address. Since the destination address is slow video memory, it costs 1 microsecond. The fastest that I have moved data onto the screen is about 8.5 frames per sec. If the palette and screen brightness bytes are not being changed, it will be faster. I think that over 9 frames per sec is doable. The Empire Strikes Back demo (for those who saw it) was 8.5 frames.
Rich Williams (IIGS Software)

MULTIPLE KEYBOARDS

apple/gs.other #151, from dbetz (David Betz, Senior Editor, BIX)

Does anyone know if software on the IIGS can tell which of several keyboards a keystroke originates from? Can I hook up two keyboards and have my program treat keystrokes from each keyboard individually or are they indistinguishable?
David Betz

apple/gs.other #152, from cheath
a comment to message 151

Interesting idea. I've often wished, when multitasking, for alternate sources of input without having to select a new window or something. Drives me batty when I start typing and the data goes into the

(continued)

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wrong window! What do you want to use multiple keyboards for, David?

apple/gs.other #153, from dbetz
a comment to message 152

Game programs. I thought it would be interesting to design a game program for the GS that would allow two (or more) players to interact with the machine (and each other) at the same time. I suppose that multiple independent keyboards could be useful for educational software also. The teacher could be the copilot ready to take over the controls but also have some command options that the student doesn't have access to.
David Betz

apple/gs.other #161, from gs.softteam
a comment to message 151

By talking to the keyboard micro you can tell which keyboard is sending the keystroke. We had a game going in the lab with 6 keyboards. Everyone would type faster to make their character win a race.
John Worthington, (IIGS Software)

Sound Capabilities

apple/gs.graphsound #6, from nightlight (Patrick Murphy)

Saw the IIGS today...pretty neat. Questions about the sound:

The Ensoniq chip that runs the sound provides 15 voices (oscillators). I presume that these are digitized waveforms.

1) What are the limitations on the waveforms? A fixed number of bytes per waveform, or fixed total of bytes for all 15, or something else?

2) Why is there 64K of RAM for the sound chip? Is it a convenience (a scratchpad) or a limitation (only 64K of samples total)?

3) The sound is mono, but a company makes a stereo board which seems to demultiplex the mono. How does this work?

4) This question is crucial to my interest, which is in running laser light shows with the IIGS: Is it possible to get two or more non-demultiplexed outputs from the chip? For example, if I open it up, are all 15 of those voices/oscillators coming out of the chip, or are they mixed internally? (Mono would be useless; the more fully independent digitized waveforms, the better.) Thanks for any info on the IIGS sound capabilities.
--Patrick Murphy

apple/gs.graphsound #8, from robmoore (Rob Moore, Manager, IIGS Hardware Design Group, Apple Computer)
a comment to message 6

The Ensoniq DOC includes 32 oscillators. Our sound tools use these in pairs and reserve one pair to generate time slice interrupts so we end up with 15 voices. With the right software you could do 32 voices.

Waveforms are stored in a dedicated 64K section of RAM and start on page boundaries. They can be up to 32K long.

Stereo or multi-channel sound is possible and stereo cards have been built. Each oscillator can be specified to be assigned to a particular channel number (0-15) and the least significant 3 bits of this channel number are available on the little DOC connector on the board. So an 8-way analog mux [multiplexer] etc. will let you have 8-channel sound.
— Rob M

apple/gs.graphsound #20, from nightlight
a comment to message 8

So to get eight independent sounds I would have to get the channel number off the DOC, and switch the signal coming from the D/As into the channel I desire, correct? Does this mean that all signals must run at the same speed (or by only grabbing every nth signal at no more than 8 (15?) multiples of a given speed)?

apple/gs.graphsound #21, from robmoore
a comment to message 20

You're approximately correct - the channel number is used to vector the unfiltered output to the selected channel circuitry. The DOC generates outputs for 32 oscillators (if 32 are enabled) and two dummy refresh cycles. It steps through the oscillators at about 7/8 MHz, so with all oscillators enabled it takes 34 cycles to complete a pass through the oscillators. This works out to about a 26.4-kHz sample output rate, so the max frequency that can be generated with 32 oscillators enabled is about 13.2 kHz. The output step rate is constant, so enabling fewer oscillators increases the max sample rate and output frequency.

apple/gs.graphsound #24, from gs.softteam
a comment to message 6

1. The Ensoniq chip has 32 oscillators available for waveform playback. The architecture of the Sound Tools has linked adjacent pairs of oscillators into "Generators." The reason there are only 15 generators instead of 16 is that Apple is reserving the last pair. The Sound tools are broken down into four main sections: free-form sound, note synthesis, sound sequencer, and speech tools. Within the free-form tools the waveform can be up to 16 megabytes wide. The firmware will take care of moving data as needed into the 64K of DOC RAM. The smallest waveform that can be played by the free-form tools is one page (256 bytes).

2. The DOC chip requires memory that can be accessed directly. The chip can access up to 128K of RAM but due to cost constraints some limitations had to be made. This memory can be used by an application program to load waveforms which any of the generators can reproduce.

4. The DOC chip time-domain multiplexes the output from each of the oscillators depending on the number of oscillators enabled, it will cycle through all of the oscillators.

apple/gs.graphsound #27, from rbradford
a comment to message 24

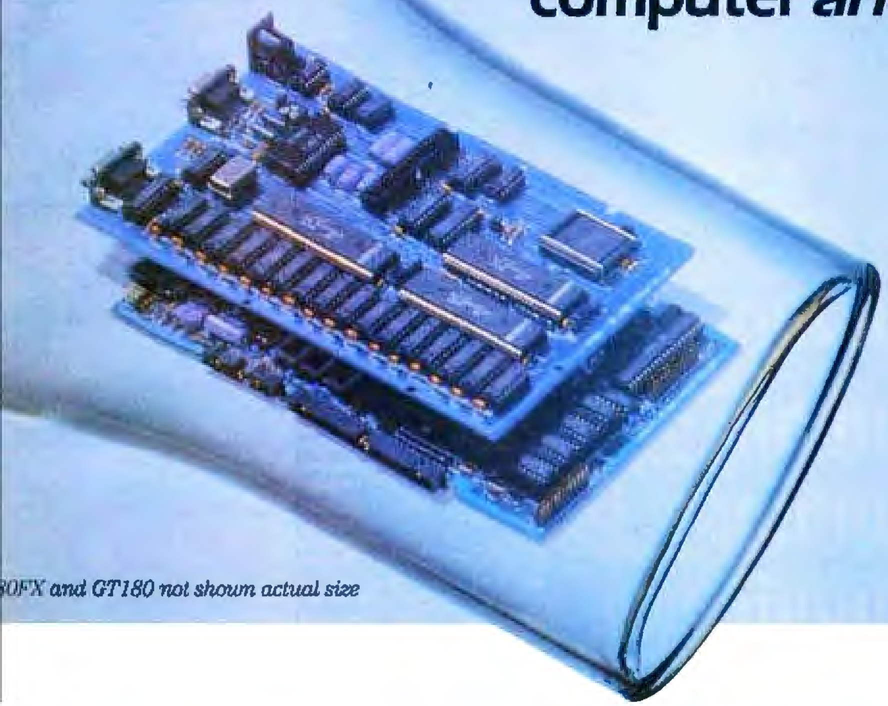
I have seen several references to the 64K sound chip RAM. Where does this exist? Can any 64K area (or part of 64K) be allocated to it? I assume it doesn't have its own 64K RAM hanging around, does it? On the subject of memory, how much of the 256K is actually available? My cursory reading of specs makes me believe that after sound RAM, graphics RAM, shadow RAM, tiny isolated pieces that are a pain to make use of, etc., are all accounted for (not to mention ProDOS itself and Finder and all), precious little is actually usable. Is Apple repeating the mistake all computer manufacturers (including Apple) have made in the past--great stuff crammed into a closet?

GLU Help

apple/gs.graphsound #26, from sgrant (Steven Grant)

HELP!! If I can get my boss details of the sound GLU quickly, he'll sign the check for a GS! What he wants is a description of the memory locations and registers used by the sound GLU chips. I've already looked at what's been posted re: the sound chips and maybe that will be enough. What he asked for specifically was

(continued)



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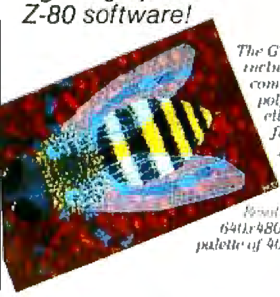

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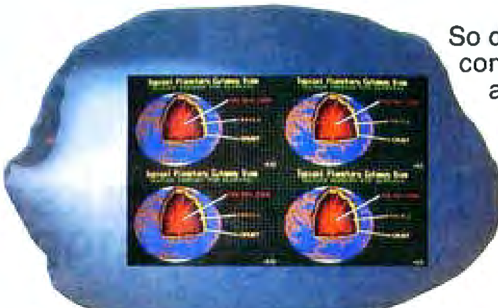

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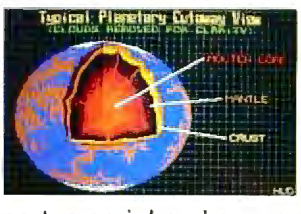

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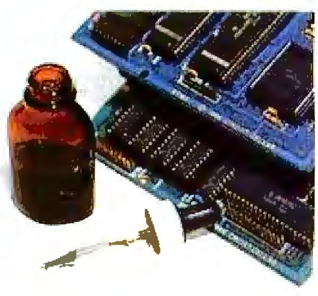

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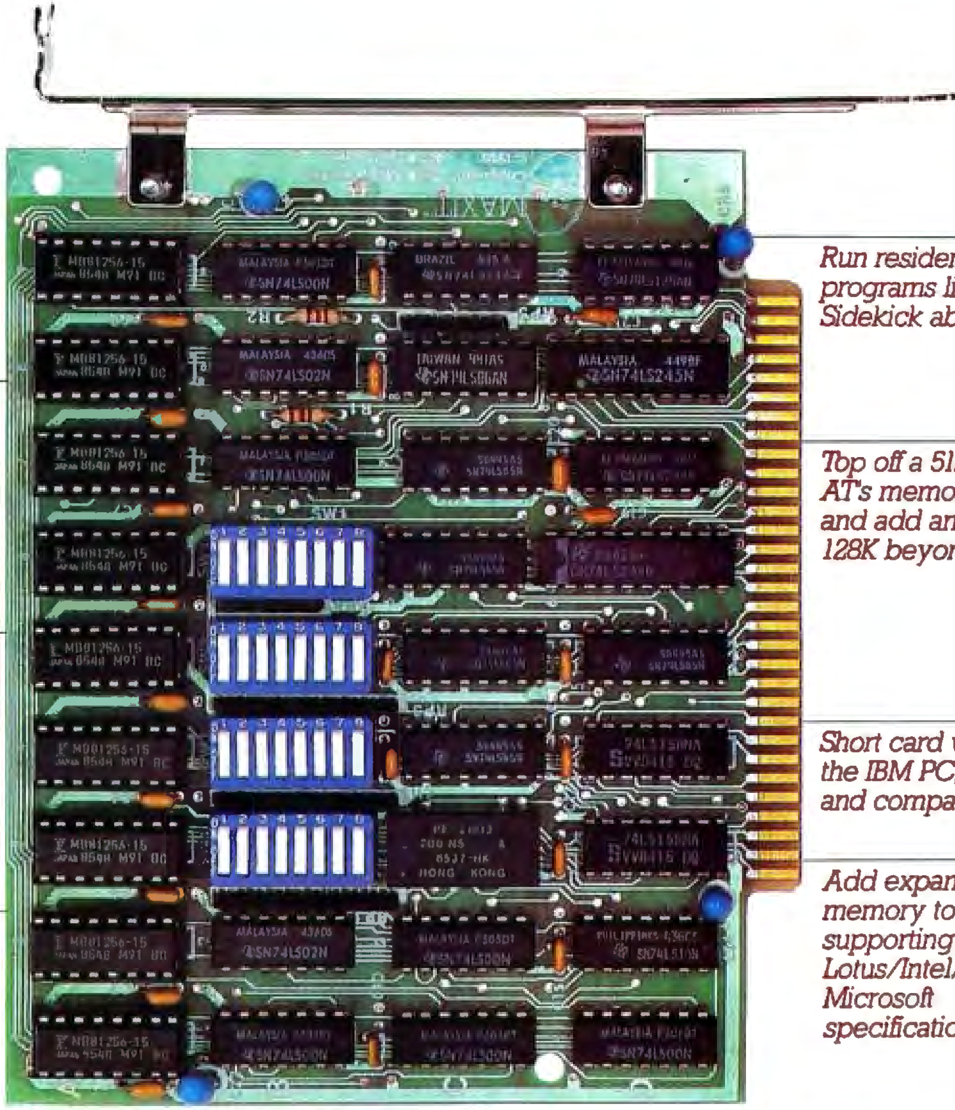

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info from the technical reference manual. We are certified (but not registered) developers at the University of Delaware, if that helps.
...Steve

---

apple/gs.graphsound #42, from robmoore
a comment to message 26

The info on the sound GLU IC is available to developers but we're trying to discourage people from talking directly to it. We have provided some very low-level, fast-access entry points in the sound tools to access the DOC sound chip and would really prefer that people use them. Otherwise it will be really tough to ever improve that stuff in the future without losing compatibility. In other words, IF YOU TALK DIRECTLY TO THE NEW HARDWARE, YOU WILL PROBABLY NOT BE COMPATIBLE WHEN WE COME OUT WITH A NEW MACHINE.

---

apple/gs.graphsound #43, from robmoore
a comment to message 27

The sound chip (the DOC) has its own dedicated 64K of RAM which is separate from the system RAM.

---

apple/gs.graphsound #51, from sgrant
a comment to message 42

OK, fair enough. But could you briefly describe what tools are available and how they are used? Also what is the sampling rate, i.e., bandwidth, for sound output and input, and can the voices be combined?

---

apple/gs.graphsound #74, from robmoore
a comment to message 51

The DOC includes 32 uncommitted oscillators that tend to be most usable when used in pairs per voice. With 32 oscillators enabled, the output sample rate is about 26.4 kHz giving a max output freq of 13.2 kHz or so - higher with less osc enabled. Voices and/or oscillators can be combined in numerous ways depending upon the software.

BRA LIMITS

apple/gs.developmt #18, from sgrant

The biggest problem I see is the limits on the branch instructions. If they are limited to a 64K bank, and wrap around on an overflow, does this mean that all program modules are limited to _exactly_ 64K? This could be a real problem for compiler writers, and a real nasty kludge for assembly programmers. Or maybe I am missing something here? I mean how can you be sure that your code will not cross a 64K boundary and what do you do if it does?
....Steve

---

apple/gs.developmt #20, from sglass (Steve Glass, Apple Computer)
a comment to message 18

Indeed a single segment of code is limited to 64K bytes since it cannot cross a bank boundary. This does not, however, limit an application to 64K bytes. Applications can be segmented and using the new development environment, tools and OS, this is very easy to do. The development environment for the IIGS is more powerful than anything we've had on the Apple II in the past. Code can be assembled and linked in multiple segments that are loaded by the system loader on an as-required basis. Intersegment references are resolved as segments are loaded. The loader calls the memory manager to find an appropriate-sized piece of memory for any segment being loaded.
Steven Glass, IIGS Software

---

apple/gs.developmt #24, from gs.softteam
a comment to message 18

You're right about the branch instructions. All of the short branch instructions are still limited to 1 byte. BRL takes a 2-byte operand. This can make things messy, but not too bad, since a code segment can't be larger than 64K. I don't know of many compilers that try to do branches between segments.
John Worthington, IIGS Software

---

apple/gs.developmt #32, from sgrant
a comment to message 20

I still don't see how dealing with a segment of code that turns out to be 68K in length can be handled without major problems.

---

apple/gs.developmt #33, from sgrant
a comment to message 24

So how do you make sure before you get deep into your code, that it won't require a branch across segments? And if it does, is it back to the drawing board?

---

apple/gs.developmt #34, from cheath
a comment to message 33

```
            bra     go_farther
            ...
 go_farther:jmp     where_I_Really_wanted_to_go
```

---

apple/gs.developmt #38, from mdavis
a comment to message 33

If the GS has any kind of decent assembler system, it should be able to report 64K boundary crossings for you. This would let you know where you should place a JML (in order to change the code segment) to the next 64K segment.

GRAPHICS

In this thread from the Graphic Display conference, requirements for a IBM PC-based graphics system and possible upgrade paths for current IBM PC owners are discussed.

---

grafic.disp/other #42, from mhaas (Mark Haas)

Robert, I'd be very interested in hearing what your criteria for a graphics system are. What do you expect from the software? The hardware?

---

grafic.disp/other #43, from rtinney (Robert Tinney, BYTE cover artist)
a comment to message 42

In answer to your question, Mark (keeping in mind that I'm not describing the ULTIMATE system; merely one with usable features and moderate price based on today's "state of the art"):

* 256 simultaneous colors, minimum;
* 600 x 400 res, or thereabouts;
* PC Paintbrush-type functions: various zoom levels, brushes, the ability to easily save the metamorphosing stages of a piece, etc. More sophisticated functions, such as pixel averaging, would be nice, but may rely on having many more colors available.
* The ability to produce a disk that is readable by color separation equipment. (This is generally already true of IBM PC-type systems, via third-party services such as ImageSet in San Francisco.)

Anyway, this is a good start; obviously this list will be quite obsolete in 2 (1? 1/2?) years, insofar as system capabilities are concerned (it already is if you have an AT and about $5000). But from another perspective, the system described above is very capable of producing genuinely moving artwork, in the right hands. And, of course, at some point during the march

(continued)

into the future one has to jump off the continuum and taste the fruit of what already exists, even if the stop is only a temporary one, before moving on.

---

grafic.disp/other #44, from mhaas
a comment to message 43

I think you'll be seeing a lot of boards coming on the market in the next 6 to 12 months that have anywhere from 640 by 480 with 256 colors to 1280 by 1024 with 256 colors (out of 16 million). Prices will probably start off high, though. And monitor prices seem a lot more sluggish than board prices. Figure on about $3 per K byte for the board and monitor for the higher resolutions and colors. My suspicion is that for your work, the number of colors is more important than the resolution. I would think 640 by 480 with 256 colors would be OK.

---

grafic.disp/other #46, from biiln (Bill Nicholls)

My current system is a nice piece of equipment, and if I was not programming, it would probably not need an upgrade. Recently I have been using MS Windows extensively and have finally figured out how to use multitasking. It only took six weeks of daily use. What are the other things I want to do? For starters, run more tasks under Windows and more concurrently. This requires a faster CPU and a larger display of higher resolution. But the higher-res display itself will take more cycles to refresh and this reduces system performance. One solution would be to wait for the new displays supported by the new graphics processors from Intel and TI. (I'll be doing some analysis on these chips in grafic.disp shortly.) But that will be an expensive solution for another year or so. Unless I win the lottery, that solution will have to wait too long. Meanwhile, here is a rough feel for the graphics-refresh problem:

IBM CGA:	640 x 200 x 1 = 16K bytes
Herc monographic:	720 x 348 x 1 = 32K bytes
IBM EGA:	640 x 350 x 4 = 112K bytes
Wyse/Amdek 700:	1280 x 800 x 1 = 128K bytes

To get the resolution I would like to have (Wyse 700) would mean eight times as many pixels to refresh (for full screen). This is not to say eight times slower. One big unknown is the speed/efficiency of pixel access. It may be that the Hercules is no slower than my CGA and the W700; much less than eight times slower. But until I test it or get info from the graphics display code writers, there is no way to tell. This is one part of the dilemma, and an important one.

Another part of the dilemma is the imminent appearance of 386-based machines. To upgrade now to an AT-class system (8-12 MHz) would be an obvious choice except that those machines will be quickly surpassed by 386-based systems, ESPECIALLY in multitasking. Finally, there's the imminent appearance of MS-DOS 5.0, the full MT system. What will be the required hardware configuration? Will it run as is on current ATs? If I move before it appears, I risk not being able to run full MT without another upgrade. AAARRRGGGHHH!!! If I wait for DOS 5.0, will the 386 machines be close enough to wait for them? GAK! If I add much more to my current system, it will slow to the point of being unacceptable. But I need to do something! [Sound of ARGH! echoing around inside of head.]

I hope that the above explanation will begin to convey the dilemma I face. Another aspect, well known to me, is that waiting for the latest (and greatest) stuff can be an infinite wait process as time and *technology* march on. One must take a stand somewhere and say "Hold, enough." I have a fairly good idea of where I want to be but what is the "best" upgrade path? More on this later. Keep in mind that a good display is an essential part of the solution.

BiIIN

---

grafic.disp/other #51, from biIIn

TITLE: Finding the Right Upgrade Path, Part 2

Given the series of linked dilemmas mentioned in my prior message, what might be done about it? One of the key but unstated issues here is user interface. Controlling multitasking (MT) needs some kind of ability for the user to "see" (in some sense) what is happening.

Under MS Windows, the method required is to have a tiled (non-overlapping) window active for each task with enough data showing so that the user can figure out what is going on. In my case (a CGA 640 x 200), a one-quarter screen is about the smallest practical size, either a quadrant or a narrow horizontal slice. Since most of my work requires the equivalent of 80 columns of text for comprehension, I usually slice the screen horizontally and move the boundary of the part I am using down until it has 75% of the screen.

This has two implications. Since a full screen is often needed for easy comprehension, working on 3/4 can be a minor problem. More importantly, I can really only run two programs effectively with my current display. The upgrade path referred to above *must* address the display capability as top priority since that will be the limiting factor in the human - machine interface for multitasking.

Now that we have wandered around the barn in discussion, we can get to the question of "What Display?" Given the above explanation, my desire for a 1280 x 800 screen may now be better understood. That is four times the horizontal and twice the vertical resolution I currently use. Unfortunately, resolution has its price - $1500 and slower refresh. How much slower? Hard to tell until I can experiment or get speed reports from other (reliable) sources. Since resolution and speed are both issues, let's look at the remaining two display options that illustrate the difficulty in making a decision. In this process, I assume that other people are like me and have limited funds for upgrades.

The two remaining choices are Hercules and EGA. The difference in resolution is small enough that we can ignore that for the moment. The big difference is the advantage of color vs. the performance cost of almost four times as many bytes to update. A second issue is the dollar cost difference, both controller and display. A Herc clone and display will set you back around $250 to $300, an EGA clone and display will cost around $800 to $1200, with most of the difference in the display cost. Another option is the EGA controller and a monochrome graphics display (about $400 to $500). There is a patch to run Windows on the EGA with Herc resolution. Given these three options, how can we choose between them? Right off the bat, one of these is NOT going to be acceptable for any PC- (8088) based system. That is the color EGA.

Between the number of pixels and complex updating code required, EGA will simply be too slow. Based on CGA performance on my 8-MHz PC clone, EGA would be slower by two to four times, even allowing for not waiting for retrace to avoid snow. Even twice as long is too long for me, regardless if the window is bigger.

(These estimates are not based on experiments - just estimates.)

There is another reason an EGA is not recommended for PCs. That is the potential compatibility problems between some speed-up boards and separate EGA controllers. Since multitasking will take as much performance as you can get at least some of the time, it makes no sense to further slow the system with

(continued)

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excessive display overhead. Adding an EGA board and 80286 board makes little sense if all you net is a fancier display (at the cost of a base AT system!). Given that, even the EGA controller/monochrome display may not be the choice for 8088 systems.

By logically eliminating 2 of 3 choices, it looks like the test to run is the Herc card and monochrome display for better MT display. But the key advantage will be based on whether the display will allow greater than 80 x 25 effective size thru the use of smaller character size. I'll try to line up a borrowed Herc card and display to run that test along with some comparative display speed tests. Stay tuned for the next episode of "As the Display Turns." :-) BillN

grafic.disp/other #66, from billn

TITLE: Finding the Right Upgrade Path, Part 3

While I line up the Herc/monochrome test, there are a few other issues. The two primary ones are disk storage and processor speed. While these problems affect everyone to a greater or lesser degree, multitasking (MT) and large graphic displays create the largest loads. Let's take a brief look at the long view to see where we're headed.

Clearly, MT systems will be based on both 286 and 386 processors. The larger demands will migrate to 386 systems while smaller may stay on fast 286 systems. With the advent of 16-MHz 286 systems (and with 20- and 24-MHz systems in development), there is more potential life in the 286 than was apparent at first. The 386 will overlap the high-end 286 and take off from there. A 16-MHz 286 runs five to ten times as fast as a standard PC, twice as fast as a standard AT, enough for three or four tasks with minimal delays.

Also, in the longer view are graphics processors such as the Intel and TI chips that will offload graphics refresh and update from the main processor, allowing better performance even for current (slow) 8-MHz ATs. Until they arrive, graphics update will continue to burden the main processor.

To the rescue for disk performance and capacity come two relatively new tools. Disk caching is a way to reduce access time to repeated files on disk. Run-length encoding will add 50% to the capacity of disks that have quality-plated media. And CORE has a very (expensive) high-performance 250-Mb disk that uses a custom controller. These developments will converge into a new set of higher-performance disk hardware and software that will become available in the near future.

In the future, then, all of our problems will be solved, right? Well, most of our current ones anyway. But there will be new challenges then to keep things from getting dull. [Who's that I hear screaming in the back "Whaddaa I do NOW?" I'm getting to that.] After the above, an 8-MHz AT doesn't look so hot anymore, does it? Based on memory speeds, the 20- and 24-MHz versions, when available, will have to use either cache memory or static RAM, both of which will raise the cost.

So it is likely that the 16-MHz version will be the most cost-effective system with large memory for the near future. Since the first one of those is now becoming available from PC's Limited (this is *not* a plug), that may be an optimum option for the next two years or so. The processor option for the short term looks to be something like the breakthru 286, an 8-MHz half-length board with 16K cache that runs at approximately three to six times the speed of the PC.

With the Compaq 386 just announced, let's look at the range of options available:

System type	Processor clock	Memory (ns)	Cost (base system)	Performance ratio (approx)	Cost/Perf ratio
IBM PC	8088/4.77	200	$600-800	1.0	600
Turbo PC	8088/8.00	150	$800-1000	1.6	500
Basic AT	80286/6.00	150	$1200-1400	2.0	600
Std. AT	80286/8.00	150	$1400-1600	2.5	560
Brk 286	80286/8.00	cache	$400	2.5	160 *
Turbo286	80286/8.00	120	$900	3.0	300 *
AT - 10	80286/10.0	120	$2300	3.1	740
AT - 12	80286/12.0	100	$2700	3.7	720
AT - 16	80286/16.0	70	$3000	5.0	600
CQ 386	80386/16.0	100 +	$6500	8.0	700

Note:
* Marks expansion cards for PCs, one short, one long.
+ Static memory

Some interesting things appear from the above table. Except for the expansion cards, the cost/perf ratio is *remarkably* constant in the range of 500 to 740 over a very broad range of systems. Though not quite as surprising when you consider that costs involved in newer products offset some of the economy of scale/higher integration used.

Another surprise - a base or turbo PC plus a short expansion card ($400) gives the best cost/perf ratios of 400-480. This does overlook other issues but appears valid for a first cut. Note that the PC ratio improves by 200 but the turbo PC only by 20. So an inexpensive 286 card will help my performance but not my cost/performance, while it helps both if you have a standard PC.

Finally, if you gotta have performance, the Compaq 386 is a buy, but costly to expand (static memory). Otherwise, an AT at 16 MHz looks good. For upgrades, if you have a PC, get an inexpensive 286 speed-up card. For turbo PCs and basic ATs that cannot be speeded up, the 16-MHz AT represents a big jump at a reasonable cost.

One last warning. As I said some months ago, 1986-87 will be similar to 1981-82 in the amount of change/new products that we see. The dam has broken on 386 products, the flood will be here soon.

This information is as accurate as I can put together right now. I'll update this periodically; meanwhile it's food for thought. Stay tuned for more on the upgrade path question. BillN

COMMUNICATIONS PROGRAMS FOR BIX

One of the most common questions asked of the BIX staff concerns communications programs that work with BIX. The following list, compiled by George Bond, Executive Editor of BIX, shows some of the programs that, according to people using BIX, work for uploading and downloading with BIX.

bix.business/tips #5, from gbond (George Bond, Executive Editor, BIX)

This is a list of telecommunications programs that BIX users have reported work reliably for file transfers to and from BIX.

Work OK	PC/BIX
Crosstalk XVI	Ascii-Pro
*PC-Talk	MDM740
MEX	*1RD
*Mini Term (sometimes)	*Procomm
*RedRyder	Mack
*TICOMM	*FastTerm
Access	*QModem
MITE (Framework II version, at least)	

* = in listings area

This list is not exhaustive. If you are using a program not listed here to upload and download from BIX, please send BIXmail to sysmgr so that the name of your program can be added to this list.

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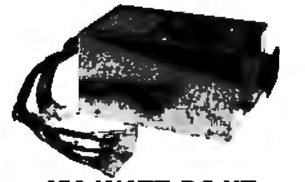

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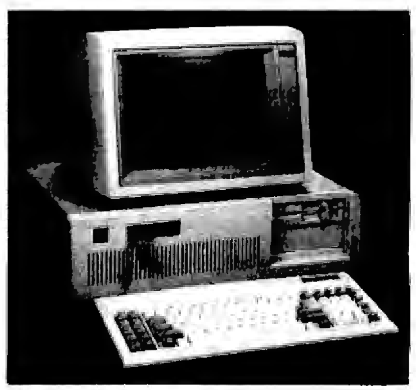

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COMMODORE

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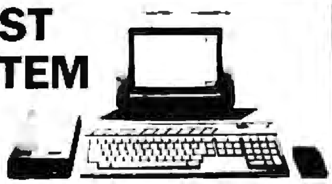

Includes 520ST computer with modulator, disk drive, mouse, Basic, Neochrome, and monochrome or color monitor.

Monochrome **$599** Color **$779**

Peripherals for ATARI

800 XL Computer........................$79.99
65 XE Computer..........................89.99
130 XE Computer........................139.00
1050 Disk Drive..........................129.00
1020 Color Printer.........................29.99
1025 Dot Matrix Printer...............149.00
1027 Letter Quality Printer...........109.00
Atari XM801 XL/XE Dot Matrix.....189.00
Atari XM804 ST Dot Matrix..........199.00
Epson Homewriter 10 w/PIC........149.00
Multi-Tech 13" Color Monitor.......159.00
NAP 12" Green Monitor................79.99
Atari XM301 Modem.....................39.99
Atari 835 Modem..........................29.99
Anchor Volksmodem.....................59.99
Supra 1200 AT Modem...............159.00
Supra 1200 ST Modem...............159.00
Supra 1150.................................49.99
ICD PR Connection......................59.99
Atari 850 Interface......................109.00
Atari 20 Meg Hard Drive for ST...729.00

COMPUTERS

Atari 520ST Computer...............$339.00
Apple Macintosh 128K...............1099.00
Apple IIc Computer......................499.00
Apple IIe 128K CPU....................499.00
Amiga 1000 Computer.................749.00
Commodore 32K/40 col...............199.00
CBM Super Pet...........................299.00
Commodore 16.............................69.00
Commodore Plus 4.......................49.00
Compaq Portable 2 DD.............1299.00
Compaq Portable 286, I............3099.00
Eagle PC-1.................................399.00
Epson PX-8 Geneva....................649.00
IBM PC 256K, 2 DD, KBD...........799.00
ITT 256K, 2 DD, P, S, KBD.........699.00
Kaypro PC 256K, 1 DD, P/S w/Soft799.00
Sperry IT 512K, 1.2 DD, 44.6 2799.00
Zenith 138 256K, 2 DD, 7" mono1099.00
Zenith 148 256K, 2 DD...............929.00
Zenith 162 Port, 2 DD...............1249.00

MONITORS

Atari 124 Hi Res Mono (ST)........169.00
Amdek 310A Amber TTL.............109.00
Amdek 300G Green Composite.....89.00
AT&T Monochrome......................179.00
BMC 12" Green Composite...........59.00
Commodore 1902 RGBI 13"........249.00
Compaq Dual-Mode Green..........179.00
IBM PCjr. Color RGB Monitor......299.00
ITT 14" Amber TTL....................109.00
Magnavox 8562 RGB/Composite..239.00
Quadram Quadchrome 8400 RGB399.00
Quadram Amberchrome 12" TTL.129.00
Taxan RBG I Monitor.................299.00
Zenith 1230 Green 12" Composite79.00

AMIGA SYSTEM PACKAGE

Includes: Amiga 1000 CPU, 512K, Mouse, Amiga RGB Monitor, Amiga DOS Basic, Tutorial, Kaleidoscope, and Voice Synthesis Library.

SYSTEM PRICE **$1199**

Peripherals for COMMODORE

Commodore 128 Package: CB128, CB1571 Drive, Magnavox 8562 RGB/Comp. Monitor...............$759.00
Commodore 64C.........................199.00
Commodore 64 Package: CB64, CB1541 Drive, Taxan 220 Color Monitor..........................479.00
Amiga 1020 5¼" External...........199.00
Amiga 1010 3½" External...........229.00
Magnavox RGB/Comp.................289.00
NEC 1216 12" RGB....................299.00
CBM 1660 (C-64).........................59.99
CBM 1670 (C-128)......................179.00
Okidata Okimate 10 Printer.........199.00
Star SL10C Printer.....................219.00
PPI Printer Interface....................34.99
Xetec 8K.....................................69.99
Micro R&D MJ350........................44.99
Commodore 1541C.....................199.00
Commodore 1541 Drive..............199.00
Commodore 1571 Drive..............249.00

SCRATCH & DENT PRINTERS

Atari 820 Printer..........................$10.00
Axiom GP 550 Parallel NLQ..........89.00
CBM 132 Column Printer............199.00
Diablo 620 Serial Printer.............299.00
Epson FX-85 NLQ, 160 cps.........299.00
Epson HI-80 4 Pen Plotter 329.00
Epson JX-80 Color Printer...........229.00
Epson LX-80 NLQ.......................199.00
Comrex CR-220 Atari Printer.........59.00
ES600 Six-Shooter 6 Pen............599.00
Hush 80 Printer............................49.00
IBM Quietwriter "R" Mod-2.........910.00
Juki 6000 LQ Daisywheel............179.00
Juki 6100 LQ Daisywheel............389.00
Mannesmann Talley 180L P/S.....399.00
Okidata 192 Parallel....................249.00
Okidata 193 IBM P-N-P..............399.00
Okidata 92 IBM P-N-P................299.00
Star SG-15 Dual Mode...............339.00
Star GRAF II Apple.......................59.00
Sanyo 5000 Letter Quality...........199.00
Silver Reed 550 LQ Parallel........259.00
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Toshiba 1351 Printer..................339.00
C.Itoh A10-30SP.........................229.00
C.Itoh 1550 BCD.........................419.00
C.Itoh F10-40 Parallel 40 cps.......729.00
C.Itoh F10-55 Parallel 55 cps.......979.00
C.Itoh 7500P..............................149.00

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18C Bus Consultant..................$139.95
12C Slim Financial.......................74.99
15C ADV Scientific........................74.99
41CX ADV Feature.......................199.00
11C Slim Scientific........................44.99
16C Prog Scientific.......................92.99

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Inquiry 88

7400

Part No.	1-9	10+	Part No.	1-9	10+
7400	.29	.19	7485	.65	.55
7402	.29	.19	7486	.45	.35
7404	.35	.25	7489	2.05	1.95
7405	.39	.29	7490	.49	.39
7406	.39	.29	7493	.45	.35
7407	.39	.29	74121	.45	.35
7408	.35	.25	74123	.59	.49
7410	.35	.25	74125	.55	.45
7414	.49	.39	74126	.75	.65
7416	.45	.35	74143	4.05	3.95
7417	.45	.35	74150	1.35	1.25
7420	.35	.25	74154	1.35	1.25
7430	.35	.25	74158	1.59	1.49
7432	.39	.29	74173	.85	.75
7438	.39	.29	74174	.65	.55
7442	.55	.45	74175	.65	.55
7445	.79	.69	74176	.99	.89
7446	.89	.79	74181	1.95	1.85
7447	.89	.79	74189	2.05	1.95
7448	2.05	1.95	74193	.79	.69
7472	.75	.65	74198	1.85	1.75
7473	.45	.35	74221	.99	.89
7474	.45	.35	74273	2.05	1.95
7475	.49	.39	74365	.69	.59
7476	.45	.35	74367	.69	.59

74LS

Part No.	1-9	10+	Part No.	1-9	10+
74LS00	.29	.19	74LS165	.75	.65
74LS02	.29	.19	74LS166	.99	.89
74LS04	.35	.25	74LS173	.59	.49
74LS05	.35	.25	74LS174	.49	.39
74LS06	1.09	.99	74LS175	.49	.39
74LS07	1.09	.99	74LS189	4.59	4.49
74LS08	.29	.19	74LS191	.59	.49
74LS10	.29	.19	74LS193	.79	.69
74LS14	.49	.39	74LS221	.69	.59
74LS27	.35	.25	74LS240	.79	.69
74LS30	.29	.19	74LS243	.79	.69
74LS32	.35	.25	74LS244	.79	.69
74LS42	.49	.39	74LS245	.89	.79
74LS47	.99	.89	74LS259	.99	.89
74LS73	.39	.29	74LS273	.89	.79
74LS74	.35	.25	74LS279	.49	.39
74LS75	.39	.29	74LS322	4.05	3.95
74LS76	.55	.45	74LS365	.49	.39
74LS85	.59	.49	74LS366	.49	.39
74LS86	.35	.25	74LS367	.49	.39
74LS90	.49	.39	74LS368	.49	.39
74LS93	.49	.39	74LS373	.79	.69
74LS123	.59	.49	74LS374	.79	.89
74LS125	.49	.39	74LS393	.89	.79
74LS138	.49	.39	74LS590	6.05	5.95
74LS139	.49	.39	74LS624	2.05	1.95
74LS154	1.09	.99	74LS629	2.29	2.19
74LS157	.45	.35	74LS640	1.09	.99
74LS158	.45	.35	74LS645	1.09	.99
74LS163	.59	.49	74LS670	1.09	.99
74LS164	.59	.49	74LS688	2.05	1.95

74S/PROMS*

74S00	.29	74S188*	1.29
74S04	.35	74S189	1.69
74S08	.35	74S196	2.49
74S10	.29	74S240	1.49
74S32	.35	74S244	1.49
74S74	.45	74S253	.79
74S85	1.79	74S287*	1.49
74S86	.35	74S288*	1.49
74S124	2.95	74S373	1.49
74S174	.79	74S374	1.49
74S175	.79	74S472*	2.95

74ALS

74ALS00	.35	74ALS138	.89
74ALS02	.35	74ALS174	.89
74ALS04	.39	74ALS175	.89
74ALS08	.39	74ALS240	1.49
74ALS10	.39	74ALS244	1.49
74ALS27	.39	74ALS245	1.49
74ALS30	.39	74ALS373	1.69
74ALS32	.39	74ALS374	1.69
74ALS74	.49	74ALS573	1.69

74F

74F00	.39	74F139	.89
74F04	.39	74F157	.95
74F08	.39	74F193	3.95
74F10	.39	74F240	1.39
74F32	.39	74F244	1.39
74F74	.49	74F253	.99
74F86	.59	74F373	1.39
74F138	.89	74F374	1.39

CD—CMOS

CD4001	.19	CD4081	.25
CD4011	.19	CD4082	.25
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.55	CD40103	2.49
CD4018	.59	CD4503	.35
CD4020	.59	CD4510	.69
CD4024	.49	CD4511	.69
CD4027	.35	CD4515	.89
CD4030	.29	CD4518	.75
CD4040	.65	CD4520	.75
CD4049	.29	CD4522	.79
CD4050	.29	CD4538	.79
CD4051	.59	CD4541	.69
CD4052	.59	CD4543	.79
CD4053	.59	CD4553	4.95
CD4059	3.95	CD4555	.79
CD4060	.65	CD4566	2.49
CD4066	.29	CD4572 (MC14572)	.39
CD4069	.25	CD4583	.89
CD4070	.25	CD4584	.39
CD4071	.25	CD4585	.89
CD4072	.25	MC14411P	8.95
CD4076	.65	MC14490P	4.49

COMMODORE CHIPS

Part No.	Price	Part No.	Price	Part No.	Price
SI-3052P 5V Pos. Reg. 2A	5.95	6545-1 CRTC	2.49	8701 Clock Chip	9.95
6502 MPU w/Clock	2.25	6551 ACIA	3.29	*8721 PLA	14.95
6504A CPU	1.95	6560 VIC-I	10.95	8722 MMU	9.95
6507 CPU	4.95	6567 VIC-II	14.95	251104-04 Kernal ROM	10.95
6508 MPU w/RAM & I/O	8.95	6569 VIC PAL	14.95	325572-01 Logic Array	24.95
6510 CPU	9.95	6572 VIC PAL-N	14.95	*82S100PLA (906114-01)**	13.95
6520 PIA	1.75	6581 SID	14.95	901225-01 Char ROM	11.95
6522 VIA	2.95	8360 Text Editing	10.95	901226-01 BASIC ROM	11.95
6525 TPI	7.95	8501 MPU	10.95	901227-03 Kernal ROM	11.95
6526 CIA	14.95	8502 MPU	7.95	901229-05 Upgrd ROM	15.95
6529 SPI	4.95	8563 CRT Contr	15.95		
6532 128x8 RAM,I/O,Tim.Ar	6.49	8564 VIC	15.95		

*No spec. avail. 8721 and 82S100PLA
**NOTE: 82S100PLA = U17 (C-64)

NEC V20 & V30 CHIPS

Replace the 8086 or 8088 in Your IBM-PC and Increase Its Speed by up to 40%!

Part No.	Price
UPD70108-5 (5MHz) V20 Chip (Replaces the 8088)	$ 9.95
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MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

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Z80A	1.35
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Z80A-PIO	1.49
Z80A-SIO/0	4.95
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6800	1.75
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6821	1.29
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6500/6800/68000 Cont.

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6850	1.49
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68000L8	11.95
68661PB	5.95
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8073	29.95
8080A	2.49
8085A	2.29
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8086-2	8.95
8087 (5MHz)	125.00
8087-2 (8MHz)	159.95
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8088-2	8.95
8116	4.95
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8156	2.49
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8203	14.95
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8228	2.49

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8255A-5	1.69
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8259-5	1.95
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8279-5	2.95
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ADC0808CCN	5.95
ADC0809CCN	3.95
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ADC0817CCN	8.95
DAC0808LCN	1.95
DAC1008LCN	6.49
AY-3-1015D	4.95
AY-5-1013A	3.95

Part No.	Function		Price
DYNAMIC RAMS			
4116-15	16,384 x 1	(150ns)	.89
4128-20 (Piggyback)	131,072 x 1	(200ns)	4.49
4164-150	65,536 x 1	(150ns)	1.15
4164-200	65,536 x 1	(200ns)	.95
TMS4416-12	16,384 x 4	(120ns)	4.25
8118	16,384 x 1	(120ns)	.69
41256-150	262,144 x 1	(150ns)	2.95
50464-15	65,536 x 4	(150ns) (4464) (41464)	4.95
STATIC RAMS			
2016-12	2048 x 8	(120ns)	1.69
2102	1024 x 1	(350ns)	.89
2102-2L	1024 x 1	(250ns) Low Power (91L02)	1.95
2114N	1024 x 4	(450ns)	.99
2114N-L	1024 x 4	(450ns) Low Power	1.09
2114N-2	1024 x 4	(200ns)	1.05
2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
2149	1024 x 4	(45ns)	4.95
5101	256 x 4	(450ns) CMOS	1.95
6116LP-2	2048 x 8	(120ns) Low Power CMOS	2.95
6116P-3	2048 x 8	(150ns) CMOS	1.89
6116LP-3	2048 x 8	(150ns) Low Power	1.95
6264P-12	8192 x 8	(120ns) CMOS	3.89
6264LP-12	8192 x 8	(120ns) Low Power CMOS	4.25
6264P-15	8192 x 8	(150ns) CMOS	3.59
6264LP-15	8192 x 8	(150ns) Low Power CMOS	3.75
6514	1024 x 4	(350ns) CMOS (UPD444C)	4.49
43256-15L	32,768 x 8	(150ns) Low Power	24.95
PROMS/EPROMS			
1702A	256 x 8	(1µs)	6.95
TMS2516	2048 x 8	(450ns) 25V	4.95
TMS2532	4096 x 8	(450ns) 25V	5.95
TMS2564	8192 x 8	(450ns) 25V	8.95
2708	1024 x 8	(450ns)	4.95
TMS2716	2048 x 8	(450ns) 3 voltage	9.95
2716	2048 x 8	(450ns)	3.75
2716-1	2048 x 8	(350ns) 25V	4.95
27C16	2048 x 8	(450ns) 25V (CMOS)	6.49
2732	4096 x 8	(450ns)	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
2732A-45	4096 x 8	(450ns) 21V	3.75
27C32	4096 x 8	(450ns) 25V (CMOS)	6.49
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.75
2764A-25	8192 x 8	(250ns) 12.5V	4.25
2764-45	8192 x 8	(450ns) 21V	3.49
27C64	8192 x 8	(450ns) 21V (CMOS)	5.49
27128-25	16,384 x 8	(250ns) 128K 21V	4.25
27128A-25	16,384 x 8	(250ns) 12.5V	4.95
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	5.95
27256-25	32,768 x 8	(250ns) 256K (12.5V)	5.95
27C256-25	32,768 x 8	(250ns) 256K (CMOS) (12.5V)	8.95
27512-25	65,536 x 8	(250ns) 512K (12.5V)	19.95
68764	8192 x 8	(450ns) 25V	15.95
68766	8192 x 8	(350ns) 25V	16.95
74S387	256 x 4	PROM O.C.	1.29
74S471	256 x 8	PROM T.S.	4.95
N82S123	32 x 8	PROM T.S.	2.49

SATELLITE TV DESCRAMBLER CHIP

The MM5321 is a TV camera sync generator designed t supply the basic sync functions for either color or mono chrome 525 line/60Hz interlaced and camera video recorde applications. **COLOR BURST GATE & SYNC ALLOW STABLE COLOR OPERATION**

MM5321N $11.9

INTERSIL Also Available!

74HC HI-SPEED CMOS

Part No.	Price	Part No.	Pric
74HC00	.25	74HC175	.6
74HC02	.25	74HC221	.9
74HC04	.29	74HC240	.7
74HC08	.29	74HC244	.7
74HC10	.29	74HC245	.8
74HC14	.49	74HC253	.5
74HC30	.29	74HC259	.6
74HC32	.29	74HC273	.7
74HC74	.39	74HC373	.7
74HC75	.39	74HC374	.7
74HC76	.45	74HC393	.7
74HC85	.79	74HC595	1.1
74HC86	.39	74HC688	.7
74HC123	.89	74HC4040	.8
74HC125	.49	74HC4049	.5
74HC132	.49	74HC4050	.5
74HC138	.49	74HC4060	1.0
74HC139	.49	74HC4511	1.2
74HC154	1.19	74HC4514	1.1
74HC163	.65	74HC4538	.8
74HC174	.69	74HC4543	1.1

74HCT — CMOS TTL

74HCT00	.29	74HCT139	.5
74HCT02	.29	74HCT157	.6
74HCT04	.29	74HCT174	.6
74HCT08	.29	74HCT175	.6
74HCT10	.29	74HCT240	.9
74HCT32	.29	74HCT244	.9
74HCT74	.49	74HCT245	1.1
74HCT86	.49	74HCT373	1.1
74HCT138	.59	74HCT374	1.1

74C — CMOS

74C00	.29	74C174	.7
74C02	.29	74C175	.7
74C04	.29	74C221	1.4
74C08	.35	74C240	1.2
74C10	.35	74C244	1.2
74C14	.49	74C373	1.4
74C32	.35	74C374	1.4
74C74	.59	74C912	7.5
74C85	1.39	74C915	1.3
74C86	.35	74C920	9.9
74C89	5.19	74C921	9.9
74C90	.99	74C922	3.8
74C154	2.95	74C923	3.9
74C173	1.05	74C925	5.9

LINEAR

DS0026CN	1.95	LM1458N	
TL074CN	.89	LM1488N	
TL084CN	.99	DS14C88N (CMOS)	1.
AF100-ICN	8.95	LM1489N	
LM307N	.45	DS14C89N (CMOS)	1.
LM309K	1.25	LM1496N	
LM311N	.45	MC1648P	4.
LM317T	.79	LM1871N	2.
LM318N	.99	LM1872N	2.
LM319N	.99	LM1896N-1	1.
LM323K	3.95	ULN2003A	
LM324N	.39	XR2206	3.
LM338K	4.95	XR2211	2.
LM339N	.39	XR2243	1.
LF347N	1.79	DS26LS29CN	4.
LM348N	.69	DS26LS31CN	1.
LM350T	2.95	DS26LS32CN	1.
LF351N	.39	DS26LS33CN	1.
LF353N	.49	LM2901N	
LF355N	.79	LM2907N	2.
LF356N	.79	LM2917N (8 pin)	1.
LF357N	1.09	MC3419CL	9.
LM358N	.49	MC3446N	2.
LM360N	2.19	MC3450P	2.
LM361N	1.79	MC3470P	1
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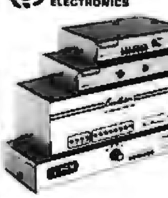

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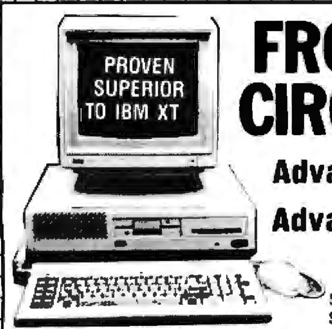
Inquiry 286



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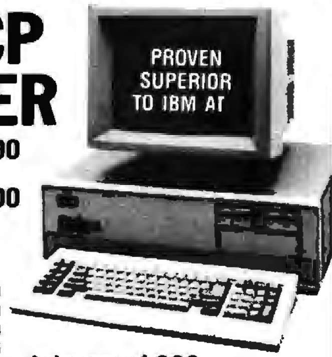

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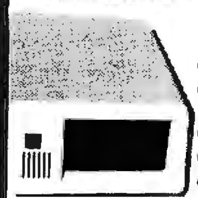

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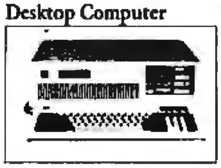

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Compaq Deskpro 286 512K	8195
IBM PC XT 640K	1699
IBM PC 256K	1095

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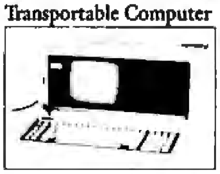

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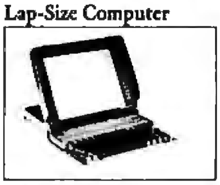

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Bernoulli 20MB cartridge	72
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Maxell MD2-HD 10 disks	35

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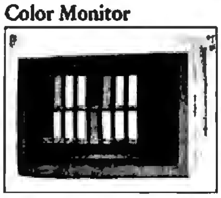

Princeton HX-12	442
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Princeton SR-12 P	735
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Taxan 630	450
Taxan 640	515

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Monochrome Monitor

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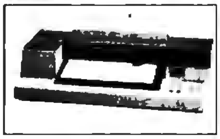

HP 7475 A Plotter	1744
Houston Ins. DPM 56	8169
Roland 880 8 pen	966

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Microsoft Mouse	119
Mouse System Mouse	139

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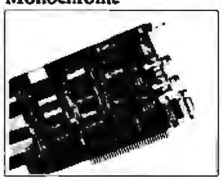

Hercules Graphics Card	194
Everex Edge	239
ATI...Mono/color/high/res	239
Clone monochrome graphic	85
Persyst Bob/MG mono/RGB	171

Graphics Board Color

Paradise Mod. Graphics	249
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Graphics Board EGA

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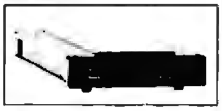

US Robotics Direct 1200	149
US Robotics 1200 PC INT	139
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Everex Evercom 1200	139

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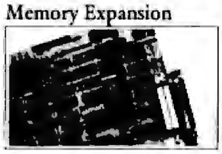

AST SixPakPlus	188
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AST Rampage PC	234
AST Rampage AT	445
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8087	119
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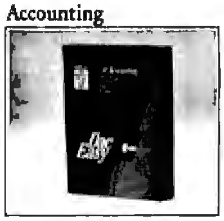

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PC-File III, Buttonware	69

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Javelin, Javelin Software	549

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Andrew Tobias' MECA	115
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Basic Compiler Microsoft	227
Turbo Prolog, Borland	58
Microsoft Quick Basic	72
R:base System V	369
Think Tank	109

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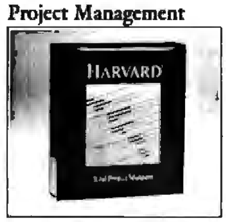

Harvard, Software Pub	299
Microsoft Project	238
Time Line, Breakthrough	235

Spreadsheet

1-2-3, Lotus	305
SuperCalc 3, Computer As	277
Multiplan, Microsoft	111
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Typing Tutor III, Simon & Simon	42

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SideKick, Borland	28
Traveling SideKick	41
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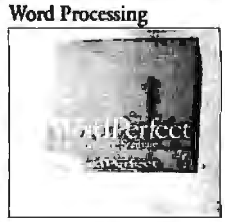

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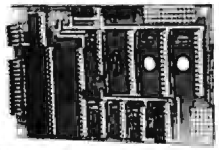

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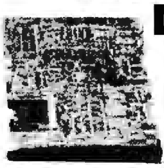

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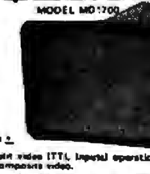

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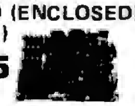

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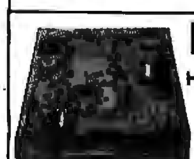

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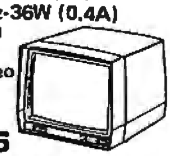

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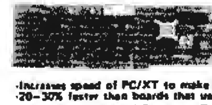

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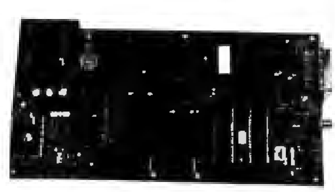

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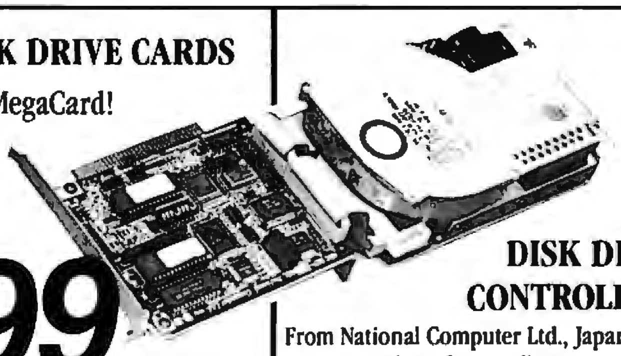

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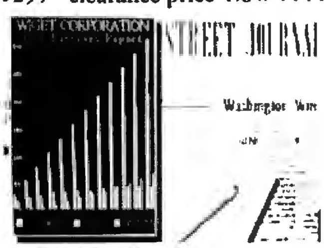

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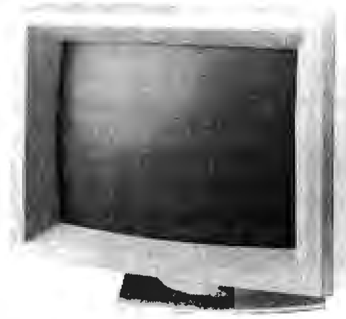

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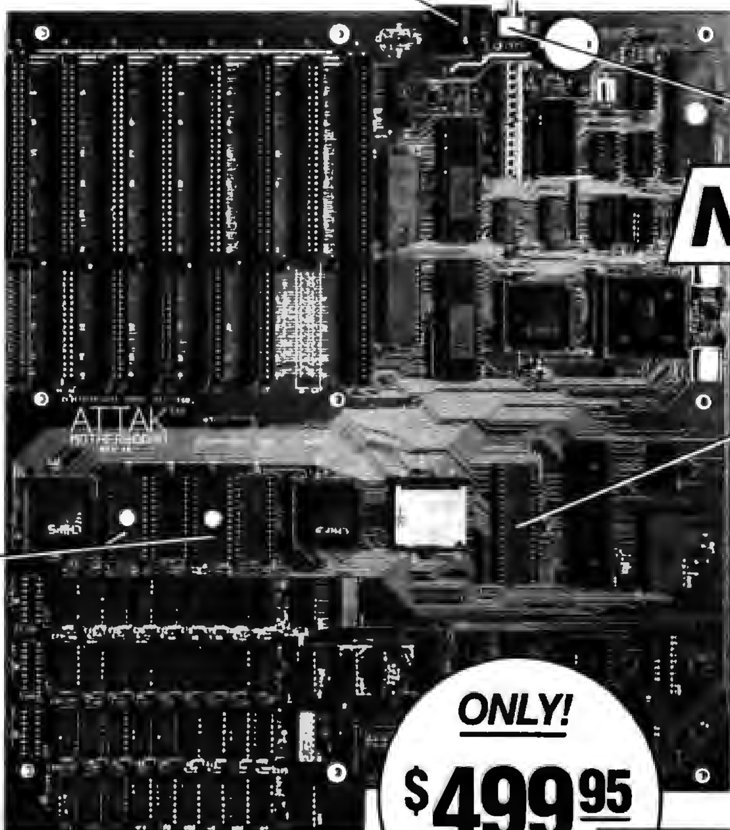

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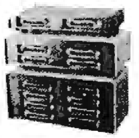

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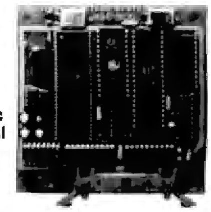

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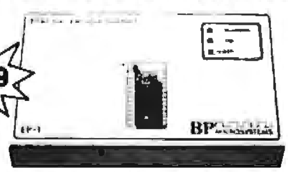

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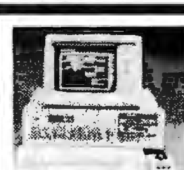
Inquiry 301



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California Digital

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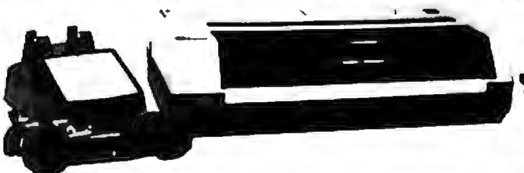
Portable FAX Machine



~~$995~~ $559

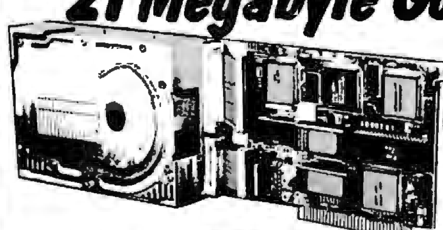
Just the FAX mam! ...Corny, well maybe, but if Sargeant Friday had a **DataFax 300** back when doing Dragnet he could have filed his report over his fax machine from any telephone in the World.

The **DataFax 300** is the first truly portable facsimile machine, operating on self contained rechargable nickel-cadmium batteries. The unit transmits or receives a full 8½" by 11" sheet is less than three minutes. This is a CCITT Group II machine and is capable of communicating with faster Group III fax machines.

The acoustical coupler supplied with the **DataFax 300** allows the user to send copy and pictures from the office or even airport payphones without the need of external power. To receive transmissions, simply make voice contact with the sending party and attach the coupler to your telephone hand set.

The **DataFax 300** includes a soft sided nylon carrying case along with 100 sheets of electrostatic copy paper. Optional RJ-11 connector jack available.

21 Megabyte Gold Card



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• 65ms Access Time - *Fastest Available* • Automatic Head Unloading - *Protects Heads an. Media* • 2K Sector Buffer - *Increases System Throughput* • High Reliability: 28,000 hr. MTBF *No one else even close* • 15.5 Watt Power Consumption - *Lowest Available* • 2 Year Warranty *Longest Available*

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IBM 8MHz./XT Compatible

$579

- DOS 3.2 & GW Basic
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- 135 Watt Power Supply
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The Eclipse Turbo 16/XT is an outstanding value in IBM Compatible Computers. After careful research and evaluation we found it to be the most reliable XT compatible available.

The computer includes some of the most recent features available, such as the 8 MHz. (software selectable to 4.77 MHz.) multi-layer motherboard with 256K of RAM upgradable on board to 640K. A generous eight expansion slots and 135 Watt power supply give you ample room and power for add-on boards. And our floppy controller supports up to four drives, so as many as three additional drives can be added. The units is complete with manuals, GW Basic and the new version of MicroSoft **DOS 3.2** along with the AT style keyboard.

The Turbo 16/XT is FCC and Underwriters Laboratories approved. Finally, each computer is configured and fully tested before sending it to you.

Satisfaction Guaranteed! We're really excited about this new unit, and so sure you will be too.. that you may return the Eclipse 16 for a full credit towards an IBM PC if you are not completely satisfied.

20MB Hard Drive w/Controller $429
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1200 Internal Modem w/Software 129

NOW YOUR COMPUTER CAN READ!!

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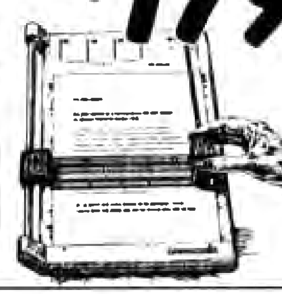
Omni-Reader... the first optical character reader **designed and priced for the small computer**



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Uses a standard RS-232 serial port hookup to interface eaisily with your computer.

1200 BAUD MODEMS

AVATEX 1200

$99

This 300/1200 baud modem matches the design specs of the Bell 212A, feature by feature, bringing you reliability, impeccable transmission and easy operation. Hayes Compatible, except for "S" register. Communication software included.

The AVATEX 1200, at $99, is a steal!

SMARTEAM 1200

$159

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.

ECLIPSE 2400 BAUD MODEM

$299

- **Hayes & Bell 212A/103 Compatible**
- **CCITT V.22. V.22 bis**

The ECLIPSE 2400 modem is a microprocessor-based full or half-duplex modem incorporating the latest in high speed data communications capabilities. It also accomodates computers and terminals equipped with an RS-232 port allowing communication with other computers or timeshar ing systems either localy or remotely. **Compatibility, Versitility and Performance** are yours in a configuration designed to provide years of reliable operation.

NEC RACKMOUNT MODEM

$69

The NEC N212BR modem is designed for use in a rackmount configuration or may be used stand alone on external power. The Unit is fully 300/1200 Hayes compatible allowing for auto dial, auto log/on password capabilities. This modem is also switch selectable to the special NEC command set, which contain too many features to describe in this limited space.

The NEC212BR originally cost $595. California Digital has available 500 units which we are offering at only $69.

MODEMS

Eclipse 1200 100% Hayes, with status lamps	EDP-1200	149.00
Eclipse 1200B internal with software	EDP-1200B	139.00
Eclipse 2400 External, Hayes Compatiple	EDP-2400	299.00
Avatex 1200 baud external, Hayes	AVA-1200	99.00
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-1200	159.00
Smarteam 1200B IBM 1200 baud card	TEM-1200B	159.00
UltraLink 1200 data and voice on same line.	UTL-1200A	99.00
CTS 212AH 1200 baud, auto dial	CTS-212AH	179.00
Terminal software for CTS 212AH	CTS-212SFT	35.00
Prometheus 1200 super features	PRM-P1200	289.00
Prometheus 1200B internal PC	PRM-P1200B	279.00
Signalman Mark VI, 300 baud internal PC	SGL-MK6	49.00
Hayes Smart Modem 1200 baud, auto dial	HYS-212AD	369.00
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Five Inch Winchester Disk Drives

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SEAGATE 225 20 Meg. ½ Ht.	329	299
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FUJITSU 2242 55 M. 35mS.	1599	1529
FUJITSU 2243 86 M. 35mS.	2095	2019
RODIME RO-202E 27 Meg.	659	629
RODIME RO-203E 40 Meg.	995	959
RODIME RO-204E 53 Meg.	995	959
CONTROL DATA 94155-86 M.	1829	1779
MAXTOR XT1140 140 Meg.	2995	2929
HONEYWELL 85M. 27 mS.	1795	1695
TOSHIBA MK56 70 M. 30mS.	1789	1729
TANDON 502 10 Meg.	419	379

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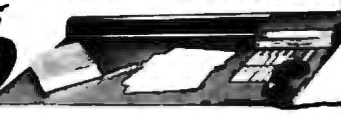
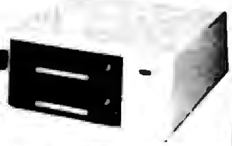


The Desk Director is a management tool engineered to increase the efficiency of any one who spends any time behind a desk. The unit incorporates: a speaker telephone with autodial, clock calendar, calculator and more all into a handsome leather desk pad. You have seen the same product selling at Sharper Image for $995. While supplies last the Desk Director is available from California Digital for only $479. Please specify mahogany brown or black leather. Will consider volume trade.

Bernoulli Box

was $3540 now only

$1595



The **Bernoulli Box** by Iomega, features 10 and 20 megabyte removable cartridges, and delivers reliability, expandability, transportability, security and speed in one versatile subsystem. It lets you transfer megabytes of information safely and swiftly for primary or backup storage. Or combine several software programs onto a single cartridge for easy switching from one to another

Reliable... the Box has incredible resistance to shock and vibration completely eliminating the possiity of head crash.

Expandable... grow at your own pace by adding inexpensive cartridges. When **security** is essential, don't lock up your system just lock up the cartridges

The Bernoulli Box delivers preformance that often exceeds the best of hard disk speed and the convenience of floppy disks At these prices don't be caught wishing you had one after a loss of irreplacable data

		List	Our Price
10+10 Meg.	A2210H	$3450	1595
20+20 Meg.	A2220H	4540	2095
Bootable Controller		255	159
10 Meg. Cartridge		79	49
20 Meg. Cartridge		99	65

PRINTERS

MATRIX PRINTERS

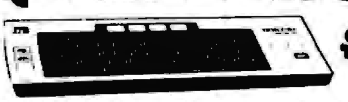
NEC/P7 132 col., par'l interface	NEC-760	659 00
Star Gemini NL-15, 300 cps, 136 col 24 wire head	STR-NB15	
Star Gemini NX-10, 120 cps/30 cps NLQ, tractor	STR-NX10	
Citizen MSP/10FT 160 char/sec	CIT-MSP10	259 00
Panasonic KX1091 120 cps draft, 29 NLQ tract & friction	PAN-KX1091	259 00
Toshiba 351P/S, 240 char/sec, 24 wire head	TOS-351PS	1099 00
Toshiba 341PS/E par'l 180 cps 24 wire head	TOS-341PSE	759 00
Okidata 182P/IBM parallel 9½" paper	OKI-182P	239 00
Okidata 192A parallel interface, 160 char/sec	OKI-192A	379 00
Okidata 84P parallel 15" paper	OKI-84P	695 00
Epson LX-80 10" 120 Char/sec	EPS-LX80	259 00
Epson LQ800 near letter quality	EPS-LQ800	629 00
Epson FX85 160 cps draft 32 cps NLQ, 240 dot/inch.	EPS-FX85	399 00
Epson FX286 132 col., 200 cps 29 cps NLQ, graphics	EPS-FX286	599 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 (6400) parallel 40 char/sec	PRO-F10P	429 00
Same as above but 55 char/sec 50 pin Diablo interface	PRO-F55P	959 00
NEC8810 55 char/second serial interface	NEC 8810	1179 00
NEC8830 55 char/sec par'l interface	NEC-8830	1179 00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	819 00
Silver Reed EXP600 25 cps 10/12/15 pitch serial/par'l	SRD-EXP600	319 00
Silver Reed EXP800 same as 600 but 40 char/sec	SRD-EXP800	729 00
Diablo 620 proportional spacing, horz & vert tab 20 cps	DBL-620	299 00
Juki 6100 18 char/sec	JUK-6100	359 00
Juki 6300 40 char/sec	JUK-6300	689 00

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 auxiliary printer port. All this is available for only $59.

FOUR PEN COLOR PLOTTER

$159

The manufacturer has asked us not to publish their name. But this four color plotter was produced by one of the Worlds largest makers of personal computers.

The 410 color plotter will connect to the serial port of virtually any micro-computer. Simple ASCII commands direct one of the four color pens to draw circles, arcs or ellipses on paper or transparency material up to 11 by 17 inches. The plotter is capable of producing the full upper and lower case alphabet along with seven international character sets. Text can be printed horizotal, vertical or diagonal in sizes from 1/16 to 6 inches, slanted forward or backward to 85 degrees.

Enlargements or reductions are achieved through elaborate firmware. Pen travel is four inches per second with .004" pen resolution. Standard pens are available in an assortment of 32 different colors and widths.

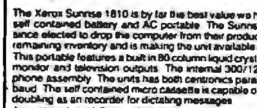
The ideal plotter for architecture, CAD engineering or graphic design. **At $595 it was a great buy, at $159 its a steal.** Support packages for specific computers available. Manual only $15 refundable upon purchase or plotter.

PLOTTERS

Four pen color plotter, 11 by 17 IBM/PC compatible	APL-410	$159
Sweet "P" 100 (Comrex) 8½ by 120	COM-C1	$159
Houston Instruments DMP29, 11 by 17	HOU-29	1779
Houston Instruments DMP40, 11 by 17, B size	HOU-40	959
Houston Instruments DMP41/42 C/D 24 by 36	HOU-41	3779
Houston Inst. DMP51/52MP C/D, 14 pen plotting	HOU-51MP	4859
Houston Instruments DMP56, E size 34 by 44	HOU-56	4795
Houston Instruments PC695, 11 by 17 multi-pen	HOU-695	579
Roland DYX-101 flat bed 11 by 17	ROL-101	419
Roland DYX-800 11 by 17 multi-pen 8 color	ROL-800	899
CalComp 1043GT plotter	CCP-1043	7899

DIGITIZERS ● MOUSE

Hitachi Tiger Tablet 11 by 11"	HIT-TT2	615
Summagraphics Summasketch 12" four button	SUM-SK12	399
Summagraphics SummaMouse 100 line resolution	SUM-MS	89
MicroSoft serial mouse with paint brush	MST-MS232	139
MicroSoft bus mouse card w/paint brush	MST-MSB	129



XEROX
Sunrise Computer

$299

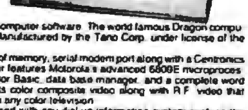
The Xerox Sunrise 1810 is by far the best value we have ever seen in a micro computer This is a self contained battery and AC portable The Sunrise was originally prices at $2995 Xerox has since elected to drop the computer from their product list California Digital has purchased all the remaining inventory 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

Dragon Computer

$89



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

RGB Color Monitor

$199

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 Litton-Monroe label and was originally scheduled for use in their "Office of the Future" equipment A change in Monroe's marketing strategy has made these units excess inventory which were sold to California Digital We are offering these "new" RGB monitors at a fraction of their original cost IBM/P/C Computer compatible NEC 1401/PC

Also available 12" Amdek Color 1 composite $159

SONY 53W Floppy Disk Drive

3 1/2" New IBM portable compatible

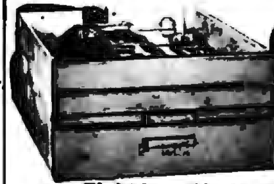
$139

5¼" DISK DRIVE

$89

Quantity Two

	One	Two	Ten
TEAC FD55BV half height	109	99	89
TEAC FD55FV 96 TPI, half ht.	119	109	105
TEAC FD55GF for IBM AT	169	159	155
PANASONIC 455 Half Height	109	99	89
PANASONIC 465 ½ Ht. 96TPI	139	129	125
TANDON 100-2 full height	129	125	119
MITSUBISHI new 501 half ht.	129	119	109
MITSUBISHI 504A AT comp.	169	159	155
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 & File Storage tubs			15



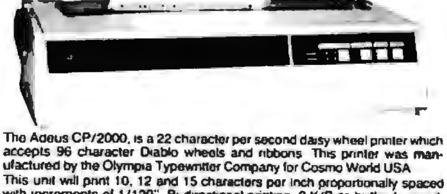
QUME

$119

Eight Inch Single Sided Drives			
QUME 841 single side	129	119	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

Adeus Daisy Wheel

$159



The Adeus CP/2000, is a 22 character per second daisy wheel printer which accepts 96 character Diablo wheels and ribbons This printer was manufactured by the Olympia Typewriter Company for Cosmo World USA

This unit will print 10, 12 and 15 characters per inch proportionally spaced with increments of 1/120" Bi-directional printing, 2 K/Byte buffer (expandable to 6K) and both serial and Centronics parallel interfacing make the Adeus CP/2000 an exceptional buy at only $159 Original price $595.

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

JADE TURBO or 286

- 640K of RAM
- 7 MHz turbo mode
- 360K disk drive
- 5151-style keyboard
- 8 expansion slots

$588

- 640K of RAM
- 8 MHz 80286
- 1.2 MB disk drive
- AT-style keyboard/case
- 8 expansion slots

$1288

OPTION #1
Two disk drives
Mono graphics card
Parallel printer port
Amdek 310A monitor

TURBO	286
$898	$1598

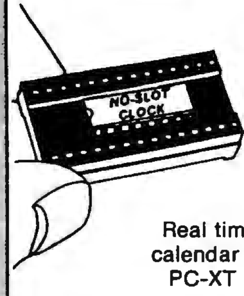
OPTION #2
20 MB hard disk
Mono graphics card
Parallel printer port
PGS MAX-12E monitor

TURBO	286
$1288	$1898

OPTION #3
20 MB hard disk
Color graphics card
Parallel printer port
Hitachi hi-res color monitor

TURBO	286
$1388	$1998

NO-SLOT CLOCK



$49

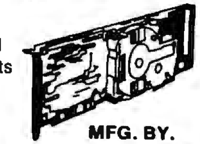
- Uses No Slot
- 20 Year Battery
- Includes Software

Real time clock/
calendar for your
PC-XT or clone

21 Megabyte Hard DISK ON A Card

$399

- 21.3 MB Formatted
- Lowpower, 11 Watts
- Head Park Zone
- Plated Media
- Light 2.4 lbs.

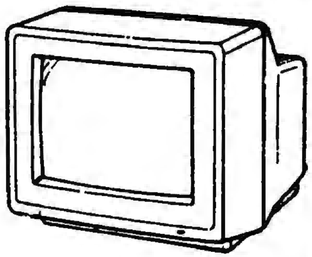


MFG. BY.
Tandon

HIGH RESOLUTION COLOR MONITOR

$269

List Price $699



- High resolution 640 x 240
- Excellent dot pitch .38 mm
- 16 true colors, 2000 characters
- Accepts standard RGB input signals
- Non-glare picture tube
- Free PC RGB cable included
- Free tilt & Swivel

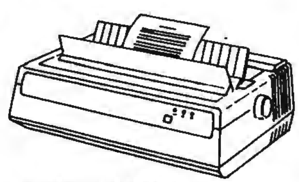
Manufactured
by Hitachi

HITACHI

80 CPS DAISYWHEEL
PRINTER FROM FUJITSU

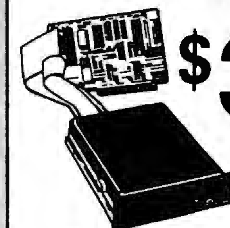
$599

List Price $2295
80 CPS,
Fully Formed
Letter Quality
Characters



LIMITED QUANTITY

HARD DISK DRIVE



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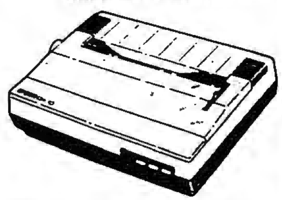

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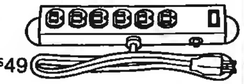

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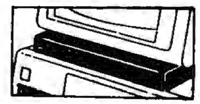

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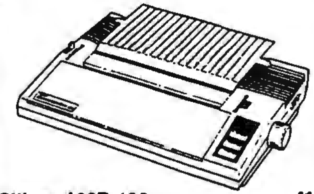

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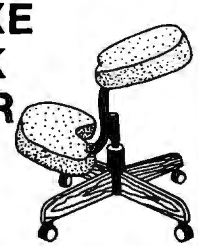

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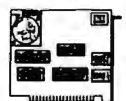

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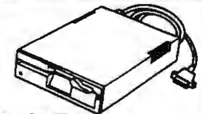

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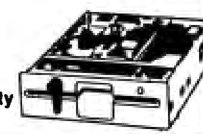

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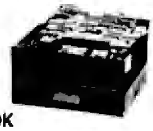

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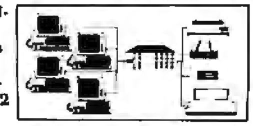

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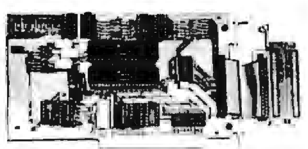

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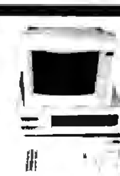

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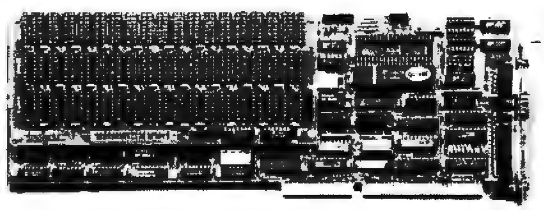

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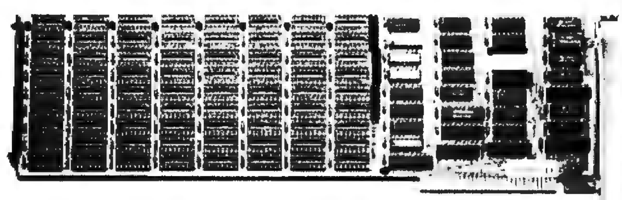

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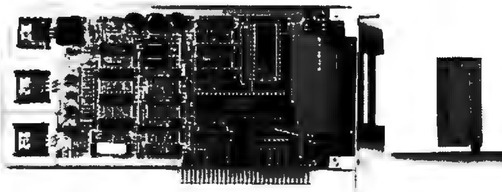

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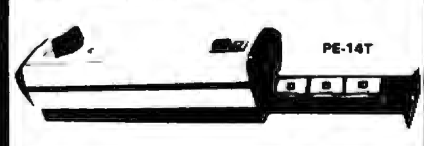
27128	16384x8	(250ns)(5V)	4.25
27C256	32768x8	(250ns)(5V)(CMOS)	10.95
27256	32768x8	(250ns)(5V)	7.49

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

VISA

MasterCard

8000

8035	1.49
8039	1.95
8080	2.95
8085	2.49
8087-2	169.95
8087	129.00
8088	6.95
8088-2	9.95
8155	2.49
8155-2	3.95
8748	7.95
8755	14.95
80286	129.95
80287	199.95

8200

8203	24.95
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 1.69

4.0 MHz

Z80A-CPU	1.79
Z80A-CTC	1.89
Z80A-DART	5.95
Z80A-DMA	5.95
Z80A-PIO	1.89
Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95

6.0 MHz

Z80B-CPU	3.75
Z80B-CTC	4.25
Z80B-PIO	4.25
Z80B-DART	14.95
Z80B-SIO/0	12.95
Z80B-SIO/2	12.95
Z8671 ZILOG	19.95

6500

1.0 MHz

6502	2.89
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	6.95
68B09	6.95
68B21	3.95
68B45	6.95
68B50	2.95
68B54	7.95

CLOCK CIRCUITS

MM5369	1.95
MM5369-EST	1.95
MM58167	12.95
MM58174	11.95
MSM5832	2.95

CRT CONTROLLERS

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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

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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
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MB8876	12.95
MB8877	12.95
1691	6.95
2143	6.95

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BR1941	4.95
4702	9.95
COM8116	6.95
MM5307	4.95

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AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	6.95
IM6403	9.95
INS8250	6.95

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76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
SP1000	39.00

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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

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TMS99532	19.95
ULN2003	.79
3242	7.95
3341	4.95
MC3470	1.95
MC3480	8.95
MC3487	2.95
11C90	19.95
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	.75	74LS259	1.29
74LS48	.85	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

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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	.89	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
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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	1.59
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	3.95
74F32	.69	74F240	3.29	74F373	4.29
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4012	.25	4503	.49
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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	.69
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	2.49
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	12.95
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
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74S08	.35	74S189	1.95
74S10	.29	74S195	1.49
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74S153	.79	74S373	1.69
74S157	.79	74S374	1.69
74S158	.95	74S471	4.95
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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	1.59	7905K	1.69
7812K	1.39	7912K	1.49

TO-93 CASE

78L05	.49	79L05	.69
78L12	.49	79L12	1.49

OTHER VOLTAGE REGS

LM323K	5V	3A	TO-3	4.79
LM338K	Adj.	5A	TO-3	6.95
78H12K	12V	5A	TO-3	8.95

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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	see 7900	XR2206	3.95
LM322	1.95	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	1.79	CA3081	.99
LM336	1.75	CA3082	.99
LM337K	3.95	CA3086	.80
LM338K	6.95	CA3089	1.95
LM339	.59	CA3130E	.99
LM340	see 7800	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
LM360	.89	LM3909	.98
LM383	1.95	LM3911	2.25
LM386	.89	LM3914	2.39
LM393	.45	MC4024	3.49
LM394H	5.95	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 / INTERFACE

ADC0800	15.55	8T26	1.29
ADC0804	3.49	8T28	1.29
ADC0809	4.49	8T95	.89
ADC0816	14.95	8T96	.89
ADC0817	9.95	8T97	.59
ADC0831	8.95	8T98	.89
DAC0800	4.49	DM8131	2.95
DAC0806	1.95	DP8304	2.29
DAC0808	2.95	DS8833	2.25
DAC1020	8.25	DS8835	1.99
DAC1022	5.95	DS8836	.99
MC1408L8	2.95	DS8837	1.65

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	.69
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)

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

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ICL7107	12.95
ICL7660	2.95
ICL8038	4.95
ICM7207A	5.95
ICM7208	15.95

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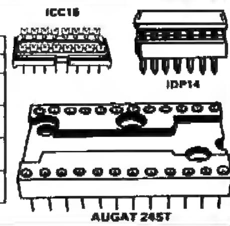
DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	—	.95	.95	—	—	—	1.75	—	2.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE BELOW



DIODES/OPTO/TRANSISTORS

1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
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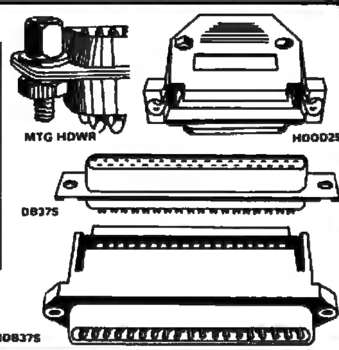
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

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



LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM ANODE	.5"	1.49
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MAN-74	COM CATHODE	.3"	.99
MAN-8940	COM CATHODE	.8"	1.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/LOGIC	.270"	9.95
HP5082-7340	4x7 HEX W/LOGIC	.290"	7.95

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MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

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DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
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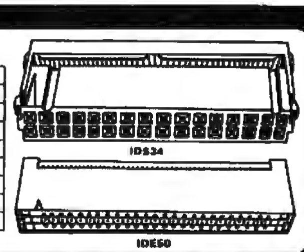

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DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
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SPST	TOGGLE ON-OFF	.49
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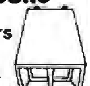

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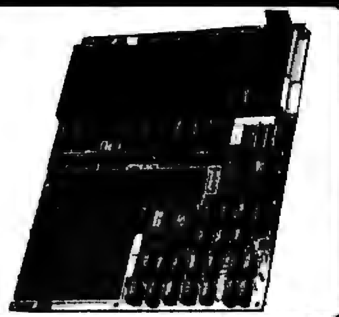

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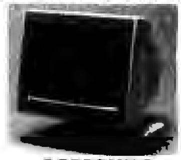

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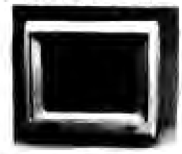

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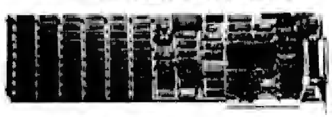

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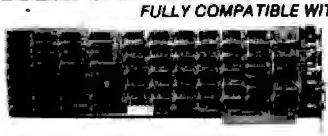

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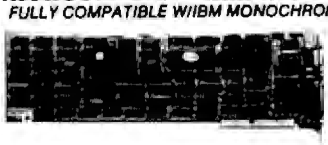

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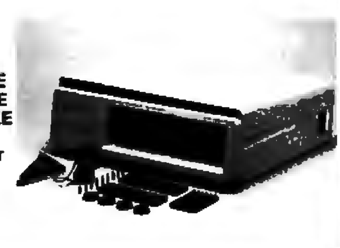

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BOMB *Results*

PRIZE COMPARISON

"A Comparison of MC68000 Family Processors" is the winning article from September, bringing author Thomas L. Johnson $100. In second and the winner of $50 is Adam Brooks Webber for his system software analysis of the two machines, "Amiga vs. Macintosh." Mike Morton's "68000 Tricks and Traps" came in third in the vote tally for quantity.

And the first place prize for quality of $50 also goes to Thomas L. Johnson for his coverage of the five MC68000s. Congratulations to all of these Theme authors.

N·E·X·T M·O·N·T·H I·N B·Y·T·E

At press time the following articles are intended for publication in the January issue of BYTE:

Theme:

Next month's theme, Programmable Hardware, includes an overview of the evolution of programmable hardware, an explanation of the theory and physics of programmable logic devices, the merits of microcode versus hard-wiring, general considerations in designing with PALs, how to choose PALs for particular applications, and a programmable hardware construction article.

Features:

Steve Ciarcia concludes his three-part graphics construction project. We have a programming project on hashing, a programming insight or two, and a 68000-related piece on creating and manipulating Macintosh regions.

Hardware Reviews:

We'll feature coverage of 8 multifunction boards for the IBM PC AT, followed by an evaluation of 15 AT clones. We also plan to present reviews of the Data General/One Model 2, the Stride computer, and the Laser 128. Peripheral reviews will include a comparison of 12 graphics boards and the All Card from All Computers.

Software Reviews:

Among the software reviews we have on hand include three Modula-2s for the IBM PC, multitasking BASIC, RuleMaster, Laser Quill, and Scribble!.

Plus columns by Pournelle, Webster, Shapiro, Pountain, and more from the Best of BIX; Book Reviews, What's New, Microbytes, and more.

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TIPS

SUBSCRIBERS ONLY!*

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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] [2] [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. □ □ □ [#] [#]
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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.

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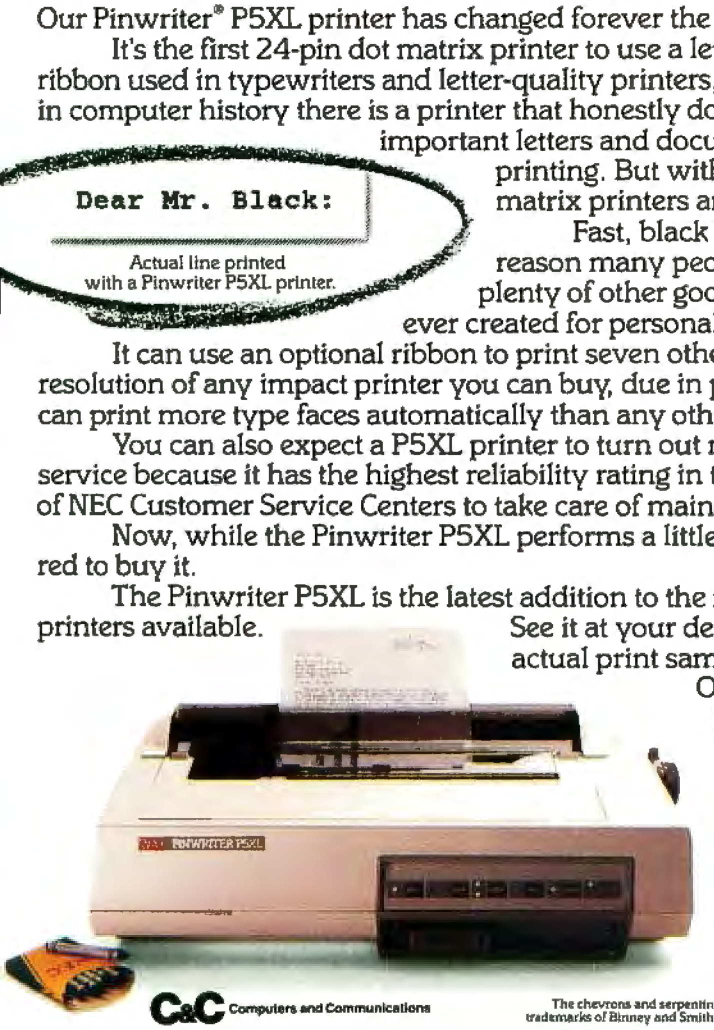

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Inquiry 247

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