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BYTE

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Image Processing

Digitizing the Mona Lisa

The New Amiga 2000

Borland's Turbo BASIC

16 Products Reviewed

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System requirements

IBM PC, XT, AT and true compatibles. PC-DOS (MS-DOS) 2.0 or later. One floppy drive. 320K.

Technical Specifications

- ☑ *Compiler: One-pass compiler generating linkable object modules and inline assembler. Included is Borland's high performance "Turbo Linker." The object module is compatible with the PC-DOS linker. Supports tiny, small, compact, medium, large, and huge memory model libraries. Can mix models with near and far pointers. Includes floating point emulator (utilizes 8087/80287 if installed).*
- ☑ *Interactive Editor: The system includes a powerful, interactive full-screen text editor. If the compiler detects an error, the editor automatically positions the cursor appropriately in the source code.*
- ☑ *Development Environment: A powerful "Make" is included so that managing Turbo C program development is highly efficient. Also includes pull-down menus and windows.*
- ☑ *Links with relocatable object modules created using Borland's Turbo Prolog into a single program.*
- ☑ *ANSI C compatible.*
- ☑ *Start-up routine source code included.*
- ☑ *Both command line and integrated environment versions included.*

*Introductory price—good through July 1, 1987

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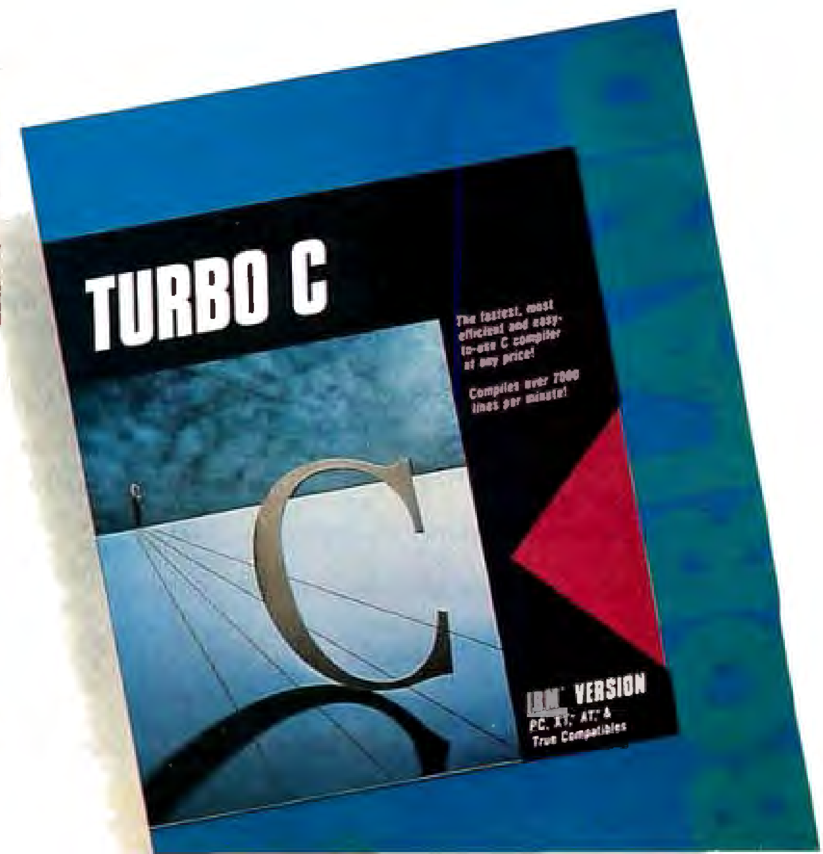

Inquiry 41 for End-Users.
Inquiry 42 for DEALERS ONLY.

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MARCH 1987
VOLUME 12
NUMBER 3

82

Contents

FEATURES

A2000

THEME: Image Processing

REVIEWS

COVER PAINTING BY ROBERT TINNEY

140

204

248

KERNEL

BEST OF BIX

DEPARTMENTS

LISTINGS

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EDITORIAL

The Enigma of the Amiga 2000

What is a 4.77-megahertz 8088 doing inside a 7-MHz 68000 system like the Commodore A2000 (aka Amiga 2000), covered this month in our lead feature article? Running IBM PC software, of course. The Amiga 2000 is the first of several new personal computers that offer IBM compatibility as one of several features. The Amiga 2000 has a lot going for it: the open architecture, with seven internal expansion slots; the Janus card, an IBM PC XT clone that shares dual-port RAM with the 68000; and the ability to use several slots for IBM-compatible cards, like card-mounted hard disks and disk controllers, and thereby to open up the entire world of IBM-compatible peripheral devices to the Amiga.

Besides the seven main expansion slots, the Amiga 2000 has two special slots: one for a CPU and another for a video controller. Try as we might, we were unable to pry out of Commodore any significant information about plans for those two slots. If the CPU slot should receive a 68020 with memory management unit and floating-point chip soon, the Amiga 2000 may emerge as a powerhouse. Commodore already has projects involving the 68020 under way in its labs but says nothing about what will emerge or when. If the video slot should receive a card that provides 640 by 400 noninterlaced video, one of the strongest objections to the Amiga would be overcome.

After much discussion, we decided against making the Amiga 2000 a cover story. With both the CPU slot and the special video slot unused, the Amiga 2000 is a very much enhanced Amiga 1000 rather than the foundation of a new series of machines. The Amiga 2000 does open up the Amiga 1000 more than the Macintosh Plus opened up the Macintosh. But as with the Mac Plus, the Amiga 2000 has the same processor running at the same clock speed with the same display controller as the previous machine in the series.

We have not yet had access to Atari's new Mega STs, its $499 IBM PC compatible with built-in EGA compatibility, or its $1500 laser printer. We will cover these products as soon as we get our hands on them. We also await the new Commodore IBM PC compatibles introduced at the Consumer Electronics Show.

New BIX Hardware

BIX, the BYTE Information Exchange, now has more than 12,000 users, the estimated capacity for the 1986 Arete supermicrocomputer running BIX. The system continues to perform well despite the heavy work load, but it is clear that the hardware must be expanded dramatically to support the substantial growth planned for 1987 and beyond. Indeed, we stopped promotional mailings for several months in order to avoid swamping the current 88-port BIX system. We will replace the system with a new one capable of supporting 250 simultaneous users, with NFS (network file server) networking capability to provide for expansion to even greater size. Approximately 20 companies were invited to submit proposals for the next generation of BIX hardware, and most did so. Bidders were required to submit hardware configurations permitting growth to 500 and then 1000 simultaneous users.

As of this writing, the number of bidders has been narrowed to four by our technical team at McGraw-Hill in New York. Two supermicrocomputer companies and two superminicomputer companies remain in contention. We are installing BIX software on all the remaining contenders and running simulations of various user loads.

By the time you read this, we should have selected a vendor and be in the process of installing the new system. If we should encounter performance problems before the new system is up, rest assured that hardware capacity will soon triple.

New Staff for Microbytes Daily

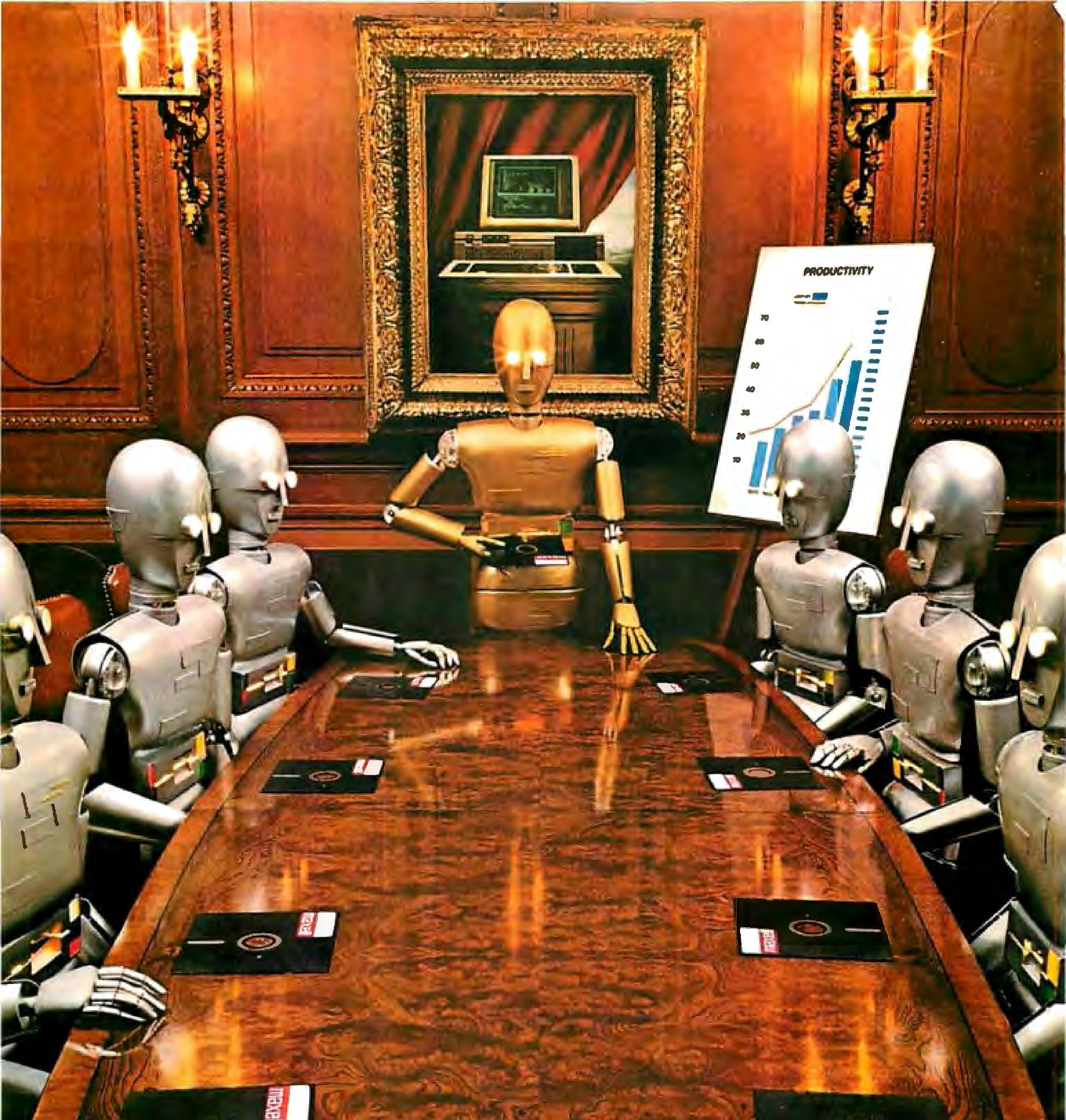
We are pleased to announce that management has authorized expansion of the staff of the Microbytes Daily news service that operates on BIX. These staff additions will enable us to provide comprehensive product coverage in the microbytes.hw and microbytes.sw sections, as well as to expand our coverage of technology news and preannouncement product news in the general microbytes/items section and timely feature articles in the microbytes/features section.

The entire news service is available at standard BIX rates—vastly less than the rates charged by other on-line news services. Furthermore, the Microbytes Daily news service is interactive. If you want coverage of a specific topic and can't find it by using the "search" command, please send BIX electronic mail to "microbytes" and let us know. We'll do our best to dig out the information you need. Before major computer shows, we post the list of scheduled exhibitors and ask BIX users to tell us which exhibits they are most interested in. We then visit those exhibits at the show. All in all, Microbytes Daily is well worth consulting before you make any purchasing decision about computer products.

80386 Events

If your interests lie in 80386-based systems, you shouldn't miss the rich related events on BIX. The os386 conference has fascinating in-depth discussions of systems software issues. Users386 has an exchange of user opinions and reactions to the early 80386 machines. Finally, BIX's Compaq conference has a lively topic on the Compaq 386. We'll publish some highlights in BYTE, but we don't have room for nearly enough of the valuable information found in these three conferences.

—Phil Lemmons
Editor in Chief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MICROBYTES

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

Genetic-Management Software Helps Biologists Save Endangered Animals

Biology researchers at the University of California's San Diego campus have proven what a lot of people have suspected for a long time—computers are for the birds. Biologists here are using Ped-Pak, a genetic-management program originally written to help save certain endangered captive species such as the California condor. The program, written by professor Mike Gilpin, consists of a database that contains all known pedigree information about an endangered species (the "stud book") and a projection model that makes offspring predictions (based on hypothetical matings) two or three generations away. Different species can be monitored by simply using the projection model with a different database.

The purpose of the program, according to Gilpin, is to prevent harmful in-breeding among endangered animals in captive environments like zoos. "As the in-breeding coefficient goes up, so does the death rate," Gilpin explained. By tracking the ancestry of captive animals and making projections along the way, biologists can avoid problems as far as five years away.

Gilpin wrote the program in VAX-11 BASIC on a UCSD computer. Since few, if any, zoos have access to a mainframe, Gilpin ported the program first to a Macintosh and then to an IBM PC. The early microcomputer versions were coded in both C and Microsoft BASIC. Since the pedigree-tracking portions of the program depend upon recursive algorithms, however, he switched to True BASIC, which supports recursion for the final version of the program. "The only difficult part of the programming was making the software user-friendly enough," Gilpin said. He said that had he used the Macintosh Toolbox routines, "it would have been much simpler, but I knew I would have to port it to the IBM PC, since not very many zoos have Macs."

Virtually every zoo in the US and Europe is taking part in a program established four years ago to control the breeding of endangered captive animals. Gilpin said he expects Ped-Pak will be adopted as part of the program.

Sensor Provides Inside Look at Integrated Circuits

An electro-optic sensor that lets engineers look inside the circuitry of integrated circuits and make on-chip measurements has been developed by researchers at Stanford University's Ultrafast Electronics Laboratory (Stanford, CA). The sensor, which uses laser beams and fiber optics, has so far been able to measure microwave signals of up to 40 gigahertz on gallium arsenide devices, but researchers believe the device should be able to measure signals in the 100-GHz range. Frequencies measured on silicon devices have been in the 200-megahertz range.

When probing a circuit, a laser beam is split into two parts, with one part aimed at a standard reference point and the other at the junction region or gate. The two beams are then reflected and combined. The resulting optical index produces a "very efficient readout" and can then be measured, said professor Bert Auld, who, along with professor David Bloom, developed the sensor. Silicon integrated circuits are measured in real time, while stroboscopic snapshots are taken for measurements of GaAs chips.

Semiconductor manufacturers have expressed interest in the sensor because such a device will enable them to quickly test a chip as it is being developed. "As they process the chip, [they can] measure what the electrical properties are, so that if something goes wrong at a certain stage, they can correct it," Auld said.

NANOBYTES

The Astronomical Society of the Pacific has published a list of microcomputer software for stargazers and planet watchers. The eight-page "Computer Software for Astronomy" contains annotated listings of 89 astronomy-related programs. The non-profit group will send you a copy if you send a $2 donation to ASP, Computer List Dept., 1290 24th Ave., San Francisco, CA 94122. Add $1 for postage if you live outside the United States. . . . For $4995, **Symmetric Computer Systems** (San Jose, CA) is selling a 22-pound transportable computer called the 375, based on a 10-MHz NS 32016, that comes with a 50-megabyte Winchester disk, 1-megabyte 5¼-inch floppy drive, 2 megabytes of RAM, four serial ports, one parallel port, 4.2 BSD UNIX, and eight languages: C, FORTRAN, Pascal, BASIC, APL, Prolog, LISP, and Assembler. . . . The **Apple Programmers and Developers Association** (Renton, WA), a project of the Seattle-based A.P.P.L.E. Co-op, is offering the Macintosh Programmer's Workshop, an assembly language environment that includes an editor/command interpreter plus an assembler, linker, debugger, ROM interfaces, resource editor, resource compiler/decompiler, and utilities. It sells for $100. APDA annual dues are $20; you can phone them at (206) 251-6548. . . . Top speed awards go to **gallium arsenide**: Researchers at **Hughes Aircraft** built an integrated circuit that runs at 18 GHz, and scientists at **Bell-Northern Research** fabricated a multiplier chip that can multiply two 4-bit numbers in 1 nanosecond. . . . **Asahi Glass** (Tokyo) and **Komag** (Milpitas, CA) are

continued

developing glass substrates for use in high-capacity sputtered thin-film disks. The joint venture says the first glass disks will let designers build 5¼-inch Winchesters with capacities as high as 90 megabytes and 3½-inch drives that can store 40 megabytes. . . . **Infoscience Services** (Northbrook, IL) has scheduled its Computer Aided Laboratories Symposium and Exhibition for May 12–14 at the Sheraton O'Hare in Chicago. The symposium will focus on laboratory automation and will include sessions on lab networking, communications, chemometrics, artificial intelligence, robotics, and data acquisition. To acquire more data, phone (312) 291-9161. . . . **MicroPro International** (San Rafael, CA) said it's planning a new version of WordStar 2000 for this year, which will have desktop publishing features, and a publishing package being designed by Island Graphics. . . . Vanna White fans, get ready. **ShareData** (Chandler, AZ) will be coming out with software games based on television shows "Wheel of Fortune," "Jeopardy," and "Family Feud.". . . We'd like to close with a fond farewell to **The Homebrew Computer Club**, which held its last meeting in December. Long-time moderator Lee Felsenstein said the group, which served as a breeding ground for computer innovations and Silicon Valley companies, would meet again on "special occasions." At the last meeting, one member speculated, "If it wasn't for Homebrew, the first personal computer might have come out of Route 128 in Boston and been called The Maple or something."

Art and Technology a Wonderful Mix; Remember, Michelangelo Was an Engineer

Akram Midani, dean of the College of Fine Arts at Carnegie Mellon University (Pittsburgh), stated in a recent interview that, contrary to popular belief, art and technology have historically been closely intertwined and that computers will have a tremendous impact on art, probably creating new art forms. Midani thinks the debate between art and technology is somewhat artificial. The artist, he says, deals with a whole body of technical knowledge of some sort. Midani points to Leonardo da Vinci and Michelangelo as artists who were highly proficient in technology. Leonardo's technical prowess is well known, but few realize that Michelangelo was also an engineer and an architect.

We are now, according to Midani, at the very early stages of development of art with a computer. Rock music, says Midani, explores technology fully. Much of today's rock is the result of devices such as synthesizers, digitizers, and samplers.

Midani thinks too many computer artists expend too much effort on the same old thing: creating printouts. He claims computer artists are merely trying to create prints without getting their hands dirty. Computer art should be "art of time," not just art of space, he says.

He sees four stages in the development of a new artistic technology. In the first, there is an ambiguous fascination with the capabilities of the new technology. In the second stage comes an understanding of the usefulness and efficiency provided by the technology. In the third stage, the new technology begins extending and altering longstanding views. And the fourth stage marks the dawning of a tremendous change, which is really a new art form. Midani believes that computers are now somewhere between the first and second stages.

Microcomputers, according to Midani, are having an enormous effect on art. He compares them to the paint tube, which freed artists from having to mix their own paints and opened up the art form to large numbers of amateurs. Like the paint tube, the microcomputer invites novices to explore the new artistic possibilities of the medium.

Synaptics Hopes to Cast Neural Nets in Silicon

The father of the Z80 microprocessor and one of the developers of silicon compilers have joined a Silicon Valley company that's trying to make computer chips that mimic the nervous systems of animals. If Synaptics Inc. (San Jose, CA) can make the concept work, the payoff could include much faster computers, with far more powerful database management capabilities.

The firm was founded to turn the theories of neurobiologist Gary Lynch into useful semiconductors. Lynch developed a model of how nerve cells transmit and store information, the so-called neural net. Neural nets are much more highly parallel than present-day computers, with processing power distributed throughout the net. They store and access information based on content rather than a specific location. By casting neural nets in silicon, researchers hope to bring these capabilities to computers.

Among the people working with Lynch at Synaptics is Frederico Faggin, who worked on the design of the 8080 microprocessor for Intel and then moved on to cofound Zilog and help design the Z80. The company's most recent acquisition is Carver Mead, who helped develop silicon compilers to speed the process of turning chip designs into silicon. In addition, Mead is an expert on how the neurons in the human eye process data.

Atari to Roll Out Number-Crunching STs

Atari Corp. (Sunnyvale, CA) confirmed that it plans to introduce 32-bit-based ST workstations sometime in the second half of this year. "Basically there are two hardware components: a number cruncher and a higher-resolution ST," said Neil Harris, director of marketing communications for Atari. "The number cruncher plugs into the DMA port on either the current ST or the enhanced-resolution ST."

Harris said the "number cruncher" is a 68020-based system with a math coprocessor (68881) and memory management unit. It will run UNIX System V software "or something close to it," said Harris. The workstation will use the Atari ST as a front end or as a kind of "genius terminal" (using the DMA port) and the ST's keyboard, graphics, and other I/O.

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Inquiry 321

Process Uses Neutron Beams to Test GaAs, Silicon Crystals

Although neutron beams are often associated with future weapons systems, they may also provide a lower-cost way of producing semiconductor chips. The reason for this is a newly proposed method of testing for crystalline defects in semiconductor wafers. Canada's Chalk River National Laboratory has made available for commercial use a testing process in which neutron beams from a nuclear reactor are used to spot flaws in gallium arsenide or silicon crystals.

The test is based on the phenomenon of neutron extinction. Simply stated, a beam of neutrons can be reflected by a crystal structure, but the intensity of reflection varies with the perfection of the crystal. Significantly, since the reflection occurs in the body of the crystal, not just at the surface, the reflection intensity is a measure of the perfection of the whole crystal at once. The test method is said to be nondestructive, and induced radioactivity is said to be minor.

Most semiconductor wafers are currently tested using an "etch" test in which three wafers are picked from a group of about 20. The three samples are destroyed in the process, and the quality of the remaining wafers is extrapolated from the results of the test.

Since the Chalk River test is nondestructive, rapid, and inexpensive, it can be used to test all wafers and can thus achieve more accurate results.

Chalk River has tested the technology with GaAs and silicon wafers and is negotiating with a number of semiconductor manufacturers. According to Paul Browne, business development manager for the laboratory, the new testing method should eventually lower chip production prices.

VLSI Could Be Approaching Its Limits

Very-large-scale integration may be approaching the limits of its growth, according to a panel of experts at the International Electronic Devices Meeting in Los Angeles. The basis of VLSI is cramming more devices, such as transistors, onto a single piece of silicon. For the past 20 years or so, the device density per square inch of integrated circuits has doubled every few years, resulting in more powerful microprocessors, higher-capacity memory chips, and less-expensive computers.

According to the panelists, this process can't continue for more than one or two more generations. A combination of fundamental roadblocks, technology problems, and soaring costs will put an end to the cycle.

As device density increases, devices have to become smaller. Today, 2- to 3-micron geometries (the minimum distance between features on the chip) are standard; many advanced chips are using 1-micron geometries, and 0.1-micron geometries are being explored. Devices will eventually become so small that the effects of electric current flowing through the circuit will tend to cause connections to break. This is called "electromigration wearout." Another form of wearout, "hot electron wearout," will affect the thinner oxide layers of the smaller devices. The result is that IC reliability and life expectancy will decrease.

But high costs might curb VLSI before device physics does. Each generation of chips has been more expensive to design and produce, and the panelists agreed that the trend shows no sign of abating.

Common LISP Acquiring Object-oriented Features; Seeking a Standard

Common LISP, the standard version of the LISP programming language, took several years to evolve, so it is no surprise that the evolution of an object-oriented (OO) enhancement to Common LISP will be a similarly lengthy task.

At a meeting of an ANSI subcommittee in Dallas, an administrative framework was set for the development of the new standard OO enhancement. The LISP community is said to have already made it clear that it favors the Common LOOPS dialect as the basis for the new enhancement. There are, however, two other candidates: Flavors, from Symbolics (Cambridge, MA), and Object LISP, from LISP Machine (Andover, MA). Their respective proponents are expected to lobby for inclusion of some of the stronger features of these dialects. By the time of the next meeting, scheduled for this month, a tentative spec for the new OO extension will be circulated; a final spec is not expected until early 1988.

Despite the lack of an OO standard, implementors of LISP on microcomputers are going ahead with variations on at least two of the above-mentioned dialects.

ExperTelligence (Santa Barbara, CA), which is now offering a full version of Common LISP for the Macintosh Plus, is including an OO capability similar to an enhanced version of Flavors. Coral Software (Cambridge, MA) will offer a version of Common LOOPS with its Mac-based Common LISP system, which it hopes to have available by summer.

And Gold Hill (Cambridge, MA), which now sells a subset of Common LISP for the IBM PC AT, will offer another variation of Flavors for its full Common LISP system for the AT and 80386 systems, due around April. Gold Hill said it might also offer versions of the other two dialects if customers request them.

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LETTERS

All Together Now

As the user of an Amiga text editor and word processor at home, and of two different word processors at the two offices where I work, I feel that there is a need for a low-level text-editing standard.

For example, to move the cursor to the end of the line it's on requires a different command for each of the word processors I use. An agreed-upon standard employing intuitively simple keystrokes like Ctrl-right arrow (the arrow keys, once unavailable to many CP/M users with dumb terminals, are now built into every "real" computer except the Macintosh) to move the cursor to the right end of the line would greatly simplify things for many users. All universal editing functions, such as cursor navigation, search and replace, block delete and copy, and help cues, could be invoked with the same keystrokes. Software vendors could benefit through reduced learning time, due to familiar commands. This would increase the appeal of their products.

Major changes to existing software needn't be implemented. Rather, developers might just include a software toggle whereby users could choose between using a program's own unique editing commands and the standardized commands. All such a standard needs to become a reality is backing from a major software company.

Jeff Mings
Hauula, HI

Radon Attention

Referring to the letters from Howard Mark and Forrest Mims III ("CRT Radiation," November 1986), I must point out that there is already a large body of academic literature on this topic. The *Health Physics Journal* and National Institutes of Health studies indicate that CRTs do not emit harmful amounts of radiation. Recently, it was speculated that radon gas may be a radiological health hazard. The *Health Physics Journal* published a study that indicates that CRTs attract radon gas because of the electric field created by the scanning electron gun.

Although it is possible to measure the radiation emitted by CRT devices outside the laboratory, the results reported by Mr. Mims must be interpreted as "below the lower limit of detection" because of the statistical nature of radiation detection. I encourage readers of BYTE to measure the radiation emitted by CRTs. However, they should use proper statistical methods when analyzing the results.

Mitchell F. Wyle
Zurich, Switzerland

Assorted Flavors

I'm pleased that Seymore J. Metz knows an outrageous claim when he sees one ("Sort Run Times," December 1986), and I certainly wouldn't want to be taken seriously about a linear time claim for a sort algorithm. My distinction between theory and practice was meant to indicate that, although no general algorithm will sort in less than $n \log n$ time, it is sometimes possible within practical situations to achieve results that are effectively linear. Specifically, within a wide range of sizes useful to me, I was able to sort files with exactly two reads and two writes per record.

My original description was undoubtedly less than clear, especially since I hadn't had any reason to generalize the sort beyond its two-pass version. The generalized version turns out to be a variation on the merge sort. The following may help to clarify:

Sorts come in at least three flavors: sorts that will fit entirely into RAM, sorts of data many times the size of available RAM but which fit entirely on direct-access storage (disks), and sorts of data too big for available disk space, which require multiple tape drives. My situation required the sorting of a disk file several hundred times the size of RAM job space, in a format our sort utility couldn't handle. The specific memory and file sizes aren't important, only relative sizes. Sooner or later, everybody is going to have to do an external sort. Just hope you can do it without resorting to tape.

Sort objectives come in any number of flavors. Since I was planning on late-night runs, my sole concern was total elapsed time for the job, which meant minimizing disk access and letting the CPU cycles fall where they might.

The common choice for external sorting is the merge sort, which is primarily a tape sort. A file with n records is read into available memory m records at a time, sorted, and written out to two new tapes, which will then contain n/m groups (or runs) of m records each. The two tapes are merged to produce two new tapes with $n/2m$ runs of length $2m$. These produce tapes with $n/4m$ runs of length $4m$, and so on, until one tape contains one run of length n. The merge sort runs in $n \log n$ time, specifically ($n \log_2 (n/m)$) or thereabouts. A simple improvement uses memory as a buffer to increase the size of the output runs and therefore increases the speed of the sort by about a factor of 2.

My suggestion is to use internal memory to increase, not run size, but the number of runs being merged. After the initial pass, we have n/m runs of length m. On the next pass, why not create n/m^2 runs of length m^2, then n/m^3 of length m^3, and so on? Note that this won't work with tape, but on disk it's easy to treat one input file as multiple segments via record access.

The time of this sort (in disk access) is still $n \log n$, but it's about $n \log_m n$. With only 300 records in memory, this could still cut elapsed time by 75 percent over the improved merge sort. A file of 90,000 records would be sorted in two passes instead of about six with the improved merge. A hefty 100 million records is finished in four passes, not fourteen. There is some increased CPU overhead with this variation, but, in my case, I could afford it.

In fairness to my former employers, a few million in sales and a staff of 40 may not be multinational, but we liked to think of ourselves as far from trivial or irrelevant. In Northeast Ohio we know a different big word—unemployment.

John W. Ward
Waynesburg, OH

Updating ASCII

Robert Sneddon has hit on an idea I have been kicking around for about a year now ("In Search of Cheaper Transmission,"

continued

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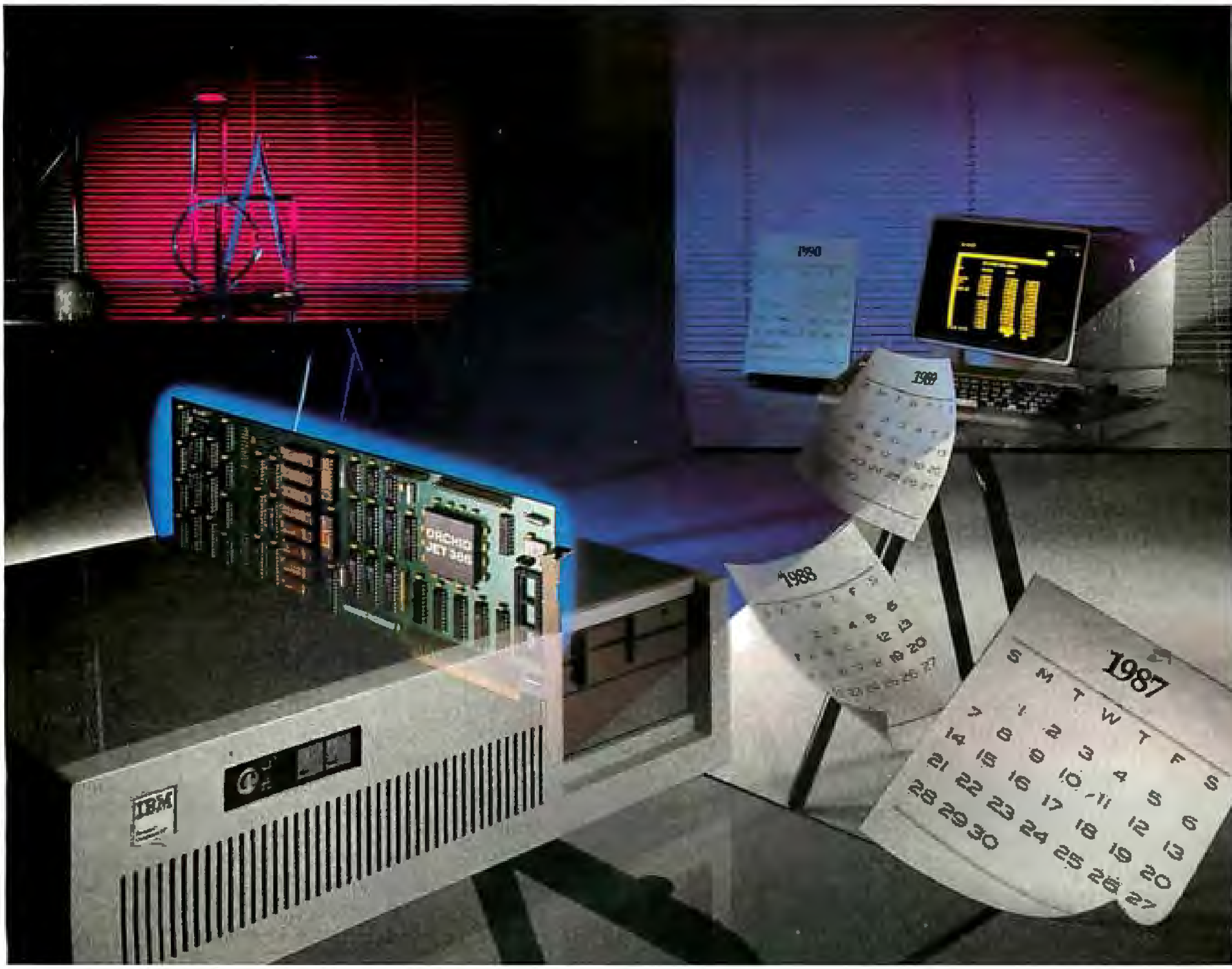

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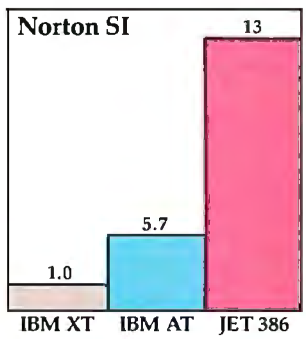

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November 1986). He mentioned updating the ASCII character set and 16-bit micros, but did not link the two. That is the key to what I wanted to do. Text compression wasn't the main aim of the technique I worked out. I decided to take advantage of the 16-bit word length of most sensible computers. I decided that the enormous investment in 8-bit (ASCII) software would prevent any drastic changes. Then I looked at ASCII closely. Most text can be written using only 7 bits; 7-bit ASCII. The eighth bit is wasted on obscure graphics characters (which are not standardized anyway). I decided to use 7-bit ASCII as a basis for a standard using 16-bit words.

If bits 7 and 15 are both 0, a word represents two 7-bit ASCII characters. If either is set, then the word as a whole represents something else. This leaves 48K characters in the standard character set. Effectively, the ASCII character set is mapped 128 times into a 64K set. Losing some space in the map is an acceptable compromise if it avoids taking up twice as much space for text.

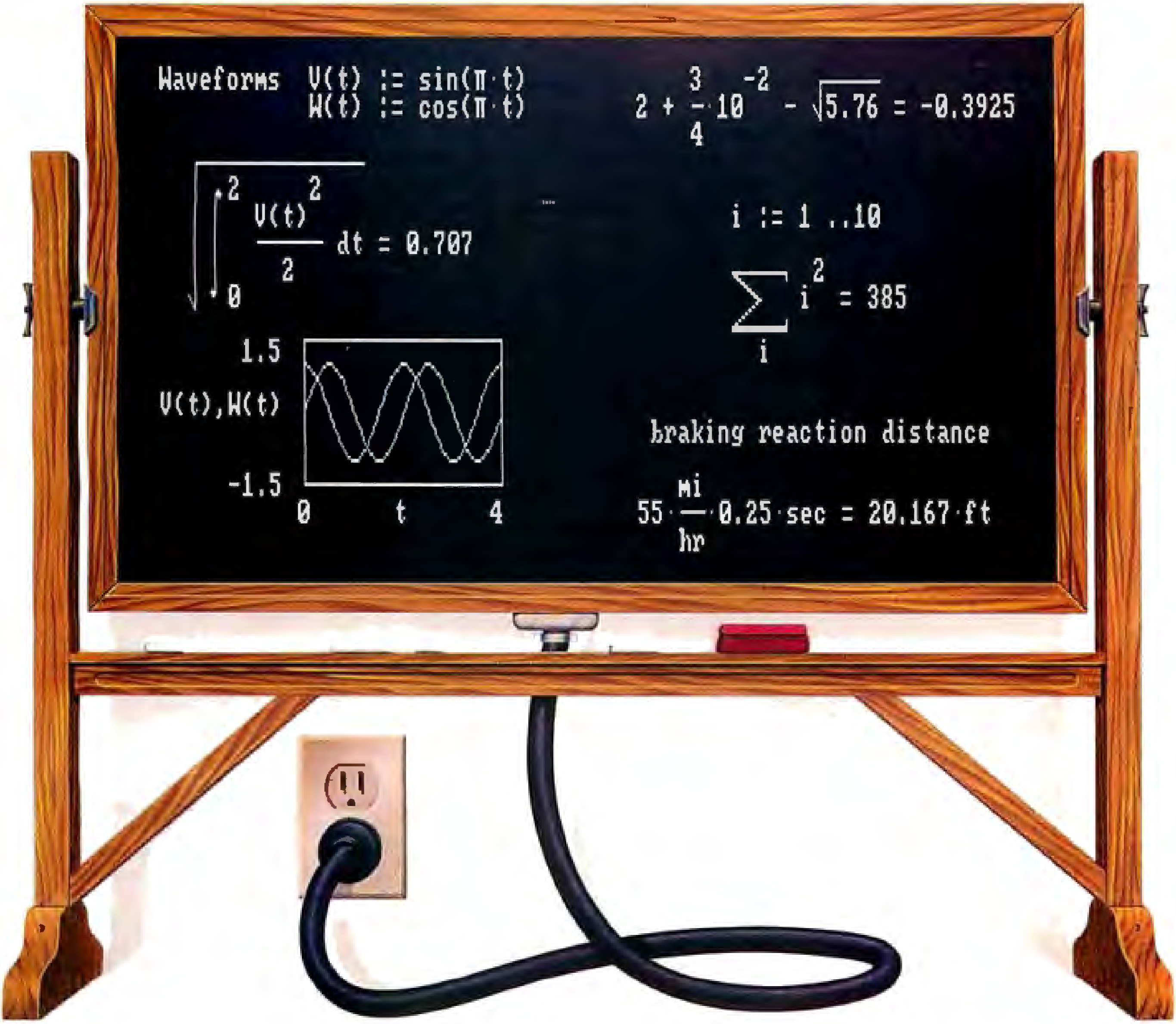
I had wondered what to put into the set after Greek, Chinese, Arabic, and Japanese characters. Perhaps I should look closer at the word count in representative samples of text. It would be easy to include, say, 4000 words in the standard set. Personally, I would include all of the most commonly used words plus all of those spelled differently in the U.K. and the U.S. You, too, could write *English*!

In addition to all of the usual text characters, the character set would include control codes for font changes, paragraph-end, soft hyphen, boldface, underline, proportional spacing, and all the other functions needed in typesetting text. If this develops into a real standard, it should control the way unsupported functions should be handled. It may be quite a while before anyone develops flashing ink.

Colour (I did say English) is a problem. It would be possible to use 16 codes for foreground and 16 for background colours. This seems too limiting. Now that computers are starting to use colour seriously, it might be better to use an escape sequence. One character would represent the message "The word following this is a binary representation of the new foreground colour." For the near future, 64K foreground and 64K background colours should be enough. Until the new 32-bit character set is introduced, of course.

There are practical problems in applying this new standard to existing machines. Most of them can be dealt with by using filter programs, which would expand the nonASCII codes into escape sequences, possibly the ANSI codes.

continued



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Level-0 compliance could be that simple. The real problem will be persuading chip manufacturers to produce the new character set ROMs. A full 48K character set in a 16- by 16-pixel dot matrix would be 1.5 megabytes. This is no problem for computers, but it is too much to expect low-cost printers to include a ROM of that size until plain-vanilla ASCII is the exception instead of the rule.

So far, the whole idea is still in my head; this is the first time I have put anything down in writing. Does anyone else have any ideas?

Bernard Peek
Watford, Hertfordshire, U.K.

Speeding Mandelbrots

Programs that plot the Mandelbrot set can be significantly speeded up by checking for repeating values.

Consider the point (0,0i). Repeatedly iterating this value under $z \leftarrow z^2 + c$ always yields the value (0,0i). Indeed, if *any* value comes up a second time, it can be said to be "caught" in a repeating cycle of some finite period. Once this occurs, further iterations are a waste of time, and the program can immediately go on to the next point, rather than waiting until some arbitrary number of iterations has been performed.

It turns out that almost all of the points that lie within the Mandelbrot set proper eventually enter a cycle like this. To check for a repeated value, I use a method discussed by A. K. Dewdney in "Computer Recreations" (*Scientific American*, August 1985) for detecting attractors.

First, declare two arrays, one for real and one for the imaginary components of the value being computed. The arrays should range from 1 to the maximum number of iterations you expect to perform for each point. Now, as each new z is computed, compare its components against the array elements (iteration count/2). If they don't match, store the values in the array elements (iteration count). If they do match, you have found a repeat and can go on to the next point. I have found that this method cuts the number of iterations needed to determine if a point lies within the set by about 80 percent.

Note that this has no effect on those points that surround the set but don't belong to it. You must still check to see how long it takes these points to exceed a size of 2. Also, the time required to enter a cycle increases for points close to the set boundary, so that the speed increase is greatest for those points that lie deep within the set.

Finally, it is instructive to color-code the number of iterations that occur before a point within the set enters a repeating cycle. It appears that on the boundary itself, the point never repeats the same value and never grows beyond a size of 2. This region is infinitesimally thin and marks the transition between two very different sorts of behavior of the function.

I would very much like to hear from anyone who has found better algorithms for computing this and other fractal objects. Please feel free to write me.

Paul McGregor Carlisle
202 West Harrison
Royal Oak, MI 48067

Peter Schroeder's article, "Plotting the Mandelbrot Set" (December 1986) contains a number of points that merit further clarification.

First, the basic generating formula given at the bottom of the second column on page 207 is in error; it should read $z = z^2 + c$.

Second, the Mandelbrot set is the set of points c on the complex plane for which the sequence of complex numbers

$$z_0 = 0,\ z_{i+1} = z_i + c,\ i + 1, 2, 3, 4, \ldots$$

does not diverge, as i tends to infinity.

Schroeder gives undue significance to the magnitude of z^{1000}, the number 1000 deriving perhaps from Dewdney's article in *Scientific American*. This number is based on the assumption that if the sequence does not diverge after 1000 iterations, it will never diverge.

As a practical matter, any other "large" number could have been chosen instead. In fact, we have found that the resulting graphic renditions are not materially altered if a cutoff value of, say, 256 is used instead. In so choosing, of course, the computation required for the plot is substantially reduced if the plot includes many points that are members of the set.

Because of the long running times required, here is an application for which optimization assumes real importance. I would suggest that one consider the use of fixed-point arithmetic at the assembler level for the iterative calculation itself. This would require treating z and c as 16-bit numbers with i integer bits and $16 - i$ fractional bits, which can be put back into the original 16-bit format with a $(16 - i)$-bit arithmetic right shift. This approach will realize significant improvements in running time, especially if an 8087 is unavailable.

Benjamin E. Chi
Albany, NY

More Updates for ATOMCC

The purpose of this letter is to inform all the users of ATOMCC (written in FORTRAN 66) that, because of all the bugs

continued

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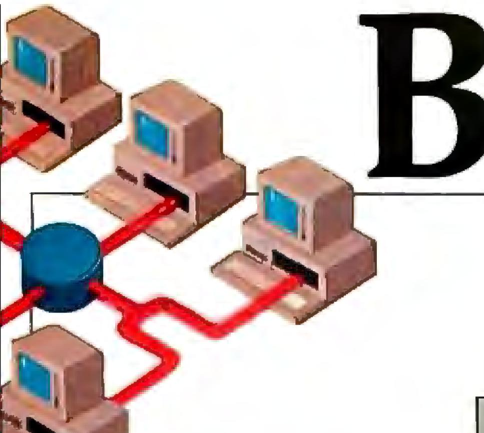

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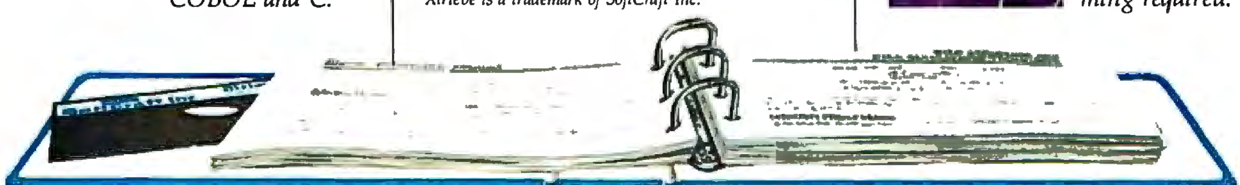

in it, I am no longer supporting it. I have recently finished the writing and testing of ATOMFT, versions 1.10 and 2.10.

Version 1.10 was written to satisfy the request made by Jet Propulsion Laboratory for the capability of solving problems with any number of user-defined functions. The FT in ATOMFT stands for function. Also, ATOMFT is written in FORTRAN 77. It is bug-free! And it is perfectly portable. The same code can be used for all micros, as well as all mainframes.

Version 2.10 was written to solve control problems, otherwise called DAEs (differential algebraic equations).

The charge is $200 for the source code of version 1.10; $30 for the object code of version 1.10 (for use with Microsoft FORTRAN 3.30 or later); $1000 for version 2.10 source code.

Y. F. Chang
Claremont, CA

Call for Papers

Computer Professionals for Social Responsibility will be sponsoring a symposium, "Directions and Implications of Advanced Computing," in Washington, D.C., in July.

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Call for Help

Help! I'm an absent-minded professor who's in trouble. I am trying to locate a machine-language simulator for the Apple II family, which I recall having seen about two years ago. The particular simulator I have in mind breaks each operation into its micro-operations, displaying them on the screen as the graphics demonstrate their execution.

My only problem is that I've forgotten the name of this program! Can anyone help me find it? Any leads will be appreciated. Please call (414) 652-3996 if you have any suggestions.

Charlotte J. Chell
Carthage College
Kenosha, WI

ZBasic Defended

I have used ZBasic for almost a year on a CP/M system. I could not let the comments from Edward L. Tottle ("Not Your Basic BASIC," November 1986) go unanswered.

First, while ZBasic has some differences from MBASIC, it is certainly no worse than going from, say, MBASIC to Color Computer BASIC (to say nothing of CBASIC). In addition, the differences usually favor ZBasic. Having used several varieties of BASIC over the years, I have

continued

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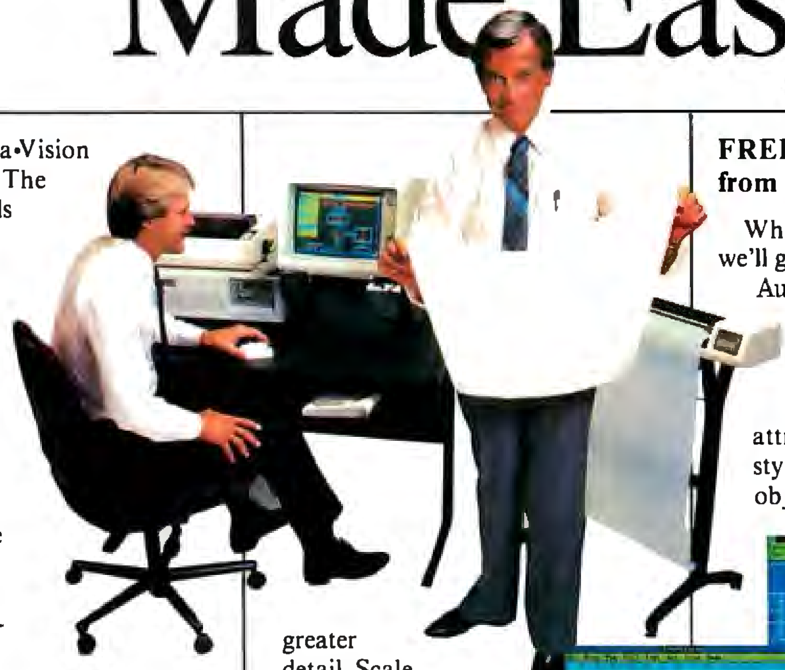

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MICROGRAFX, Inc., 1820 North Greenville Avenue, Richardson, Texas 75081.

Inquiry 188

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*Offer good only on purchases after January 1, 1987
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yet to see two totally compatible versions. As for Microsoft's "Gee, I didn't know you had to put a space there" solution to the embedded-word problem, I would question whether it is any better, especially as it is all but undocumented in any information I have seen on MBASIC.

Second, if you want a forced floating-point divide in ZBasic, use 1\3 instead of 1/3 and you will get the correct answer. This is clearly stated in the ZBasic reference manual.

Third, as far as digits of precision, you can only set this on the configuration option. As a standard, the precision is 6 digits for single precision and 16 digits for double precision, which is the same as MBASIC. In this or any other type of BASIC, special configuration information should be put in REM statements.

Now, let us review some features of ZBasic that reader Tottle dismisses.

One very nice feature is being able to use labels or line numbers for branching. This makes programs much more understandable (i.e., GOTO "main program start" is much more understandable than GOTO 1000).

ZBasic allows you to write structured programs easily while still allowing you to be flexible. Commands like LONG IF, LONG FN, and the three types of looping allow a program to be written to allow for easy understanding when improving or maintaining programs. ZBasic also allows for libraries to be built of common commands and subroutines, and added from disk for easy programming.

Another feature that speeds up program debugging is the fact that programs can be run in an interpreted mode. You can check for syntax errors and the like quickly, and repair them using the built-in editor. After debugging, you can compile to disk with one command and, if necessary, increase your memory to allow for large arrays. I have used up to 32K bytes, but more is possible. (And while running CP/M. Try that with MBASIC.)

ZBasic is also available for an Apple IIc, IIe, and Macintosh, TRS-80 I, III, and 4, IBM PC (and compatibles), and CP/M systems. With that many systems supported, it might not totally eliminate rewriting code when going from one machine to another, but it will simplify it.

Machine-language support in ZBasic is very good. With the MACHLG statement, it is possible to put machine-language routines in your BASIC code and to use ZBasic variable names in those routines. This allows for special routines to be written and installed in your programs easily.

Zedcor gives good support for ZBasic. In fact, their support by phone and mail is better than some computer dealers have given in person.

While ZBasic is not perfect, if you are looking for a BASIC that can either compile or interpret, and is fast in either mode, ZBasic is a good choice. It is also much cheaper than Microsoft's BASIC interpreter and compiler.

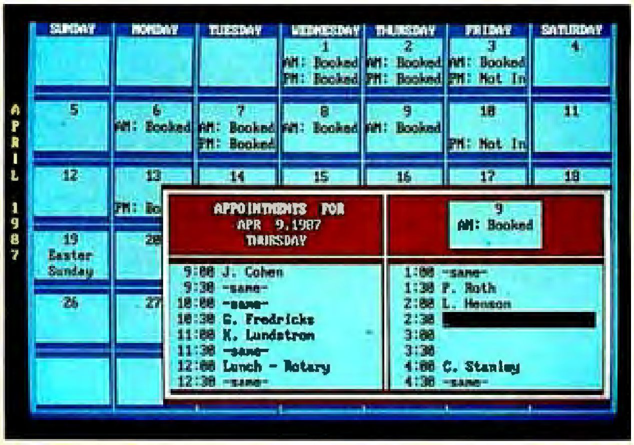
David Postler
Elgin, IL

FIXES

Photographic Switcheroo

In the December 1986 What's New section, we mistakenly ran a photo of a graphic produced with the Stella Business Graphics program where we should have shown an image generated by VCN Concorde 1.01 (see page 30). Two pages later, we ran the VCN Concorde graphic where the Stella image belonged. Our apologies to all, and particularly to Stella Systems and Visual Communications Network. ■

BOB STANTON HAD A GREAT IDEA. AN HOUR LATER HE WAS TESTING IT.



Appointments. Everybody takes them — dentists, auto-body shops, dance instructors. And lots of computer applications need appointment screens.

Bob thought that a calendar made a terrific graphic metaphor for taking appointments. Simply use the arrow keys to pick an open date, then press the Enter key, and up pops an appointment window.

Lucky for Bob, he's a CLARION programmer, one of a fast growing cadre of super-productive application developers.

With CLARION's Screener utility, he painted a white calendar on a black background. Then he drew a white-on-blue track around the page and between the days. He typed in the days of the week — and *voila!* — a calendar!

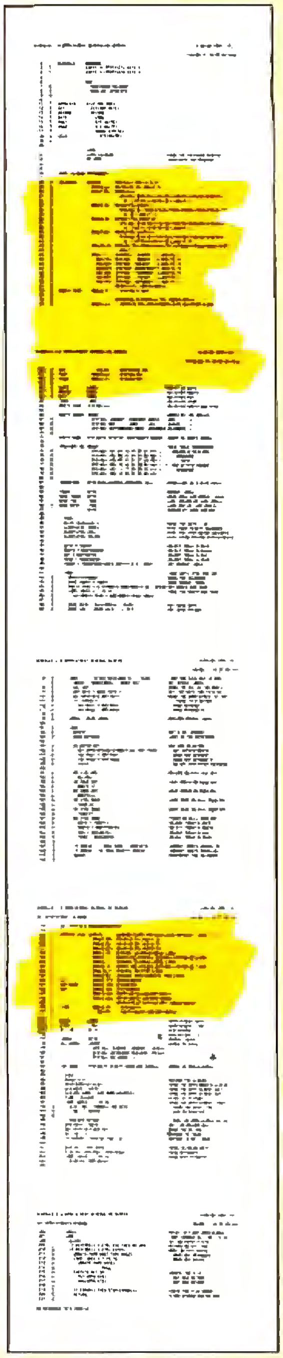
CLARION knows that a PC monitor is refreshed from memory, so it treats a screen layout like a group of variables. Just move data to a screen variable, and it shows up on the monitor.

Bob set up dimensioned screen variables for the days of the month and a screen pointer for selecting a date, and he was done. Then Screener generated the code.

Then Bob drew the appointments window, built an appointment file, filled in the connecting code and tested it — ONE HOUR AFTER HE STARTED!

Testing was a breeze. Screener doesn't just write code, it compiles your source, displays a screen, gets the changes, then replaces the old code in your program.

So here are Bob's appointment screens. You can see the source listing to the right. We marked all the code Screener wrote for him.



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Inquiry 302 for End-Users.
Inquiry 303 for DEALERS ONLY.

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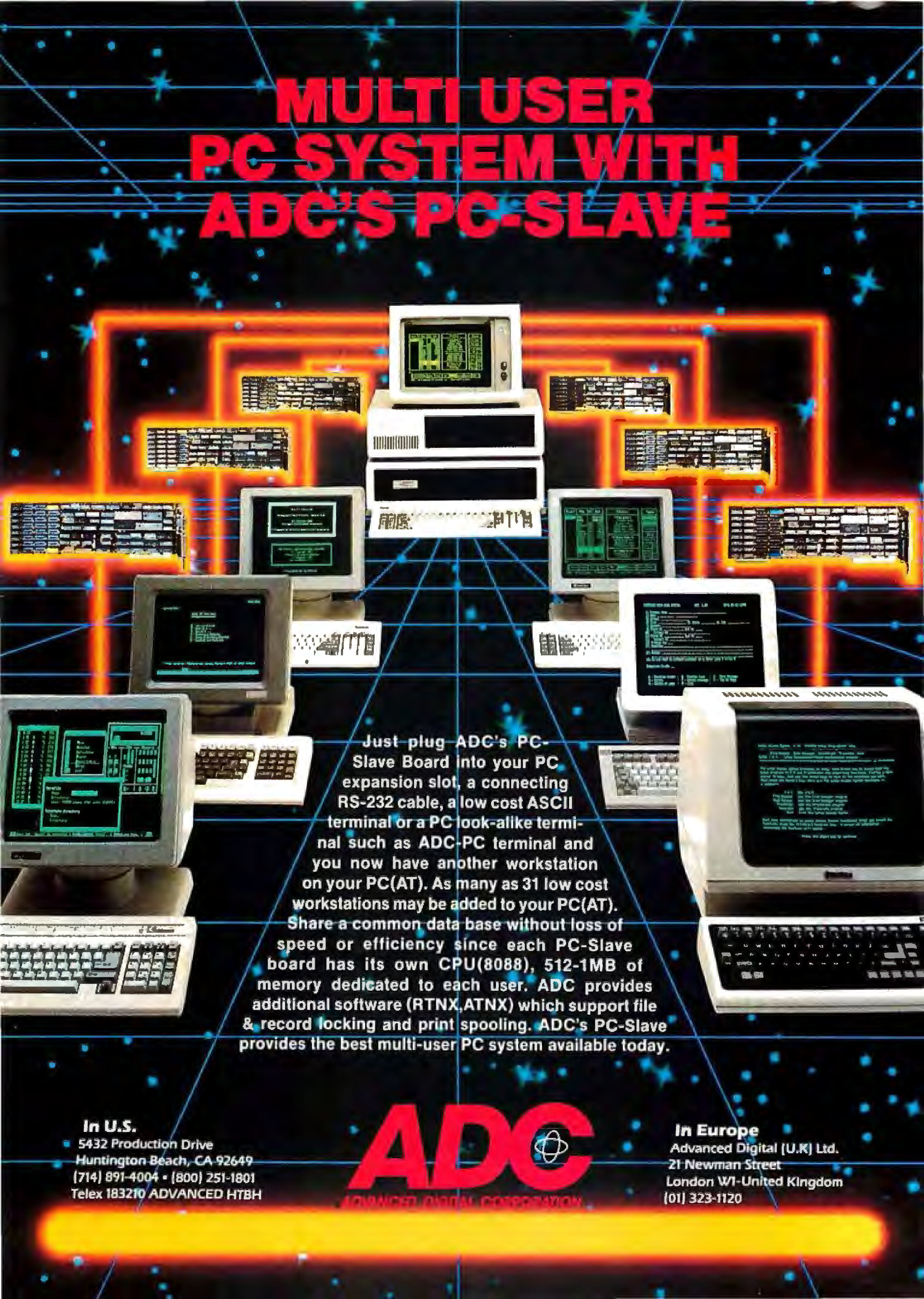
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Price: $495.
Contact: Adobe Systems Inc., 1870 Embarcadero Rd., Palo Alto, CA 94303, (415) 852-0271.
Inquiry 576.

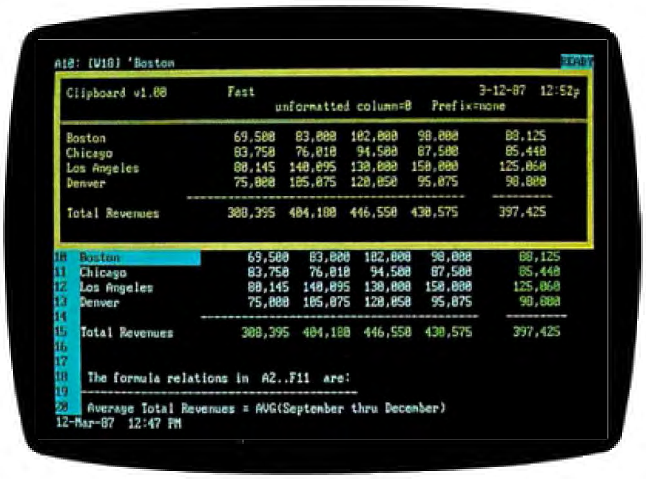
Atari's PC Clone

The Atari PC is the company's first move into the world of IBM clones. The low-cost system is based around an 8086 microprocessor running at either 4.77 or 8 MHz. There's also a socket on the motherboard for adding an 8087 math coprocessor.

The system comes with a single 5¼-inch floppy disk drive and has provisions for an external 5¼- or 3½-inch drive. It comes with 512K bytes of RAM, and memory can be expanded to 640K bytes on the motherboard. On the rear panel, there are serial, parallel, video, and Atari ST-style disk ports. There's also a mouse and a mouse port based on Microsoft's Inport chip. There's no room in the box for adding circuit cards, but the company says it will introduce an external expansion box later.

For graphics, the Atari machine provides Hercules, IBM monochrome, CGA, and EGA capabilities. An optional monochrome monitor supports all the display modes using gray scales to represent color.

The Atari PC system unit measures 22 inches square by 2 inches high and comes with an "XT-style" keyboard. The company claims that it's 100 percent compatible with software designed for the IBM PC.
Price: $699 with monochrome monitor and EGA capability; $499 less monitor and EGA capability.
Contact: Atari, 1196 Borregas, Sunnyvale, CA 94088, (408) 745-2000.
Inquiry 577.



Clipboard, one of Metro's pop-up application-management tools.

Pop-Up Desktop Accessories with Metro

Metro, a memory-resident desktop manager from Lotus Development Corporation, can be used as a companion to 1-2-3, Symphony, Manuscript, and other Lotus programs or can be used alone.

The program's pop-up application-management tools include a text editor, a DOS file manager, a clipboard, an HP-12C-style financial calculator, a notepad, a phone book, a list manager, and a macro generator. You can configure your system's memory by loading in the application tools that you need. The text editor offers word processing capabilities in a familiar Lotus interface and enables you to create and edit files without leaving 1-2-3, Symphony, or other application programs you're working with. The clipboard lets you cut and paste data between Metro and other Lotus application programs, and the DOS file manager formats disks and creates subdirectories also without leaving the main application.

Metro's macro generator features a command language, which includes IF. . .THEN branching with variable definitions and GOSUB routines. A learn mode records a series of keystrokes and commands that you can execute with a single key. The generator also enables you to create your own menus, templates, and text screens.

The program uses the same TSR (terminate but stay resident) kernel used by the Lotus Express communications program. Metro is based on Lotus's adaptation of Spotlight, a TSR-based program created by Software Arts, a recent Lotus acquisition. In creating Metro, Lotus added to Spotlight the memory configuration capability, text editor, list manager, DOS filer, clipboard, and macro generator. Spotlight users can upgrade to Metro for $40, Lotus reports.

To run Metro, you'll need an IBM PC, XT, AT, or compatible with at least 80K bytes of RAM available for the RAM-resident portion of the program. MS-DOS or PC-DOS 2.0 or higher is necessary, along with two floppy disk drives. (Lotus recommends a hard disk drive for optimal performance.)
Price: $85.
Contact: Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142, (617) 577-8500.
Inquiry 578.

Four New 80386 Products

Intel Corporation has introduced four new products for the 80386 line.

The 80386/20 is a 20-MHz version of the 80386. It's

continued

available in production quantities immediately.

The 80387 numeric coprocessor, which was first announced in October 1985, is now available, also in production quantities.

For system designers, the 82380 DMA controller is a 32-bit, 8-channel, 32-megabyte-per-second controller that includes DMA, DRAM control, interrupt controller, program interval timers, and other control logic.

Finally, the 82385 cache controller has features such as bus watching and posted writethrough. It will be available in production quantities by the end of 1987.

Prices: $599 for the 80386/20, quantity of 100; $350 (80387, quantity 1000); $145 (82380, quantity 1000). 82385 pricing not yet available.

Contact: Intel Corporation, 3065 Bowers Ave., Santa Clara, CA 95051, (408) 987-8080.

Inquiry 579.

HP's Symbolic Math Calculator

Coinciding with the fifteenth anniversary of the HP-35, the world's first handheld scientific calculator, Hewlett-Packard has introduced the HP-28C, which the company claims is the first calculator capable of doing symbolic mathematics. With a 4-line by 23-character liquid-crystal display, 128K bytes of ROM, and separate alpha and numeric keyboards, you can view, edit, and use complex numbers, matrices, vectors, lists, algebraic expressions, and other data types. A built-in operating system lets you mix direct entry of algebraic expressions with reverse Polish notation.

Equations can be entered and stored in whatever terms you choose with the HP-28C's equation-solver capability. The unit then solves an equation for any unknown variable anywhere in the equation.

The HP-28C calculator performs symbolic mathematics.

The display can graphically depict any single-valued functions and plot statistical data. Once an expression is plotted in the display, you can locate an appropriate root, press a key to record the coordinates, then use the equation solver to calculate the root with 12-digit accuracy.

The HP-28C weighs 8 ounces and measures 7½ inches by 6¼ inches by ½ inch when open. An optional compact printer is available that can be used to record keystrokes, show stored data, or selectively print the display contents. It communicates with the HP-28C via an infrared beam.

Price: $235; printer, $135.

Contact: Hewlett-Packard, 1820 Embarcadero Rd., Palo Alto, CA 94303, (800) 367-4772.

Inquiry 580.

Xerox's Hardware Spelling Checker

Developed by Xerox's Palo Alto Research Center, PC Type Right is a hardware spelling checker that plugs in between the keyboard and system unit of any IBM PC- or AT-compatible computer system, thus taking up neither disk nor RAM space. The spelling checker instantly checks words as they're entered against its built-in dictionary and beeps at you if it detects an error. The volume and tone of the beep are adjustable, and you can also incorporate a 1200-word personal dictionary.

Xerox claims that PC Type Right recognizes far more words than competing spelling checkers, including proper names, place names, and technical terms. It will also let you know if you type two identical words in a row (e.g., the the).

Price: $199.95.

Contact: Xerox Corporation, Xerox Square 006, Rochester, NY 14644, (716) 423-5078.

Inquiry 581.

Split-Screen Text Editor for Under $30

The Mix Editor was designed to work with the Mix C Compiler, although it features automatic indenting for languages such as C or Pascal, automatic line numbering for BASIC, and fill and justify for English.

Several of the editor's features simplify the development of source code in high-level languages. For instance, you can move text between windows with the screen split horizontally or vertically. And over 100 predefined commands are included, on which you can build macros.

The program runs on the IBM PC and compatibles with MS-DOS or PC-DOS 2.0 and higher and on CP/M-80 systems. The MS-DOS version has a macro for compiling directly from memory, and if the program discovers an error, it places the cursor on it and displays an error message.

Mix Software reports that the editor is designed for novice programmers in that it generates functional programs that are larger but slower than those generated by professional C compilers.

Price: $29.95; the Mix C Compiler sells for $39.95.

Contact: Mix Software Inc., 2116 East Arapaho, Suite 363, Richardson, TX 75081, (214) 783-6001.

Inquiry 582.

Mailman for the 386

RPM Systems has announced an electronic mail system for 80386-based systems. The program, called Mailman, runs on the IBM PC and compatibles while the heart of the system resides on an 80386 PC.

The interface is a set of windows that enable you to see where you are in the system at all times. A built-in word processor lets you create mail messages. Other functions of the system include reading new and old mail, sending, checking the user list, and withdrawing a mail message before it is sent.

Mailman is PC-Net LAN-compatible, and you can use it as a node on a PC-Net LAN or attach it to other LANs through an RPM interface.

You'll need an 80386 system with UNIX V or XENIX V and an IBM PC or compatible running MS-DOS or PC-DOS 2.0 or higher.

Price: $2000.

Contact: RPM Systems, 13 Corporate Plaza, Newport Beach, CA 92660, (714) 720-0226.

Inquiry 583.

continued

Imagine the speed and power of a $100,000 minicomputer in a desktop PC costing under $7,000. Now imagine all that power going to waste because the operating system you chose was never meant to take advantage of a computer this powerful. It will take more than just a "window environment" or an outdated operating system to unlock the 80386.

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Memory Management Without Boards. PC-MOS exploits the memory management capabilities built into the 80386. So, up to four GIGABYTES of memory are accessible to multiple users and to future 80386-specific applications requiring megabytes of memory.

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Inquiry 286 for End-Users. Inquiry 287 for DEALERS ONLY.

MicroPro Announces New Version of WordStar

WordStar Professional 4.0 has 129 new features, which include an on-line 220,000-word thesaurus, line and box drawing capability, programmable macros and function keys, and file locking for local area network support. A local area network file-server version and a LAN node version are available as well.

Also available with WordStar Professional is a 6000-word legal, 68,000-word medical, and 8500-word financial dictionary that you can use with the 87,000-word dictionary for CorrectStar, which is included. The specialized dictionaries sell for $25 each.

MicroPro reports that you can install the program to be completely or partially RAM-resident.

The program runs on the IBM PC and compatibles with MS-DOS or PC-DOS 2.0 or higher with at least 256K bytes of RAM (you'll need 320K to use the thesaurus). The LAN versions are available for Novell NetWare, 3Com Ethernet, and IBM PCNet, and the program supports the IBM Color Graphics Adapter card or monochrome adapter.

Price: $495 for the single-user version; $595 for the LAN file-server version; $150 for the LAN node documentation and license registration forms.
Contact: MicroPro International, 33 San Pablo Ave., San Rafael, CA 94903, (415) 499-1200.
Inquiry 584.

MicroPro's WordStar Professional 4.0.

High-Speed 386 Board for 286 Machines

Orchid Technology has rolled out Jet 386, its entry into the 80386 add-in board market. Running at 16 MHz, the Jet has a socket into which you plug the 80286 processor that you remove when you install the board. You can then switch between the 286 and 386 via a toggle switch on the rear of the board.

Jet 386 supports both 80287 and 80387 arithmetic coprocessor chips and has 64K bytes of cache memory. Orchid claims the board is 100 percent compatible with AT-compatible software and add-ins.

Price: $1499
Contact: Orchid Technology, 47790 Westinghouse Dr., Fremont, CA 94539, (415) 490-8586.
Inquiry 585.

GCLISP for the Compaq Deskpro 386

Gold Hill Computers has announced the Golden Common LISP 386 Developer for the Compaq Deskpro 386. You can integrate C programs with artificial intelligence applications with GCLISP 386, according to Gold Hill. The program features a large memory interpreter and compiler, an on-line help system, and an enhanced editor that has over 150 commands, uses EMACS key-chord bindings, and gives you the option of defining your own key-chord bindings. Also supported are lexical scoping, packages, and transcendental functions, which enable you to port Common LISP programs to personal computers.

Price: $1195.
Contact: Gold Hill Computers, 163 Harvard St., Cambridge, MA 02139, (617) 492-2071; in MA, (800) 242-5477.
Inquiry 586.

1200-bps Security Modem

Besides being a Bell 212A-compatible modem that uses the Hayes AT command set, the GTX-100R from A-O Electronics can be used to turn computers or other equipment on and off from a remote location. The modem incorporates dial-back verification and password security so that only authorized users can get through the modem to power up equipment. After access is attempted, the GTX-100R hangs up and searches for the calling number in an "authorized directory" stored in CMOS RAM. If a number is found, it dials back, re-establishes contact, and asks for a password. As a further security measure, after several unsuccessful password entry attempts, the GTX-100R removes the telephone number from its authorized list.

The remote-on feature can also be disabled, allowing the GTX-100R to function as a normal modem.

Price: $895.
Contact: A-O Electronics, 2137 Flintstone Dr., Tucker, GA 30084, (404) 491-8044.
Inquiry 587.

A Color Dot-Matrix Printer/Plotter

Honeywell Information Systems Italia has rolled out the 4/66P, an 18-pin color dot-matrix printer with plotter capability that is compatible with the Hewlett-Packard 7475A plotter and the Hewlett-Packard graphics language.

Used as a plotter, the 4/66P has three choices of resolution: 144 by 72 dots per inch; 144 by 144 dpi, and 288 by 144 dpi (all at 13.3 inches per second). The maximum plotting area is 15.6 by 19.6 inches.

Used as a printer, the 4/66P is compatible with Epson and IBM control codes. It prints in up to seven colors at 480 cps for draft quality, 180 cps for near letter quality; and 75 cps for letter quality. The unit will print on paper up to 17 by 24 inches. You can also switch between cut-sheet and continuous-form paper without having to remove the continuous paper.

Price: $2995.
Contact: Honeywell Information Systems Italia, 390 Fourth St., San Francisco, CA 94107, (415) 974-6116.
Inquiry 588.

Toshiba Enhances Top-of-Line Printer

Toshiba's P351 Model 2 is an enhanced version of the company's top-of-the-line 24-pin dot-matrix printer. New features on the Model 2 include the ability to select print quality, font, and pitch from the front panel. The unit's DIP switches are located directly beneath the front cover for easy access. And to meet government and

continued

accounting requirements, the P351 Model 2 can print six-part forms.

The Model 2 has a 4K-byte buffer and prints at 300 cps in draft mode, 250 cps in condensed mode, and 100 cps in letter-quality mode. It comes with Prestige elite and Courier fonts built in, and the company offers a wide selection of fonts on both cartridges and disks.

The P351 can emulate the Qume Sprint 11 and the IBM Graphics Printer and takes paper up to 15 inches wide. Both unidirectional and bidirectional tractor feeds and single- and double-bin sheet feeders are available as options.
Price: $1599.
Contact: Toshiba America Inc., Information Systems Division, 2441 Michelle Dr., Tustin, CA 92680, (714) 730-5000.
Inquiry 589.

Computer Service Kit

The CSK-16 from Davle Tech is a portable computer service kit packaged in a black zipper vinyl case that measures 11⅜ by 7½ by 1½ inches. The kit contains IC inserters with pin straighteners, an IC extractor with pin straightener, an anti-static wrist strap, a desoldering tool, a soldering iron, solder, soldering aid tools, a lead nipper, and a lead shear.
Price: $61.
Contact: Davle Tech Inc., 2-05 Banta Place, Fair Lawn, NJ 07410, (201) 796-1720.
Inquiry 590.

Controller Handles All Floppy Drives

Computer Peripheral's Drivemaster is a floppy disk controller for the IBM XT/AT that operates both 5¼-inch and 3½-inch drives and handles both 360K and 1.2-megabyte capacities. The board's built-in ROM software supports all DOS version 2 and 3 commands. This feature allows you to use a 3½-inch disk drive in your computer without the need for DOS 3.2. Up to four drives can be hooked up to the Drivemaster, and the board includes a built-in buffer that backs up data when media with different storage capacities are used together.
Price: $249.
Contact: Computer Peripherals, 2635 Lavery Ct., Suite 5, Newbury Park, CA 91320, (805) 499-5751, (800) 854-7600.
Inquiry 591.

Designing Newsletters with PageMaker

PageMaker Portfolio: Designs for Newsletters from Aldus contains 21 newsletter formats. The PageMaker accessory enables you to incorporate your own copy, headlines, and artwork into your project.

The program runs on the Apple Macintosh with PageMaker version 1.2.
Price: $79.
Contact: Aldus Corp., 411 First Ave. S., Suite 200, Seattle, WA 98104, (206) 622-5500.
Inquiry 592.

Maxi-Keyboard: 122 Keys Plus Software

The Ultra Memory Pro keyboard from Maxi-Switch is a 122-key keyboard that's fully compatible with all IBM-type systems. It has 25 function keys, separate cursor and numeric keypads, and switchable key click.

Of the 25 function keys, 12 are compatible with the IBM enhanced keyboard, while the other 13 can be quadrupled when used with the Shift, Alt, and Control keys.

The software lets you define key pauses, delays, and fixed and variable fields and allows automatic loading of key definitions from soft-key files. Soft keys can also be programmed to have different macros for different programs, with individual macros up to 45,000 characters long.
Price: $250.
Contact: Maxi-Switch, 9697 East River Rd., Minneapolis, MN 55433, (612) 755-7660.
Inquiry 593.

Charting the 68000

Micro Logic Corporation's Micro Chart reference card for the Motorola 68000 is the 15th of the company's series. The two-sided chart measures 8½ by 11 inches and is made of plastic. It covers detailed instruction descriptions, instruction cycle times, addressing modes, condition definitions, flag states, registers, exception processing and vectors, supervisor and user states, stacks and queues, operand conventions, pinouts, ASCII, and miscellaneous notes.

Among the other 14 reference cards available are 8086/8088, Z80, and 6502 microprocessor references, a WordStar reference card, and cards for BASIC, C, and UNIX.
Price: $5.95 (plus $1 shipping).
Contact: Micro Logic Corporation, P.O. Box 174, 100 2nd St., Hackensack, NJ 07602, (201) 342-6518.
Inquiry 594.

Taxan Big Screen RGB Monitor

Designed especially for CAD/CAM, desktop publishing, and business graphics, the Taxan Model 840 is a 16-inch RGB color monitor. When used with Taxan's 557 Gold Card, the system will automatically switch the monitor modes from CGA (640 by 200) to EGA (640 by 350) to TGA (Taxan Graphic Adapter—640 by 400).

The 840 has a bandwidth of 25 kHz, weighs 40 pounds, and measures 13½ by 15 by 16½ inches.
Price: $1195.
Contact: Taxan USA Corporation, 18005 Cortney Ct., City of Industry, CA 91748, (818) 810-1291.
Inquiry 595.

RS-232C Converter/Buffer for the Commodore

TecTrans's 98064 converter/buffer allows you to connect your Commodore 64 or 128 to any computer, modem, or printer that uses an RS-232C serial interface. The unit works bidirectionally and has a 32K-byte input buffer and a 32K-byte output buffer.

The converter/buffer can handle speeds between 225 and 57,600 bps, and protocols (issued from the keyboard) are stored in CMOS memory.
Price: $149; AC power supply, $15.
Contact: TecTrans, 6925 Rosemead Blvd., San Gabriel, CA 91775, (818) 285-3121.
Inquiry 596.

Quick, Erase Those EPROMs

Designed for low-volume users of EPROMs, the model PE-140T UV erasing lamp erases up to nine EPROMs at a time in as little as 13 minutes. This portable unit includes a conductive foam pad for protecting EPROMs against static charge and a 60-minute automatic-shut-off timer.

The high-intensity short-wave UV tube is enclosed in an anodized aluminum housing with a safety interlock mechanism to protect users against exposure to UV radiation. The PE-140T is UL listed and meets OSHA safety standards.
Price: $139.
Contact: Spectronics Corporation, 956 Brush Hollow Rd., P.O. Box 483, Westbury, NY 11590, (516) 333-4840.
Inquiry 597.

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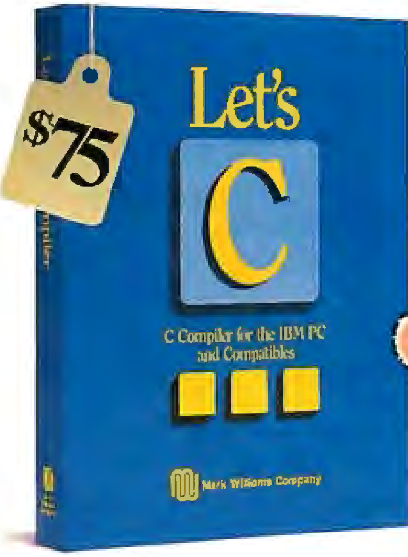

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"Let's C is a thoroughly professional C environment loaded with tools and programming utilities...another fine Mark Williams product."
–Christopher Skelly, *COMPUTER LANGUAGE,* February 1986

"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..."
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- 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

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Inquiry 179

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SYSTEMS

English PC Compatible Comes to the States

Brentwood, England-based Amstrad has started distributing its low-priced IBM PC clone in the United States. The PC 1512 comes standard with 512K bytes of RAM, an 8-MHz 8086 processor, and an integrated motherboard that contains monochrome/CGA circuitry, serial and parallel ports, a clock/calendar, and three full-length expansion slots.

Either monochrome or color monitors are available, and a two-button Microsoft-compatible mouse is included. The unit is available with one or two 360K 5¼-inch floppy disk drives or with one floppy disk drive and a 20-megabyte hard disk.

Standard software includes MS-DOS 3.2, Digital Research's DOS Plus (which will run multitasking MS-DOS and CP/M applications), and DRI's GEM (Graphics Environment Manager), including GEM Desktop, GEM Paint, and GEM Locomotive BASIC 2.

Price: $799 with single floppy drive and monochrome monitor; $899 with dual floppy drives and monochrome monitor; $999 with single floppy drive and color monitor; $1099 with dual floppy drives and color monitor; $1299 with single floppy drive, 20-megabyte hard disk, and monochrome monitor; $1499 with single floppy drive, hard disk, and color monitor.
Contact: Vidco, 1915 Harrison Rd., Longview, TX 75604, (214) 297-4898.
Inquiry 598.

The Amstrad PC 1512, a low-cost PC clone.

AT Clone Has 12 Expansion Slots

FiveStar's Korean-built FS286 is an IBM PC AT-compatible with a number of unique features. The unit comes with 12 expansion slots (six 16-bit and six 8-bit) backed up by a 242-watt power supply. FCC-approved, the FS286 also comes standard with one megabyte of RAM (expandable to 16 megabytes) and five half-height peripheral drive slots (four external and one internal). A 1.2-megabyte or 360K-byte floppy disk drive is included in the base unit.

The FS286 runs at 8 MHz (software switchable to 6 MHz) and has a built-in clock/calendar. MS-DOS 3.1 is included with the system, and it has a three-year warranty.

Price: $1695 with single floppy disk drive.
Contact: FiveStar Electronics Inc., 12900 Valley Branch #400, Dallas, TX 75234, (214) 484-4850.
Inquiry 599.

Low-Cost 65SC02 Single-Board Computer

The LCM-32 from Intrep Corporation is a low-cost single-board computer that uses the 65SC02 microprocessor, the CMOS version of the 6502. The board includes 8K bytes of CMOS RAM and a 28-pin socket for including an applications program in EPROM.

The LCM-32 has 32 individually programmable I/O lines, with four CMOS 6522 16-bit timer/counters. Two standard 26-pin headers are provided for connection to the outside world, and there's an on-board 5-volt DC regular so that the system can be powered via a battery or wall transformer.

Price: $56.95.
Contact: Intrep Corporation, 874 Jackson St., P.O. Box 5381, Napa, CA 94581, (707) 224-6000.
Inquiry 600.

Pocket-Size 6800 System

Hand Held Products has rolled out the Advanced Pocket Computer (APC), a 6800-based computer for applications that require the ultimate in portability. Measuring just 5.1 by 3.1 by 1.1 inches, the APC weighs 10 ounces and gets its power from a standard 9-volt alkaline battery. It has a full alphanumeric keyboard, a 2-line by 16-character liquid-crystal display, and 64K bytes of RAM.

The APC is programmable using its own BASIC-like language. It can also be used as a full-function calculator and can be programmed with up to eight different alarms using its built-in clock/calendar.

For those who want to develop their own custom applications, the company also offers plug-in EPROM memory modules in four different sizes. Other options are available as well.

Price: $295. 16K EPROM module, $39; 32K EPROM module, $69; 64K EPROM module, $139; 128K EPROM module, $249; 32K RAM with battery backup, $179; bar code interface, $200; RS-232C interface, $95.
Contact: Hand Held Products, P.O. Box 2388, Charlotte, NC 28211, (704) 541-1380.
Inquiry 601.

Three Speedy AT Clones

The Master Series from Intronics includes three high-speed IBM PC AT clones. The top of the line is the AT/12, which runs at a 12 MHz. With a software-switchable speed between 6 and 12 MHz, the AT/12 is able to run all AT compatible software. The AT/12 comes with one megabyte of RAM, a single 1.2-megabyte floppy disk drive, and a combined floppy/hard disk controller that can drive two floppy and two hard drives. It also has eight expansion slots (six 16-bit, two 8-bit) and a 200-watt power supply.

The AT/10 runs at 10 MHz and comes with 512K bytes of RAM. Otherwise, it's configured identically to the AT/12. Finally, there's the AT/10 Mini, a slightly stripped-down version of the AT/10. The Mini also runs at 10 MHz and has six instead of eight expansion slots. This results in a system with a smaller footprint than the other models.

Price: $2895 (AT/12); $2595 (AT/10); $2495 (AT/10 Mini).
Contact: Intronics Computer Corp., 1212 Knoxville St., San Diego, CA 92110, (800) 422-3366.
Inquiry 602.

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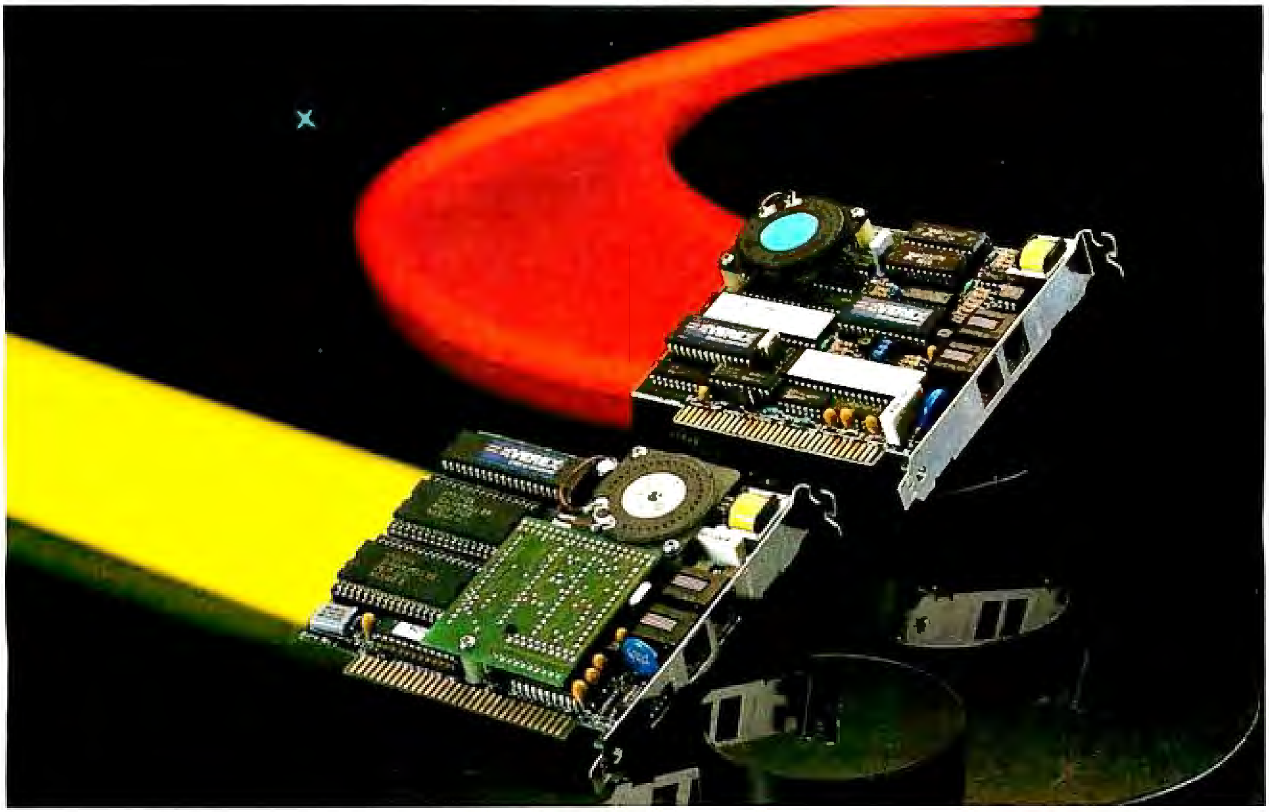

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★ Hayes* AT compatible	YES	YES
★ 300/1200 baud	YES	YES
★ SW VOL control	YES	NO
★ Runs in slot 8 of IBM XT*	YES	NO
★ Runs with all versions of Smartcom II*	YES	NO
★ ROM test on command	YES	NO
★ Simplex communication	YES	NO
★ Phone-off-hook detect	YES	NO
★ Auto voice-to-data switching	YES	NO
★ Format (speed & parity) ID on command	YES	NO
★ Speed Mismatch message	YES	NO
★ Works with call waiting	YES	NO

Features	EVERCOM 24 2400 Baud	Leading Edge Model "L"
★ Hayes* AT compatible	YES	YES
★ 300/1200/2400 baud	YES	YES
★ Runs in slot 8 of IBM XT*	YES	NO
★ Runs with all versions of Smartcom II*	YES	NO
★ Runs with multi-line phones	YES	NO
★ Phone-off-hook detect	YES	NO
★ Auto data-to-voice switching	YES	NO
★ Allows "at" in lower case	YES	NO
★ Format (speed & parity) ID on command	YES	NO
★ Speed Mismatch message	YES	NO
★ Adaptive dialing	YES	NO
★ Leased line operations	YES	NO
★ Programmable response to DTR	YES	NO
★ CCITT guard tones	YES	NO
★ Self-test (RDL)	YES	NO
★ Installation program	YES	NO

1-800-821-0806 1-800-821-0807 (in CA)
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Inquiry 104 for End-Users. Inquiry 105 for DEALERS ONLY.

PERIPHERALS

Oasys Rolls Out Laser Printer

The LaserPro 814 from Oasys is an eight-page-per-minute laser printer that uses the Ricoh print engine. It comes standard with 1.5 megabytes of RAM (expandable to 3 megabytes) and is compatible with the Hewlett-Packard graphics language.

The 814 emulates the HP LaserJet Plus, HP 7475A, Epson FX-80, Diablo 630, ANSI 3.64, and a standard line printer.

Office Automation Systems' proprietary EXPRESS command language is also included with the 814. EXPRESS allows users to access all printer features using English-like commands. Also included is the Pyramid Font System, a custom font-generation system that allows you to vary parameters such as typeface and point size through direct commands. OASYS claims the PFS reduces the need for additional font cartridges.

The LaserPro has a duty cycle of 10,000 copies per month and a rated life of 600,000 copies before overhaul.

Price: $5650.

Contact: Office Automation Systems Inc., 8352 Clairemont Mesa Blvd., San Diego, CA 92111, (619) 576-9500.

Inquiry 603.

Wise Old Owl SCSI Hard Disk Drive

Xebec has introduced two 5¼-inch hard disk drives for the Small Computer System Interface (SCSI). The Owl III Model 40 is a half-height drive with a formatted capacity of 40 megabytes; the Owl III Model 80D is a full-height hard disk with a formatted capacity of 80 megabytes.

Both models incorporate controller and drive electronics on a single circuit board. The Owl III drives use a rotary voice-coil positioner with an average access time of 40 milliseconds and a data path that uses a dual-port data buffer with 1:1 sector interleave.

Because of the dual actuators, dual data path, and the multiplexing capabilities of the SCSI, Xebec claims the drives are particularly well suited for multiterminal/multitasking systems.

Price: $750 (Model 40); $1295 (Model 80D).

Contact: Xebec, 3579 Highway 50 East, Carson City, NV 89701, (702) 883-4000.

Inquiry 604.

Two LED Printers from Kaypro

Kaypro's Page Printer I is a nonimpact printer that uses LED technology. Kaypro reports that it has the print quality of laser printers but requires less repair and maintenance.

The Page Printer I is rated at eight pages per minute, 5000 copies per month, and an average life of 300,000 copies between major overhauls. The unit is controlled by an 80186 microprocessor, has 128K bytes of RAM, and can emulate a Diablo 630. It has a 250-sheet input hopper, a 250-page output stacker, and can handle letter size, legal size, and most standard envelopes.

The panel of the Page Printer I has a two-line by 16-character LCD that shows machine status, current font in use, possible system errors, and notification of maintenance or service needs.

The Page Printer II is an upgraded version of the Page Printer I. Also 80186-based, it has 1.5 megabytes of RAM and can handle full-page bit-mapped graphics (300 by 300 dpi) using HPGL (Hewlett-Packard Graphics Language). The unit also emulates a graphics plotter, the HP LaserJet, and the Diablo 630.

Like its little brother, the Page Printer II has a 250-sheet input hopper, a 250-page output stacker, and can handle letter size, legal size, and most standard envelopes.

Price: $2995 (Page Printer I); $3995 (Page Printer II).

Contact: Kaypro Corp., P.O. Box N, Del Mar, CA 92014, (619) 481-4300.

Inquiry 605.

A Galaxy of Starcom Modems

SCOA Systems has introduced a new line of external and internal 1200- and 2400-bps modems. All are compatible with the Hayes AT command set and meet Bell 103/212A standards. The external modems have configuration DIP switches that are easily accessible from the front panel, eight LED status lights, and a single RJ-11C jack. The internal modems have dual RJ-11C jacks. All models feature a built-in speaker and a volume control on the rear panel. All use an 8039 microprocessor and a 40-character command buffer.

Price: 1200 SE (external 1200 bps), $299; 1200 SH (internal 1200 bps), $249; 2400 SE (external 2400 bps), $599; 2400 SB (internal 2400 bps), $579.

Contact: SCOA Systems, 2100 Golf Rd., Suite 100, Rolling Meadows, IL 60008, (312) 640-8782.

Inquiry 606.

Multi-Compatible 2400-bps Modem

The Evercom-24 from Everex Systems is a half-slot 2400-bps modem that offers full worldwide compatibility. Besides conforming to Hayes and Bell 212A/103 standards, the unit also accommodates European, Asian, Australian, and South American CCITT V.22bis standards. The Evercom uses adaptive equilization for improved performance on noisy communications lines and comes with both installation software and BITCOM communications software. The Evercom-24 includes built-in diagnostics with local analog loopback with self-test, local digital loopback, and remote digital loopback tests. For users who install an Evercom at both ends of the line, data-to-voice switching can be done automatically.

Price: $289.

Contact: Everex Systems Inc., 48431 Milmont Dr., Freemont, CA 94538, (415) 498-1111.

Inquiry 607.

High-Speed Laser Printer

The Talaris 1500 is a 15-page-per-minute laser printer with a resolution of 300 dots per inch and a full-page bit-map controller for mixing text and graphics. The 1500 features 21 standard fonts and a dual-page buffer in the 68000-based print controller that comes standard with 3.5 megabytes of RAM. You can store up to 60 fonts in the system, which is compatible with the Diablo 630, Qume Sprint, and Tektronix 4014 printers.

The 1500 uses the Ricoh LP4150 print engine, which the company claims has a lower maintenance cost than comparable speed print engines, and has a duty cycle of between 5000 and 25,000 copies per month.

The unit uses Talaris's QUIC programming language and is compatible with the company's other software products.

Price: $11,990.

Contact: Talaris Systems Inc., 5160 Carroll Canyon Rd., P.O. Box 261580, San Diego, CA 92126, (619) 587-0787.

Inquiry 608.

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CLIPPER™ NETWORKS DBASE APPLICATIONS

LOS ANGELES, California...Nantucket's Clipper now lets developers and business persons plug an unlimited number of workstations together to run their dBASE III and dBASE III PLUS applications, using Clipper's new networking capabilities.

This new release compiles programs to run on networks that support DOS 3.1 calls for networking functions, plus single-user programs for DOS 2.0 or greater.

Compiled Applications can be distributed freely, need no runtime module, no licensing fee or royalty. And there is no extra cost per user, regardless of how many users are connected to a Clipper network. Plus the new release now packs even more of Clipper's famous speed, on both single-user and networking applications.

The new Clipper also sports Expanded Memory support, additional functions and improved memo fields. The new release, dubbed Autumn '86, is not copy protected.

Clipper Autumn '86 is available for a suggested retail price of $695. Registered users of Clipper may upgrade to the new version for $139.

Inquiry 200 for End-Users. Inquiry 201 for

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Reputation. More and more, people are making Princeton Graphic Systems their number one choice in personal computer displays. Because people know Princeton delivers the ultimate in compatibility, reliability, and performance.

*Dot pitch is the measure of the distance between phosphors of like color (dots) on the display screen. The smaller the dot pitch, the closer the dots are to each other. Thus, there are more picture elements which can be displayed on the screen which results in a higher resolution.

ADD-INS

12.5-MHz PC Accelerator

Orchid's latest 80286 accelerator board runs at 12.5 MHz. The full-length add-in board doesn't require that the system's current processor be replaced, and it can be selected or deselected via software, so the PCturbo 286e-12 can work in systems with soldered-in processor or non-8088 processors such as V20, 8086, 80186, or 80286. The board comes with one megabyte of RAM and can support up to 4 megabytes of EMS or extended memory. It will also take an 80287 math coprocessor.
Price: $1499.
Contact: Orchid Technology, 47790 Westinghouse Dr., Fremont, CA 94539, (415) 490-8586.
Inquiry 609.

Fast88 Upgrade Speeds PCs

Microspeed has introduced an enhanced version of it Fast88 accelerator for IBM PCs and most clones. The Fast88 speeds up your system by replacing your microprocessor with a faster 8088-2 or an optional NEC V-20. It also replaces the normal 4.77-MHz system clock with a circuit that allows the computer to run at either 6.1 MHz, 6.7 MHz, or 7.4 MHz.

The Fast88 installs inside the computer system unit without using an expansion slot. The new version allows software switching of speed, though an external switching control module is optional. Also included with the new Fast88 is a device driver that allows high-speed floppy-disk formatting and copying.

Microspeed is also offering an upgrade program for existing Fast88 users.
Price: $129; $149 with V-20 option; $149 with external control option: $169 with external control option and V-20; $50 for upgrade for existing Fast88 users.
Contact: MicroSpeed Inc., 5307 Randall Place, Fremont, CA 94538, (415) 490-1403.
Inquiry 610.

Real-World Controller/ Communicator

Designed to interface with up to 72 discrete inputs or outputs (in groups of four) and up to eight latchable interrupts, PX-XIO from Step Control Limited lets you control/communicate with electrical apparatus or electronic instruments such as test equipment, assembly or inspection devices, robotics, or process control.

The board can be configured via jumper selection of inputs and outputs in groups of four, and the eight interrupts can be wired to any I/O point on the board.

The PC-XIO comes with software and documentation for use with Microsoft BASIC, Turbo Pascal, Lattice C, and 8088 assembly language. Five feet of ribbon cable is also included.
Price: $445.
Contact: Step Control Ltd., 910 St. Vincent Ave. Suite 4, Santa Barbara, CA 93101, (805) 966-9553.
Inquiry 611.

Data Acquisition for 1-2-3 Users

Microstar Laboratories' Data Acquisition Processor is a single-slot add-in card that works with Lotus 1-2-3 for real-time data I/O. Using an on-board 80186 processor and a custom ROM-resident multitasking operating system, the board performs complex real-time computations such as fast Fourier transforms, digital filtering, and thermocouple compensation. The board then sends the results directly to a 1-2-3 spreadsheet. The Data Acquisition Processor can sample at speeds as fast as 17,500 samples per second and can process data 1000 times faster than 1-2-3 alone. All data manipulation is done by the board, and results are buffered to prevent data loss. The Data Acquisition Processor comes with custom interface software. Lotus 1-2-3 is required for operation.
Price: $1595 to $2500 (depending upon configuration).
Contact: Microstar Laboratories, 2863 152nd Ave. NE, Redmond, WA 98052, (206) 881-4286.
Inquiry 612.

SCOA's Multi-Compatible Graphics Board

The Star EGA from SCOA Systems comes equipped with 256K bytes of RAM and is compatible (through software switching) with the IBM Enhanced Graphics Adapter, Color Graphics Adapter, monochrome display adapter, and the Hercules Graphics Card. It provides graphics resolution of 640 by 350 pixels in 16 colors using an enhanced color display and either 640 by 200 or 320 by 200 pixels in 16 colors using a standard color display. The board can be jumpered for operation at 4.77, 6, 8, or 10 MHz and has a light pen interface as well a connector for an RGB monitor and a standard RCA video jack.

The Star EGA Plus adds a serial and parallel port to the basic package.
Price: $499; $599 for Star EGA Plus.
Contact: SCOA Systems, 2100 Golf Rd., Suite 100, Rolling Meadows, IL 60008, (312) 640-8782.
Inquiry 613.

Taxan Color Card for all Standards

The 557 Gold Card from Taxan USA is designed for total compatibility with all software designed for use with color. The board automatically adjusts itself to accommodate the software you're using and switches among Color Graphics Adapter, Enhanced Graphics Adapter, and Taxan Graphics Adapter mode, with a resolution of 640 by 400 pixels.

Although the 557 Gold Card is matched to Taxan's line of high-resolution monitors, it will operate in EGA and TGA on any monitor with a 25-kHz scan rate.
Price: $495.
Contact: Taxan USA Corp., 18005 Cortney Ct., City of Industry, CA 91748, (818) 810-1291.
Inquiry 614.

Multifunction Floppy/ Hard Disk Controller

The SMC4013-PC from Standard Microsystems is a full-slot expansion card that will control up to four disks: two standard Winchester hard disks and two 5¼-inch floppy disk drives. The board is based on several of Standard Microsystems' own MOS/VLSI circuits, including the HDC9224 Universal Disk Controller, the HDC9226 Digital Data Separator, the HDC9223 Analog Data Separator Support Circuit, the FDC9268 Floppy Disk Controller and Digital Data Separator, the SMC30002 Personal Computer Interface Circuit, and the SMC30501 Logic Array.
Price: $195.
Contact: Standard Microsystems Corporation, 35 Marcus Blvd., Hauppauge, NY 11788, (516) 273-3100.
Inquiry 615.

continued

SOFTWARE • PROGRAMMING LANGUAGES AND AIDS

Turbo Prolog Toolbox Announced by Borland

The Turbo Prolog Toolbox for IBM PCs contains over 80 tools, 40 sample programs, and source code, with which you can build expert systems, spreadsheets, database systems, communications programs, and compilers in Turbo Prolog. A report generator enables you to print reports that look the same as the screen layout, and the screen editor lets you create screen I/O functions. You can also set up context-sensitive help menus with windows containing text and graphics.

For designing communications programs, the toolbox offers you a serial communications sample program, and guidelines are provided for implementing the XMODEM protocol.

Built-in predicates allow you to incorporate status lines into your program, construct a terminal-emulation program, and import data from other programs. The source code is provided for the predicates.

The toolbox also features a parser generator, which you can use to build a parser by specifying the grammar for the language that is to be built.

Price: $99.95.

Contact: Borland International, 4585 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-8400.

Inquiry 616.

Creating Prototypes on the Macintosh

Prototyper, a program for creating prototyped applications, demonstrations, and user-interface designs, has been announced by SmethersBarnes. You use windows, pull-down menus, conditional statements, arithmetic operations, sounds, and scrolling graphics through a step-by-step process to create the double-clickable, stand-

Borland's Turbo Prolog Toolbox.

alone applications.

Price: $185.

Contact: SmethersBarnes, P.O. Box 639, Portland, OR 97207, (503) 245-7270.

Inquiry 617.

Building Applications with dBASE III

Occidental Computer Systems has announced a dBASE application builder and program-development tool called dbTEMPLATE. It includes a toolkit of standardized application program shells, complete programs, and callable procedures to perform add, change, and delete file functions.

The program shells provide you with structured code that you can modify. A Main shell provides the program that calls all subsequent functions. The ACDL shell provides Add, Change, Delete, and Look file functions. Submenu offers standard menu and submenu functions, and the Report shell is for generating single or dual file reports.

The programs and callable procedures include the Menu program for main menus and submenus, TTL title programs that provide for long or short title highlights and centering, and MSG procedures that center and display messages in a standard or blinking format to the desired row.

You also get a library of 10 dBASE III utility programs, which include Indent functions with or without connecting lines and line numbers, Find functions for single or multiple strings, Structure with DOS options, DCopy after dates, Change for string replacement, dbTree for program call reference, and NDXKey to list a dBASE or Clipper index with DOS options.

The program requires an IBM PC or compatible with 256K bytes of RAM and dBASE III.

Price: $96.

Contact: Occidental Computer Systems Inc., 21201 Oxnard St., Woodland Hills, CA 91367, (818) 712-9011.

Inquiry 618.

Common LISP

TransLISP Plus is a Common LISP system that interfaces to Microsoft C and runs on the IBM PC. The interface to Microsoft C enables you to customize LISP or combine C functions with LISP programs.

Over 400 Common LISP primitives come with TransLISP Plus, and you can create your own as well. Thirty sample programs are also included, along with an integrated editor, a trace facility, and cross-referencing. Solution Systems reports that you can port your programs to other Common LISP systems on micro, mini, or mainframe computers.

TransLISP, a smaller version of the program, is available for programmers interested in learning LISP. It includes a tutorial, demo programs, and over 300 primitives, and it enables you to write up to 12,000 lines of code. An optional run-time program is also available for TransLISP Plus.

TransLISP Plus runs on the IBM PC and compatibles with 320K bytes of RAM and a 360K floppy disk drive.

Price: $195 for TransLISP Plus; $95 for TransLISP version; $150 for the run-time version.

Contact: Solution Systems, 335 Washington St., Norwell, MA 02061, (617) 659-1571.

Inquiry 619.

Ada Compiler for the IBM PC

Meridian Software has introduced an Ada language compiler and development system. The company reports that AdaVantage implements all Ada language features, including tasking, exceptions, fixed point, generics, and separate compilation, without additional memory or coprocessor boards.

A set of tools for managing an Ada program library database is included with AdaVantage. Utility packages are also available that enable you to interface with MS-DOS, compute transcendental math functions, and examine the program environment.

AdaVantage runs on the IBM PC, XT, AT, and compatibles.

Price: $129.95.

Contact: Meridian Software Systems Inc., 23141 Verdugo Dr., Suite 105, Laguna Hills, CA 92653, (714) 380-9800.

Inquiry 620.

continued

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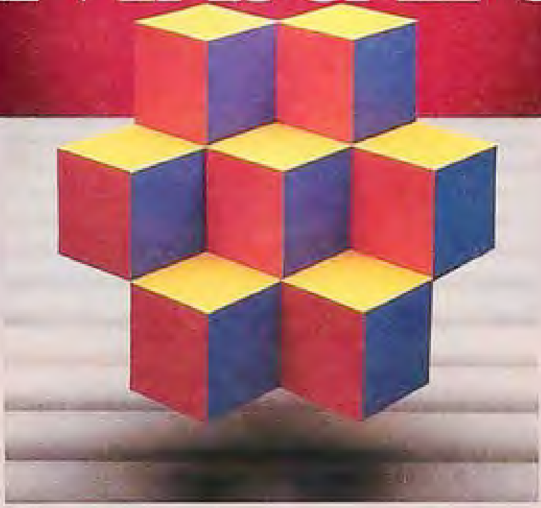

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Inquiry 170

SOFTWARE • SCIENTIFIC AND ENGINEERING

Digital Electronics Analysis on the IBM PC

Micro-Logic II is a system for designing and analyzing digital electronics. It includes a mouse-driven schematic editor, component library editor, shape editor, data channel, and clock waveform pattern editors. The schematic editor can handle up to 1000 components or integrated circuit packages per drawing, Spectrum reports.

The program offers a high-speed logic and timing simulator that enables you to display simulation results in a graphical form that is similar to logic analyzer displays, according to Spectrum Software. The simulator can handle networks of up to 10,000 equivalent two-input gates.

Micro-Logic II runs on the IBM PC, XT, AT, and compatibles with 640K bytes of RAM.
Price: $895.
Contact: Spectrum Software, 1021 South Wolfe Rd., Sunnyvale, CA 94086, (408) 738-4387.
Inquiry 621.

CAD on the Mac

Abvent has introduced Space Edit, a three-dimensional computer-aided design program that runs on the Macintosh. Abvent reports that the size of your vector-based documents created with Space Edit is limited only by the RAM in your system.

You can use a mouse, a graphic tablet, or a keyboard for input, and you can output to a variety of plotters and laser printers without using any special interfaces, since Space Edit has built-in drivers for many pen plotters. Your drawings can be sent by the clipboard to MacDraw, MacDraft, MacPalette, and other programs. Space Edit offers such capabilities as hidden-line removal, multilayering, and access to a three-dimensional library.

Micro-Logic II, a digital electronic design and analysis program.

You can view objects from many vantage points using three perspective modes with Space Edit. You can choose to display your objects in wire frame or in a solid format, using the hidden-line removal capability. The changes you make to your objects automatically update the area and dimension lines.
Price: $625.
Contact: Abvent, 9903 Santa Monica Blvd., Suite 268, Beverly Hills, CA 90212, (213) 659-5157.
Inquiry 622.

Data Acquisition Software for $125

UnkelScope Junior is a data-acquisition program that can replace strip-chart recorders, x-y plotters, or oscilloscopes, according to Unkel Software. The menu-driven program displays, stores, and retrieves data, and you can port that data to other programs as well. Cursor scrolling techniques are featured, enabling you to move two independent cursors through stored data with the cursors' numerical voltage and time values displayed.

UnkelScope Junior requires an IBM PC, XT, AT, or a compatible running MS-DOS or PC-DOS 2.0 or higher. You also need a data-acquisition board and an IBM graphics board or compatible.
Price: $125.
Contact: Unkel Software Inc., 62 Bridge St., Lexington, MA 02173, (617) 861-0181.
Inquiry 623.

Macintosh Statistical Analysis

StatView 512+ enables you to perform statistical analysis, including descriptive and comparative statistics, multivariate factor analysis, and nonparametric tests. The program runs on the 512K RAM Macintosh and you can import data from other Macintosh applications, using text files or the clipboard. Using text files, you can gather data from other computers.

With StatView 512+, you can define variables, run analyses, and produce graphic views in table, scattergram, line chart, pie chart, or box plot form. Any changes you make to variables, specifications, or presentations are automatically recalculated by the program. You can also enter alphanumeric data.
Price: $349.95.
Contact: Brainpower Inc., 24009 Ventura Blvd., Calabasas, CA 91302, (818) 884-6911.
Inquiry 624.

Fast Fourier Subroutines

A pair of fast Fourier transform subroutines, written in assembly language for the 8086 family, is available from J.W. Hartwell and Associates.

One of the subroutines is designed for 16-bit integer data and is used in real-time applications when computation speed is important. Hartwell reports that a forward transformation of 1024 real-valued samples typically requires less than 150 ms. on a 6-MHz IBM PC AT, and the same sequence of points can be transformed in about 580 ms. on an 8088 running at 4.77 MHz.

The second subroutine is for single-precision floating-point data and requires an 8087 or 80287 coprocessor. It is designed for uses in which accuracy is important. Hartwell reports that a real-valued sequence of 1024 points can be transformed in less than 770 ms. on a 6-MHz IBM PC AT with an 8-MHz 80287.
Price: $149 each or $249 for both.
Contact: J.W. Hartwell and Associates, P.O. Box 515, Hillsborough, NC 27278, (919) 732-7951.
Inquiry 625.

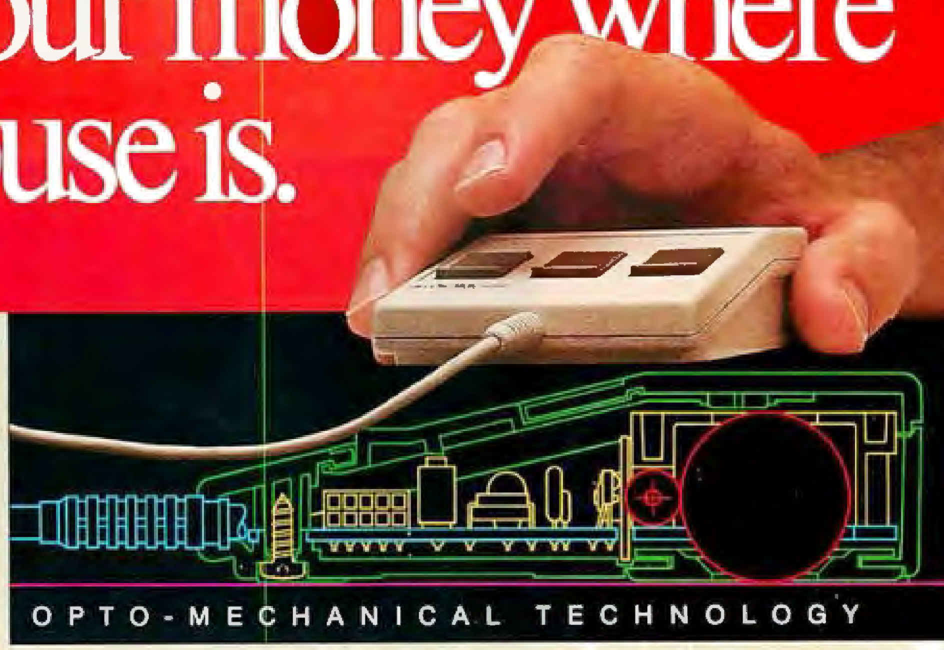
PlotSMITH

Fulton Findings has announced PlotSMITH, a program that creates rectangular plots in ASCII from data you enter by the keyboard or through disk files. You can show 10 sets of data with up to 250 points. The files PlotSMITH creates are in ASCII format.

PlotSMITH runs on IBM PCs with 256K RAM.
Price: $59.
Contact: Fulton Findings, 1251 West Sepulveda Blvd., Suite 800, Torrance, CA 90502, (213) 518-5045.
Inquiry 626.

continued

We put our money where our Mouse is.



LOGITECH C7 MOUSE $99

PC MAGAZINE "EDITORS CHOICE"

"...To sum up my feelings about this mouse and menu generating system: this is the one I want." *Phil Wiswell*
PC Magazine, Jan 27, 1987

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The opto-mechanical LOGITECH Mouse offers the best of all worlds. Mechanical tracking (a ball) and optical decoding (precise, reliable optical encoders). Every major computer manufacturer, including Apple, IBM and DEC, has chosen opto-mechanical mouse technology. LOGITECH offers the only opto-mechanical mouse on the retail market.

BEST MOUSE FOR GRAPHICS & CAD

High (200 dot per inch) resolution, precise tracking, and a 3-button design are essential for graphics and CAD.

BEST MOUSE FOR DESKTOP PUBLISHING

Ergonomic styling is a must for all mouse-intensive desktop publishing applications. High resolution is essential for high-resolution screens.

BEST MOUSE FOR SPREADSHEETS & WORD PROCESSING

The smooth-tracking LOGITECH mouse is a productivity tool for all types of data entry and editing. We've even created a special mouse interface for 1-2-3 which makes 1-2-3 users up to 30% more productive!

BEST MOUSE SOFTWARE

"Logitech's Plus Package adds an excellent menu builder (with useful examples), a fast windowing text editor, and an outstanding Lotus 1-2-3 interface." *Ezra Shapiro*
Byte, Dec. '86, pg. 324

Our Plus Software also includes our Microsoft-compatible drivers, and CLICK which sets the mouse automatically for any application.

Inquiry 171

BEST DEALS

We offer either our C7 or Bus mouse, with Plus software, packaged with some of the most exciting applications on the market, at very exciting prices.

LOGIPAINT **Special Offer! $149**

The LOGITECH Mouse with PC Paintbrush is the most advanced paint set available for the PC. It offers 11 type fonts, a pallet of 16 colors, and the ability to import and embellish files from other applications.

LOGICADD **$189**

The LOGITECH Mouse packaged with Generic CADD and Dot Plot turns your PC into a complete CADD workstation. Generic CADD offers the features and performance of high priced CADD at an unbelievably low price. DotPlot is the add on utility that enables you to produce crisp, high resolution drawings from your dot matrix printer.

LOGIPAINT-&-DRAW **$219**

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SOFTWARE • BUSINESS AND OTHER

Risk Analysis and Simulation

PRISM uses probabilites and simulation techniques to enable you to model uncertain or risky situations. It makes use of Monte Carlo simulation and lets you define the modules with graphic representation of probability distributions and a high-level programmable modeling language. Prism's output shows potential risks and payoffs, and you can also generate a spreadsheet of results.

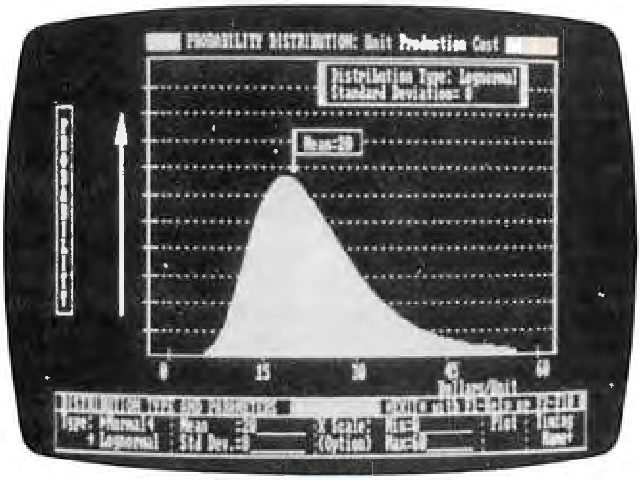
The program runs on the IBM PC, XT, AT, and compatibles with at least 512K bytes of RAM.
Price: $895.
Contact: Tempus Development Corp., 1941 North Vermont St., Arlington, VA 22207-9990, (703) 522-3780.
Inquiry 627.

Linking Laptops and IBM PCs

The Brooklyn Bridge lets you transfer files between 3½-inch disk laptops and 5¼-inch disk IBM PCs. According to White Crane Systems, the program transfers files at 115,200 bits per second, attaining a throughput of 10K bytes per second.

Besides transferring files, you can use the program to edit on a remote machine, access remote drives from within a program, and direct ouput to a laser printer, plotter, or other device.

One IBM-compatible serial port is required on each machine. The program comes with one disk for each system and a connector cable for 9- or 25-pin models.
Price: $129.95.
Contact: White Crane Systems, 6889 Peachtree Industrial Blvd., Suite 151, Norcross, GA 30092, (404) 454-7911.
Inquiry 628.



PRISM provides risk analysis using Monte Carlo simulation.

Two Word Processors for the IBM PC

Celebrity and ProofWriter are word processors that feature spelling checkers and mail-merge capabilities. Both require an IBM PC or compatible with 256K bytes of RAM.

Celebrity offers a calculator, an appointments and reminder calendar, a forms and reports system with mail-merge functions, a file-cabinet capability, and macro and command-file capabilities. The program also enables you to work in up to four windows simultaneously.
Price: $89.95.
Contact: Good Software Corp., 5429 LBJ Freeway, Suite 720, Dallas, TX 75240, (214) 6085.
Inquiry 629.

ProofWriter offers word processing in color and foreign language and scientific symbol capability. Optional versions enable you to print symbols that aren't included in the IBM PC character set, and a character generator lets you construct any printed symbol on a dot-matrix printer.

Other options offered by ProofWriter include underlining, superscripts and subscripts, software-generated shadow and bold type, italics, condensed print, and page-numbering options. ProofWriter's editor offers WYSIWYG (what you see is what you get) word processing, which gives you desktop publishing mark-up capabilities.

ProofWriter is available in a standard version for use with the IBM PC character set and an international and scientific version. Other versions are available for a variety of boards.

Price: ProofWriter, standard version, $250; international/scientific version, $125; other versions range from $300 to $475.
Contact: Image Processing Systems, 6409 Appalachian Way, P.O. Box 5016, Madison, WI 53705, (608) 233-5033.
Inquiry 630.

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.

Mathematical Tool with Graphics

CompMath is a menu-driven mathematical program that runs on the IBM PC and compatibles with 256K bytes of RAM and PC-DOS or MS-DOS 2.0 or higher. It covers general mathematics, complex arithmetic, matrix operations, engineering, and basic statistics.

You can create two-dimensional statistical and vector operation graphs in cartesian and polar coordinates. The mathematical program also enables you to store and retrieve numerical data disk files for basic statistical analysis.

An IBM color graphics adapter or equivalent is required to run CompMath.
Price: $59.95.
Contact: Esoft Software, 444 Colton Rd., Columbus, OH 43207, (614) 491-0832.
Inquiry 631.

Photographic Switcheroo

In the What's New section of our December 1986 issue, we mistakenly swapped two photos. The screen pictured on page 30 was produced by Stella Business Graphics and should have run on page 32. The screen on page 32 was produced by VCN Concorde and should have been on page 30. Our apologies to all, and particularly to Stella Systems and Visual Communications Network.

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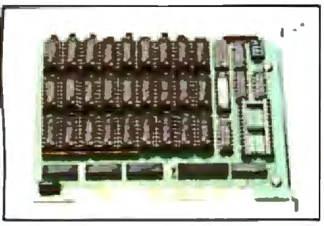

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w/384K 119
w/576K 139
Logic (AST Comp) I/O
Mini Half Card 105
TECMAR
Captain (384K) 199
QUADRAM
Quadboard (384K)........ 155
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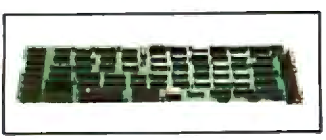
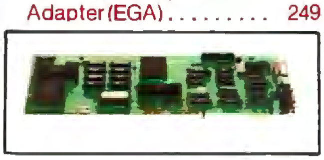


Logic (IBM Comp.)
Enhanced Graphics
Adapter (EGA)......... 249



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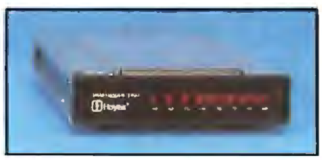

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Smartmodem 2400B
w/Smartcom II 549
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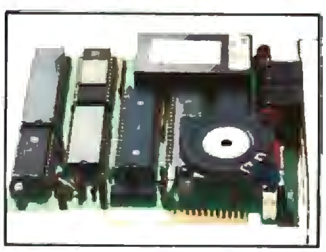
Logic (Hayes Comp.) 1200
Baud External Modems . 179
Logic (Hayes Comp.) 2400
Baud External Modem .. 309



Logic (Hayes Comp.) 1200B
Internal Modem with
Mirror (Crosstalk Clone)
Software 129
Logic 2400B Internal Modem
2400B w/Software 299
PROMETHEUS
Pro-modem 1200 279
Pro-modem 1200B
w/software 239
TOSHIBA
1200B Laptop Modem
(T1100 Plus)........... 329

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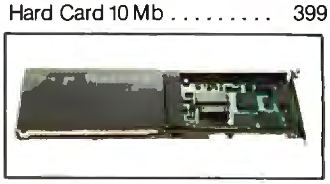

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10 Mb Int 78
Image Tape Backup
20 Mb Int 59
Image Tape Backup
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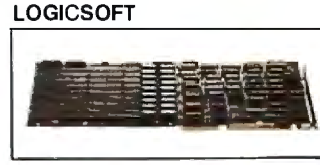

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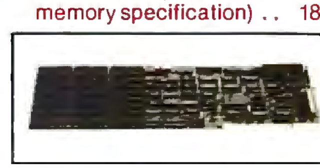

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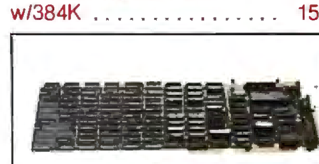

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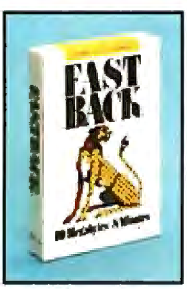

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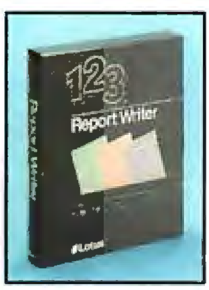

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Spring National Design Engineering Show and Conference, Chicago, IL. Show Manager, Spring National Design Engineering Show, 999 Summer St., Stamford, CT 06905, (203) 964-0000. *March 2–5*

Second International Conference on CD ROM, Seattle, WA. Microsoft Corp., 16011 NE 36th Way, P.O. Box 97017, Redmond, WA 98073-9717, (206) 447-1986. *March 3–5*

Hannover Fair CeBIT '87, Hannover, West Germany. Deutsche Messe- und Ausstellungs-AG, Messegelände, D-3000 Hannover 82, West Germany, tel: (05 11) 89-1, telex: 9 22 728 messe d. *March 4–11*

Securicom 87: Fifth Worldwide Congress on Computer and Communications Security and Protection, Paris, France. Securicom, 8, rue de la Michodiere, 75002 Paris, France, tel: 47.42.41.00, telex: 250303 PUBLIC X PARIS. *March 5–7*

FOSE '87: Federal Office Systems Expo, Washington, DC. National Trade Productions Inc., 2111 Eisenhower Ave., Suite 400, Alexandria, VA 22314, (800) 638-8510; in the Washington area, (703) 683-8500. *March 9–12*

SMIA Meeting on Artificial Intelligence, Puebla, Mexico. Sponsored by Mexican Society of Artificial Intelligence. Mat. Warren Greiff, Department of Computer Systems Engineering, University of the Americas, Apartado Postal 220, Sta. Catarina Martir, 72820 Puebla, Mexico. *March 12–13*

Tenth Annual PACS Computer Festival, Philadelphia, PA. Stephen Longo, Philadelphia Area Computer Society, c/o La Salle University, Philadelphia, PA 19141, (215) 951-1255. *March 14*

Computer Fair II: People and Computers Now, Kenosha, WI. David Kanecki, Applied Computer Science, University of Wisconsin-Parkside, P.O. Box 2000, Kenosha, WI 53140. *March 21*

NGCA's Computer Graphics '87, Philadelphia, PA. National Computer Graphics Association, 2722 Merrilee Dr., Suite 200, Fairfax, VA 22031, (703) 698-9600. *March 22–26*

Video Computer Animation at Compugraph Designs/MTI. Sponsored by NYC/ACM SIGGRAPH and New York University. Ed Kramer, Compugraph Designs/MTI, 885 Second Ave., New York, NY 10017, (212) 355-0510. *March 24*

Southcon/87, Atlanta, GA. Electronics Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045-3194, (213) 772-2965. *March 24–26*

Third International Conference on Creating Patient Information Systems (Computerization of Medical Records), Chicago, IL. Institute for Medical Record Economics Inc., 121 Mount Vernon St., Boston, MA 02108, (617) 720-2229. *March 24–27*

Student Computer Fair '87, Camillus, NY. Boces Regional Computer Center, 6820 Thompson Rd., P.O. Box 4866, Syracuse, NY 13221, (315) 433-8319. *March 28*

Small Computers in Libraries '87, Arlington, VA. Meckler Publishing, 11 Ferry Lane West, Westport, CT 06880, (203) 226-6967. *March 30–April 1*

IEEE INFOCOM '87: Global Networks—Concept to Realization, San Francisco, CA. Izhak Rubin, IEEE INFOCOM '87, 6731 Boelter Hall, Electrical Engineering Dept., University of California, Los Angeles, CA 90024, (213) 825-2327. *March 30–April 2*

1987 IEEE International Conference on Robotics and Automation, Raleigh, NC. Harry Hayman, Exeter C3037, Boca Raton, FL 33434, (305) 483-3037. *March 30–April 3*

AIDD 27th Annual Convention and Technology Exposition, St. Louis, MO. American Institute for Design and Drafting, 966 Hungerford Dr., Suite 10 B, Rockville, MD 20850, (301) 294-8712. *March 31–April 2*

If you send notice of your organization's public activities at least four months in advance, we will publish them as space permits. Please send them to BYTE (Events and Clubs), One Phoenix Mill Lane, Peterborough, NH 03458.

CLUBS

Coastal Area Atari Users' Group and BBS, David E. Warner, P.O. Box 5098, Biloxi, MS 39534; BBS: (601) 388-3490.

Amygdala, newsletter of the Mandelbrot Set; Box 219, San Cristobal, NM 87564.

Fourth Generation (+), newsletter for SQL and expert system users; Performance Computing Inc., 25 East Washington St., Suite 1500, Chicago, IL 60613, (312) 984-0431.

Ada Information Clearinghouse Newsletter, 3D139 (1211 Fern St., C107), The Pentagon, Washington, DC 20301-3081, (703) 685-1477.

North American Amiga Users Group and BBS, Box 376, Lemont, PA 16851, (814) 237-5511; BBS: (814) 339-6042.

Tugboat newsletter, Technical and User Groups Network (TUG-NET), P.O. Box 705, Van Nuys, CA 91408-0705.

TI PPC Notes, newsletter of the TI Programmable Calculator Club; P.O. Box 1421, Largo, FL 34294.

Business Software Users Group, 2252 Main St., Suite 15, Chula Vista, CA 92011, (619) 423-0538.

ACCumulator, newsletter of the Amateur Computer Club; Andy Leeder, Membership Secretary, Church Farm, Stratton St. Michael, Norwich NR15 2QB, U.K.

New York Personal Computer Inc. (NYPC) user group, Suite 614, 80 Wall St., New York, NY 10005, (212) 829-5534.

Pasadena Commodore Computer Club (PCCC), P.O. Box 1163, Arcadia, CA 91006, (818) 447-2212.

CADalyst, journal for AutoCAD users; P.O. Box 282, 810 West Broadway, Vancouver, BC, Canada V5Z 4C9.

Adam User's Group of San Diego County, 868 North 2nd St., Suite 242, El Cajon, CA 92021, (619) 445-2400.

First Rochester Osborne Group (FROG), Jim McCollum, 321 Executive Office Building, Rochester, NY 14614, (716) 232-7272. ■

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ASK BYTE

Conducted by Steve Ciarcia

Big-Screen Turbo

Dear Steve,

I am looking for software that will allow me to define screens of 132 columns by 80 rows in Turbo Pascal. I would be running this application on a WYSE-700 graphics monitor. I checked with Borland, Wyse, and most of the companies that sell Turbo Pascal screen generators. None was able to help me or could tell me how to do it myself in Turbo Pascal. Do you have any ideas?

Koenraad Lecot
Los Angeles, CA

As I understand Turbo Pascal, it uses the PC's BIOS to handle most of the work of putting characters on the screen. Therefore, you'd have to find a way to persuade the BIOS to handle the additional columns and rows.

Unfortunately, the BIOS was never designed to handle anything other than 80 by 25 and 40 by 25 displays. As witness to this fact, the IBM EGA has to provide an alternate screen-print routine in the EGA's BIOS just to handle the new 80 by 43 format.

If you wrote a set of "external" assembler routines (Pascal would most assuredly be too slow for this) that handled the screen output, you could call them from within Turbo. These new routines would have to duplicate all of the functions found in ClrScr, Write, Writeln, *and so forth, as well as the character generation required to build the output in display RAM. This is not a trivial project.*
—Steve

Put This Amiga Under Your Tongue

Dear Steve,

I would like to use my Amiga as a biofeedback training device. Is there a simple circuit that could connect through the joystick ports as a sensitive electronic thermometer? My thought is that the Amiga joystick ports have analog-to-digital converters built in, just like the Commodore 64. Normally, the ADC is used to read the potentiometer of a game paddle. I'd like to use the ADC to input the values from the temperature-reading circuit. The joystick ports also have a 5-volt power source of up to 150 milliamps. I could use this to power the interface.

It seems that, to be an effective training device, such a circuit would have to be sensitive to a tenth of a degree Fahrenheit. Is such a circuit possible?

J. Eric Chard
Seattle, WA

It should be possible to measure temperature using the joystick port of your Amiga. The hardware supports variable-resistor-type joysticks, although switch-closure-type joysticks (for example, the kind used with the Atari 400/800 series) are more often used with the Amiga.

The simplest way to implement your temperature-reading circuit is with a temperature-dependent resistor (TDR), also known as a thermistor. These devices, available from sources such as Digi-Key (P.O. Box 677, Thief River Falls, MN 56701-9988, (800) 344-4539), vary resistance with temperature. If you tie one lead to +5 volts and the other to a potentiometer input, the computer would be able to read a value whose magnitude varies with temperature.

You will probably have to experiment extensively in order to determine the best resistance-category thermistor to use with your particular system. A device with a room temperature (25° Celsius) resistance of about 30,000 to 50,000 ohms would be a good starting point for experiments.
—Steve

Multiple Hard Disks

Dear Steve,

I plan to replace my present computer with an IBM PC AT (or one of the compatibles) equipped with a hard disk. I have noticed that you can purchase such a computer with a hard disk already installed or add the hard disk yourself and possibly save some money. Also, I have noticed that available hard disks have various access times, with those having the smaller access times costing more. Can you provide some guidance concerning the relationship of hard disk access time and overall operational speed of the computer?

I realize that when you have a computer with a hard disk, you need some way to back up all that data. Most tape backup systems cost about as much as a hard disk, which brings up the possibility of using a second hard disk purely as a backup device for the first. Since I have never read or heard of anyone doing this, I wonder if you know of any reason why it wouldn't be practical. I have no great concern about the risk of keeping the backup in the same room with the original; I need a backup only to recover in case of a crashed disk. However, in case the computer does not have room or sufficient power for two hard disk drives, I might like to save desk space by locating the backup drive in an adjacent room. Is there any reasonable way to run the control and data signals for this backup drive a distance of, say, 30 feet?

James G. Barr
Littleton, CO

To answer your first question: There is no absolute relationship between hard disk access time and the overall operational speed of the computer other than that, in general, the faster the access time, the more likely that computer throughput will be increased in disk-intensive applications. For example, a system with a 30- to 40-millisecond hard disk will perform a disk-based sort program faster than the same system with an 85-ms hard disk, though not necessarily twice as fast. On the other hand, CPU-intensive tasks (such as recalculating a spreadsheet) would not be any faster, though saving or loading a spreadsheet would be.

In general, XT-style machines use a hard disk with a 60- to 90-ms access time, while AT-style machines use 30- to 40-ms hard disks (though they can use disks that are slower as well).

continued

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MICROSOFT LANGUAGES NEWSLETTER VOL. 2, NO. 3

News about the Microsoft Language Family

Tracing through User Libraries with Microsoft® QuickBASIC

Large programs are easier to maintain and debug if they are divided into smaller, more manageable parts. These units are called modules and may contain up to 64K of subprograms. You may separately compile subprograms with Microsoft QuickBASIC and build user libraries of these BASIC subprograms as well as assembly language routines. These user library routines can be used over and over again and are linked into your BASIC programs as needed.

Debugging these user libraries is made very simple with the built-in debugger in Microsoft QuickBASIC. QuickBASIC's built-in Debugging mode allows you to control the rate of program execution and the number of source lines displayed during execution. The Debugging mode is activated when the TRON statement is executed and is turned off with the TROFF statement. You can activate the Debugging mode for part or all of a source file. The Debugging mode has three "submodes": Step, Trace and Animate.

When you debug your BASIC programs that call subprograms contained in user libraries, Microsoft's QuickBASIC Debugging mode lets you trace through the user library routines when you activate the Trace mode. This mode traces program execution one line at a time like the Step debugging mode but you may also trace program execution through subprograms and user-defined functions. If you call any assembly language routines in your main program, the Trace mode will not trace through each line of the assembly routine but will trace the entire routine as a whole. Because the built-in debugger allows you to display both the source code and the output screen, you may observe the program execute while seeing the output.

Support Available for Microsoft Language Products

Once you purchase your Microsoft language product, a number of support services are available to you. If you have any problems with your product, you may call the Microsoft Product Support Hotline at (206) 882-8089 for assistance. A Product Support Representative will try to help you find a solution. In addition, Microsoft provides technical assistance on some electronic bulletin boards, such as CompuServe.®

If you are a software developer who needs in-depth information, you may purchase Microsoft DIAL, an integrated set of on-line services. You can gain access to information on the DIAL bulletin board (which lists answers to frequently asked technical questions and provides information on new products, bug lists, seminars, and many other topics), and if the answer you are looking for is not on the bulletin board, you can electronically submit technical assistance requests (TARs) directly to Microsoft's support organization. Contact Linda McCarty at (206) 882-8080 for an application form and additional information on DIAL.

Filling out and sending in your product registration card is very important. It will allow you to receive notices about new versions and enhancements to your Microsoft product. The update notices let you know about the enhancements and instruct you on how you may receive the updated version. If you are in the market for a language product, you may receive useful information from this newsletter; you may also purchase a subscription to our Microsoft System Journal that contains technical articles on our languages and operating systems/environments. Microsoft Consumer Response can help you by sending you data sheets and other information such as the Language Support Directory (for available third-party libraries that support Microsoft languages).

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.

Latest DOS Versions:

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Microsoft Macro Assembler	4.00
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Microsoft QuickBASIC	2.01

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

Many people do use a second hard disk as a backup unit just as you suggest. In fact, I am beginning to see products specifically for this purpose. However, due to the nature of the electrical signals going to and from the hard disk, it is not possible to locate the backup drive more than a few feet from the computer—5 feet perhaps, but not 30 feet. If you cannot fit a second drive within your machine, then a "hard-card" type hard disk or a standalone unit with its own power supply would be good bets. Most hard disk controller cards can handle two drives, but consult a dealer for a particular machine to be sure.—Steve

dIRECT dBASE to dISK

Dear Steve,

I have an IBM PC with two floppy disk drives and a hard disk. I need to be able to redirect printer output to a file on a floppy disk. Do you know how to do this?

I am using dBASE III to write material specifications. I am using the full-screen edit commands to create the body of a form; data is merged into the form only at printing time. I am fairly certain, after talking to an Ashton-Tate technical representative, that there is no way to redirect dBASE III printer output to a file. I have also perused the PC-DOS 2.10 manual and there doesn't seem to be any way to redirect output through the DOS. Any help you can give would be appreciated.

Paul Knutson
Denver, CO

Without knowing exactly how you are trying to accomplish printer redirection, it is difficult to answer you specifically. I realize that in dBASE III, full-screen edit or @ SAY commands cannot be redirected to a file with the SET ALTERNATE TO <filename> *command. I assume that this is what you are attempting. This problem has been addressed (though not consistently or reliably) by some public domain programs from Mark DiVecchio, 9067 Hillery Dr., San Diego, CA 92126, (619) 566-6810. He will send you the programs if you send him a PC-DOS-formatted floppy disk and a self-addressed stamped floppy disk mailer.*

Another program that may be of help is PrintQ, from Software Directions Inc., 1572 Sussex Turnpike, Randolph, NJ 07869, (800) 346-7638. A call to them may be able to answer your question specifically.

If neither of these two suggestions works out, is it possible to reprogram the part of your system that is using the full-screen edits? That is, set up a temporary file to hold the information and merge it with the rest of your text so that a SET ALTERNATE *command would redirect the information to a file. If this sounds at all feasible, a good dBASE III consultant might be able to help.*—Steve

Exceeding the Speed Limit

Dear Steve,

I have recently installed a math coprocessor (8087-2) and 20-megabyte hard disk unit in my Panasonic Exec. Partner FT-70 computer. This computer has two clock options: normal 4.77 MHz and fast 7.16 MHz.

Since I have made the additions to my computer, I have started having problems. When I run the computer in the fast-speed mode, the moment a program accesses the hard disk, the system locks up and cannot be restarted unless I switch off the power to the computer and reboot. This doesn't happen if I operate the computer (a) in the normal 4.77-MHz mode, (b) in the fast mode but using only the floppy disk drive, or (c) in the fast mode after I have physically removed the math coprocessor. (The problem remains if I disable

continued

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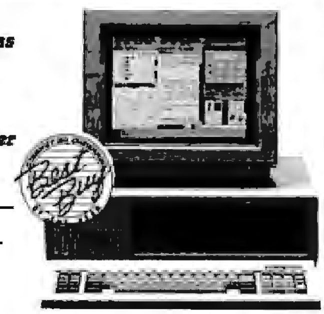

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the coprocessor by DIP switches only.)

Any suggestions?

M. T. Basarankut
Ankara, Turkey

It sounds very much like the hard disk controller was designed to run at 4.77 MHz and you're running it beyond its limits at 7.16 MHz. The 8087 is connected to one of the DMA request lines and it may be that at the higher clock speeds the disk controller DMA goes awry. I don't have any solid proof of that, but it sounds reasonable, given your description.

These sorts of problems are almost impossible to diagnose without a full set of schematics and a pile of test equipment, so I think the only practical solution is to restrict the clock speed to 4.77 MHz. That will allow you unrestricted use of the hard disk and coprocessor, and I think you'll find that the speed is entirely adequate, particularly because the disk is much faster than floppies for I/O-intensive operations.—Steve

CIRCUIT CELLAR FEEDBACK

SB180

Dear Steve,

Although I don't have a computer yet, I intend to purchase one soon. I need it for several cataloging jobs, doing foreign language translation, some writing, plus numerous other projects including programming to customize files and reports.

I would like to program the Z80 rather than the 8088 (or any processor more complex) because my short-term memory does not serve me well (I am 73). Consequently, I am interested in your SB180 project described beginning in the September 1985 Circuit Cellar.

Could you send me the addresses of any SB180 users groups, any articles or reports other than your original project description, and the addresses of any firms other than the Micromint that package the SB180 as part of a complete hardware system? Your sophisticated but down-to-earth projects make a big contribution to BYTE. Thanks.

John D. Van Vliet
Spring Valley, NY

Thanks for your interest in the SB180. There is a national users group that publishes a monthly newsletter about the machine and its software as well as offering low-cost public domain programs for it. The address is

North American One Eighty Group
P.O. Box 2781
Warminster, PA 18974

Because the SB180's operating system is compatible with CP/M, there are literally thousands of programs available that will run on an SB180 equipped with two disk drives and a serial ASCII terminal. A variety of languages, such as BASIC, C, Pascal, FORTRAN, and assembler, are all available for the SB180 to allow you to write programs of your own design.

The SB180 circuit board is used in a number of dedicated control applications, but I believe the Micromint may be the only place offering an assembled and tested personal computer system. Micromint also offers cable sets, cabinets, and so on, if you are interested in building the system yourself.—Steve

C-128 CP/M

Dear Steve,

There has been a growing interest in CP/M among the members of our local Commodore users group. We have been wondering if the Commodore 128's CP/M mode could be improved by replacing the Z80 chip with the Hitachi HD64180 chip that you used in your SB180. The local Commodore-Amiga service dealer said it was possible.

We would like your opinion on the conversion before we start.

William E. Gary
Lafayette, LA

The HD64180 chip is compatible with the Z80 instruction set; however, it is not a pin-compatible replacement for the Z80. In addition to the additonal CPU instructions available on the HD64180, the chip also has built-in memory management units and two serial ports. Adapting the chip to your C-128 might be possible, but the amount of work involved might not be worth it.

If you and your group are serious about wanting to experiment with the Hitachi chip, you might consider either building the SB180 from scratch or buying an assembled board. Your Commodore could be used as a terminal to talk to the SB180 and in the long run you would probably spend less money than if you modified a C-128, without voiding your Commodore warranty.—Steve

Home Control

Dear Steve,

I wrote to you several years ago about a home control system that I was playing with. My system was more oriented toward laziness than most of your work, with the emphasis on control of home entertainment and X-10 switches. I have developed my system to the point that I am quite satisfied with it.

I am pleased to see commercial vendors

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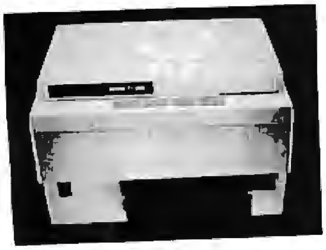

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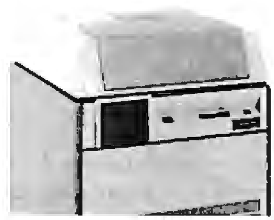

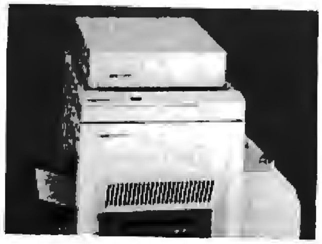

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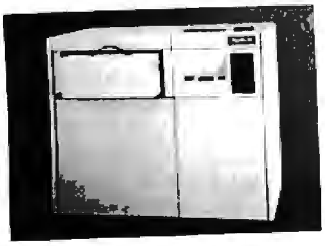

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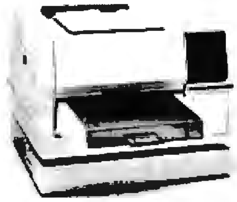

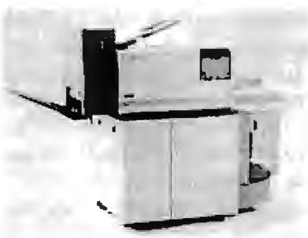

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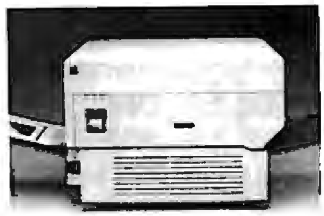

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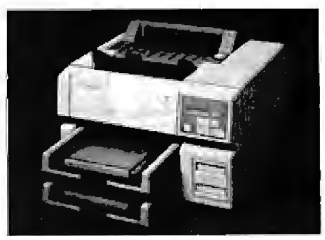

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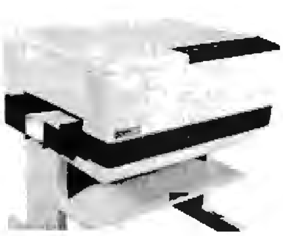

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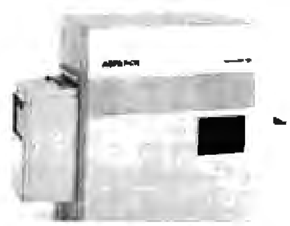

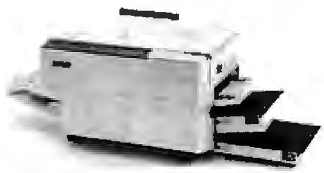

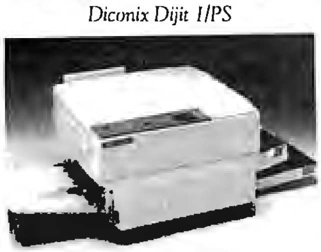

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beginning to offer products that hint at home control, but I am often dismayed at their implementations. GE's universal keypad is a good example: This keypad learns the coding of up to four infrared transmitters and replaces the four keypads with one large and expensive one.

I want more than this. I want my keypad to be small, simple, and cheap. I want several of them around the house, and in some instances I'd like to replace wall switches with keypads. I want a central controller to learn the codes required by my home entertainment components and I want receivers in each room to communicate with it. I'd be pleased if that communications link could be a protocol akin to GE's Homenet over an X-10–style carrier. In the meantime, I'm using Videolink to pipe the infrared around.

How about covering some of this in future Circuit Cellar articles? In particular, a remote-control keypad and receiver connecting to a PC through a serial port would be interesting.

Also, I enjoyed your AVMUX article (February 1986). I have a similar system, but mine is more primitive. I select one input and route that to all destinations. I will use the ideas you presented in your article to allow each destination to select a different source. I do have computer-controlled attenuators on my system and find them a necessary feature. You might cover this topic sometime. The Analog Devices AD7110 digitally controlled audio attenuator would make a nice addition to the AVMUX.

Ian Smith
Laguna Beach, CA

I'm happy to hear of your successes in home control. You can be assured that there will be future Circuit Cellar articles addressing different phases of the subject. With regard to the remote keypads: You might look into the DTMF keypad units that are available from many sources. Each pad can have up to 12 (or 16, depending on the device purchased) functions and the signal can be routed over a pair of wires or used to modulate either an RF or X-10–type carrier. There are also many approaches you can take to decode the signal at the computer, the easiest being the use of an all-on-one-chip decoder interface (several are available). Once the decoded signal is in the machine, the software can take over from there.

A computer-controlled audio attenuator might be a nice addition to the AVMUX. I would suggest that you use an additonal buffer stage when utilizing this type of control on the outputs, to allow proper matching to the destination equipment.—Steve

EPROM Programmer et al

Dear Steve,

I have some questions regarding your serial EPROM programmer (February 1985) and the RS-232C monitor (April 1983). I hope you can help.

My first two questions relate to the EPROM programmer. First, how would I modify the design so that the programmer would run directly off the PC bus? It doesn't seem like it should be too much trouble, but I haven't had a chance to figure it out. Second, would it be much trouble to modify the system to handle 27256 EPROMs? I don't have the specifications for the 27256, so I can't tell.

In the case of the RS-232C monitor, are there any substitutes for the MCL1303 (in figure 2)? I have not found a substitute in any of the data books I own.

Also, I would like to comment on your reply to Claudio Roland Sonnenburg in the July 1986 Ask BYTE. Mr. Sonnenburg was looking for a cross **assembler** in a high-level language. The Cross-8 by Universal Cross Assemblers (P.O. Box 384, Bedford, Nova Scotia, Canada B4A 2X3) is a table-based cross assembler

continued

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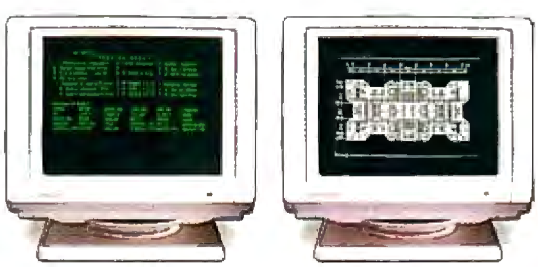

AMDEK

Clearly the finest in monitors. Inquiry 15

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2201 Lively Blvd., Elk Grove Village, IL 60007, Phone: 312/364-1180 written in Turbo Pascal that can be modified to support any 8-bit processor instruction format by altering the contents of a table. It comes with tables for 12 of the more popular processors, as well as instructions for creating additional tables. It is considerably less expensive than the cross assemblers you mentioned ($100).

Lee Thalblum
Bronx, NY

By now, you've seen the new and improved serial EPROM programmer in the October 1986 Circuit Cellar. I think it will take care of all your problems!

Attaching an EPROM programmer to the PC's bus isn't quite as good an idea as you might think. It's no faster than a serial programmer, since the EPROM programming time is much longer than the data transmission time. And, worst of all, it uses up a slot in your PC.

The MCL1303 diodes limit the current through the LEDs to about 3 milliamps, regardless of the RS-232C signal level. If you don't mind having LED brightness vary, you can replace the MCL1303s with resistors. A 2.2-kilohm resistor will allow about 1 mA through for a 5-volt signal and about 3 mA at 12 volts. Don't use less than a 1-kohm resistor; this will keep the current reasonable. Don't use more than a 3.9-kohm resistor or you won't see the LED light up.

Thanks for the information on the cross assembler.—Steve

RS-232C Chip

Dear Steve,

In reviewing your design for the data encryptor in the September 1986 BYTE, I noticed that you used the MAX232 chip by Maxim rather than the more common MC1488/1489 combination. I can see the advantages of using the MAX232 chip and would like to know where I can reach the manufacturer for more information.

George A. Hadgis
Rochester, New York

The MAX232 RS-232C level converter using a single 5-volt supply is made by

Maxim
510 Pastoria Ave.
Sunnyvale, CA 94086
(408) 737-7600

The device is described in Don Lancaster's "Hardware Hacker" column in the May 1986 issue of Modern Electronics *magazine. The MAX232 is available from*

JDR Microdevices
110 Knowles Dr.
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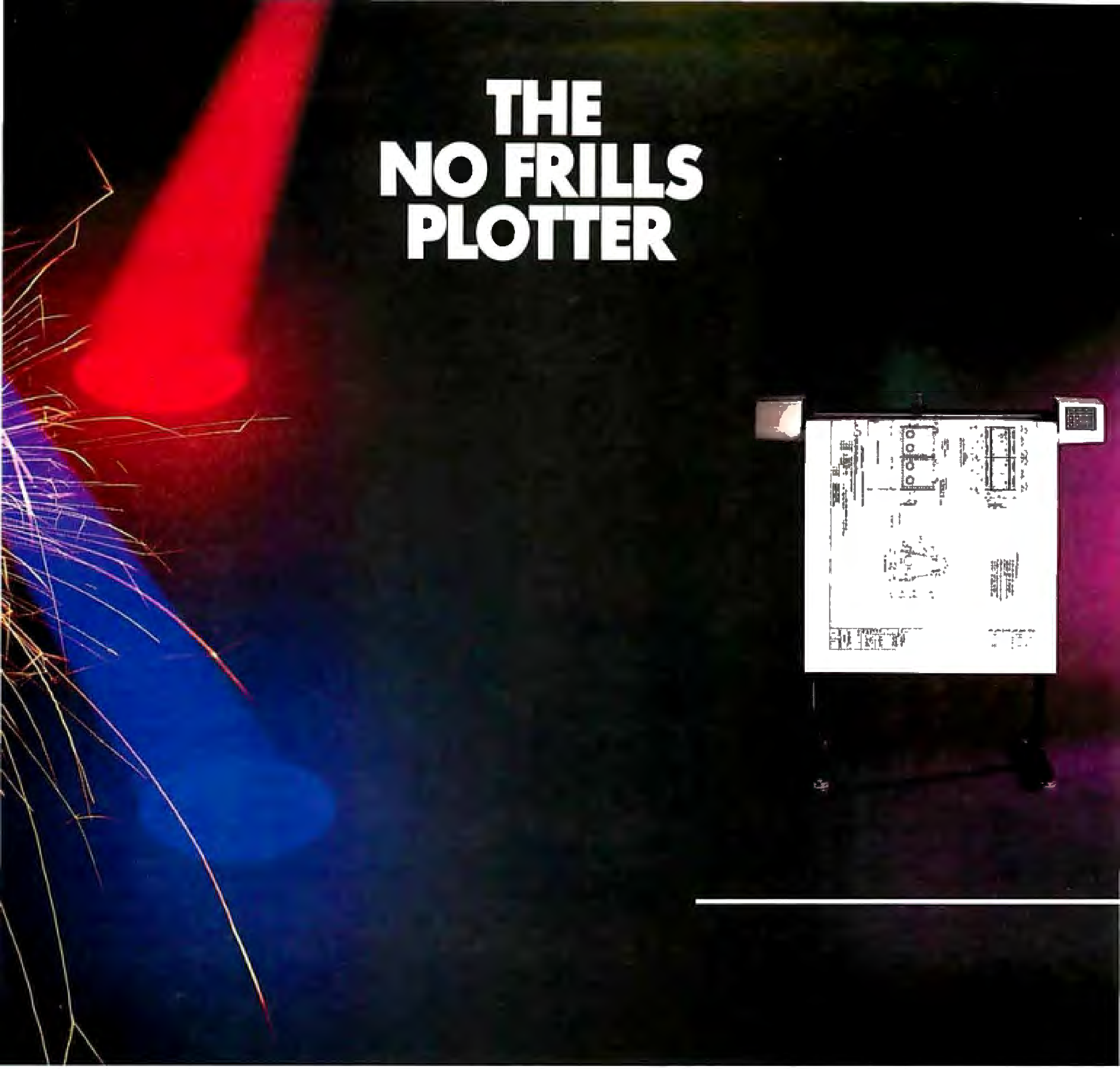

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abc
ABC Company Newsletter
August
Technical Report on Desktop Publishing
Desktop Publishing Terms
At the heart of the personal computer publishing movement is a set of skills almost unknown to anyone outside the typesetting trade. A unique lexicon of terms describes the methods used to arrange letters on a page in an eye-pleasing manner. The typographer's language contains terms dating back to Gutenberg's time.
Crispness and clarity are the measures of good typography. These two elements are a function of image resolution, point size and typeface. The eye is very sensitive to the spacing of letters and the placement of words on the page.
Measurements
Pica and point are two important words. They are the fundamental units of typographic measurement. A pica equals .166050, or about one-sixth, inch. The pica is in turn divided into 12 points. Using these typesetting terms will ease your communication with the professional graphic arts industry.
A standard measure for open space is the em, named for the width of the M, which is usually the widest letter in a typeface's character set. The size of an em is always equal to the current point size. When you're setting a line in 12 point type, an em is 12 points wide.
Related to the em is the en, which is equal to half the width of an em or the width of the letter N. The thin space, is a user-definable unit, usually half an en. Typographers adjust the space between letters to improve readability. The process, called kerning, is determined by the shapes of the adjacent letters. In electronic publishing, typographic attributes are imposed by embedding codes within unformatted text. A hyphenation and justification program then interprets the codes and makes the line-ending decisions.
Because the letter blocks were originally made out of lead alloy, the vertical space between lines of type
Desktop Publishing Systems Sold Worldwide
IN THIS ISSUE
Editorials 15
Columns 32
Strategies 78
Cover Story .. 83
Printers 92
Computers ... 95
Graphics 97
Dealer Info 98
News 103
Reviews 125
Industries 129
Careers 146
Figure 1.1 The art of typography is now combined with the power of the PC.

COMPUTERS & TYPESETTING
Donald E. Knuth
Addison-Wesley
Reading, MA: 1986

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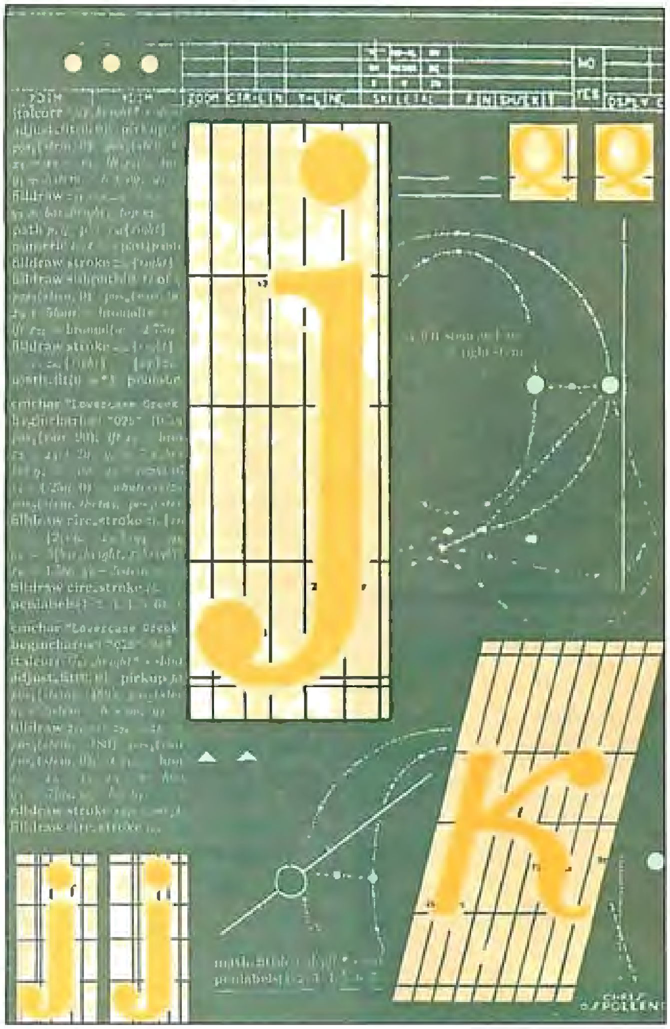

Reviewed by Alan Hoenig

The five volumes in Donald E. Knuth's *Computers & Typesetting* series constitute complete documentation of one great achievement in computer science: the development, from scratch, of a professional document formatter (typesetting program) and typefounding (typeface design) program. With these books in hand, you become a participant in the creative process.

Whether or not computer typesetting and typefounding interest you, you will acknowledge the significance of Knuth's system by virtue of its design and implementation and by virtue of this documentation, containing detailed user's guides and superbly documented Pascal code. If you are in any way interested in computer typesetting, you will love these books for what they will tell you about TEX and METAFONT.

A Complete Typesetting System

Don Knuth, a professor of computer science at Stanford University, is known for his ongoing series *The Art of Computer Programming*, of which only the first three massive volumes have appeared (Addison-Wesley: 1973, 1974, 1981). By 1979, Knuth had become seriously dissatisfied with the way these books had been typeset (their math or technical requirements are a typositor's nightmare) and was concerned with the decline in the beauty of typeset mathematics in general (see figure 1, page 68). Then he became aware that digital typesetting machines possessed the necessary sophistication to make serious computer typesetting systems possible. After all, raster devices print out an array of dots, and you simply have to shoot out an array of zeros and ones corresponding to the absence or presence of a dot in the raster display. Knuth realized that he knew as much about zeros and ones as anybody. The eventual results were a typesetting system called TEX (pronounced "tek") and a typefounding system called METAFONT.

Both programs conform to several guiding principles: They must be in the public domain (Knuth retains control only of the names), they must be easily portable to virtually any computer, and the output must be capable of display on any raster device. The final versions of these programs are written in a generic form of Pascal, reportedly because with no clear consensus for first place, everyone seems to agree that it's their second-favorite language.

You work TEX by preparing a document file with an ASCII text editor—TEX will complain if it sees any nonprintable characters in the text file. You control the formatting by inserting any of several hundred format commands within your document file. Use TEX to compile this file to produce a device-independent file, which contains all the information that any raster printer needs to generate output. Your document will have the same precise layout on an Okidata dot-matrix printer as it will on an Autologic phototypesetter. Of course, the resolution will differ on the two devices. It's not TEX, but rather a second program called a device driver, that bridges your device-independent output file to your printer. Device drivers have to be specially written and are generally not in the public domain.

Where do the letterforms that TEX works with come from? With great effort, you can force TEX to use the fonts that come with a typical laser printer, but you get vastly superior results if you use the fonts that Knuth designed himself using the META-

continued

ILLUSTRATION BY CHRIS SPOLLEN

FONT typefounding system. The source input files to this program consist of a series of draw commands, and a skilled user of METAFONT can create type and other graphic elements of great beauty.

Although these programs are in the public domain and you can alter them as you see fit, Knuth retains control of the names TEX and METAFONT to ensure that all programs identified by these names produce identical output given identical input. Your TEX files are the same whether they were generated by an IBM mainframe or an IBM personal computer.

All five volumes in this series were completely set by TEX using the METAFONT fonts. The five-volume set is a virtuoso graphic arts performance and a testament to the power of TEX and METAFONT. Duane Bibby's rather whimsical lion drawings and the optical characters that make up the ISBN numbers on the back covers appear to be the only exceptions. TEX handles all details of complex layout—setting several type sizes and varieties, automatic hyphenation, justification, kerning, ligatures, multiple columns, superior professional mathematics, and complex paragraph indenting—with ease.

Two New Computer Languages

From a computer enthusiast's point of view, TEX and METAFONT are distinguished not so much by their achievements in the graphic arts as by their structure. Both allow you to place commands in your input files. Both let you string commands together to form new commands. Each program recognizes many primitive commands for assigning values to variables, testing conditions, performing loops, and communicating to the outside world via input and output—in short, all the elements of a high-level computer language. It's entirely appropriate to regard both TEX and METAFONT as new computer languages, albeit with rather special purposes. (METAFONT is particularly unique.) Actually, you could do standard programming in both "languages," although it would waste your computer's resources. So another group of people interested in these books is aspiring compiler writers. Knuth offers prime examples of compilers written in structured, documented Pascal. This audience will read the user's guides as the specifications for these unusual languages.

Volumes A and C are user's guides to TEX and METAFONT, while volumes B and D are the program listings for both pro-

continued

In practice, the left-hand sides of aligned formulas are often blank, and the alignment is often done with respect to other symbols as well as =. For example, the following display is typical; see if you can guess how the author typed it:

$$\begin{aligned} T(n) \le T(2^{\lceil \lg n\rceil}) &\le c(3^{\lceil \lg n\rceil} - 2^{\lceil \lg n\rceil}) \\ &< 3c\cdot 3^{\lg n} \\ &= 3c\,n^{\lg 3} \end{aligned}$$

The result of \eqalign is a vertically centered box. This makes it easy to get a formula like

$$\left\{\begin{aligned}\alpha&=f(z)\\ \beta&=f(z^2)\\ \gamma&=f(z^3)\end{aligned}\right\}\qquad\left\{\begin{aligned}x&=\alpha^2-\beta\\ y&=2\gamma\end{aligned}\right\}.$$

You simply use \eqalign twice in the same line:

```
$$\left\{
\eqalign{\alpha&=f(z)\cr \beta&=f(z^2)\cr \gamma&=f(z^3)\cr}
\right\}\qquad\left\{
\eqalign{x&=\alpha^2-\beta\cr y&=2\gamma\cr}\right\}.$$
```

Figure 1: *An example from* The TEXbook, *showing the capabilities for creating complicated mathematical display equations. An appendix provides answers to all the exercises contained in this volume. Reprinted with permission from Addison-Wesley Publishing Co. Inc.*

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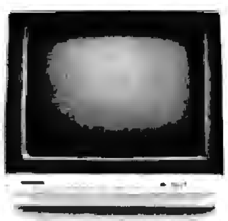

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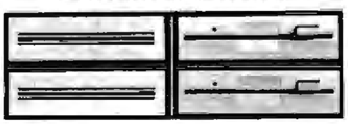

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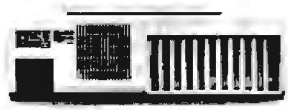

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Inquiry 217

grams. Volume E, the final volume in the series, is a detailed survey of the way Knuth used METAFONT to generate the roman fonts TeX uses.

The TeXbook

Volume A of this series, the user's guide for TeX, has been around for a year or more in a softcover, wire-bound incarnation entitled *The TeXbook.*

First-rate scientists are often first-rate writers. Einstein, Freud (in the original German; he's not well served by his translators), Darwin, and Feynman lead this class, but scores of other scientists have not yet caught the public eye. Knuth emphatically belongs among this group. His book is a model of clear exposition—there are even jokes once in a while (but you have to be sharp and read the text carefully). The book is well organized in a series of short chapters, each centered on a particular TeX topic. But fine science writing undoes itself in a peculiar manner. Science starts slowly as it sets forth the basic concepts and carefully builds the foundation. The unsuspecting reader jumps all too soon to the conclusion that there's no substance to this subject. It's similar to the frog in the biology experiment: The frog luxuriates in a pot of water heated ever so slowly, but by the time the water becomes hot, the animal's muscles are immobile. Gentle reader, heed this lesson while reading *The TeXbook.* Don't be lulled by the gentle temperatures of the early chapters—the water heats up soon.

Knuth imposed two structures on this exposition. On one hand, the first few chapters can be viewed as a very short course on TeX that culminates in a guided hands-on tour of the system (chapter 6). The remainder of the book expands on this introduction. (By the way, you'll better track the learning curve if you have access to TeX and you try things out as you go along. This is no hardship—you'll find TeX is fun. Several implementations of TeX are available for IBM computers and clones, the Apple Macintosh, the Commodore Amiga, and the Atari 1040ST, although these last two have been demonstrated only as of this writing and may not yet be commercially available.)

On the other hand, Knuth has segregated the entire book into two levels, elementary and advanced. Since any particular chapter contains both high and low subject matter, each chapter contains elementary and advanced material. Fortunately, there is no danger of mixing the two levels—the advanced material is set in smaller type, and these paragraphs begin with a "dangerous bend" sign, a logo like a road-sign warning of an approaching hairpin, Z-shaped curve you might encounter on a mountainous pass. Knuth clearly wants his readers to ignore the dangerous bend material on the first pass through the book and to refer to it later on. Scattered throughout the text are problems and exercises, many of which will give most readers a run for their money. The answers to all the exercises are included in the first appendix to the book.

More than a third of the book consists of ancillary material in various appendixes. Most of these topics are advanced and some are for reference, but some of the material is intriguing. I especially like Appendix D, "Dirty Tricks." Here Knuth really makes TeX sit up and beg. Watch TeX perform multilingual double-column typesetting, do elementary Cartesian graphing of points, draw dragon curves, and set hanging punctuation.

The extensive index (another appendix) Knuth prepared is an essential limb enabling you to find things tucked away in obscure corners of this long book. As you get deeper into TeX, you'll find yourself needing to clarify a specific point, so Knuth took great care to index each topic in every reasonable way. The entries use typography to indicate where something is defined, where it's used in a good example, and anywhere else it's mentioned.

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But here's the bottom line for most users: Can you learn TeX from *The TeXbook*? You can, but just remember to skip the dangerous bend material on your first pass. Also, personal computer users may be a tad uncomfortable with the book, because it implicitly assumes the existence of resident TeX wizards at your local computer site who can convey the nuts and bolts of TeX usage to you (What switch do I flick now? Where do I stick this floppy disk? What's the best text editor to use?). This assumption makes sense when your site is some VAX or mainframe, but it leaves you hanging when you're trying to work by yourself at your own Macintosh with your own version of TeX. (See editor's note at end of review.) However, the commercial implementations of TeX come with more detailed instructions for getting the program up and running on your computer.

Fortunately, TeX is sufficiently redundant that you can perform good TeX no matter how you start. TeX provides so many ways to do most tasks that you can always rely on a couple of tricks until you master the skills for the more clean and elegant approach. *The TeXbook* will grow with you as you build TeX skills—that's its great advantage. Little by little, even the dangerous bend stuff makes sense.

Addison-Wesley wisely offers *The TeXbook* in two formats. The hardbound edition is perfect for libraries, but the wire-bound edition, in which facing pages lie flat, is just right for those who need a copy right by the computer.

A METAFONT User's Guide

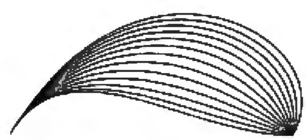
The METAFONTbook, volume C in the typesetting series, is the user's guide to METAFONT, the companion program to TeX (see figure 2). This book parallels *The TeXbook* in many respects. The same structures prevail—introductory first few chapters, advanced remainder, easy material intermingled with dangerous bend material. Again, it's wise to leave the dangerous material until you have some experience under your belt.

Exercises are strewn throughout the book, and once again Duane Bibby has provided the drawings. The index is superb. Knuth employs the same witty, engaging style (but new jokes). *The METAFONTbook* is also available in a less expensive, wire-bound edition for hands-on computing.

The resemblances end there, because METAFONT is so different from TeX. If anything, METAFONT is more interesting, and I find its problems more challenging. It is more the toy than TeX—there are lots of fun things you can do with it—but maybe, as I'm newer to METAFONT, there is just greater novelty.

continued

Here are some of the curves that METAFONT draws between two points, when it is asked to move outward from the left-hand point at an angle of 60°, and to approach the right-hand point at various angles:



This diagram was produced by the METAFONT program

```
for d = 0 step 10 until 120:
      draw (0,0){dir60} .. {dir -d}(6cm,0); endfor;
```

the 'dir' function specifies a direction measured in degrees counterclockwise from a horizontal rightward line, hence 'dir −*d*' gives a direction that is d° below the horizon. The lowest curves in the illustration correspond to small values of d, and the highest curves correspond to values near 120°.

Figure 2: *An excerpt from* The METAFONTbook, *demonstrating the versatility and mathematical structure of the METAFONT language. Notice the dangerous bend icon. Reprinted with permission from Addison-Wesley Publishing Co. Inc.*

Why is METAFONT so nifty? As you might expect in a program that creates letterforms, there are a variety of commands that shape, position, and draw using an imaginary pen nib. The fun begins, though, because you can instruct METAFONT to do its work on-line and actually watch the creation process taking place on your screen. METAFONT uses an elegant algorithm for deciding which graceful curves will connect several points.

But there's more. Because people find it easier to specify certain key points as intersections of given lines (such as the central peak in an uppercase W) rather than by coordinates, METAFONT solves systems of linear equations for you, and does it on-line. Still more, METAFONT can even attack nonlinear equations. For many people, this alone is worth the price of the package. (PC versions of METAFONT will be available from Addison-Wesley and from Personal TEX, mentioned below.)

Because of its graphic nature, METAFONT lends itself better to recreational purposes than does TEX. At one point, you'll come upon a recipe for playing John Conway's Game of Life on-line with METAFONT. Martin Gardner would highlight this game from time to time in his late, lamented "Mathematical Games" column in *Scientific American*. Life is a set of rules whereby one pixel configuration evolves to some new state in the next generation. If you're clever enough to choose your original configuration carefully, you'll generate the stills for some surrealistic cartoon.

A Coffee-Table Volume

If you assiduously read *The METAFONTbook*, you'll be master of all the tools you need to create your own alphabet, at least in theory. But Knuth only gives examples of very simple letters in volume C. How difficult is it to expand on these skills and create an alphabet of beauty and serviceability, replete with thick and thin strokes that blend gracefully into the flangelike serifs of good roman type? How hard is it to create an alphabet suitable for the finest texts?

It turns out to be very difficult, as you soon appreciate by glancing through the pages of the final volume of this series, *Computer Modern Typefaces*. This volume presents the METAFONT source programs for all characters in the basic fonts, including uppercase and lowercase letters, digits, punctuation, math symbols, and ligatures. Each letter is specified in terms of about 60 parameters that are adjusted to various values or turned on or off. The idea is that adjusting these things carefully, we can generate a wide variety of different fonts. This was Knuth's original goal, and it explains the origin of the prefix "META."

You can adjust these parameters with one of two goals in mind. First, by carefully scaling certain parameters, you create different sizes of a particular font. It's a common misconception that a 24-point version of some font is geometrically similar to its 12-point version. Wrong! Each size has to be subtly adjusted. (Printers traditionally measure the size of type in points. There are 72.27 points in an inch. To speak of type as being 12 point—about 1/6 of an inch—means that the height of a parenthesis in that font is 12 points.)

Second, by scaling other parameters you can create different font styles. For example, by slanting a roman font and softening some of the curves, you approximate the corresponding italic. Because these fonts share the same underlying structure, there will be a visual unity that might be missing in type designed entirely by hand.

Although physically a match for its siblings in the series, *Computer Modern Typefaces* plays the role of star. The bulk of the book contains the METAFONT programs for each character, together with large proof mode examples of each, the proofs being rendered in substantially enlarged 10-point roman, 10-point

continued

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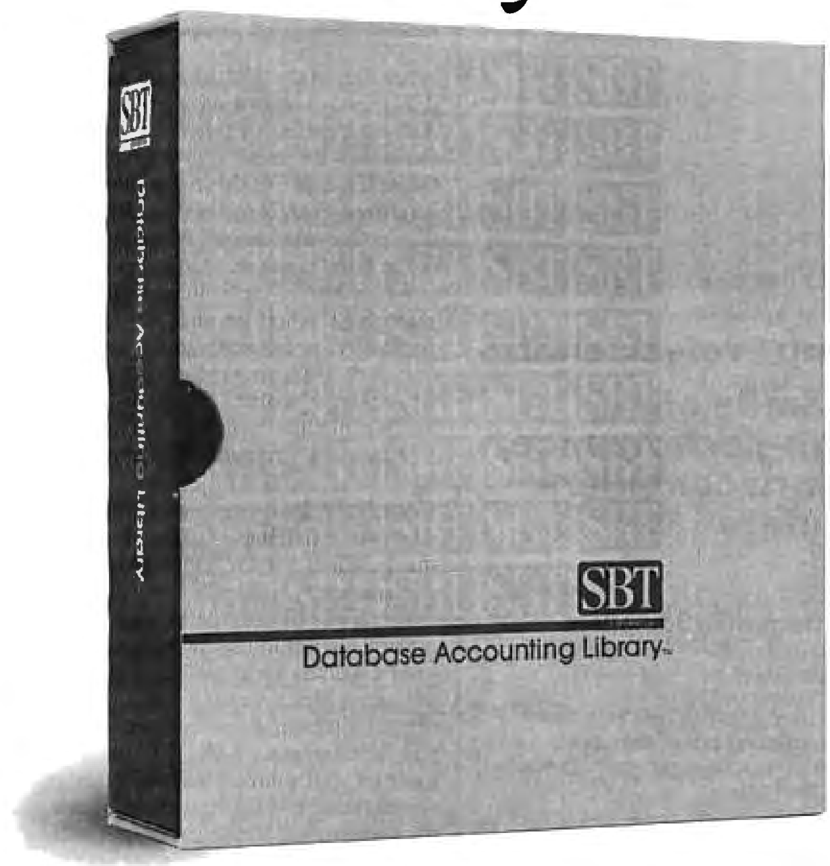

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Knuth has long advocated the concept of programs as literature, and now he can put his money where his mouth is.

typewriter style, and 10-point sans serif bold extended. These drawings are shown on a grid, with their key points labeled. Although details of other important METAFONT files are in the book, it's these drawings that occupy center stage. Leaf through a copy. At this large scale, the curves of many of these handsome characters take on a hypnotic quality. Knuth calls this the "coffee-table book" of the set. A smaller section at the end of the book contains specimens of all styles and sizes of type.

As in the other volumes, amusing nuggets are scattered throughout. Knuth presents, for example, a font whose numerical parameters occur somewhere in the Fibonacci sequence (0, 1, 1, 2, 3, 5, 8, 13, etc.) in hopes that "these will yield an especially pleasing alphabet." (Perhaps there is beauty in mathematics, as the mathematicians have been saying all along.) Also, be sure to check out Computer Modern Funny Roman and its italic.

Computer Programs as Literature

The two remaining volumes (B and D) contain the listings for the TeX and METAFONT programs. Well, not quite; further explanation is needed.

Knuth has already developed the WEB system of structured documentation to use in tandem with the writing of large programs such as TeX. (WEB is also in the public domain.) You prepare a file containing the source code, documentation, and certain formatting instructions. The WEB system consists of a pair of programs, TANGLE and WEAVE. Letting TANGLE loose on your source generates Pascal object code. Running your source through WEAVE generates a file that you next run through TeX and print. Your final output will be a handsome mélange consisting of the program code and documentation, plus a few other nice features. (For a fuller explanation, see the "Programming Pearls" columns in the May and June 1986 issues of the *Proceedings of the ACM*.) What you get in these books is the WEAVE printout. (For nominal fees, Stanford University will provide you with computer tapes containing the WEB source for both TeX and METAFONT and the WEB programs. WEB user's guides are also available from Stanford.)

There's certainly a utilitarian purpose in making such programs available—you might want to modify them for your own computer. Is there another point in making large-scale program listings available to the general public? I think that there is. Architects avidly study the works of their colleagues. Scientists turn to scholarly publications to examine the work of their fellows. Novelists read other people's novels. But when was the last time you studied someone else's program? If you're a serious programmer, here's your chance to review the work of a world-class programmer.

Knuth himself has long advocated the concept of programs as literature, and he now has a chance to put his money where his mouth is. You'll like the presentation. The program is heavily segmented, each such module being consecutively numbered. WEB performs cross-referencing and tells you the numbers of the other sections that use this module. In addition to the usual comprehensive index at the end of each volume, at the bottom of each right-hand page there is a mini-index to the rest of the book of all terms, variables, and modules that appear on this and the facing page. This must have been difficult to implement, but it's one of those ideas like the invention of the wheel or dif-

continued

ferentiation that seem self-evident after you see them in action.

Good things flow from documentation as structured as this. Of prime importance is that you can use the listing as the ultimate arbiter for any problems with TEX or METAFONT. Second, it's easy to comprehend these programs. Each listing of TEX and METAFONT contains roughly half a megabyte of Pascal source code, but because WEB makes them so readable, Knuth estimates that more people are familiar with their innards than with any other comparably sized program.

Finally, it's easy to debug such programs. Knuth is confident that there is at most one more bug in TEX, the last known TEX one having been squashed in November 1985. TEX has accumulated many tens of thousands of user-hours since then with nary a bug in sight. (By the way, if you're the first to snare the bug, Knuth will pay you $20.48. Next year, the rate rises to $40.96, and so on. There's also a bounty on mistakes in any of these typesetting volumes.) This latest version of METAFONT is bug-free, at least so far.

Other Possible References

Knuth's aim in preparing this series is to provide complete documentation to his vision of computer typesetting. These five books are not the whole story, though. You may want to consult several reports of the Computer Science Department at Stanford for fuller explanations of certain aspects. There are alternatives for learning "first-grade" TEX. Two texts written by Mike Spivak are *The PC-TEX Manual*, a chatty and well-written introduction ($19.95 from Personal TEX Inc., 20 Sunnyside Ave., Suite H, Mill Valley, CA 94941), and *The Joy of TEX*, an introduction to AMS-TEX, an enhanced variant of TEX especially prepared for mathematicians ($35 from the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, (800) 556-7774). The TEX Users Group (TUG), an offshoot of the American Mathematical Society, publishes *First Grade TEX: A Beginner's TEX Manual* by Arthur L. Samuel. This is available from TUG, as is their newsletter, "The TUGboat," which publishes articles of TEXnical merit (TUG, P.O. Box 9505, Providence, RI 02940). Of interest will also be *TEX and METAFONT: New Directions in Typesetting* (Digital Press/American Mathematical Society, 1979), in which you'll see the clearer motivations into this system, how these programs used to work, and fuller explanations of some of the mathematical underpinnings (particularly in the drawing routines of METAFONT). ■

Editor's note: *Addison-Wesley's disk set for TEX to be implemented on microcomputers is called MicroTEX. It is designed for the IBM PC family and compatibles; a hard disk is recommended because the system requires MS-DOS and 512K bytes of RAM. Version 1.5A1 costs $295. A disk set for TEX implementation on Macintosh computers, called TEXtures, costs $495. Both are available from the Order Department, Addison-Wesley, Reading, MA 01867, (617) 944-3700.*

TEX for the PC family is also available from Personal TEX Inc., 12 Madrona St., Mill Valley, CA 94941, (415) 388-8853. A version of TEX for the Macintosh, called MacTEX, is available from FTL Systems Inc., 234 Eglinton Ave. East, Suite 205, Toronto, Ontario, Canada, (416) 487-2142. A version of TEX for the Amiga is available from N^2 *Computer Consultants, P.O. Box 2736, College Station, TX 77841.*

Dr. Alan Hoenig (17 Bay Ave., Huntington, NY 11743) is a professor of mathematics at a branch of the City University of New York and a TEX consultant. He has written extensively on microcomputers, with books published by Little, Brown and William C. Brown Co. His latest book, a college text, is due to be published by Random House shortly.

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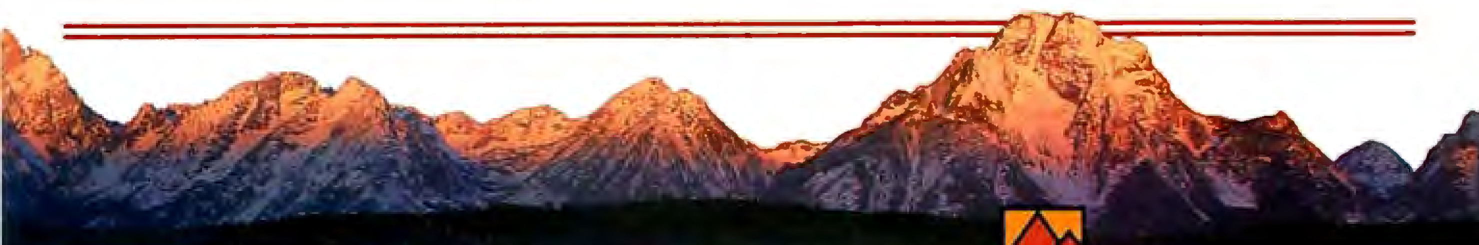

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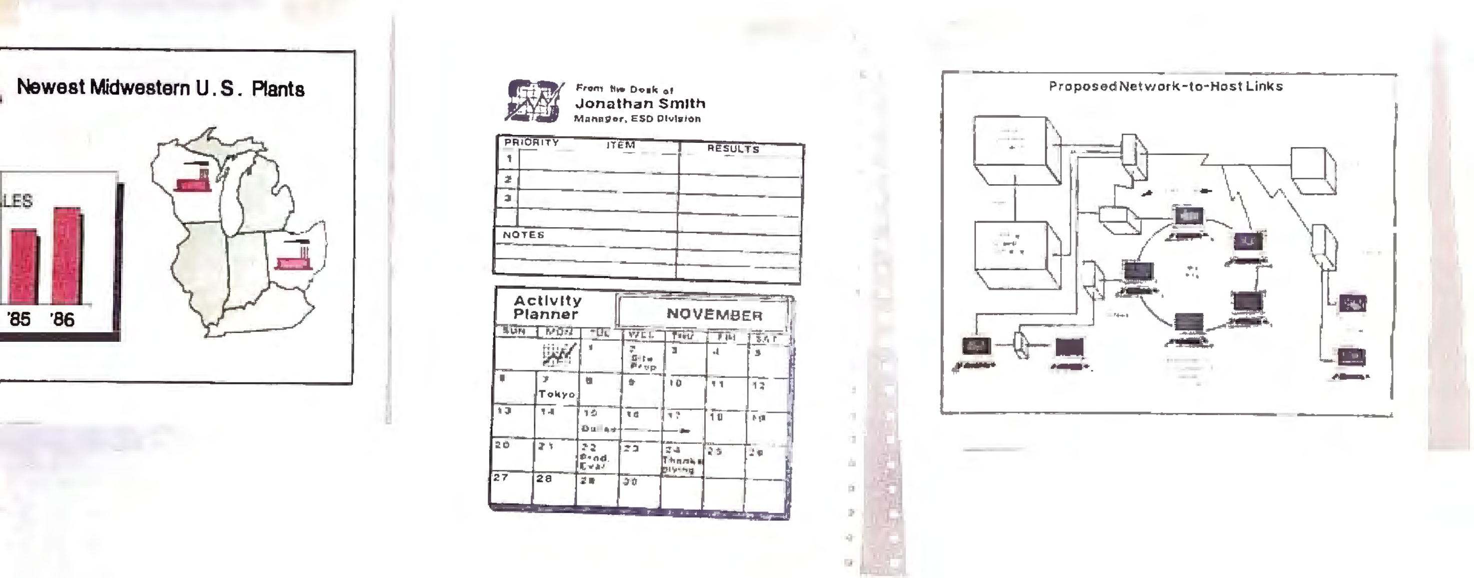

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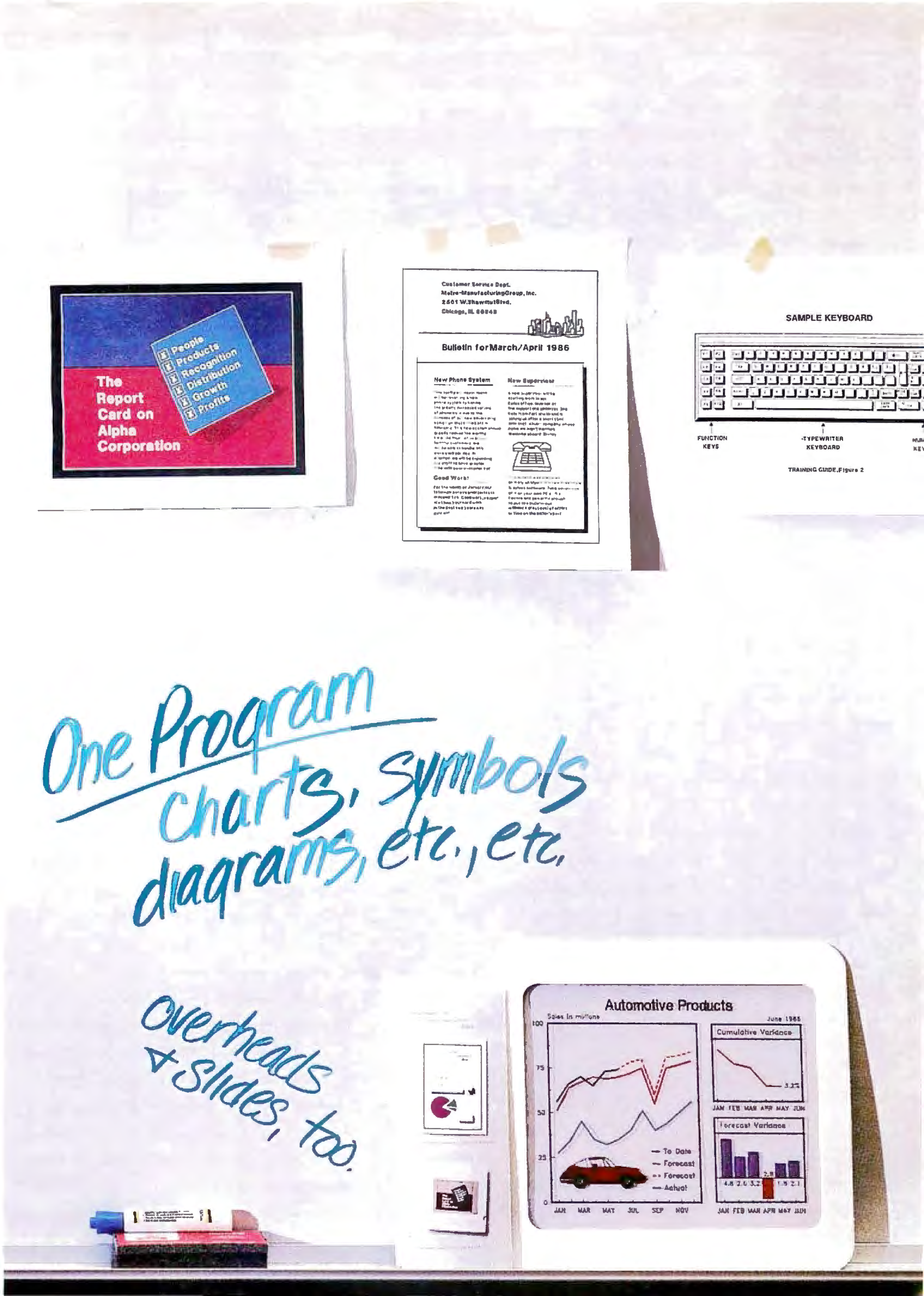
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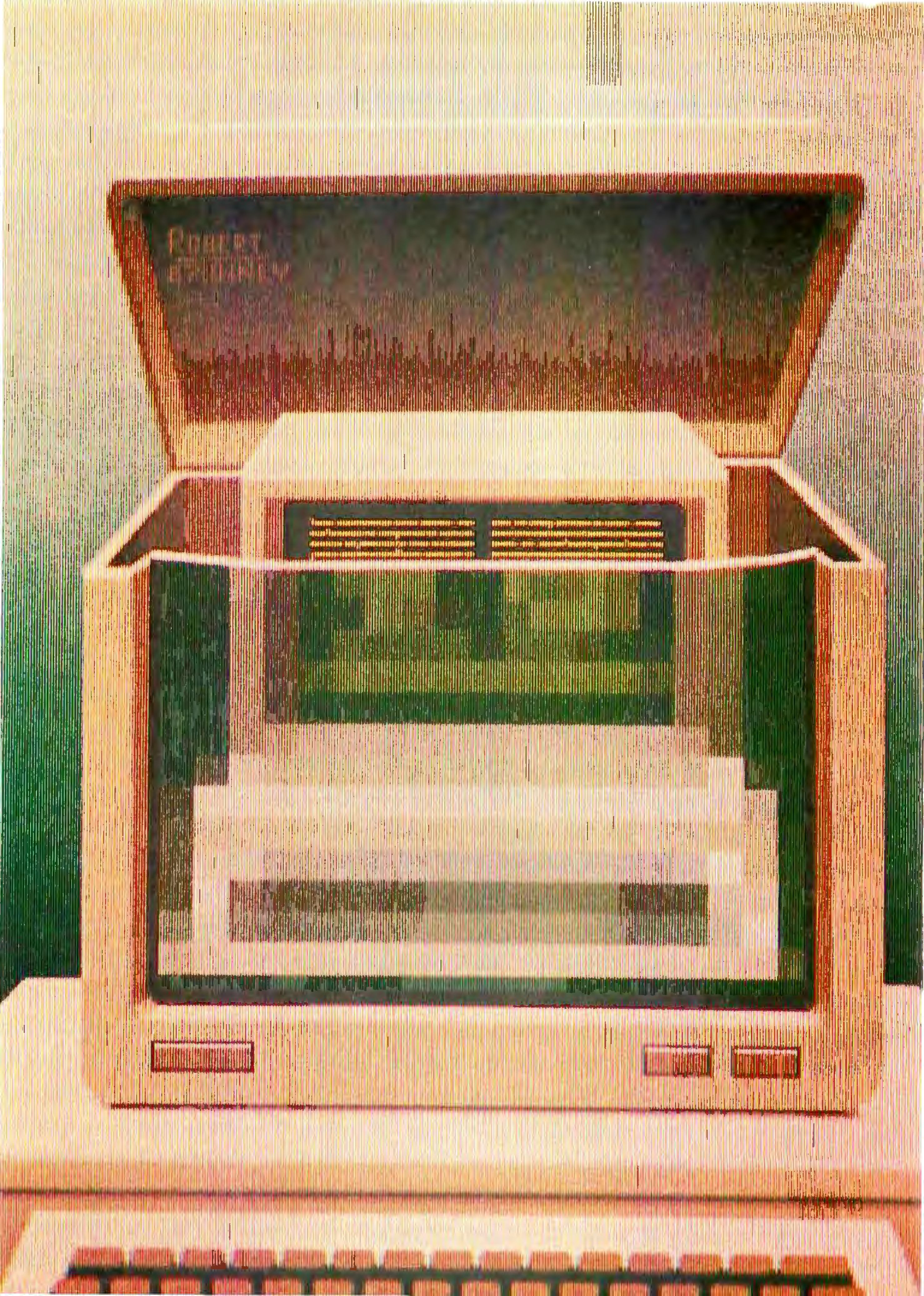

Features

THIS MONTH'S FEATURES SECTION offers two product previews. In the first, BYTE technical editors Gregg Williams, Tom Thompson, and Richard Grehan give us an advance look at Commodore's new Amiga, the A2000. They believe this new model will make accessible much of the potential that was locked inside the A 1000. Its most exciting feature is the optional A2088 board that gives it IBM PC compatibility. A complete review will follow in an upcoming issue.

Next, BYTE technical editor George Stewart gives us a preview of Turbo BASIC, Borland International's answer to Microsoft BASIC. It offers 8087 compatibility, fast and versatile compilation, recursion, and it's BASICA-compatible.

Although this month's Circuit Cellar is not the second part of a two-part article, it does relate to last month's project, which was an infrared remote control for Steve's home control system. The infrared Master Controller takes charge of all your home entertainment equipment. It "learns" the infrared signals for each function and plays them back on command. Commercial units now available have two shortcomings: First, the necessary circuitry is contained in a single hand-held unit; second, they are not user-programmable. Steve designed the Master Controller to avoid these shortcomings.

In our Programming Insight, "Building a Random-Number Generator," Brian Wichmann and David Hill caution against relying on built-in random-number generators, which do not always produce sequences that will stand up to severe tests. The authors present a Pascal routine that combines three simple generators into one that produces satisfactory statistical results.

Although techniques for making an assembly language program stay resident are common enough, making a C program resident, according to Brian Edginton, is a new adventure. In our Programming Project, he explains how he used C to write a simple interrupt-processing program that remains resident in memory.

Gregg Williams, Tom Thompson, and Richard Grehan

The Commodore A2000

The new machine features slots and optional PC compatibility

Editor's note: *The following is a BYTE product preview. It is* not *a review. We provide an advance look at this new product because we feel it is significant. A complete review will follow later.*

When Commodore released the first Amiga computer, the A1000, in September 1985, the world got a look at a sophisticated 68000-based computer whose unusual multitasking hardware and stunning graphics had never been seen in an under-$1500 microcomputer (see the August 1985 BYTE for more details). Even though it did have a connector on its side that allowed future hardware expansion, the A1000 was essentially a "closed box," and many potential users felt the machine was limited as it stood.

Now, with the new Amiga 2000 (see photo 1), Commodore has made accessible much of the potential that was locked inside the A1000. With a larger case that can enclose hard disks, Amiga and IBM expansion cards, the A2088 board (the one-card equivalent of an IBM PC), and a price tag of under $1500 (for the basic machine with 1 megabyte of memory and an 880K-byte 3½-inch floppy disk drive), the A2000 has the potential to grow—and grow inexpensively—in whatever direction you want. The A2000 will suit the engineer, artist, and businessperson better than the A1000 ever could.

System Description

The A2000 comes in a metal housing of approximately the same width as the A1000 but several inches deeper and substantially taller to accommodate internal peripheral boards. You'll immediately notice knock-out front panels for an additional 3½-inch floppy disk drive and either a 5¼-inch floppy disk drive or hard disk drive. The mouse ports have moved from the right side of the housing to the bottom front panel on the machine. The detachable keyboard now plugs into the front with a PC-style keyboard connector, rather than to the rear of the unit as on the Amiga 1000.

If you check the In Brief section for the A2000 with the A1000's hardware specifications, you'll see that they're quite similiar: a 68000 CPU running at 7.14 MHz with the same three custom chips handling video, DMA, sound, and I/O (see figure 1). But here the similarities end: The Amiga 2000 has a battery-powered calendar/clock, 1 megabyte of RAM, and a built-in expansion bus with slots. Also, the latest version of the low-level system routines are in ROM, eliminating the Kickstart disk required to load these routines into write-controlled storage RAM as you do on the Amiga 1000. See the text box "Version 1.2 Changes" for additional information on modifications to the system routines and Workbench.

The A2000 serial and parallel ports accept standard cables, eliminating the cabling nightmare of the A1000 caused by the voltages that were present on some of the pins. There's an external drive connector as on the A1000, but the RCA jack for composite video output is gone (see photo 2).

Keyboard

The keyboard (photo 3) now has 94 keys instead of 89. New keys include Help, Enter, and math keys (+, −, *, /) for the numeric keypad. The cursor keys are arranged in a "T" fashion instead of a cross. The keyboard has full *n*-key rollover capability, which eliminates a "ghosting" phenomenon (extra keycodes that are generated if several keys are pressed simultaneously) that is present in the A1000 keyboard.

Slots

Unlike the A1000, which is equipped with only a single external edge connector, the A2000 comes with seven internal slots for peripheral cards. Five slots use the Amiga system bus, and four slots are on a secondary bus that is IBM XT-compatible. (Commodore has also added 36-pin connectors for potential IBM AT compatibility in the future.) The slots total seven because two pairs of slots—a pair being one slot on the Amiga bus and one slot on the secondary system bus—are physically situated to serve as bridges for Amiga/PC data communications (see photo 4). The Amiga 2088 card (described later) resides in one of these "bridge" slots. You can plug the 2088 card into either bridge slot depending on your needs. If PC emulation is your major concern, you will want to position the 2088 card so that three of the four PC bus slots are available for peripheral cards. Or you can position the card to permit the use of four out of five Amiga bus slots.

There is an 86-pin slot for access to the Amiga CPU bus called the CPU bus slot. This slot taps directly into the unbuffered signals from the Amiga's CPU and is identical to the external slot on the Amiga 1000. It can be used for special peripherals, such as a coprocessor, that need to be tightly coupled to the CPU.

Finally, there's a slot provided for the support of either NTSC or PAL composite video boards. Since the A2000 does not produce a composite video signal (as the A1000 did), you must insert a composite

continued

Gregg Williams, Tom Thompson, and Richard Grehan are technical editors at BYTE. They can be reached at One Phoenix Mill Lane, Peterborough, NH 03458.

PHOTOGRAPHS BY PAUL AVIS

Photo 1: *The Amiga A2000 computer. The A2000 comes with 1 megabyte of memory and one 3½-inch floppy disk drive. You can also substitute internal hard disks for the second (left) 3½-inch and the 5¼-inch drives that are installed in this machine. The image of the IBM PC shown on the screen was captured using NewTek's Digi-View software.*

Photo 2: *The A2000 back panel. Notice the cutouts for outputs from peripheral cards.*

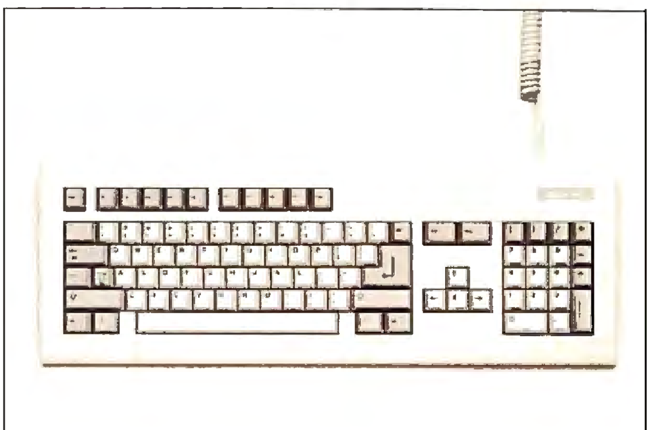

Photo 3: *The A2000 keyboard. All the keys on the keypad are labeled on their front face with the IBM PC–related functions associated with them.*

IN BRIEF

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Price
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Microprocessor
Motorola 68000 7.14-MHz, 16-/32-bit microprocessor

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1 megabyte RAM standard, expandable up to 8 megabytes using AutoConfig
256K ROM containing 192K bytes of system code

Disk Memory
880K-byte 3½-inch double-sided floppy disk drive

Keyboards
Detachable 94-key keyboard, with 10 function keys, separate numeric keypad, separate cursor keys
Detachable 96-key keyboard, international version

Pointing Device
Optomechanical two-button mouse

Ports
RS-232C serial port, PC-compatible
DB-25 parallel port, PC-compatible
DB-23 RGB video port
External disk drive port
Two RCA jacks for stereo sound
Two DB-9 joystick ports (one port used for mouse)

Miscellaneous
Three custom chips provide graphics, DMA, video, and sound; built-in battery-powered calendar/clock

Optional Peripherals

Internal 3½-inch floppy disk drive	$199
Internal 5¼-inch floppy disk drive	$299
A2088 PC coprocessor card	$499
A2050 2-megabyte expansion memory card	$499
A2060 Composite video interface card	$99
A2094 Hard disk/SCSI controller card	$349
A2002 color monitor (analog RGB)	$349
A2080 color monitor (long-persistence phosphor, analog RGB)	$499

video card in this slot to generate the required signal.

Buses

Data traffic among the slots and the CPU is handled by three distinct buses (see figure 2).

The CPU bus consists of 86 lines, some of which are connected directly to the 68000 CPU. There are no buffers between the CPU and the CPU bus slot.

The PC bus is a 62-line IBM XT bus. A peripheral board—such as the A2088 board—is required to allow the Amiga to communicate to this bus.

The Amiga bus consists of 100 lines that carry CPU and other signals that handle external interrupts and bus arbitration logic. These lines are buffered, which simplifies the task of designing the interface for a peripheral board. It must be noted that several of the Amiga bus signals are not identical to the 100-line expansion bus on the Zorro backplane. (Zorro is a bus card that extends the external slot for the A1000 by allowing for five plug-in boards. See table 1 for further information.) Additionally, the required form factor for the boards has changed: The square Zorro boards will not fit in the space provided for the rectangular A2000 boards.

AutoConfiguration

You encounter a problem when you include slots in a microcomputer: How do you make sure that all the peripheral boards will interact properly on the bus? For the Amiga, an AutoConfiguration protocol (referred to for the remainder of this article as AutoConfig per the Commodore documentation) is used to ensure that all peripheral boards are installed into the system at boot-up. This AutoConfig protocol is provided by version 1.2 of the system software and is manipulated via two lines on the Amiga bus ($\overline{\text{CONFIG-IN}}$ and $\overline{\text{CONFIG-OUT}}$).

At power-up or reset, all peripheral boards are in an unconfigured state. The $\overline{\text{CONFIG-IN}}$ line goes low to the first peripheral board on the bus, allowing it to respond to bus cycles. The processor reads signature data from the peripheral board. This data informs the configuration software of the size of the board's address space, whether initialization code must be run to complete the configuration of this board, the manufacturer's serial number, and whether the board is to be added to the Amiga's free memory pool (if this peripheral is a memory board). With this information, the Amiga now computes how much address space this board requires and writes a base address to its address latches. The board will respond to bus accesses at this new address until a reset occurs. The Amiga also runs any initialization code that the board requires.

Once the board has been configured into the Amiga's address space, it lowers $\overline{\text{CONFIG-OUT}}$, allowing the next board on the bus to respond to the processor. This signal is passed along, daisy-chain fashion, as each board is configured on the Amiga bus.

In the event board initialization fails, the software can issue a write to an optional "shut up" address that is provided in the board signature data. Writing to this address causes the board to lower its $\overline{\text{CONFIG-OUT}}$ line and never respond to any address until the system is reset. This allows the AutoConfig sequence to proceed while removing any malfunctioning boards from the system.

The CPU bus slot does not support the AutoConfig protocol. However, there is special code in Kickstart to detect and determine the capacity of any memory board that may be installed in this slot.

Fast and Chip Memory

Memory boards placed on the CPU bus or Amiga bus have the advantage of being *fast* memory. Fast memory is RAM that does not have to share bus access with the custom blitter chip that manages the video display. RAM that the blitter chip can access is called *chip* memory. The blitter operates at a higher priority than the 68000 and steals bus cycles when necessary to maintain the display. This results in contention for chip memory access between the CPU and blitter. Programs normally have to run in chip memory on the A1000 because all of the 512K bytes of internal RAM are chip memory. On the A2000, half of the megabyte of RAM is fast memory; this should result in an increase in program performance. Since an image must be located in chip memory for the blitter to display it, locating program code in fast memory also allows more images to be placed in chip memory.

Amiga 2088 Board Hardware

Simply put, the A2088 board is a modified IBM XT–compatible computer on a single 13.25- by 4.5-inch card (see photo 5). Its microprocessor is an 8088 operating at the standard 4.77-MHz clock rate. A 16K-byte EPROM provides a BIOS with modifications by Commodore that supply routines necessary for communication between the 8088 and the Amiga. The A2088 can accept up to 512K bytes of RAM on board (it will be shipped with 512K), not counting 128K bytes of dual-port RAM used for interprocessor communication. A socket adjacent to the 8088 chip allows you to add an 8087 math coprocessor chip. Additionally, the A2088 card is equipped

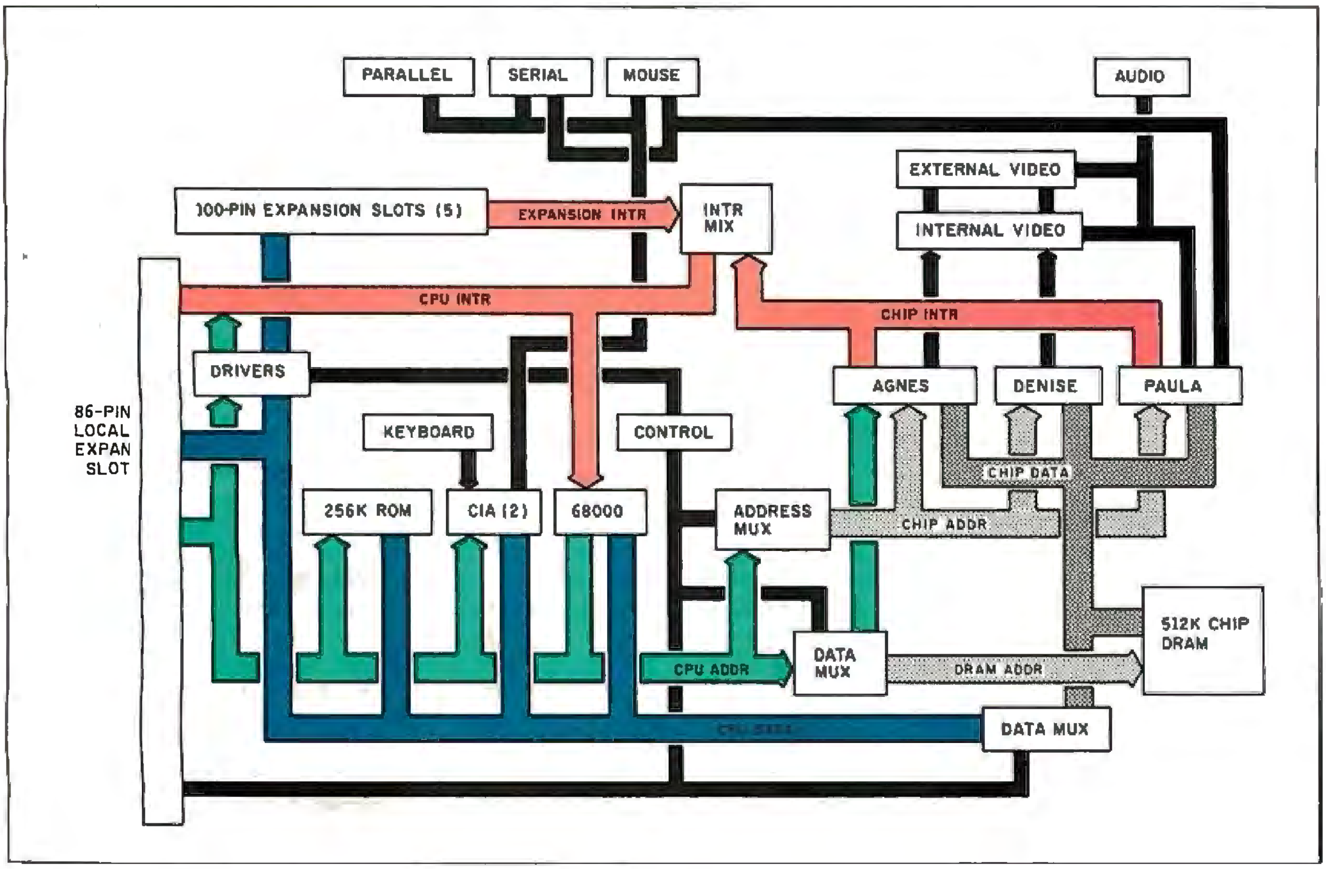

Figure 1: *A detailed block diagram of the Amiga 2000.*

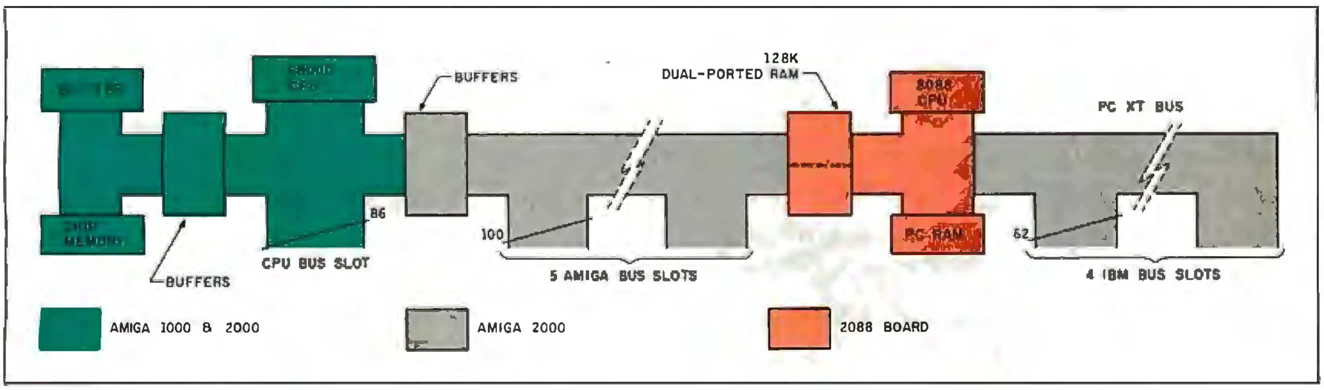

Figure 2: *A simplified block diagram of the Amiga 2000 with the Amiga 2088 board installed. The CPU bus slot, Amiga bus slots, and PC bus slots can operate without interfering with the blitter chip.*

with an SMC 9268 floppy controller chip and a standard 5¼-inch floppy connector; this permits you to connect up to two 5¼-inch drives in daisy-chain fashion—one external and one internal.

What makes such complexity possible on a single board? The answer is a custom integrated circuit that Commodore refers to as the PC Multifunction chip. This single chip does the work of a DMA controller, an interrupt controller, and a timer as well as providing all the PC bus timing signals. An 8088 wired to a PC Multi-

continued

Table 1: *Differences between the 100-pin Zorro expansion bus and the 100-pin Amiga bus.*

Pin number	Zorro signal	Amiga bus signal	Comment
19	$\overline{\text{INT2}}$	$\overline{\text{EINT2}}$	Name change
22	$\overline{\text{INT6}}$	$\overline{\text{EINT6}}$	Name change
40	$\overline{\text{IPL0}}$	$\overline{\text{EINT7}}$	Signal change
42	$\overline{\text{IPL1}}$	$\overline{\text{EINT5}}$	Signal change
44	$\overline{\text{IPL2}}$	$\overline{\text{EINT4}}$	Signal change
92	7M	$\overline{\text{7ME}}$	Name change
96	RESERV7	$\overline{\text{EINT1}}$	Signal change

function chip and some memory would make a complete PC, less peripherals.

The A2088 card has two edge connectors, one PC-compatible connector that plugs into a slot on the PC side of the A2000, and a 100-pin slot for the Amiga bus side. Consequently, you insert the A2088 board into one of the two bridge slots. The PC-side edge connector drives PC bus signals and provides A2088 with access to peripherals plugged into the other PC card slots. The Amiga bus edge connector is the means by which the A2000's 68000 processor accesses the A2088's dual-port RAM. This RAM is designed to be accessible by both the PC and Amiga sides of the machine.

Some additional hardware on the A2088 board deceives the PC side of the A2000 into believing that it is indeed a PC. For example, the PC Multifunction chip expects to be connected to a standard PC keyboard (which communicates through a synchronous serial interface), but the A2000's keyboard is not PC standard, nor is it connected directly to the A2088 board. So the designers of A2088 added a parallel-in/serial-out shift register and some clever software. When a key is pressed on the keyboard, it is translated (on the Amiga side) into its PC keyboard equivalent and this value is loaded into the dual-port RAM. The Amiga side then alerts the A2088 board to the presence of the key value, software on the A2088 board transfers the value from dual-port RAM to the shift register, and the key value is transmitted serially into the PC Multifunction chip looking as though it has just come hot from a keyboard.

Amiga 2088 Card Software

How does the A2088 board coexist with the Amiga? In general, each computer responds when the other sends it an interrupt. Hitting a key on the Amiga sends an interrupt to the A2088. This triggers an interrupt service routine on the A2088 that feeds the board's hardware with a keystroke exactly as if it had been typed into a keyboard on the PC side. When the A2088 draws to either the graphics or monochrome display memory, it sends an interrupt to the Amiga, which then looks at the A2088's video display memory (part of the dual-port RAM) and determines what and how to draw on the Amiga screen.

When you click on the "PC Mono" or "PC Color" icons, these programs run a program called PCWindows. PCWindows opens a screen and a window in which the A2088-generated information will appear. The A2000 sees the 2088 board as a peripheral device and looks for its associated library routines on the default disk. PCWindows (or any other Amiga program) then has access to a collection of routines that allow it to interact with the 2088 card's hardware in a way that is both high-level and unchanging; this allows Commodore to modify the actual Amiga 2088 card's hardware or the library software without affecting existing software.

The PCWindows program starts several Amiga tasks (remember that the Amiga itself is multitasking) that are awakened by the interrupts from the PC as described above. Actually, an interrupt causes the Amiga to send an exec signal to the task. In this way, an Amiga programmer does not have to deal directly with interrupts.

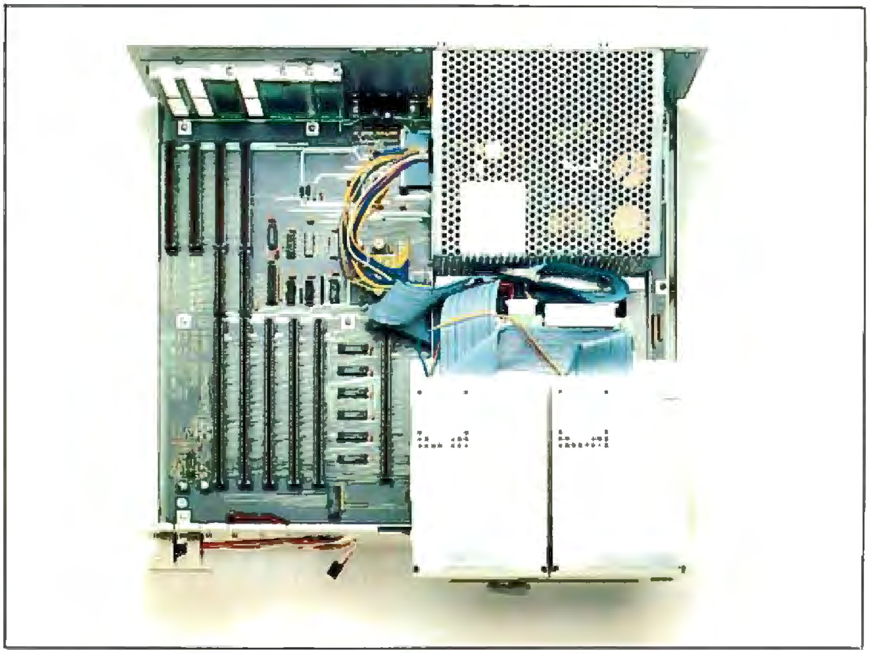

Photo 4: *Inside the A2000. Note the slots in back (top) and the two floppy disk drives in front (lower right). The CPU slot is directly to the left of the disk drives. The five connectors in the bottom left corner are the five Amiga slots. The four connectors in the upper right corner are the four PC slots; two can hold standard IBM PC cards, and two can hold IBM AT cards. The 2088 PC emulator card must go in one of the two slots that have PC and Amiga connectors in common. The video slot is in the upper right corner but is not visible in this photo.*

Dual-Port Memory

The Amiga and the PC sides of the computer need to be able to read from and write to the dual-port memory quickly, yet each machine's architecture presents different needs. For example, the 8088 processor stores a 16-bit quantity in low-byte-first order (i.e., with the least significant byte stored at a lower address), while the 68000 processor in the Amiga stores a word with its high byte first. Also, the PC stores a color pixel as 2 adjacent bits within the same byte of color graphics video memory, while the Amiga stores the 2 bits in separate bytes.

The engineers who designed the Amiga 2088 card came up with an elegant but convoluted solution. On the PC side (with one exception), each word of memory maps to one location. The Amiga side can reference a given chunk of memory in three ways, using three different locations. It uses one address to access a byte of memory, another to access a word of memory, and a third to access 2 bytes of color video memory (see figure 3). In the second case, the 2 bytes of the word are read on the Amiga side in the opposite order of how the PC side sees them.

In the third case, the word of data read by the Amiga side contains the first bit of each of the 8 pixels involved in the first byte and the second bit of the pixels in the second byte (see figure 4). This interleaved access makes the PC's 320 by 200 four-color mode possible. The A2088 card also supports a 640 by 200 one-color mode, but since each pixel is defined by one bit, no such bit manipulation is needed.

In other words, the Amiga and the PC see the same memory differently depending on what memory location the Amiga side uses to access it. By putting these functions in hardware, the Amiga and the PC can run their usual software without having to worry about data conversion or, more importantly, the time it might take to perform such conversions.

continued

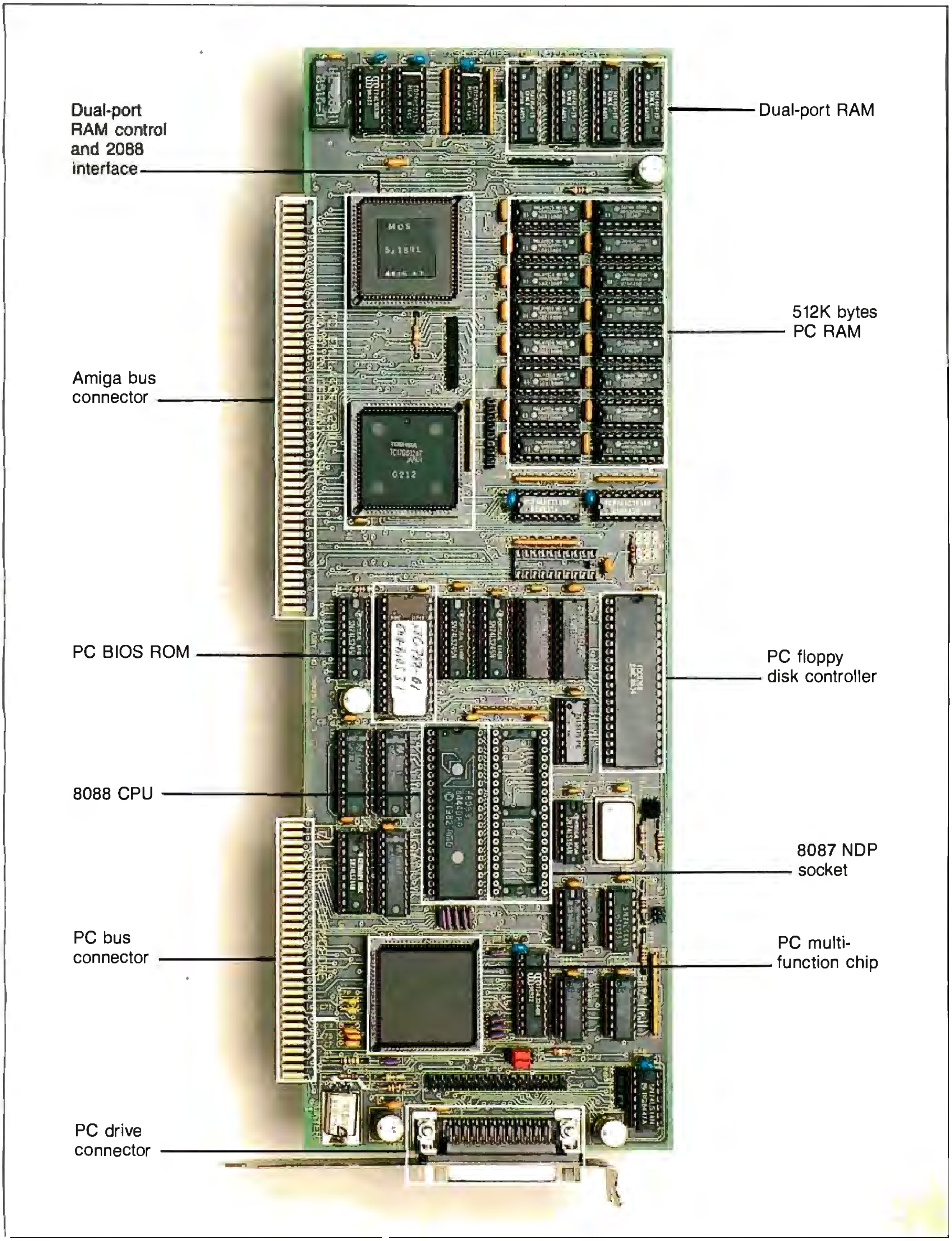

Photo 5: *The A2088 PC emulator board. This board contains the 8088 processor, memory, ROM, and support chips of an IBM PC-compatible computer and correctly uses any PC peripheral cards connected in the PC slots.*

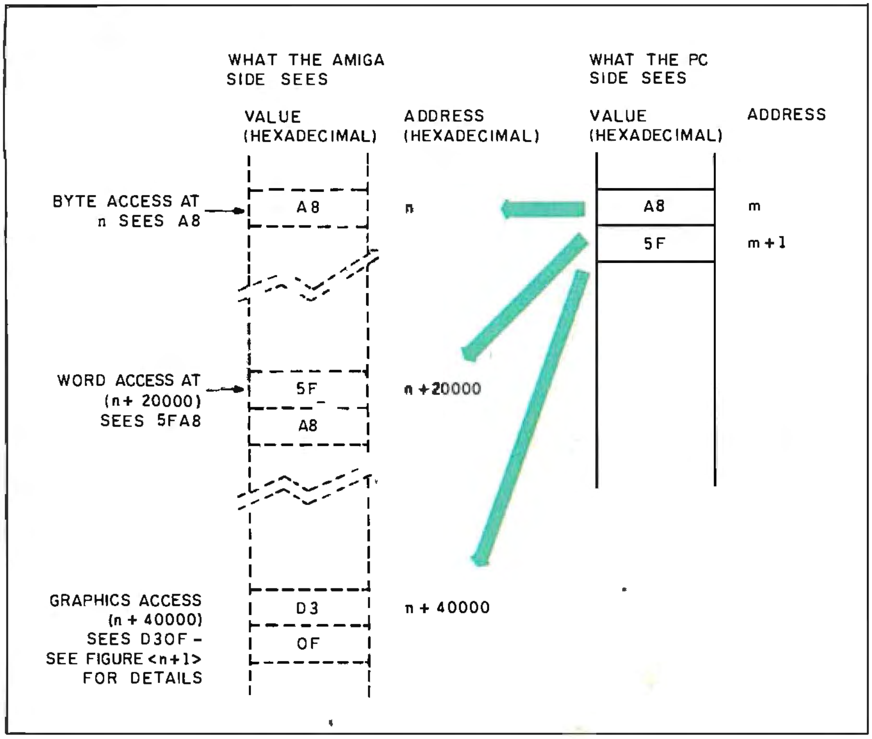

Figure 3: *Three modes of access for the Amiga 2088 board's dual-port RAM. Though each memory location in the dual-port RAM has only one address on the PC-compatible side, it appears at three different locations in the Amiga's address space. The dual-port RAM maps the bits to the Amiga side in a different order based on the location accessed.*

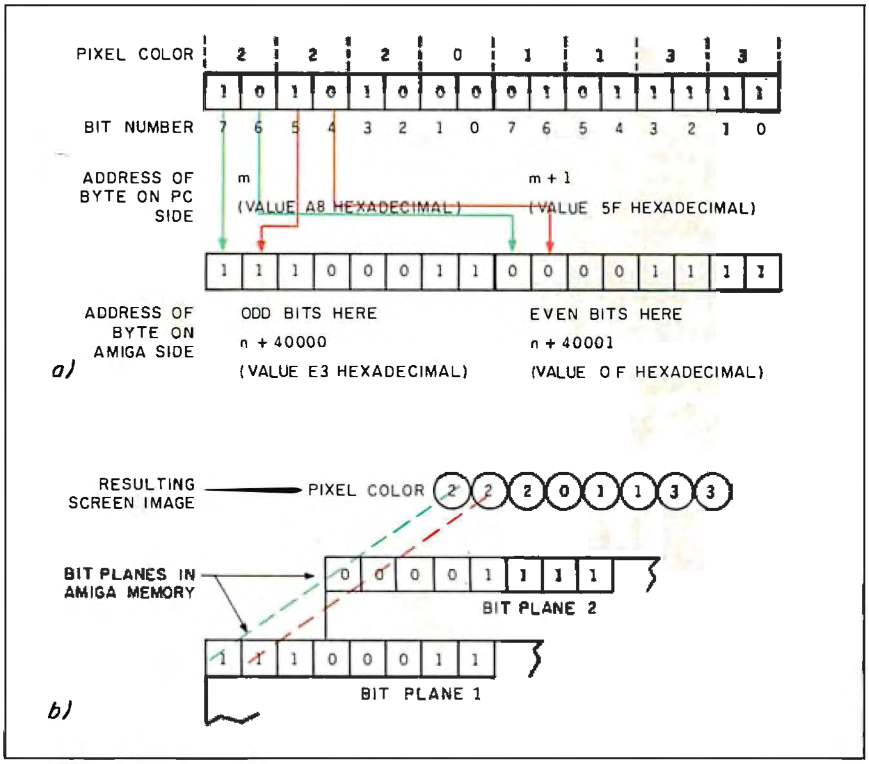

Figure 4: *Graphics access of the dual-port RAM. Two adjacent bits on the PC side make up a pixel, but these bits must be in different bit planes to recreate the same pixel on the Amiga side. Figure 4a shows how 2 bytes on the PC side (top) are mapped into the Amiga side (bottom). Figure 4b shows how the 2 bytes on the Amiga side are placed in different bit planes to recreate the pixel pattern created on the PC side.*

Different portions of the dual-port memory are reserved for specific usage. A 64K-byte area is used as a general-purpose buffer (most often used to transfer disk sectors between the two machines), 32K bytes are used for the PC's color video memory, and 8K bytes are used for its monochrome (character) video memory.

A 16K-byte area is called parameter RAM. This memory serves two functions. First, both computers use one byte of it, called the lock byte, to signal if they are about to reserve part of the general-purpose buffer for their use (which they release as soon as they are finished with it). It is possible that the two independent computers might try to allocate the same memory simultaneously. By checking the lock byte until it has an "unused" value, setting it to a "used" value, allocating memory, then restoring the "unused" value, the two computers can successfully share the dual-port memory.

The parameter RAM's second function is to store blocks of parameters that one computer sets and the other computer reads. For example, when the Amiga wants to transfer a block of data to the PC side, the data is passed through an area of the general-purpose buffer, but the parameter RAM contains information necessary to perform the transfer: the location and length of the data and the desired destination for it on the PC side.

The final 8K-byte area of the dual-port RAM is called the I/O page RAM. On the Amiga side, this memory maps to a certain range of addresses, while on the PC side it corresponds to a standard set of I/O register locations on the PC that are used to control the serial and parallel ports and the PC's monochrome and color CRT controller. In some cases, these locations are the registers. In others, they duplicate the value of the register, and the Amiga can read its value but not change it; in these cases, the dual-port memory is said to *shadow* the register.

PC Video Display

Now that we have an overview of how the Amiga and the A2088 talk to each other, let's look at some specific situations. A monochrome (character-based) or color (character- or graphics-based) video display gets from the A2088 to the Amiga's display as follows. When a program running on the PC side outputs data to the screen, the BIOS screen I/O routines write information into the monochrome or color video memory portion of the dual-port RAM. The act of writing to this memory generates an interrupt from the A2088 to the Amiga. The Amiga recognizes this as a video memory interrupt and "wakes up"

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The reality of the PC world is that no area is always empty in every possible PC configuration.

a task that compares the contents of the dual-port video memory with what currently appears in the active PC window on the Amiga display. This task is *smart*: It knows the current contents of the Amiga display and updates only those portions that have changed. This makes, for example, the addition of one character to the display a pretty quick process, much quicker than updating an entire screen.

If the PC is currently in the monochrome display mode (which, on the PC side, stores the screen as a matrix of ASCII values), then the video display task must convert that character to a rectangular matrix of bits and paint them to the Amiga display. To do this, the Amiga refers to a file called PCFONT.FONT that describes the bit patterns of the IBM monochrome character set (ASCII characters plus additional characters defined by IBM). If the character being drawn has a background color other than the default, the Amiga monochrome video display task has to draw an image into several Amiga display bit planes.

The Case of the Nine-headed Buffer

It turns out there are not three but nine sets of addresses for the 64K-byte general-purpose buffer memory. Three of them come from the need to address the memory in byte, word, and graphics modes. Where do the rest come from?

The answer lies within the structure of the IBM-compatible PC. The first 640K bytes of memory (hexadecimal 00000-9FFFF) are reserved for programs. This means that areas like the video memory, PC BIOS, ROM BASIC (for IBM PCs), and the ROM code associated with certain expansion cards must live in the space between hexadecimal A0000 and FFFFF. In the Amiga 2088 card, the 64K dual-port buffer memory must also reside somewhere in that space.

The reality of the PC-compatible world is that no area is always empty in every possible PC configuration. The 64K areas starting at hexadecimal A0000, D0000, and E0000 are most likely to be free. Therefore, the Amiga 2000 engineers designed the 64K area to map (on the PC side) to one of these three areas so as not to conflict with the hardware and software you will be using with the Amiga 2088 card. (This option can be selected from the Amiga Workbench screen.) Consequently, any byte within this 64K region can map to one of three address ranges on the PC side, and each range can be accessed on the Amiga side from three separate ranges.

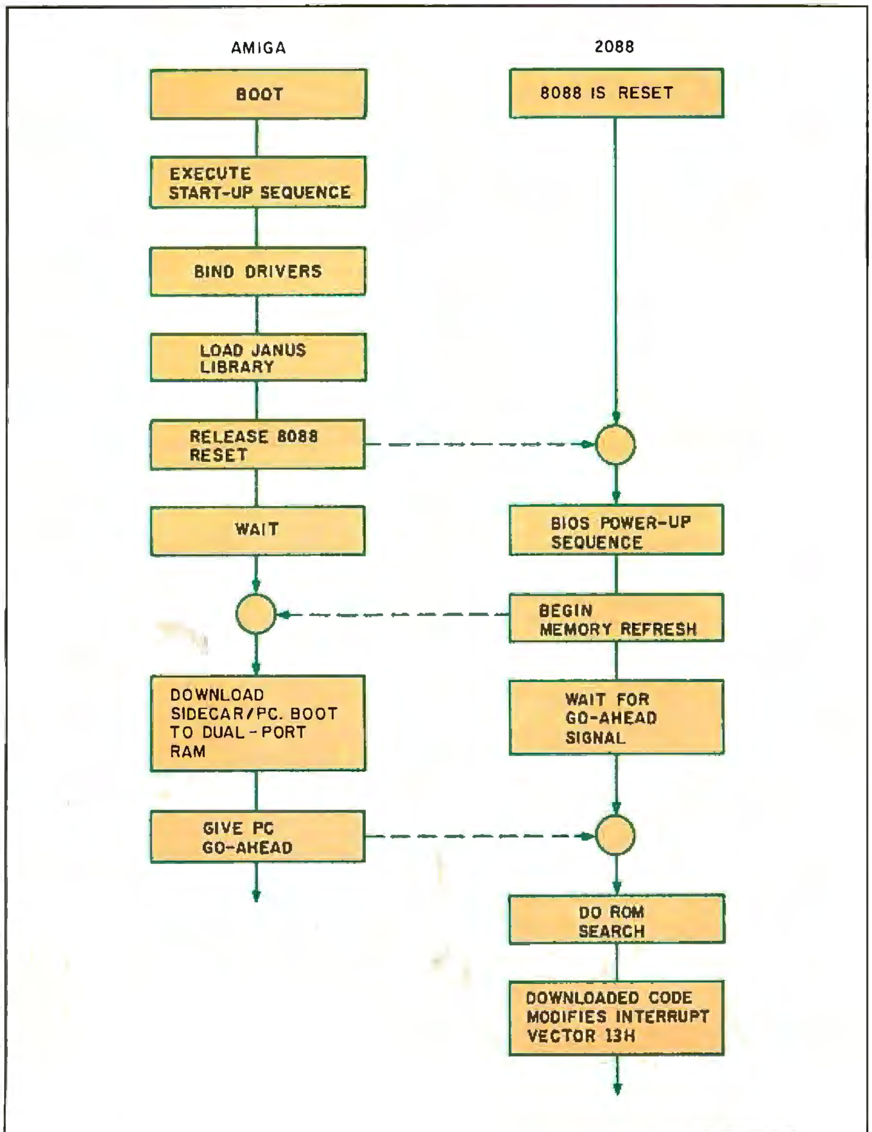

Figure 5: *The sequence of events necessary to boot the A2088 board with the Amiga 2000.*

Accessing a Hard Disk

Commodore has designed the Amiga 2088 board so that the Amiga side of the A2000 can access a partition of a hard disk on the PC side. You run the usual FDISK program on the PC side to allocate part of the hard disk for the PC. Commodore has provided a similar program called ADISK that you run to create an AmigaDOS partition on the hard disk.

On the Amiga side, this partition of the PC hard disk appears as JH0: and can be treated like other Amiga disk (although you cannot use it to boot up the system—you must boot from the floppy disk in DF0:). JH0: has its own device driver that uses the dual-port memory and an interrupt mechanism to get (or put) file sectors to the hard disk.

How do the two sides of the machine establish and coordinate conversation with one another? To answer this with an example, let's suppose you have a PC-compatible hard disk whose controller is plugged into one of the PC slots. We'll follow the processes that take place when you power on the A2000 (refer to figure 5).

When power is applied to the system, the 8088 on the A2088 board is immediately placed in a RESET state. Basically, this keeps the processor from running

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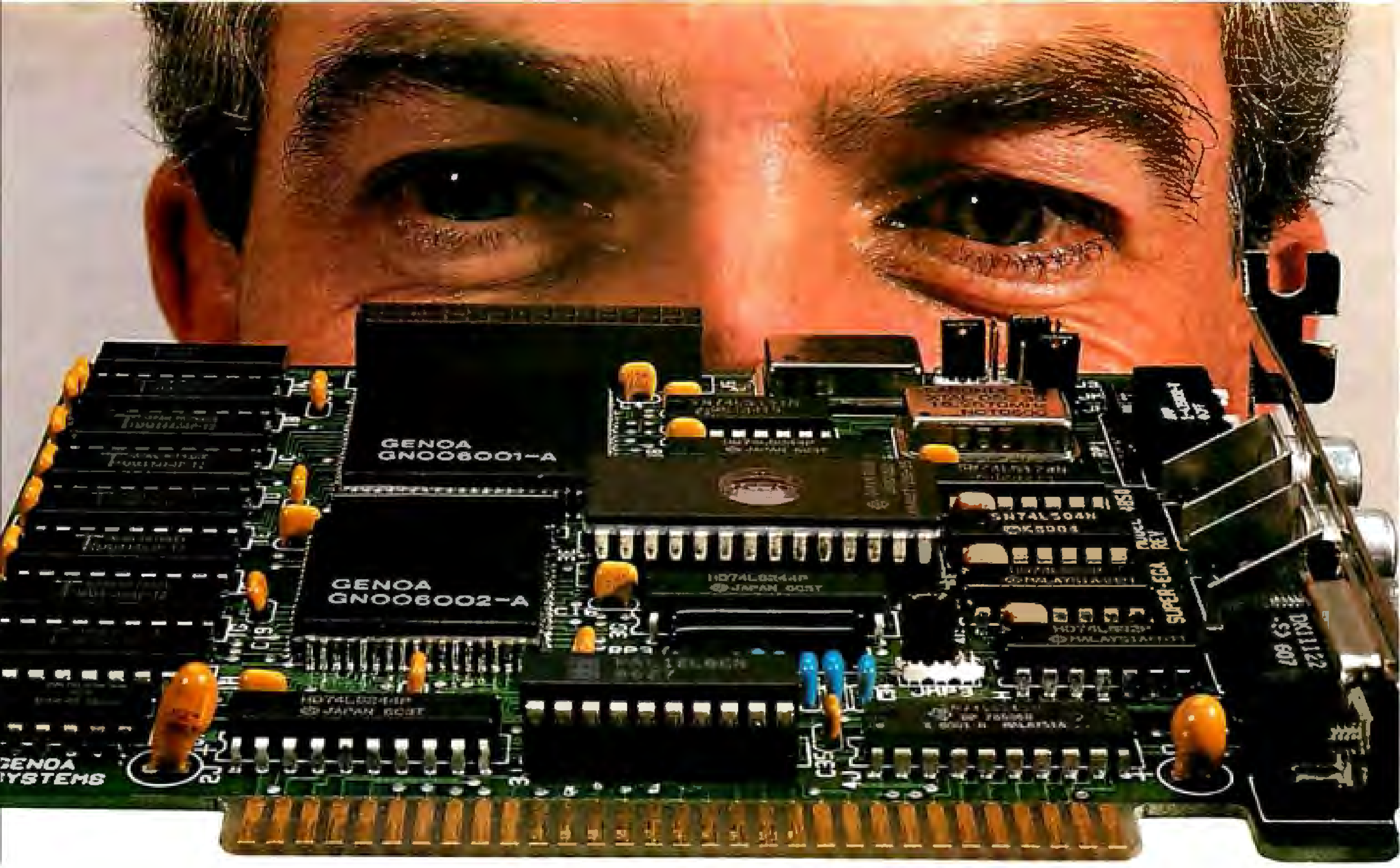

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Version 1.2 Changes

Version 1.2 of Kickstart and Workbench corrects a number of bugs present in version 1.1 and adds improvements to existing features. There are also a number of new AmigaDOS commands. These are covered briefly in the appropriate sections.

Workbench

An Expansion drawer holds drivers and code required to configure and communicate to boards on the Amiga bus. For example, libraries for interfacing to the A2088 board reside in this drawer. This drawer is searched for drivers and initialization code at boot-up.

The tool SetMap allows you to select several different keyboard types, such as German, French, or Spanish.

NTSC and PAL video displays are supported.

Two utility programs for manipulating MS-DOS disks are provided. One program formats disks to the MS-DOS standard, another allows copying data to or from MS-DOS disks.

AmigaDOS

Some new commands:

addbuffers — adds sector cache buffers in memory for a drive, improving disk access time.

binddrivers —binds device drivers in the Expansion drawer to peripheral boards configured on the Amiga bus.

changetaskpri and settaskpri — allows you to change or set the running priority of a CLI task.

mount — mounts a new device. The device's characteristics and unit number are stored in the text file MountList in the devs directory.

path — allows you to specify a search path for AmigaDOS to use when searching for a program.

ROM Kernel

The 68881 math coprocessor is now supported under multitasking. Several new graphics functions have been added: DrawCircle, DrawEllipse, AreaCircle, and AreaEllipse.

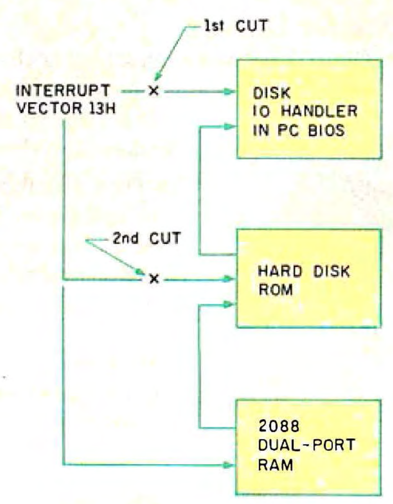

Figure 6: *Modification of the disk controller interrupt vector to support a hard disk drive. This sequence of modifications allows you to use any type of PC hard disk with the A2088 board.*

wild and perhaps doing some damage. Meanwhile, the Amiga side goes through the boot process (including AutoConfig); it executes the start-up sequence, executes a BINDDRIVERS command that loads hardware device drivers into memory and loads the A2088 Library routines. When all this loading is completed, the Amiga releases the 8088 from its RESET condition and enters a loop to await a signal from the 8088.

Released from RESET, the A2088 board's 8088 now begins executing a BIOS power-up routine. This code is, for the most part, standard and includes routines that check the 8088, perform a ROM checksum, initialize DMA channels, set up interrupt vectors, and more. However, Commodore has modified the routines so that when the A2088 has begun memory refresh, it signals the Amiga and then enters a loop to await a "go-ahead."

Once the Amiga has been informed that memory refresh has begun on the PC side, it reads a block of code (called PC.BOOT) from its own disk and loads it into the parameter area of the dual-port RAM (note that this is 8088-executable code). This is the only code that exists in the dual-port RAM, and it is loaded so that it appears to the PC in an address range above the region in which a peripheral board's ROM would appear. The Amiga gives the 8088 the "go-ahead" signal.

Now the A2088 completes the BIOS power-up sequence. As part of this sequence, the 8088 checks for peripheral board ROMs in the address region C8000 to F4000 hexadecimal by scanning that area in 2K-byte increments for a series of 3 signature bytes (hexadecimal 55AA followed by a length-indicator byte). If such a sequence is found, the BIOS transfers control to the address location following the signature bytes, which it assumes to be initialization code for the attached device. In this example, the device is a hard disk controller, and the initialization code takes this opportunity to reroute the INT 13H vector (see figure 6). This vector has been set by the power-up routines to point to the BIOS code that handles floppy disk I/O; the hard disk ROM alters the vector to point to its own routines. In this way, a request for hard disk I/O is intercepted by the ROM; floppy disk I/O requests are identified and passed onto the BIOS handler. The hard disk ROM initialization routine then exits and BIOS continues the scan for peripheral board ROMs.

As the BIOS power-up routine continues searching for peripheral ROMs, it encounters the PC.BOOT code in the dual-port RAM. This code is preceded by the necessary signature bytes so that it

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Because of the complex interaction between the PC and the Amiga, the designers had to make some compromises.

"looks like" a peripheral board ROM. BIOS dutifully passes control to what it thinks is a peripheral initialization routine but which is actually a routine in the PC.BOOT code that reroutes the INT 13H vector again. Now a disk I/O request will be intercepted first by the PC.BOOT code—the Amiga side has "wired" itself into the PC side's disk I/O routines. The BIOS completes its ROM scan and the remainder of the boot process.

From this point on, the Amiga side can make I/O requests to PC disks directly to the ROM routines on the PC hard disk controller card or onto the BIOS for floppy I/O. In this way, the Amiga side can access an AmigaDOS partition on a PC hard disk by going "beneath" whatever DOS happens to be running on the PC side. (If the Amiga side were forced to access a disk on the PC side through, say, PC-DOS, an AmigaDOS partition would be inaccessible—PC-DOS will not recognize a non–PC-DOS partition.) Additionally, the PC.BOOT code performs necessary semaphore functions that prevent simultaneous disk I/O requests from both sides of the machine. Whenever the PC side performs disk I/O, PC.BOOT intercepts the I/O request and sets a flag in the dual-port RAM that tells the Amiga side to hold off on any disk I/O requests of its own.

Limitations of the Amiga 2088 Board

With the Amiga 2088 board containing an actual IBM PC–compatible computer on its board, you can run virtually any IBM- or MS-DOS–compatible program and plug in virtually any expansion card. This approach works so well because it is not an emulation of a PC—it is a PC. Right?

No, not really. Because of the complex interaction between the PC and the Amiga, the A2000 designers had to make some compromises. Your personal preferences will determine how major they are to you. Starting with the small problems and working up:

- The video display won't support flashing characters. This attribute, done in hardware on the PC, would have to be done in software on a continuous basis and would take up a lot of the Amiga's computing power. Since flashing characters aren't widely used, the A2000 designers left them out.
- The Amiga will display only monochrome PC video, 320 by 200 four-color graphics, and 640 by 200 two-color graphics. However, you can disable the Amiga-produced screen and get any kind of video you want (Hercules, EGA, PGA, or whatever) by plugging a video card into a PC slot and feeding its output to an appropriate monitor.
- IBM-compatible PCs can make only simple tones and beeps through a speaker in the body of the computer, while the Amiga can make complex sounds through a separate audio output or the sound channel of a television. Because the Amiga 2000 is multitasking, its designers could find no good way to integrate the PC audio into the Amiga's sound channels. Commodore reports that the A2088's and Amiga's sound signals can be mixed and routed to the Amiga monitor's speaker.
- While a PC program is in use, the Amiga mouse and cursor belong to the Amiga, not to the PC, so PC applications that use a mouse won't work. Commodore plans to implement this feature eventually by having the mouse emulate a Microsoft mouse.
- The PC can be given control of the Amiga's parallel port by running a program called LPT1:. This maps the parallel port to the LPT1: printer device on the PC side and prevents the Amiga from using it at all. The PC will not be able to use the Amiga's serial port when it is first released, but Commodore says it's working on similarly enabling that connection sometime in the future.
- One of the most serious flaws of the 2088 card/Amiga duo is its inexact display of the PC's video on the Amiga's screen. Remember that as the PC writes to its video memory, the Amiga must update the PC window (on the Amiga's display) to correspond with the visual interpretation of the contents of the PC's video memory. Unfortunately, even the Amiga can't keep up with that process instantaneously and this causes some noticeable effects. For example, since the Amiga must draw the characters displayed in a text window, scrolling the entire screen often causes the display to jump several lines at a time. Also, some graphics programs that use animation work (Microsoft's Flight Simulator, for example), but others don't (ExecuVision).

The A2000 designers have done what they could to improve this situation. If you are having update problems with the PC color display, you can decrease the number of bit planes the Amiga has to draw into, thus reducing the number of colors that can be shown but also decreasing the amount of time the Amiga spends to update the screen once.
- We saw only rudimentary cut and paste functions for the transfer of text (not graphic) data between a PC window and the Amiga's Notepad. For example, you can type DIR in the Notepad, copy it into the Clipboard, and then use an EDIT menu to paste the directory command into the PC window. Conversely, you can select text in the PC window by dragging the mouse over the selected region (the copy to the Clipboard is automatic) and pasting it into the Notepad. The degree to which the transfer of data between the two machines is implemented could determine the ultimate success of the Amiga 2000.

Pricing

At the time of this writing, Commodore has set only preliminary suggested retail prices for the A2000 and related products (see the text box "A2000 Peripherals"). The A2000 with 1 megabyte of memory and one 3½-inch floppy drive is set at $1499; the A2088 IBM PC–compatible board, $499; internal 3½-inch or 5¼-inch floppy drives, $199; external 3½-inch or 5¼-inch floppy drives, $299; 2-megabyte expansion memory card, $499; composite video interface card, $99; hard disk controller supporting ST506 and SCSI hard disks, $349; standard analog RGB monitor, $349; long-persistence phosphor analog RGB monitor, $499.

The under-$1500 price for the A2000 is fairly competitive. This makes an A2000 with a high-quality RGB color monitor cost around $2000, which is slightly less than the $2199 price of an Apple Macintosh Plus (not counting the inevitable discounting more likely to be available on the older Macintosh Plus line).

Potential buyers of the A2088 board should note that the hidden cost of a 5¼-inch floppy drive brings the price of a usable IBM PC–compatible computer to between $700 and $800.

Caveats

We wrote this product preview in December 1986, after two meetings with Commodore engineers and several follow-up calls; there was very little documentation because the A2000 and the Amiga 2088 board were so recently finished. We had access to two machines for little over a week. One had an Amiga 2088 board with a 10-megabyte Hardcard shared by the Amiga and the PC, an IBM multifunction board, and 512K bytes of memory; the other had a 5¼-inch, 20-megabyte hard disk connected through the SCSI port of the Amiga 2094 Hard Disk/SCSI controller board and an Amiga 2050 2-megabyte memory board. Both had 512K bytes

A2000 Peripherals

Commodore will release the following peripheral boards with the Amiga 2000.

Hard Disk Controller

The 2094 Hard Disk/SCSI (HD/SCSI) controller board is a full-size Amiga card that plugs into one of the Amiga bus slots and allows access to the two most popular hard disk interfaces: ST-506 and SCSI (small computer system interface). To date, most hard disks available for microcomputers are equipped to connect via the ST-506 standard interface. However, more and more SCSI-compatible hard disks are emerging, and indications are that this interface will ultimately replace the ST-506 standard due to SCSI's faster transfer rate and flexibility. The HD/SCSI board can control up to two ST-506-compatible drives and up to seven SCSI drives in any combination.

The ST-506 portion of the board is built around a custom LSI chip called the DJC (manufactured by the Konan Corporation) that performs most of the control functions (data serialization, error correction, etc.). The data-transfer rate on the ST-506 side of the board is on the order of 5 megabits per second. On the SCSI side, the HD/SCSI board uses a Western Digital 33C93 SCSI controller chip. This chip incorporates some intelligence, so that SCSI commands can be issued quickly and succinctly. Up to 128K bytes at a time can be read to or written from a hard disk. The board's data-transfer rate on the SCSI side is around 10 megabits per second.

An on-board Z80A processor running at 4 MHz can operate both the ST-506 and SCSI sides of the board. (The Amiga's 68000 can issue commands directly to the 33C93 chip. When we saw the board running an SCSI drive, it was with the 68000 managing the SCSI channel.) The Z80 is provided with a 2K by 8 on-board RAM into which the 68000 can download commands so that the Z80 can perform a series of hard disk functions in a true coprocessing fashion. Throughput is further enhanced by a proprietary DMA controller chip with a built-in 64-byte FIFO memory. Using this chip, you can transfer data from disk to memory at full speed (depending on which interface your disk is connected to) while consuming only 16 percent of the Amiga bus's time. This suggests some interesting possibilities, since you could download an entire screen's data from a hard disk directly to video memory at the rate of approximately 800 ns per byte.

The HD/SCSI board provides not only an SCSI 50-pin connector, but also a Macintosh Plus–compatible DB-25 connector. This addition is good planning; you can immediately draw from the growing number of Mac Plus SCSI drives that appear to be getting less expensive by the week.

Memory Boards

Commodore will release three memory boards with the A2000. The boards fall into two general classes: One plugs into the 86-pin CPU slot and two plug into Amiga bus slots. The former will be shipped with early versions of the A2000 and will be populated with 512K bytes, bringing the total memory of the machine as shipped to 1 megabyte. (Commodore intends to ultimately provide 1 megabyte directly on the A2000 motherboard, so that later A2000s will not come with this board installed. Since the stated purpose of the 86-pin CPU slot is to allow for the installation of an alternate CPU—a 68020, perhaps—purchasers of early A2000s may find themselves unable to make use of any future coprocessor boards unless they give up some memory.)

The other two memory boards plug into an Amiga bus slot. One board can be populated with up to 2 megabytes of RAM in increments of 512K bytes, 1 megabyte, or 2 megabytes; the other can accept up to 8 megabytes (Commodore had not yet determined what partial amounts the board could be configured to accept). These boards are based on the same design; the engineer who had developed them told us that once he had built a working version of the 2-megabyte board, it took him only a matter of weeks to produce an 8-megabyte board. Both boards perform memory refresh during cycles when the processor is off the bus, so that memory refresh is invisible.

You may be asking yourself what advantage the 2-megabyte board has over the 8-megabyte board, particularly if the latter is available in partially populated form. The advantage is simply cost: The 2-megabyte card is a single-layer circuit board, while the 8-megabyte card is a double-layer circuit board. Additionally, the 2-megabyte board can accept the less expensive 256K-bit DRAM chips as well as 1-megabit DRAM chips; the 8-megabyte board can only accept 1-megabit DRAM chips.

All three memory boards sit on the fast RAM side of the A2000 where there is no contention between the 68000 and the graphics processors. The 2-megabyte and 8-megabyte boards support the AutoConfig feature and, although the 1-megabyte board does not, the system is able to recognize its presence. None of the memory boards support write protection, an extremely desirable feature if you plan to use the memory for a RAM disk. (We mentioned this to the boards' designer; he told us that he thought he could add write protection to the 8-megabyte board by reprogramming a PAL, and that he would consider adding the capability.)

of memory on the motherboard but lacked the extra 512K that will ship in the CPU slot of the A2000. The computers, according to Commodore, were off the "first production run" and had no wires on any of the circuit boards. The Amiga 2088 board ran MS-DOS 2.11, but Commodore said the board would ship with MS-DOS 3.2. The A2088 board didn't have an 8087 coprocessor installed, so we cannot comment on its performance. The Amiga software was pretty stable but might still undergo some small changes.

Observations

The computer we looked at was still unfinished, so this product preview is not the place for us to run benchmark programs and, in general, critique its strengths and weaknesses. Still, we feel the comments below are in order, largely because the units we saw were much more "stable" than most of the other computers we preview.

Overall, the A2000 with the optional A2088 card delivers a second-computer-in-a-box better than most of the previous attempts to do so in this industry. Stan Wszola, a BYTE editor who regularly uses

continued

Though the interaction between the Amiga and the PC is minimal, there are opportunities for someone to write a hybrid program.

an IBM PC compatible, said the A2000 ran and looked like a normal PC. We ran one benchmark, the Sieve of Eratosthenes, and found that the Amiga ran it within one second of the time recorded for a "plain vanilla" IBM PC.

One fascinating implication of using the Amiga to display the PC monochrome and video screens is that the colors used in the screen can be chosen from the Amiga's palette of 4096 colors. This makes working with PC software—especially programs that use graphics—a lot easier on the eye. When a PC screen is in an Amiga window, you can scroll both vertically and horizontally to see any portion of it (see photo 6). Alternately, you can double-click on the window and get a full 25-line by 80-character display with no window border. If you set your colors right, you don't even know you're on an Amiga! On the other hand, the system with the A2088 board installed takes between 1½ and 2 minutes to boot even if you aren't going to use the PC capabilities.

Though the normal interaction between the Amiga and the PC is minimal, there are some real opportunities for someone to write a hybrid program that uses both the 8088 in the PC (perhaps augmented by an 8087 numeric coprocessor) and the 68000 in the Amiga to achieve performance that is beyond either of the two machines alone.

Amiga's use of Kickstart 1.2 in ROM speeds up the A2000's loading, but it presents problems to some prospective customers. There is no way the A2000 can load Kickstart 1.1 into memory, and we found several programs that wouldn't run correctly in the A2000. In general, games were less likely to run than "serious" applications, and (this comes as no surprise) older programs were less likely to run than ones released more recently. This is a problem that should eventually go away as more new products come out using Kickstart 1.2 and older ones are (perhaps) upgraded.

Clive Smith, general manager of the Commodore Product and Market Development Group, indicated that the 2088 was just the beginning of the A2000's extension into coprocessing. "Commodore has provided for integrating 80286 processors and coprocessors into the Amiga environment," Mr. Smith said. "Commodore is currently developing its own A2286 card and support software, which will bring [IBM PC] AT-level coprocessing to the Amiga environment. The next multiprocessor/multiDOS environment which Commodore is implementing for the A2000 is a 68020-based version of UNIX 5.2 [UNIX System V, version 2] that uses a proprietary MMU [memory management unit] currently under development and evaluation, which will be manufactured by the company's MOS Technology division."

Photo 6: *Running IBM PC software on the A2000. Here, the Amiga's desktop screen has been "pulled down" to reveal the PC color display screen. You can see Microsoft's Flight Simulator program running in the PC screen.*

Conclusions

Who will buy this machine? Certainly people who want an 8-megabyte Amiga with one or more hard disks will. Although the original Amiga, the A1000, can be expanded, that task was taken on by small companies that work in low volumes and so must charge higher-than-average (when compared with the IBM or Macintosh worlds) prices. Commodore never produced a card cage for the A1000 and will eventually discontinue the machine (no specific date has been set, though, and Commodore pledges to continue supporting the A1000).

The A2000's expandability and its IBM PC compatibility make the computer a valid possibility for business and scientific users. The ability to expand the machine's memory and disk storage within a reasonably sized box is an unobtrusive but important change from the A1000. Some users will be attracted to the multiprocessing of a machine that can run 8088 and 68000 software in parallel, with the possibility of the same computer someday running, say, an Intel 80286 processor with a Motorola 68020 processor and assorted numeric coprocessors on both sides.

Professionals (especially scientists, engineers, and artists) who are already attracted to the Amiga's graphics or other features will now be able to buy a machine with the memory and disk storage they need. Other users who are attracted by the Amiga but who work in offices that use IBM PCs can now "safely" buy an office computer that has both Amiga and IBM capabilities. These same people may now be interested in buying an Amiga for home use, knowing that they can also use it to do PC-related work brought home from the office.

Software for the Amiga family of computers has grown to quite a respectable level in the year and a half since the A1000's release. Now that Commodore has introduced a machine that has elbow room inside it for more system resources and for entirely new hardware products, we can expect similar growth in Amiga hardware in the year to come. This development can only help the fortune of this most capable and exciting line of microcomputers. ■

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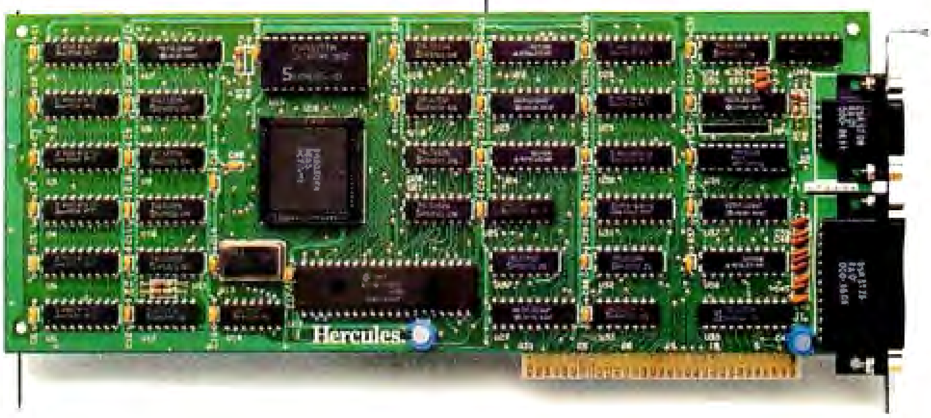

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George A. Stewart

Turbo BASIC

Borland's version offers 8087 compatibility, fast and versatile compilation, recursion, and it's BASICA-compatible

Turbo BASIC is Borland International's answer to Microsoft BASIC. With minor exceptions the integrated editor, compiler, and linker can use source code written for the QuickBASIC 2.0 compiler and the BASICA and GW-BASIC interpreters. The language also offers certain structured programming constructs not available in any version of Microsoft BASIC. But these aren't the features that could upstage Microsoft.

Most important, Turbo BASIC implements the IEEE standard for numeric data storage and operations. As a result, Turbo BASIC programs are able to use the Intel 8087 (or 80x87 family) numeric coprocessor when that chip is installed in the host computer, gaining a tremendous speed advantage in number-crunching applications. (When no 8087 is available, the program automatically emulates an 8087 via software.) Meanwhile, Microsoft continues to use its nonstandard system for numeric data, thwarting compatibility with the 8087 and limiting the arithmetic precision and range available in Microsoft BASIC.

Turbo BASIC has other features that will probably be welcomed by software developers. Conditional compilation, for instance, lets a single source program produce different executable versions depending on the state of compiler variables; the static arrays in an accounting package might be configured differently, say, for use in California and Arizona.

Like Turbo Pascal, which put Borland on the map with Pascal programmers, Turbo BASIC creates stand-alone programs that require no run-time library or other support files. A programmer can sell these .EXE programs without paying any royalties or licensing fees to Borland. The announced price of Turbo BASIC is just $99.95—again mimicking the low-cost appeal of Turbo Pascal.

As of mid-January, Borland expected to begin shipping the IBM PC-compatible version of Turbo BASIC in the first quarter of 1987. (No other versions have been announced to date.) This article is based on a preliminary version of the product.

User Interface

Turbo BASIC is a combined program editor, compiler, and run-time system. The functions are integrated via a windowing system with pull-down menus used to select different operations (see photos 1 and 2). Unlike QuickBASIC, Turbo BASIC does not include support for the mouse as a cursor-control device.

At the command level of Turbo BASIC, four windows are defined: "Edit" lets you edit a BASIC source program. "Run" is the output window for text and graphics created by your program. "Message" presents system-generated information about the compilation progress and the size of your compiled program. "Trace" (when enabled) displays the line number or label of the statement or procedure currently being executed. At any given time, only one of the windows is active; the active window can be moved, resized, and closed. Any window can also be zoomed to full-screen size by pressing the F5 function key.

Pressing F1 calls up a context-sensitive help screen; however, this feature was not implemented in the prerelease version I tested.

The top line of the display lists eight menus: Files, Edit, Run, Compile, Options, Debug, Window, and Setup.

The Files menu includes options for loading and saving a source file to and from disk, starting a new source file, exiting from Turbo BASIC, and so on. Turbo BASIC's windowing system is particularly handy when you want to load or save a file or change directories; Turbo BASIC presents a directory window in which you can move the cursor around to specify the desired file or path. Subdirectories and root directories are also shown in these windows, enabling you to move throughout the entire directory structure of a disk. File selection in QuickBASIC 2.0 is similar.

The Files menu also lists a "shell" option to let you transfer control to DOS, enter commands there, and return to Turbo BASIC manually by typing the DOS command EXIT. QuickBASIC 2.0 also supports a shell feature.

The Edit, Run, Compile, and Debug menus perform the indicated operations on the currently loaded source file. I will discuss these in detail later on.

The Options menu controls the operation of the compiler in several ways. For instance, the "Compile to" setting determines whether the compiler outputs its code to memory (the usual case during program development), to an .EXE file (to create a stand-alone application), or to a "chain" file that can be executed only via a CHAIN command in an .EXE file. The chain file capability allows you to have applications that are larger than a computer's available memory; only portions of a program are resident at any given time.

Other check-off items on the Options menu are support for the 8087; the ability to stop a program with Ctrl-Break; and run-time checking of array references, numeric overflow, and stack overflow. The 8087 setting determines whether the com-

continued

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Turbo BASIC incorporates the needed run-time routines into your executable file automatically.

piler generates in-line 8087 code unconditionally or generates self-modifying code that will access the 8087 or emulate it depending on whether the run-time host has the coprocessor installed.

Turbo BASIC provides a COMMAND$ function that retrieves parameters from the command string used to invoke a program. The Options menu enables you to test how well a program uses this feature without having to execute the program from the DOS command line. A "Parameter line" option lets you specify the text that would normally be typed on the command line. When you run a program that uses COMMAND$, the specified text will be returned.

The Options menu also gives you control over the size of the run-time stack, music buffer, sound buffer, and communications buffers (COM1 and COM2).

The Window menu lets you open and close windows, switch between them, and arrange them automatically in one of two ways: tiled or stacked.

The Setup menu lets you customize features of the Turbo BASIC user interface. You can control the appearance of text within pull-down menus, windows, and system boxes; control how selected text in any of these is highlighted; and specify a default path to be used for $INCLUDE files (explained below), .EXE files, and Turbo BASIC files. Other Setup options let you select a "CGA snow check" to improve performance on color screens driven by the IBM color graphics adapter, and specify automatic saves of edited source files before they are run.

The Setup menu also lets you load a previously defined configuration file or save the current configuration so it can be loaded automatically or manually each time you start Turbo BASIC.

Overall, Turbo BASIC's user interface is easy to master and quite versatile.

Edit/Compile/Run/Debug Sequence

The typical procedure for running a program in Turbo BASIC is as follows. Load a source program using the Files menu or type a new one into the Edit window. Type C to compile the program. The Compile window shows the status of the compilation and, when compilation is complete, gives the size and segmentation of the executable program in terms of code, data, and stack areas. You now press R to run the program. If you type R without first compiling the program, Turbo BASIC compiles and runs it in a single step. You will probably want to zoom the run window to full screen while your program is running.

Veterans of Microsoft's original BASIC compiler, BASCOM, and users of QuickBASIC may be looking at this point for some reference to the linking of .OBJ files. Turbo BASIC doesn't use .OBJ files. Instead of producing relocatable object modules that the user links manually to produce an executable file, Turbo BASIC goes directly to the executable code.

In QuickBASIC, the link step can be performed automatically if you specify it, but the resulting .EXE file is not stand-alone. It will run only in the presence of Microsoft's run-time package BRUN 20.EXE. To get a true stand-alone program from QuickBASIC, you must do the compile and link steps familiar to BASCOM users.

The advantage of the Turbo BASIC approach is simplicity. There is never any need to link a main program to a run-time library because Turbo BASIC incorporates the needed run-time routines into the .EXE file automatically. The apparent disadvantage is that commonly used sections of code must be compiled with each source program that references them. In a system with separately compiled object modules, these library routines can be compiled one time and then linked to the various main programs that refer to them.

However, Borland programmers maintain that Turbo BASIC will process source code so much faster than older-generation BASIC compilers—thousands of lines per minute as opposed to hundreds—that the time penalty for recompiling these oft-used routines is negligible. In fact, Borland predicts that version 1 of Turbo BASIC will turn source code into executable code much faster than QuickBASIC can compile and link the same source code to produce an executable program. This contention was borne out in our tests of the prerelease version of Turbo BASIC. Turbo BASIC's compile-to-.EXE file time was one-fourth the time QuickBASIC took to compile and link the same file. (See the performance chart on pages 104–105 for our test results.)

Another possible objection to Turbo BASIC's inclusion of run times in every .EXE file concerns disk space. When several applications can share the same run-time library, each application can be smaller. But when each application includes its own run-time library, a lot of identical code gets duplicated.

Borland programmers respond that most commercial applications are distributed alone on a disk, making moot the question of run-time library duplication. And for applications too large to fit in memory at once, Turbo BASIC allows the creation of chain programs that do not include run-time libraries; instead, when a main program passes control to the chain program, the run-time library of the main program stays resident. (Creating a chain file is one of the compiler options on the Options menu.)

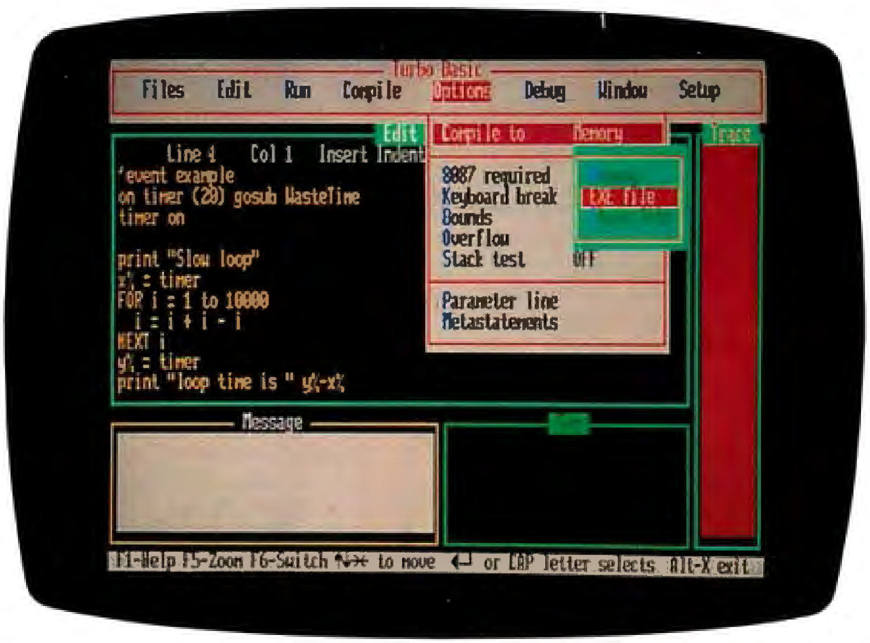

Photo 1: *Turbo BASIC screen showing pull-down menus and the four windows.*

Advanced programmers who work with many languages may have another objection to the absence of support for separately compiled relocatable object modules. Not having a way to link separately compiled object files limits your ability to use relocatable code from other sources such as assemblers and other languages. With Microsoft BASIC, you can incorporate an assembly-language object module into a program through linking—providing, of course, that you handle parameter passing and other interfacing matters properly. To accomplish the same thing in Turbo BASIC, the assembler code must be in opcode form and be fully relocatable. Under that condition, you can incorporate it into your program via the $INLINE compiler directive. QuickBASIC's method of linking to an assembler (or Pascal, FORTRAN, etc.) object module is more versatile though sometimes less convenient.

Debugging

If an error is detected during compilation, the Edit window is activated and the cursor is positioned at the point of the error. (QuickBASIC continues the compilation, remembering up to 25 errors.) If an error occurs while the program is running, Turbo BASIC activates the Edit window and points out the error location and error type. Of course, this is possible only while you are using the Turbo BASIC environment. If an error occurs while you are running an .EXE program, all you will get is the error number and the program counter value. To use this information, you start Turbo BASIC, load the main program, select a Debug option called "Runtime error," and enter the program counter value. The compiler will then recompile your source code, stopping when it reaches the point in the source code corresponding to the program counter value. It's an ingenious answer to one of the traditional disadvantages of compilers as compared to interpreters—debugging is slow and tedious.

Another Debug option is the Trace function, familiar to Microsoft BASIC users. When activated, the function displays in the Trace window the source program line numbers and labels (including functions and procedures). In Trace mode, Turbo BASIC lets you single-step a program or execute lines continuously as they are encountered. QuickBASIC's debugging environment offers Trace and an animated mode for monitoring program execution closely.

The Editor

Turbo BASIC's editor is very similar to the one used in Turbo Pascal and closely resembles the WordStar word processor. It is screen-oriented rather than line-oriented and has many more features than the typical program editor.

Single-key sequences give you cursor motion by character, word, line, and screen page, as well as delete character, word, and line, and insert line. Two-key sequences give you top of file, bottom of file, top of window, bottom of window, page up, page down, and start of block, end of block. Other block commands are mark block beginning and end, mark word, copy block, delete block, read block from disk, write block to disk, and hide or display block. Other key sequences allow global search and replace, search for the *n*th occurrence, set and find place marker, save to disk and exit, and exit without saving text to disk. Turbo BASIC's editor allows you to embed control characters in a program (typically and advisedly inside quotes as a literal) by pressing Ctrl-P followed by the character.

Many programmers use indentation to make a program's structure obvious. Turbo BASIC's editor has an auto-indent feature to facilitate entering programs in this manner; after pressing Return, the next line is automatically indented to match the indentation of the previous one. At the end of an indented block, you backspace to delete the unwanted tabs. The feature can be turned on or off with a two-key sequence.

Word processing is an essential part of serious programming, and Turbo BASIC has an editor that is up to the task.

Turbo BASIC's editor is very similar to the one used in Turbo Pascal and closely resembles WordStar.

Handling Large Source Files

The Turbo BASIC editor is limited to 64K-byte text files. The way around this problem is to use $INCLUDE statements in your main program. Each $INCLUDE statement tells the compiler to read in the referenced source code module.

If your program generates an error during compilation or execution, Turbo BASIC will load the error-causing module and activate the Edit window with the cursor on the point of the error. $INCLUDE files can themselves contain $INCLUDE statements (up to six levels deep).

Turbo BASIC does not have an option for generating a compiler listing file. Listing files are invaluable in debugging and optimizing programs. They also enable you quickly and reliably to relate the program counter values given in an error message to the source code that generated the executable program. Compiler listings also give you an inside view of how smart a compiler is, and they bring to light techniques a compiler uses. QuickBASIC 2.0 doesn't give listings files, either.

The Language

Being BASICA-compatible largely defines the language features of Turbo BASIC.

continued

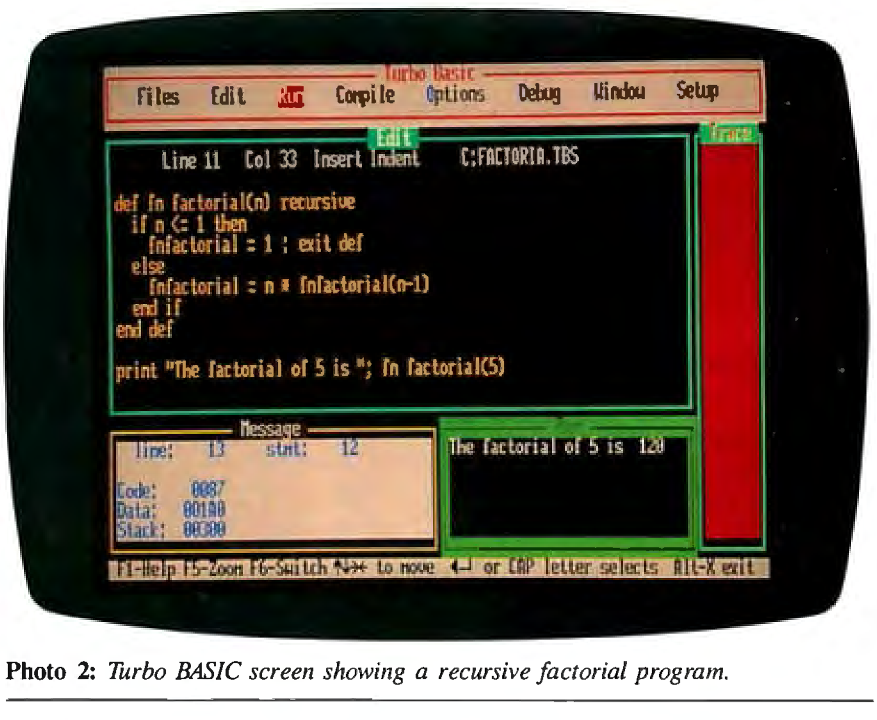

Photo 2: *Turbo BASIC screen showing a recursive factorial program.*

Turbo BASIC (Prerelease Version) vs. QuickBASIC 2.0

COMPILER PERFORMANCE (PARANOIA.BAS)

These tests were done using a 669-line source program called PARANOIA.BAS, which includes extensive arithmetic and flow-control statements, but little in the way of graphics commands. The program was created as a floating-point benchmark. For further details, see "Paranoia: A Floating-Point Benchmark" by Richard Karpinski, February 1985, page 223. All times are in seconds.

Compile and Link in Memory

Compiler	Time	Comments
Turbo BASIC 0.69f	42	8087 off, keyboard break enabled, bounds checking on, overflow checking on, stack overflow checking on.
QuickBASIC 2.0	72	Debug on, ON ERROR enabled, RESUME enabled, optimized for speed.

Compile and Link to an .EXE file

Compiler	Time	.EXE file size	Comments
Turbo BASIC 0.69f	47	96,808	8087 off, keyboard break enabled, bounds checking on, overflow checking on, stack overflow checking on.
QuickBASIC 2.0	100 (compile) + 88 (link) = 188 total	101,704	QB parameters /d/e/o/x/q (debug on, ON ERROR and RESUME enabled, create stand-alone .EXE file, optimized for speed.)

RUN-TIME PERFORMANCE

These tests were run using standard benchmark tests combined by Borland into a single program. The original source program compiled and ran without modification under Turbo BASIC 0.69f and QuickBASIC 2.0. The host compiler was an IBM PC with 512K bytes of RAM and a 4.77-MHz 8088 processor. Turbo BASIC was also benchmarked on a 4.77-MHz IBM PC with 512K bytes of RAM and an 8087 numeric coprocessor. QuickBASIC programs were compiled using /o/q options (create stand-alone .EXE files, optimize for speed, no error checking, no keyboard break checking). Turbo BASIC programs were compiled with no error checking and no keyboard break checking. All times are in seconds.

Graphics (Screen Mode 1, CGA, 320 by 200 Pixels)

Run-time program creator	Draw 500 circles	Draw 320 lines	Draw 500 boxes	320 vertical lines	200 horizontal lines	Fill 200 circles	Fill 200 boxes
Turbo BASIC 0.69f with 8087	43.0	4.9	4.5	4.5	0.3	69.6	3.2
Turbo BASIC 0.69f without 8087	44.4	7.4	7.1	6.2	1.3	71.4	4.3
QuickBASIC 2.0	53.4	5.7	5.2	4.8	0.4	93.5	3.1

Math (Add, Subtract, Divide, 10,000 Times; Multiply 20,000 Times)

Run-time program creator	Integer math	Floating-point single-precision	Floating-point double-precision	Mixed-mode floating-point	Calculate 720 sines and cosines
Turbo BASIC 0.69f with 8087	1.5	3.6	3.8	2.2	0.9
Turbo BASIC 0.69f without 8087	1.5	83.6	86.5	54.9	18.5
QuickBASIC 2.0	1.5	17.4	28.1	23.3	4.8

Loops

Run-time program creator	FOR/NEXT, floating-point counter	FOR/NEXT, integer counter	WHILE/WEND, floating-point test variable	WHILE/WEND, integer test variable
Turbo BASIC 0.69f with 8087	21.8	0.2	21.0	0.3
Turbo BASIC 0.69f without 8087	319.9	0.2	312.3	0.4
QuickBASIC 2.0	43.8	0.2	44.2	0.3

Empty Function and Procedure Calls

Run-time program creator	Integer function, parameters	Integer function, four parameters	Floating-point function, no parameters	Floating-point function, four parameters	Procedure, no parameters	Procedure, four parameters
Turbo BASIC 0.69f with 8087	3.5	4.7	5.1	6.1	1.0	1.7
Turbo BASIC 0.69f without 8087	3.5	4.7	20.1	21.8	0.9	1.7
QuickBASIC 2.0	3.7	4.6	5.6	6.4	4.6	5.0

Savage Benchmark (Accuracy Test)

Run-time program creator	Double precision Time	Double precision Result	Double precision Error	Single precision Time	Single precision Result	Single precision Error
Turbo BASIC 0.69f with 8087	4.7	2500.000000000005	5.0×10^{-12}	4.6	2500.0	0.0
Turbo BASIC 0.69f without 8087	NA	NA	NA	NA	NA	NA
QuickBASIC 2.0	175.3	2499.999999941009	5.899×10^{-8}	47.9	2403.318	96.682

This test calculates the value of TAN(ATN(EXP(LOG(SQR(A*A))))) for A=1 to 2500. The value 1 is added to each result, which at the end should equal 2500 exactly. (Note that single-precision results for Turbo BASIC are accurate only within the limitations of single precision; the inaccurate digits are to the right of the least significant single-precision digit, and thus are not shown.) The program would not run under Turbo BASIC 0.69f without a numeric coprocessor available.

TURBO BASIC DEF *type*	IEEE DATA FORMATS	RANGE	PRECISION	STORAGE FORMAT (MOST SIGNIFICANT BYTE FIRST)
DEF INT	Word integer	10^4	16 Bits	1_{15} … 1_0 Two's complement
DEF LNG	Short integer	10^9	32 Bits	1_{31} … 1_0 Two's complement
DEF SNG	Short real	$10^{\pm 38}$	24 Bits	S E_7 … E_0 F_1 … F_{23} F_0 Implicit
DEF DBL	Long real	$10^{\pm 308}$	53 Bits	S E_{10} … E_0 F_1 … F_{52} F_0 Implicit
	Temporary real	$10^{\pm 4932}$	64 Bits	S E_{14} … E_0 F_0 … F_{63}

INTEGER: 1
REAL: $(-1)^S(2^{E-BIAS})(F_0.F_1\ldots)$
BIAS = 127 FOR SHORT REAL
1023 FOR LONG REAL
16383 FOR TEMPORARY REAL

Figure 1: *IEEE numeric data types supported by Turbo BASIC.*

However, Turbo BASIC includes several important enhancements and additions to BASICA.

The most important difference concerns number-crunching capabilities. Turbo BASIC numeric data types correspond to those defined in the proposed IEEE microprocessor floating-point and extended precision integer data types and implemented in the Intel 80x87 numeric coprocessor.

Using the terminology of the Intel 80x87 documentation, Turbo BASIC supports word integers (two bytes, 16-bit precision), short integers (four bytes, 32-bit precision), short reals (four bytes, 24-bit precision), and long reals (eight bytes, 53-bit precision). Furthermore, all temporary floating-point values are stored as temporary reals (10 bytes, 64-bit precision) as required in the IEEE standard. Figure 1 defines these types more specifically.

In Turbo BASIC terminology, these numeric data types are called integer, long integer, single precision, and double precision. Except for long integer, the names are familiar and preserve compatibility with Microsoft BASIC. But the internal differences are very important, since they make Turbo BASIC numeric data fully compatible with the requirements of the Intel numeric coprocessor 80x87 chip family, so that floating-point operations can be offloaded onto the 8087 without requiring a time-consuming data conversion.

Contrast this with Microsoft BASIC's three traditional numeric data types: integer (16 bits, the same as Turbo BASIC's); single-precision (24 bits, approximately the same as Turbo BASIC's); and double-precision (8 bytes). For internal, temporary values, Microsoft uses the double-precision data type. To use the numeric coprocessor where it matters most—for double-precision operations—every Microsoft value would have to be converted to the long-real format and the result converted back again to Microsoft double-precision. This latter step could present problems, since the range of long reals is many orders of magnitude greater than Microsoft's double-precision ($\pm 10^{\pm 308}$ as opposed to $\pm 10^{\pm 38}$.

Of course, you pay a price for the added

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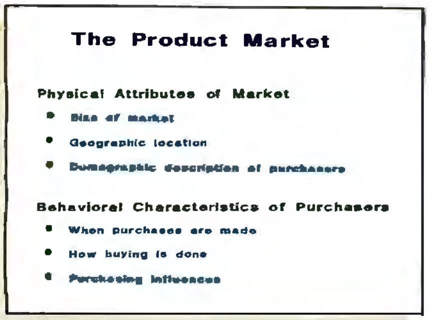

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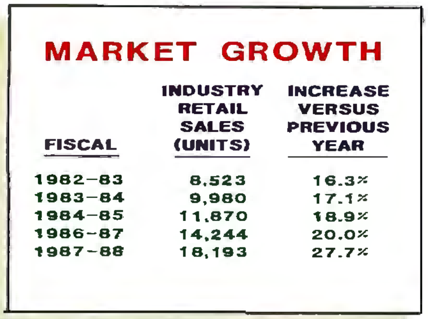

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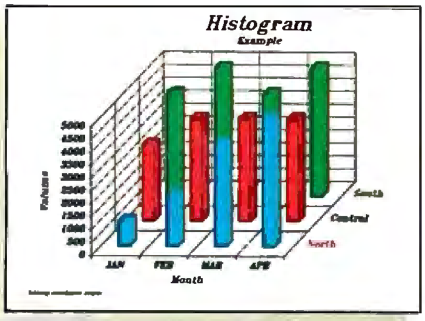

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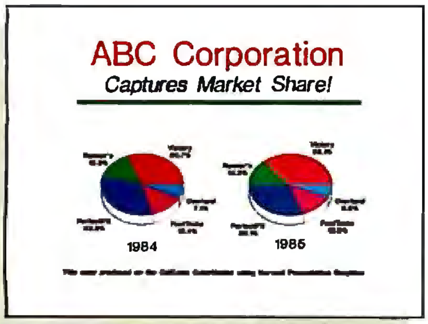

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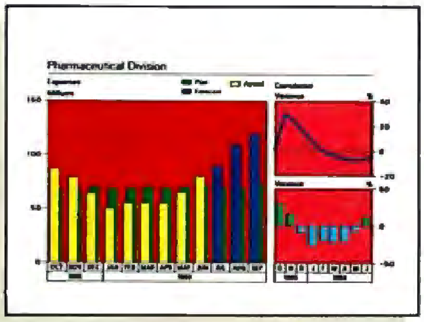

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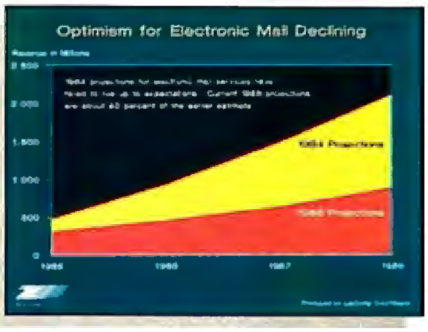

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precision when a numeric coprocessor is not present. In that case, Turbo BASIC does all its floating-point arithmetic using 8087 emulation at a much slower pace. And since all floating-point operations must be done in the 80-bit format—even when the operands are single-precision—the slowdown is considerable. For that reason, Borland acknowledges that QuickBASIC will likely outperform Turbo BASIC in single-precision arithmetic when the 8087 chip is not available in the host computer. However, Borland programmers say that version 1 of Turbo BASIC will be close to QuickBASIC 2.0 on double-precision operations, even without the 8087.

The range of word integers (Microsoft's integer type) is -2^{15} to $2^{15}-1$, or −32,768 to 32,767. This range seems especially restrictive in machines with an address space of 2^{24} bytes. The range for Turbo BASIC's long integer types is -2^{31} to $2^{31}-1$, or −2,147,483,648 to 2,147,483,647, which is more than adequate for handling memory address references and other demanding integer-arithmetic problems. Of course, the long integers consume twice as much memory and require more time for processing, but they allow you to do things in integer arithmetic that would require resorting to single-precision in Microsoft BASIC, with the consequent slowdown and introduction of round-off errors.

One good use for the long integer type is with monetary data, where floating-point approaches require extra work to avoid errors in the cents columns. Using long integers and counting money in cents rather than in dollars avoids the problem for dollar amounts up to $21,478,836.47. (The decimal place is dropped into place when the value is printed.)

Our test results using the prerelease version of Turbo BASIC showed the power of the numeric coprocessor, with a predictably degraded speed when Turbo BASIC had to perform 8087 emulation; nevertheless, the answers came out the same (with an 8087 or 8087 emulation). Borland programmers say the times of 8087 emulation will be substantially improved in version 1 of Turbo BASIC.

Recursion is another strong feature of Turbo BASIC not present in QuickBASIC. A function or subprogram may include calls to itself, passing and retrieving parameters in the process. This feature is possible because Turbo BASIC allows local variables—variables that are placed on the stack and initialized each time a module is entered. That way, a parameter is not destroyed when a module is entered recursively; the stacked parameters are removed from the stack one at a time with each exit from the subprogram. Problem-

Table 1: *Enhancements and new features of Turbo BASIC as compared with QuickBASIC 2.0. Unless stated otherwise, QuickBASIC lacks the specified feature.*

Keyword	Description and comments
Metastatements	
$INLINE	Allows inclusion of relocatable machine language code, represented as a sequence of one-byte values. Alternatively, you may specify a file containing the relocatable machine code.
$IF/$ELSE/$ENDIF	Allows conditional compilation of source-code blocks.
$EVENT	Controls the generation of event-trapping code so that not every part of a program has the associated overhead of event trapping.
$COMn	Specifies the size of the communications buffer for COM1 or COM2.
$SEGMENT	Declares a new code segment; this allows a main program to exceed 64K.
$SOUND	Specifies the size of the sound buffer.
$STACK	Declares the size of the run-time stack.
$STATIC	Declares the default array allocation to be static.
$DYNAMIC	Declares the default array allocation to be dynamic.
Statements and functions	
BIN$ function	Returns the binary string equivalent of a number; similiar to HEX$.
CALL statement	Invokes a STATIC, RECURSIVE, or INLINE procedure; in the first two cases, parameters are checked for type and number.
CALL ABSOLUTE statement	Invokes an assembly language routine. Parameters may be specified in the command line or implicitly through values preassigned via the REG function. QuickBASIC lacks the REG function.
CALL INTERRUPT statement	Generates the system interrupt for access to BIOS and DOS functions. Parameters are passed to the system implicitly through values preassigned via the REG function; parameters are returned through the same function. QuickBASIC lacks the REG function.
CEIL function	Returns the arithmetic ceiling, the smallest whole number greater than or equal to its argument.
CHAIN statement	Passes control to a Turbo BASIC chain module (extension .TBC), leaving the run-time module resident; variables declared as COMMON are retained; similar feature in QuickBASIC.
CLNG function	Converts a numeric expression to a long (4-byte) integer.
CVMD and CVMS functions	Convert Microsoft-format double- and single-precision values stored in random disk file format to Turbo BASIC IEEE form, to allow Turbo BASIC program to read Microsoft BASIC random files containing numeric data.
DECR function	Decrements the value of a variable by 1 or by a specified amount; executes faster than the corresponding assignment statement with a subtraction: A=A−1.
DEFLNG statement	Declares the default type for a variable as long integer.
DELAY statement	Causes a pause for a specified number of seconds; independent of the machine's clock speed.
DIM statement	Declares an array; lower bounds and upper bounds may be specified; e.g., DIM GMT(−12|12) QuickBASIC allows only 0 and 1 as lower bounds.

Keyword Statements and functions	Description and comments
DO/LOOP statements	Set up a loop with optional WHILE and UNTIL conditions at either end.
ENDMEM function	Returns a long integer representing the end of physical memory.
ERADR function	Returns a long integer representing the position of the most recent error. The value returned can be given to the Runtime error function to find the corresponding place in the source program.
EXIT statement	Allows exiting from a program structure (SELECT CASE, FOR/NEXT, DO/LOOP, WHILE/WEND, IF/END IF, DEF FN, SUB END). More general than QuickBASIC's version.
EXP2 and EXP10 functions	Calculate 2 and 10 raised to the specified power.
FRE function	Returns a long integer representing the number of bytes of free memory in the string area, in the array space, or on the stack, depending on the value of the argument.
GET$ function	Reads a string from a BINARY file.
INCR statement	Increments the value of a variable by 1 or by a specified amount; executes faster than the corresponding assignment statement with an addition: A=A+1.
INSTAT function	Returns a numeric flag indicating whether the keyboard buffer contains any characters; does not remove characters from the buffer.
LCASE$ function	Returns the argument string converted to lowercase.
LOCAL statement	Declares variables in a procedure or function to be local; local variables are stored on the stack and initialized upon each entry to the function or procedure, allowing recursive calls.
MEMSET statement	Declares an upper memory limit to be used by the executable program; address is specified as a long integer.
MKMD$, MKMS$ functions	Convert Turbo BASIC single- and double-precision values to Microsoft random disk file format.
MTIMER statement and function	Function reads, statement resets, the microtimer; accurate to 2 microseconds.
PUT$ statement	Writes a string to a BINARY file.
OPEN BINARY	Opens a file in BINARY mode (not available in Quick statement BASIC).
REG function and statement	Statement sets, function returns, a value in the microprocessor register buffer; used before and after calls to assembly routines and system interrupts. Register is specified as a number from 0 to 9.
SEEK statement	Sets the position in a binary file to a specified byte offset from the beginning.
SELECT CASE statement	Sets up an expression testing and branching block.
SUB/END SUB statement	Defines a subprogram or procedure, which may have any of the following; LOCAL, STATIC, and SHARED variables.
UCASE$ function	Returns the argument string in all uppercase.

solving routines that apply the same logic steps at various levels are naturals for recursion, as are many mathematical routines such as factorials (see photo 2).

Turbo BASIC adds two block structure elements that are available in True BASIC but not in QuickBASIC 2.0: DO/LOOP with WHILE and UNTIL conditions at the beginning or end of a block and SELECT CASE structures. Both constructs are key features of any structured language, allowing programs to be written in a way that corresponds to the logical structure of a problem at hand.

Another Turbo BASIC feature absent from QuickBASIC (but present in True BASIC) is programmable lower bounds for arrays. For instance, an array called moderntimes might be set up with a lower bound of 1920 and an upper bound of 1987, using the statement

```
DIM moderntimes (1920|1987)
```

Table 1 summarizes the highlights (new or enhanced keywords) of Turbo BASIC as compared with QuickBASIC 2.0.

Conclusions

Will Turbo BASIC be another Turbo Pascal? It offers many of the features that made that language such a smash hit: the production of stand-alone executable applications; no royalties or licensing fees; a versatile, intuitive user interface; a good program editor; fast compilation; fast execution of completed applications; and significant enhancements or additions to the "standard" language. The big difference is that Turbo Pascal didn't have to confront a popular de facto standard like Microsoft BASIC.

For the time being, Turbo BASIC offers some significant advantages over QuickBASIC 2.0. Chief among these are 8087 support in hardware and emulation; production of executable, royalty- and license-free programs; recursion; and conditional compilation.

Using just a preliminary version of Turbo BASIC, it is not possible to get definitive timings of Turbo BASIC's executable programs in the absence of an 8087. However, it is clear that with the 8087 available, Turbo BASIC vastly outperforms QuickBASIC. (See the performance chart.)

At the very least, the arrival of Turbo BASIC will certainly apply further pressure to Microsoft to make some long overdue changes in the company's flagship programming language. In the meantime, since Turbo BASIC costs just $99.95 and is generally compatible with Microsoft QuickBASIC, BASIC programmers and would-be BASIC programmers should take a close look at Borland's new baby. ■

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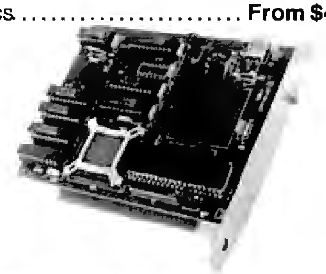

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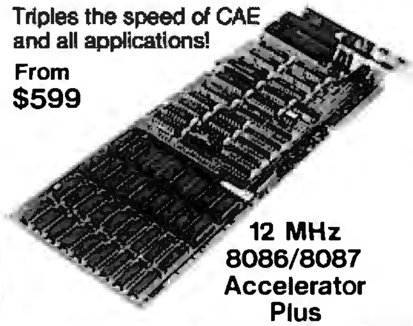

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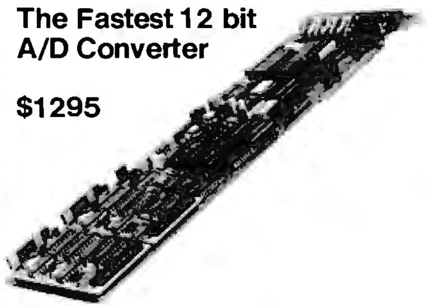

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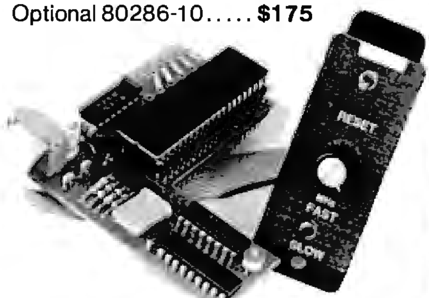

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Steve Ciarcia

Build a Trainable Infrared Master Controller

This device can control all your home entertainment equipment

First of all, this is not the second part of a two-part article. As you will come to understand, this month's project is the solution to a problem I aggravated by building last month's project (an infrared remote control for my home control system). Confused? Let me explain.

While people residing in warm climates tend toward Jacuzzis and hot tubs, some of us who live in colder climates prefer not to tempt fate and brave the elements for about six months of the year. Of course, I could succumb to the winter sports thing. You know, skiing, skating, snow this, and snow that, but it would be much too great a chore at this stage to reorient my sedentary lifestyle to enjoy northeast winters. I hibernate like most indigenous mammals and wait for the color outside the window to metamorphose from white to green.

About a year ago, I decided that holing up in the cellar for six months a year was antisocial. While the isolation proved beneficial in coming up with great projects for the summer and fall issues, I did find that by the time March rolled around, I looked very much like a bear that was leaving his cave, and I communicated just about as well.

In an attempt to improve the quality of winter life and break the cycle of hibernation, this last year I decided to spend some of the time aboveground (upstairs) in an environment that allowed me to observe the realities of my existence (through the windows) and absorb the cumulative knowledge of our culture (watch TV).

In layman's terms, I built a media room. Not just a TV den, mind you, but a room where I could be immersed in a synthesized environment so far from the ice and snow that six months seemed like overnight. Of course, this audiovisual experience was tastefully produced by massive amounts of electronic equipment.

The beautiful scene of the tropical island was accurately reproduced on a Kloss 2000 projection TV. You'd think you were sitting next to that tinkling waterfall as the music moves above and around you in complete surround sound. And when the warm breeze of island spring (actually the heat wafting from the seven amplifiers) is tumultuously interrupted by a hurricane faithfully reproduced with 2400 watts of Nakamichi audio power through a pair of B&W 808s (180 pounds each), two Speakerlab subwoofers, and 11 Canton surround speakers, you feel like the walls are about to explode. Sometimes it is good not to have neighbors.

Enough of warm breezes. I now had a new problem. In addition to all the audiovisual stuff, there were a couple of VCRs, an FM tuner, and a CD player. All this equipment required the 14 remote handheld controls shown in photo 1. Media rooms are a great idea, but you can't expect people to glue a dozen remotes on a long board. There had to be a better way.

IR Master Controller to the Rescue

This month's project, an infrared Master Controller that takes charge of all your gadgets, can prevent "controller clutter." It "learns" the infrared signals for each function and plays them back on command. It uses a six-button keypad to select the device and functions, shown on a two-line LCD, and a single button, Do It, to execute what's selected.

I am not the first person to design a trainable remote control. More than a year ago, I bought a similar device made by General Electric, called Control Central. This device could be trained to simulate the functions of four remotes.

Control Central and similar commercial units have two major shortcomings. First, all the acquisition, data-reduction, processing, and memory circuitry is contained in the single hand-held unit. Given the finite physical size of today's integrated circuitry, there is a limit to the capacity of such a device that allows it to still be cost-effective. Second, it is designed for use by a mass audience assumed to have a finite set of electronic devices. The buttons have predesignated nomenclature, so it is not user-programmable.

You can still train your GE controller to simulate the remote control for your CD player. The Mute button on the GE unit could be trained to be the Auto Repeat on your CD player remote, for example. Unfortunately, every time you want to repeat a CD, you'll have to remember to press Mute since there is no Repeat button on the GE.

I am not criticizing the GE Control Central. I am merely making a case for designing something different for a very vertical, gadget-happy, affluent audience: BYTE readers. Why tie a design to the lowest common denominator. Instead, yell "let them eat cake" and demand the remote to end all remotes: the Circuit Cellar Master Controller!

The shortcomings of the GE and other trainable remotes are the strengths of the Master Controller. Rather than attempt to contain all the necessary intelligence and processing circuitry, the Master Controller temporarily utilizes an external computer

continued

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Infrared controllers are not compatible because each manufacturer speaks in a different language.

as a user-programmable interface. Also, rather than having buttons with fixed-function nomenclature, the Master Controller incorporates a scrolling LCD to identify unit designations (devices) and functions (commands). Device designations like "Bedroom VCR" or "Nakamichi preamp" and commands like "CD repeat/all" or "slow motion" are used instead of remembering what the Mute button was supposed to do.

The Master Controller uses an IBM PC for training. After that, it is battery-operated and completely independent. The IBM PC is connected to the Master Controller via an RS-232 interface and is used to set up menus of devices (receivers, CD players, tape decks) and functions for each device (turn on, play forward, etc.). After a menu is downloaded to the Master Controller, each function is "taught" and tested. Next, the completed menu and synthesis data are then uploaded to the IBM PC and stored on disk (in case you want to load it into another Master Controller or add another device later without retraining all of them).

The Master Controller's IBM PC program can also combine sets of infrared signals once they are trained for their respective devices. I can now use a single Master Controller button to turn on the audio system, route the output to the living room, select the CD player, move to the third selection, and repeat it forever. Compared to other commercial controllers, the Master Controller solves the IR remote plague hands down. Because it uses an external computer for functional modifications by the user, more room is available for its ultimate task. Instead of four remotes, the Master Controller can be trained to simulate the functions of 16 individual remote controls complete with descriptive command designations.

An Infrared Introduction

Most infrared remote controls are functionally similar. The microprocessor in the remote controller creates a stream of bits that is turned into on/off pulses of IR light from an IR LED. An IR-sensitive photodiode in the receiver turns the light pulses back into an electrical signal from which the original bits can be extracted.

The IR LED's fast on-and-off action creates a carrier signal. The carrier is then turned on and off to form the individual bits of the message. Each controller uses a different carrier frequency, sets different bit timings, and assigns different meanings to the bits in the message. The reason that controllers are not compatible is that there is no standard for the format of the bits in the message. Each manufacturer speaks in a different language.

The Master Controller sidesteps this problem by simply recording and playing back the infrared signals without attempting to decode the messages. It's just like a tape recorder. You can record English, Russian, and Spanish on the same tape because they all occupy the same frequency bands, and you don't have to understand the languages to play them back.

This scheme works because of a limited range of differences in the IR signals. The controllers I've tested had carrier frequencies ranging from 32 to 48 kilohertz. Each message bit has between 10 and 30 carrier cycles, and there are two different carrier modulation systems: pulse-width modulation and pulse-position modulation. Last month I explained pulse-width modulation. Pulse-position modulation works by determining the time when a bit occurs relative to a fixed starting point.

The Heart of the Master

An Intel 8031 single-chip microprocessor running a program stored in a 2764 EPROM directs the operation of the rest of the circuitry. (See photos 2 and 3 and figure 1.) The menus and IR signals are stored in a single 32K-byte battery-backed static RAM. The user interface consists of a two-line LCD and a six-button keypad. The keypad is either a simple membrane matrix or individual keys arranged in a matrix that is scanned by the 8031. This eliminates the need for a keyboard encoder. Two keys each are used for device and function up/down scrolling on the LCD. A fifth button, Do It, executes the device/function command appearing on the display. A sixth button, Learn, is used for training.

The LCD has 20 characters on each of two lines. The interface to it requires only six wires: four data bits, one timing strobe, and an address line. The display's internal character generator converts ASCII data into character dots, so the 8031 can communicate directly in ASCII.

A TIL413 photodiode converts the IR signals from other remote controllers into a discernible logic signal. Because the Master Controller and the remote are placed close together during training, there is no need for the sophisticated signal processing that's required to detect weak IR signals across a room. The Master Controller photodiode circuitry was designed to accept strong IR signals only. You should position the remote-control unit within a few inches of the Master Controller's photodiode. If it's too far away, the Master Controller will "see" nothing. If it's too close, the Master Controller will receive a distorted signal. A little experimenting with each controller will locate the correct position.

An LM311 comparator converts the photodiode input signal to a TTL-level signal. A 74LS164 shift register samples the output from the LM311 at a 1-megahertz rate and converts the data into

Photo 1: *The six-button Master Controller can duplicate the functions of the 14 controllers shown in the background.*

parallel format. The 8031 reads the shift register every 8 microseconds while it is learning a new IR signal. This data is stored in RAM for later analysis.

At the transmitting end, the process is reversed. Although the 8031 is a fast microprocessor, it cannot generate both the carrier and bit timing of the IR signals instantaneously. To lighten the processing overhead, an 8254 programmable interval timer controls the IR carrier frequency and duty cycle as well as the duration of each message bit. The 8031 sets up the 8254's registers for each bit of the IR message.

A pair of TIL39 infrared LEDs produce the IR signal. Because the human eye cannot see IR light, a visible LED is connected in parallel as an indicator. The LEDs are switched by a field-effect transistor driven by a standard logic gate. The FET is an efficient way to interface logic levels with real-world devices because it directly translates an input voltage into an output current.

Power

Power is an important consideration in any battery-operated device. The Master Controller was designed to use either 74LS or 74HC devices at 5 volts. The 5 V is derived from a 6-V battery (four AA cells) using a special low-dropout voltage regulator. While LS takes considerably more power than HC, the duty cycle is low. The Master Controller need only be powered up long enough to set the device and function and press Do It. It can be shut off afterward. Admittedly, I could have spent more time developing automatic power up/down circuitry, but it would have complicated the design and added more software. Feature-specific circuit tailoring will have to wait.

Turning the power on and off is not a problem. The 8031's system software is contained in a 2764 EPROM, and the LCD and IR data are contained in battery-backed RAM. The memory is a 32K by 8-bit static low-power CMOS RAM chip. The backup circuit consists of two 3-V lithium batteries and a Dallas Semiconductor DS1210 battery-backup controller chip. The DS1210 senses loss of the +5-V supply voltage and automatically write-protects the RAM as it switches power to the battery. The second battery is necessary only if the first one fails.

Signal Processing

As you can see from the schematic in figure 1, most of the Master Controller's functions are done in software. It's worthwhile to look more closely at the processing required for the learning and reproduction of the IR signals. The IR carrier frequency is about 40 kHz, giving a period of about 25 μs. The particular frequency used by a controller must be measured precisely because each microsecond of error changes the reproduced frequency by about 4 percent. While this doesn't sound like much, when the Master Controller reproduces the IR signal, the receiver could completely ignore it. The reason for this is that the IR receivers in consumer electronic gear must detect faint IR signals.

Generally, the receivers use a phase-locked loop, tuned to the remote unit's carrier frequency. The PLL can handle a 10 to 20 percent frequency error, but the design margins include errors due to temperature, voltage, and other effects.

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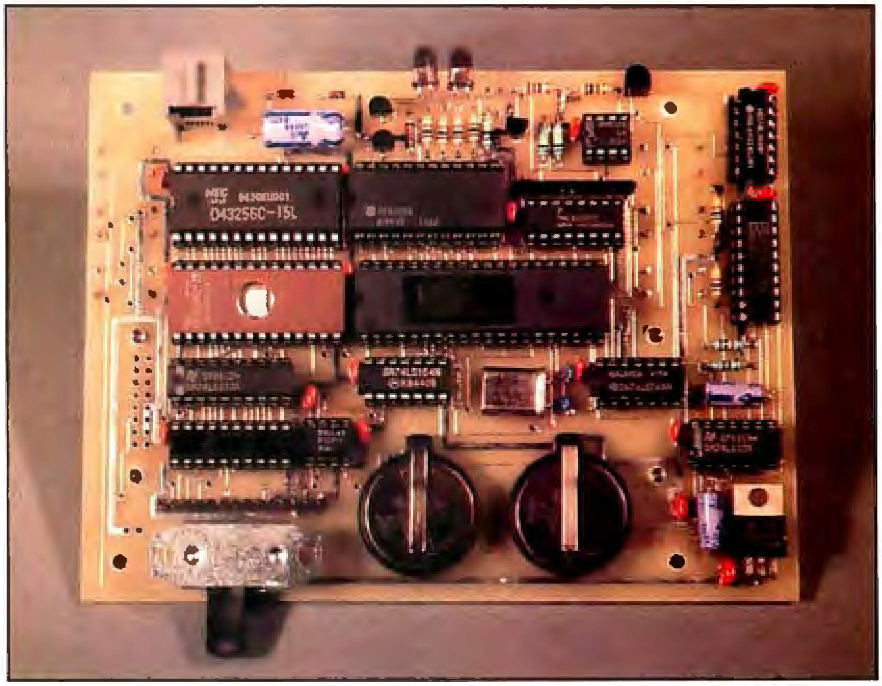


Photo 2: *Component side of the Master Controller, showing the 2764 EPROM and 8031 CPU (center left and right). The backup batteries and Dallas Semiconductor DS1210 battery controller are in the bottom center and right.*

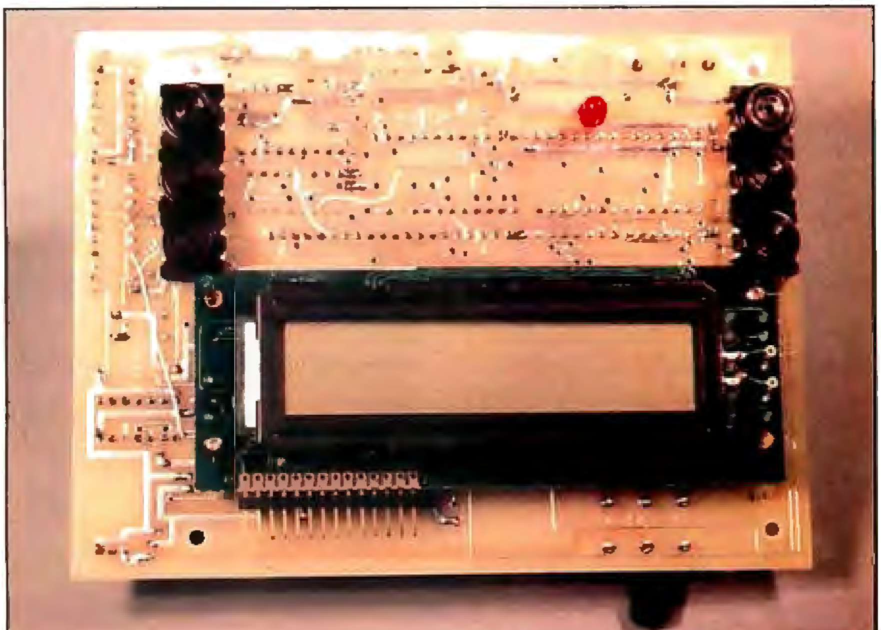


Photo 3: *The etch side of the Master Controller showing the 2-line by 20-character LCD and six control buttons.*

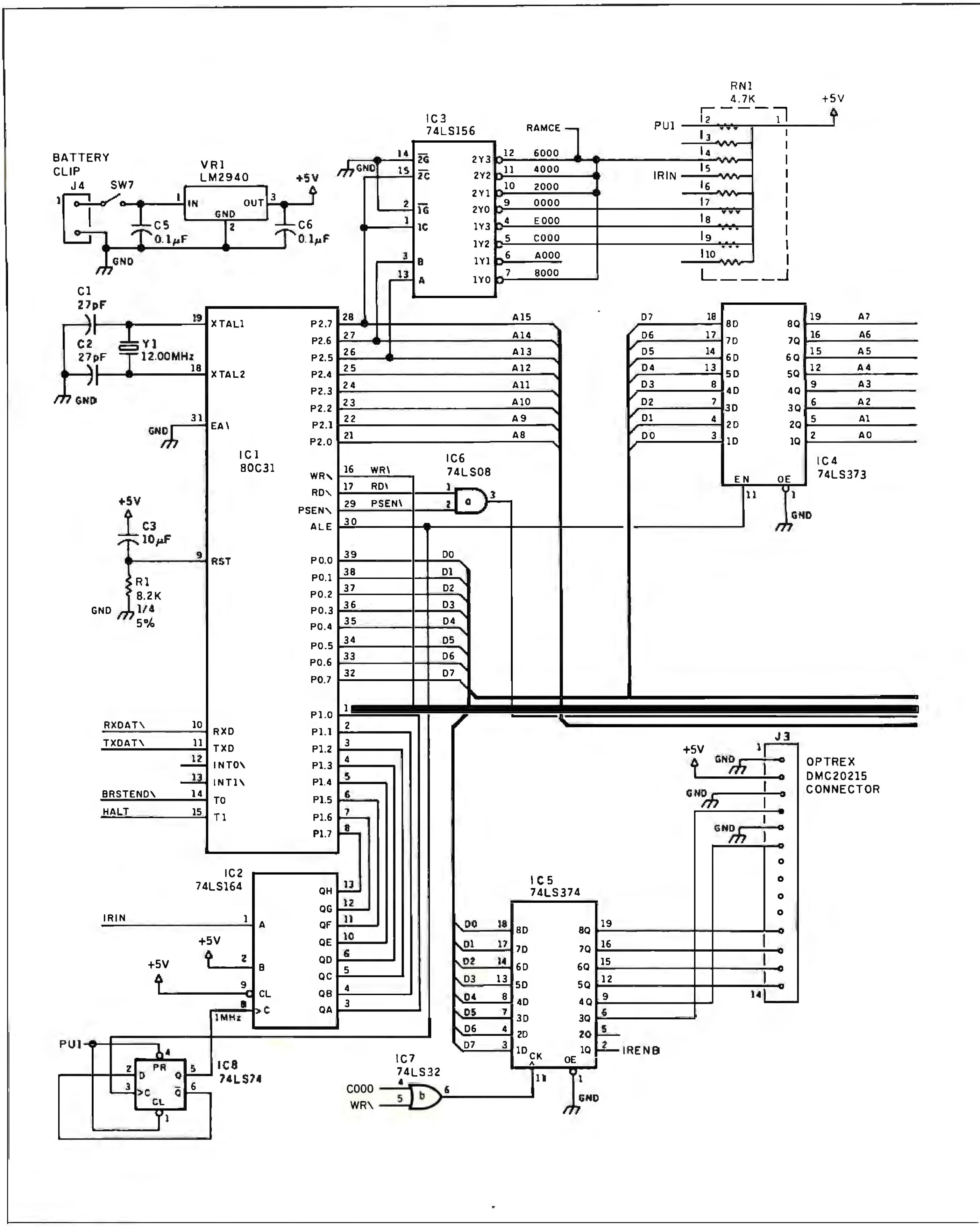
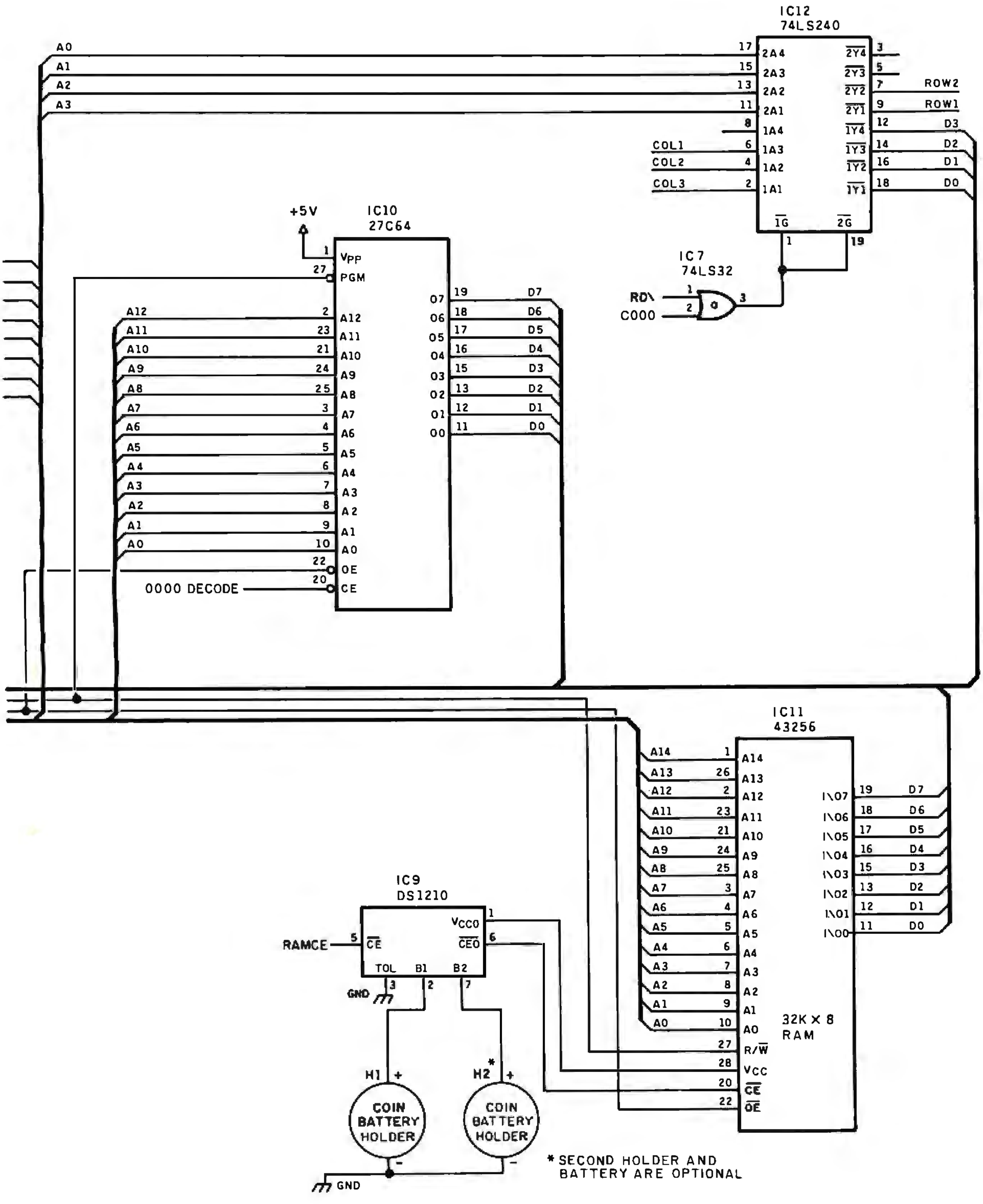


Figure 1: *Master Controller schematic diagram.*


IC12
74LS240
IC10
27C64
+5V
IC7
74LS32
RD\
C000
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IC11
43256
32K X 8
RAM
IC9
DS1210
RAMCE
GND
H1
H2*
COIN
BATTERY
HOLDER
ROW2
ROW1
COL1
COL2
COL3
*SECOND HOLDER AND
BATTERY ARE OPTIONAL

The whole margin isn't available for the Master Controller. An 8031 with a 12-MHz crystal can execute most instructions in 1 or 2 μs. The shortest possible loop used to sample an input pin takes 2 μs. While this might seem very fast to you, reading and storing the value takes much longer and necessitates some form of input buffering.

The solution involves using a 74LS164 shift register to accumulate 8 bits of IR signal at a 1-MHz clock rate (see figure 2). The shift register in turn is sampled once every 8 μs, a requirement that's easily met. The 1-MHz clock for the shift register (and also the 8254, which I'll describe in a moment) is derived from the 8031's address latch enable output. The ALE signal occurs at a 2-MHz rate and is divided down to 1 MHz by half of the 74LS74 flip-flop. Exactly 32 samples of the shift register data are copied into internal RAM, a process that accumulates 256 μs of IR signal. The software then examines the data to pick out the start and stop of each carrier pulse. The 256-μs sample will include 8 to 12 complete carrier pulses, depending on the exact frequency (generally, 32 to 48 kHz). The software averages the length of the pulses to compute the carrier period and also determines the average duty cycle. Using several samples reduces the effect of noise on the final average.

Once the carrier frequency is determined, the next step is to measure the length of each bit in the message. The shortest bits we've measured contain at least 10 carrier pulses, and the average seems to be about 20 (although some contain more than 60 pulses). Given the variability in carrier frequency and pulse length, the main problem lies in determining when the bit ends. The software assumes that 32 μs without an IR signal marks the end of a bit.

The duration of each bit and the following pause are recorded in the external RAM of the 8031. Each IR message can contain up to 256 bits (and the following pauses) and can last up to half a second. Because most remote controllers repeat the message as long as the key is held down, it is very important to tap that key lightly.

Although the carrier frequency and message analysis could be done on one sample of the IR signal, the Master Controller requires two separate samples. The first is analyzed for carrier frequency, the second for message bits (see figure 3). This reduces the chances that a partial signal will be recorded in case the first bit is less than 256 μs long. Each IR signal is summarized by its carrier frequency and duty cycle and up to 256 pairs of 16-bit numbers that record the bit times. Therefore, each signal can occupy up to about 1K byte of RAM. Typical signals have a few dozen bits and require only about 100 bytes. This allows the Master Controller to easily accommodate 16 remote-control units with 16 commands each.

Just as the 8031 isn't quite fast enough to directly record the IR signals, it needs a little help creating them. An 8254 programmable interval timer provides the high-speed logic required to generate signals with microsecond timing resolution. The 8254 PIT contains three identical timers that can be set up in a bewildering variety of modes. The Master

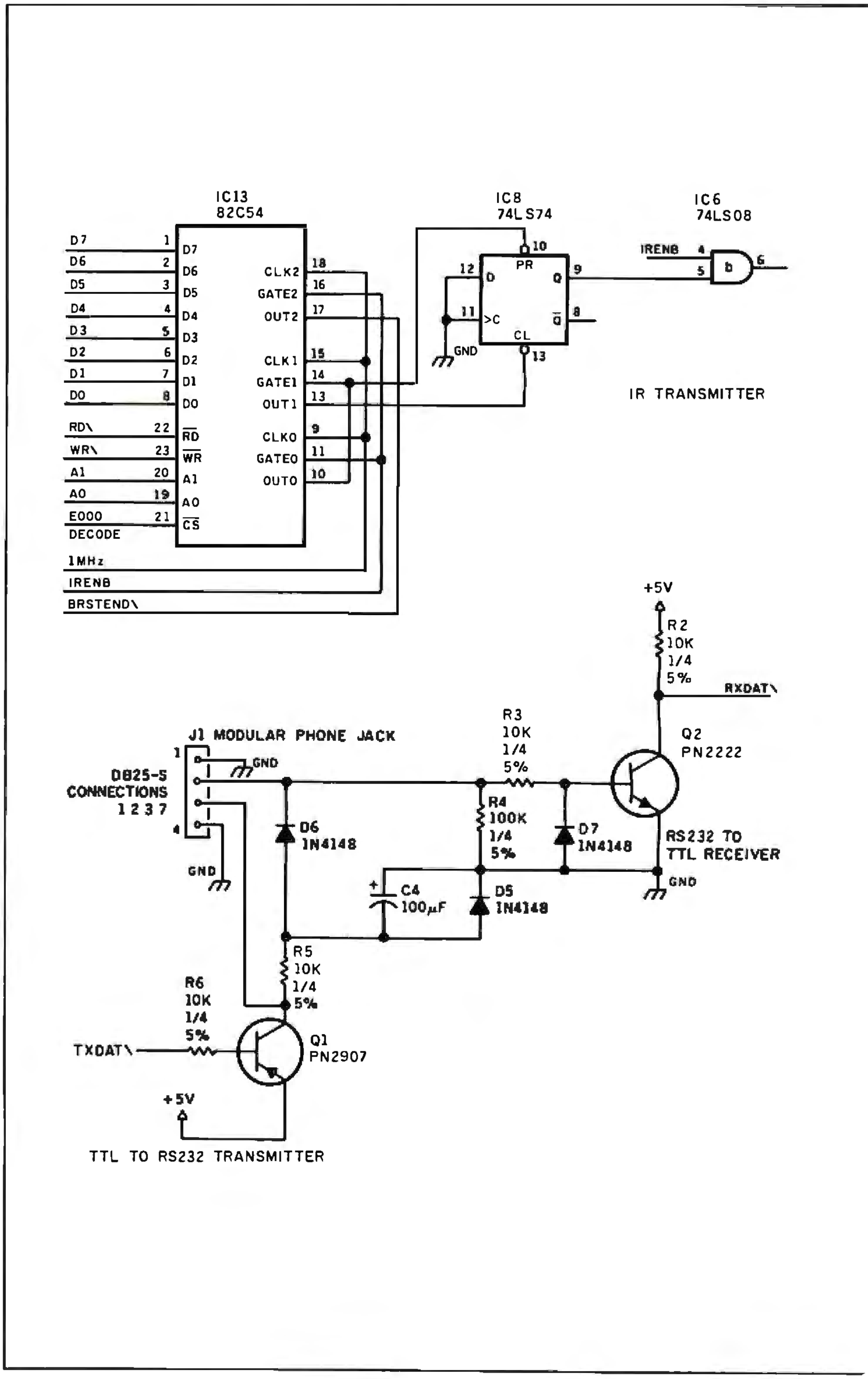
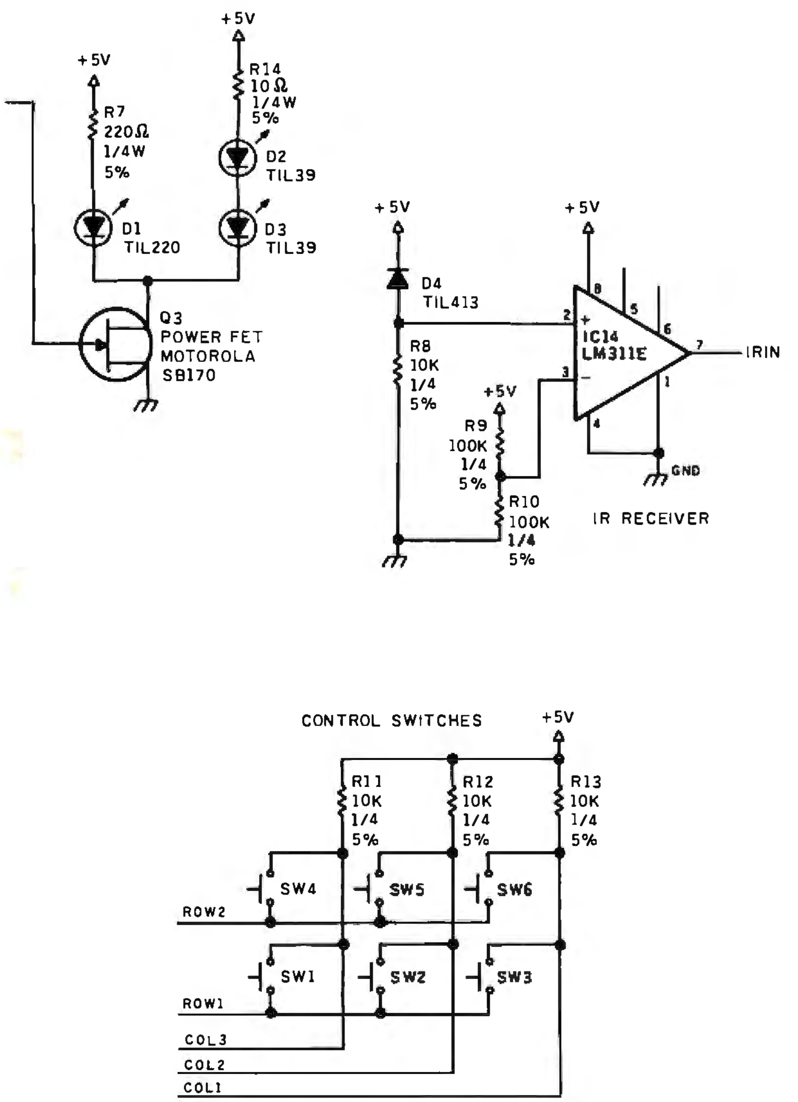


Figure 1: *Continued.*

Controller software uses all three of them, as well as a timer inside the 8031, during the IR playback.

Timers 0 and 1 in the 8254 (IC13) set the IR carrier frequency and duty cycle, respectively. Timer 2 determines the duration of each message bit, and the 8031 timer controls the pause following each bit. The first two timers are set once at the beginning of the message, while the last two are set for each bit. The times are stored in external data RAM accessed only when the 8031 is running.

Because the 8254 produces a pulse only at the end of each timer's count, a 74LS74 (IC8) is used to create the actual IR pulses. The Timer 0 pulse (pin 10 of IC13) sets the LS74's output at the start of the carrier cycle, with Timer 1 (pin 13 of IC13) resetting the output at the end of the carrier pulse. The LS74's output is combined with a gating signal (IRENB) and sent to the IR LED drivers. As you can see, a great deal of code is required to handle the IR signal analysis. The code is written in 8031 assembly language.



The PC Connection

Using an IBM PC to create menus for the Master Controller may seem like overkill, but it really simplified the logic. The PC has a full keyboard and display, disk storage, and, best of all, high-level programming languages. Writing a PC program is much easier than writing an 8031 program, so I decided to put as little code in the Master Controller as possible.

The PC program (called MASTER) provides three main operations: creating and editing menus of devices and functions, saving and loading these menus in disk files, and transferring them to and from the Master Controller. (See photos 4, 5, and 6.) The Master Controller is connected to the PC only when uploading and downloading menus. Under normal use, the Master Controller doesn't have any wires trailing out of it.

I'll have to admit to taking a little poetic license in the design of the RS-232 circuit. Rather than include a separate negative-voltage power supply for the RS-232 signal levels, I used a diode and capacitor to "borrow" the negative voltage from the PC's transmitted data line. A pair of transistors are simpler than the power-hungry level converters normally used to translate between logic levels and RS-232 levels. This is an important consideration in battery-operated devices. Because I know the communication will always be with an IBM PC, a worst-case, tolerant RS-232 circuit is not a necessity.

The serial connector is an RJ-11 telephone jack instead of the usual 25-pin DB-25 connector. Only three wires are required: data from the PC, data to the PC, and signal ground. Because the MASTER program and the Master Controller were designed together, they use an efficient method of passing data that doesn't require the normal RS-232 RTS/CTS and DSR/DTR status lines.

The 8031 serial interface includes a bit-rate generator. The exact bit rate depends on a number programmed into a register as well as the frequency of the 8031's clock crystal. I used a 12-MHz crystal to get the highest resolution possible for the IR signal-processing circuitry, but that's not the optimum crystal for the serial interface. As a result, the 8031 transmits data

continued

The MASTER program, which is written in Turbo Pascal, can create menus for up to 16 devices.

to the PC at 10,417 bits per second. If you're familiar with normal RS-232 data rates, you'll recognize that 10,417 isn't one of the choices. Fortunately, the PC's serial port also determines the bit rate from a number in a register. The closest match is 10,473 bps, but everything works just fine.

Here I should point out that, although the link between the Master Controller and the PC is called RS-232, it is surely not standard. For example, using mismatched bit rates and voltage levels is acceptable only if you've carefully checked out the consequences and assured yourself that both ends of the connection are still compatible. If you elect to build a Master Controller, you shouldn't try to stretch the limits of the connection too much. A 50-foot cable probably won't work at all!

The Master in Action

Perhaps an example of how to use the Master Controller is in order. I'll show how to set up the first menu, then how to combine IR signals to produce customized effects.

The MASTER program, written in Turbo Pascal, can create menus for up to 16 devices: receivers, CD players, tape decks, and so on. Each device can have up to 16 functions (on/off, play, rewind, volume up, etc.). While up to 256 functions are possible, the ultimate limit to the number of devices and functions is the size of the Master Controller's RAM. MASTER and the Master Controller cooperate to make sure that you don't download a menu that's too big.

MASTER treats the devices (Bedroom VCR, Kitchen TV, etc.) and functions (volume up, power on, etc.) as a collection of lists. Function keys let you "cut" an item from one list and "paste" it elsewhere (see photo 4). You can delete an item permanently, and you can insert a new item and give it a name. Devices and functions are treated as different items, so you can't cut a function and then paste it into the device list.

Table 1 shows the complete list of MASTER function keys on the IBM PC. As an example, you might use the MASTER screen for the Sony RM-S750 controller menu. The Tape Deck line in the Devices list is highlighted, and the Functions list details all the tape deck's functions. The word "new" at the end of each function indicates that the IR signals have not been learned yet (see photo 6).

The Remote Keyboard item in the Devices list contains the general functions like power on/off and volume up/down as well as the digits from 0 to 9 to allow direct radio tuning. You can duplicate functions under more than one device to make the Master Controller easier to use. After all the devices and function names have been entered, you should save the menu on disk. A good choice for a filename is the manufacturer's model number, so RM-S750 is a good choice for this one. The MASTER program will automatically supply an .MC file extension.

The next step is to download the menu to the Master Controller. The MASTER program and the 8031 program first verify that each other exists, exchange some status information, and finally transmit the menu. (The PC cable can be disconnected after the download is complete.) The Master Controller learns one function at a time. Use the Select Device keys to scroll through the Devices list, then the Select Function keys to pick a function for the device. The Learn key will record an IR signal for the selected function. You can test the signal and relearn it until it's correct, but you can learn only one signal for each function.

As I described earlier, the Master Controller requires two samples of the IR signal to find the carrier frequency and message bits. You should tap the remote's keys quickly to avoid filling the Master Controller's RAM with repetitions of the same signal. Because most remote controllers will repeat their IR signal as long as the key is held down, you should tap the Remote key and release it immediately. You should see the remote's LED blink briefly to indicate that it sent a signal. There's no point recording repetitions because the Master Controller will repeat the signal as long as you hold down the Do It key.

After the second tap, you can test the Master Controller's stored signal by aiming its IR LEDs at your VCR or TV system and pressing the Do It key. If the function works correctly, the Master Controller has a valid IR signal in RAM. You can repeat the learning process by tapping the Learn key again. Once you have a good signal stored in RAM, tap any key other than Learn or Do It to return to the

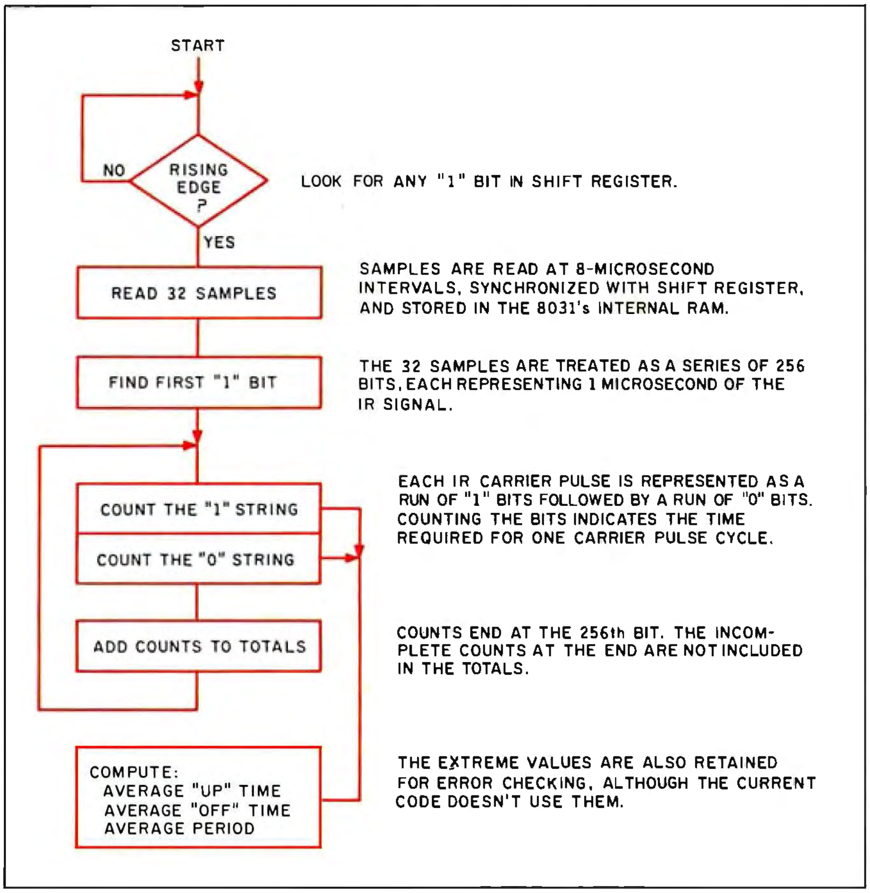


Figure 2: *Carrier-frequency measurement flowchart.*

normal display. Select the next function and repeat the learning process again. The cycle takes only a few seconds once you get the hang of it.

When all the functions are learned, reconnect the RS-232 connection to the PC and upload the menu using the MASTER program. The word "new" after each function is replaced with the length of the IR signal in bits. The Sony RM-S750 produces three repeats of 13 bits for each key press, so each function shows a length of 39. Other remotes will, of course, have different signal lengths.

Menu Modifications

At this point, you have a Master Controller menu that duplicates the functions of the RM-S750 as its first device. The MASTER program can combine the IR signals for two functions to produce the same effect as pressing two keys on the remote in sequence. This comes in handy for operations that you normally do in sequence, like turn on the power to the FM tuner and select your favorite station, for example.

To combine two IR signals, first "cut" one signal from the function menu by pressing F7. Then position the cursor over the other signal and press F10. Notice that the signal length is now the sum of the two old signals. You might want to use F9 to change the function name to reflect the new signal.

You can combine any number of function signals, with the only restriction being that the total length of the combined signals cannot exceed 1024 bits. The "cut" signal (or signals) is put at the end of the combined sequence. (Because the Master Controller uses a single carrier frequency for an entire IR signal, a combined signal may not work correctly if the signals came from different controllers.) MASTER will warn you if the carrier frequencies differ by more than about 10 percent but will allow you to shoot yourself in the foot. The Master Controller will use the first signal's carrier frequency for all the combined signals.

Some tape decks require pressing two keys (usually Record and Play) simultaneously to start recording. Generally, you can't get the same effect by pressing the Record key followed by the Play key. The reason is that the remote sends out a different message when the two keys are pressed simultaneously than it does for either of them separately. If you combine the Record and Play signals using Master, it won't work any better than the two separate keys will. You must "learn" the correct signal by pressing the two keys simultaneously. You've got to be quick on the keys to avoid filling the Master Con-

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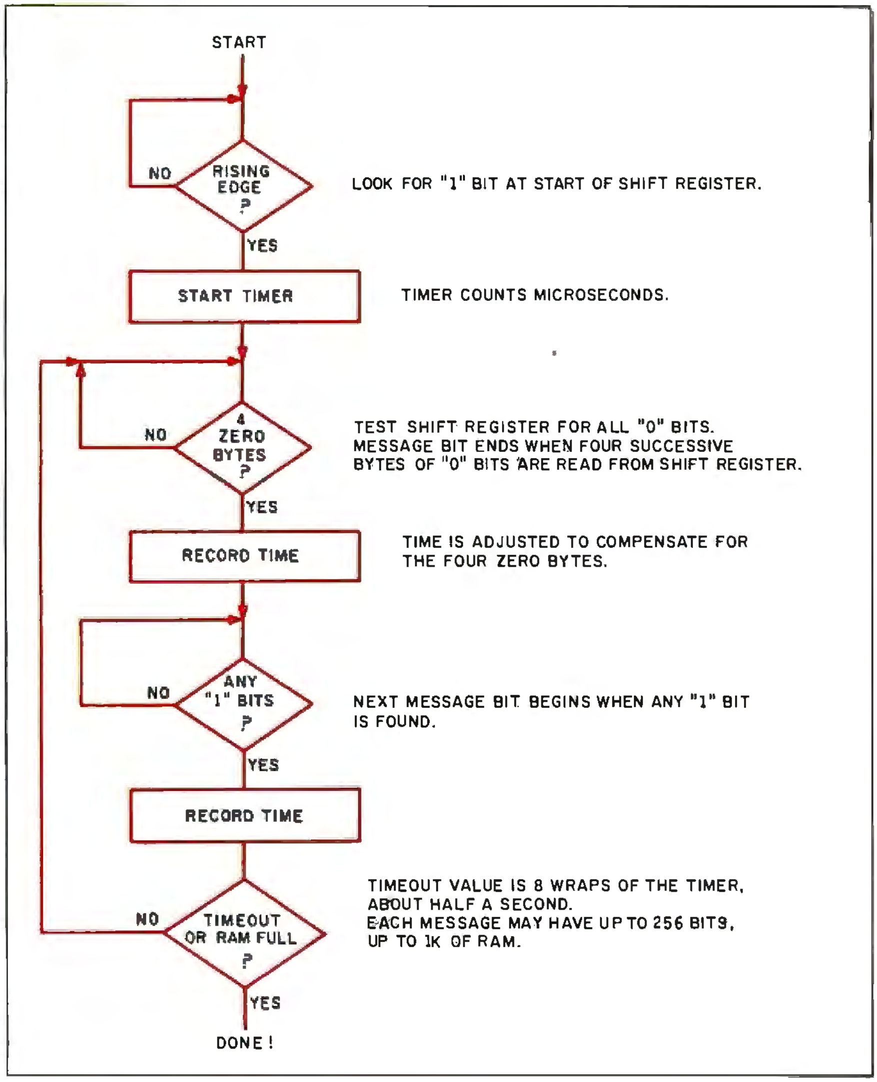

Figure 3: *Signal-capture flowchart.*

Photo 4: *The Master Controller and the IBM PC keyboard showing the MASTER program function-key template.*

troller's RAM with repetitions, though. As usual, practice makes perfect.

Conclusion

Once you've recorded the basic controller functions, you can use MASTER to combine them in wonderful ways. Although I've been calling the menu selections "devices" and "functions," you don't have to. You might wind up with a device called "Coming Home" with functions ranging from "Tired" to "Exhilarated" to turn on your system and select just the right lighting and music. Get the idea?

The Master Controller was designed and prototyped as a Circuit Cellar project. While it has some obvious and immediate consumer market potential, without a clear goal in mind it is hard to convince someone to go through the expense of manufacturing it (especially producing a custom enclosure). I have only a short time between projects, and I don't have the time to speculate on the eventual market niche or the specific configuration the Master Controller will take (Sharper Image, are you listening?). However, unless there is some way to evaluate the present device, another generation of the Master Controller will never be built.

To facilitate these evaluations, I've made a printed circuit board for the Master Controller. My intention is to populate a few more and circulate them in the proper consumer channels. While the Master Controller is not available as a kit per se, these PC boards are available if you want to build your own plague antidote.

If you don't mind a little hand-wiring, I encourage you to build the Master Controller from scratch, and I will support your efforts as usual. A hexadecimal file of the executable code for the 8031's system EPROM and the Turbo Pascal source code for the IBM PC are available for downloading from my bulletin board at (203) 871-1988. Alternatively, you can send me a preformatted PC disk with return postage, and I'll put all the files on it for you (the hexadecimal file could be used with my serial EPROM programmer, for example). Of course, this free software is limited to noncommercial personal use.

Finally, I apologize if Master Controller is someone's trademark. It seemed an obvious descriptive name for the project, but there is no way for me to know whether it has been taken without a costly trademark search. That might be necessary eventually, but it is premature at present. Perhaps I should just call it ROVER (Response to Obnoxious, Valueless, and Extraneous Remotes).

Photo 5: *MASTER program menu-maker screen with a five-device menu. Line 25 displays the function-key menu.*

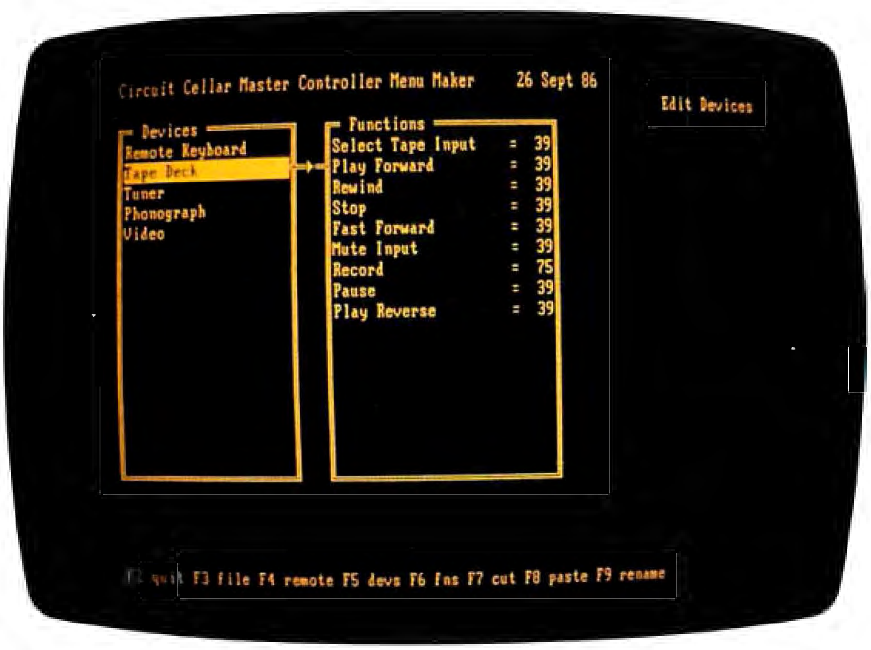

Photo 6: *MASTER program device-editor screen showing device and function menus. The Master Controller has just been trained to emulate the Sony RM-S750 controller.*

Circuit Cellar Feedback

This month's feedback begins on page 58.

Next Month

Neighborhood Strategic Defense Initiative. ■

Special thanks to Ed Nisley for his talented contributions to this project.

The 2-line by 20-character LCD is available from Jordan Technology Inc., P.O. Box 362, Lexington, MA 02173, (617) 863-8898.

The DS1210 is available from Dallas Semiconductor, 4350 Beltwood Pkwy., Dallas, TX 75244, (214) 450-0400.

Many of the individual components are available from JDR Microdevices, 1224 South Bascom Ave., San Jose, CA 95128, (800) 538-5000; Jameco, 1355 Shoreway

Table 1: *IBM PC function keys and their MASTER program functions.*

IBM PC function keys and their MASTER program functions

Rule of thumb: F2 through F6 select what you want to do
F7 through F10 actually do something
F1 does nothing
To get out of MASTER, press F2

F3 selects file I/O, then:

F7	writes the current menu to disk
F8	reads a menu file from disk
F9	creates a menu with simple names and random IR data (may be too big to fit into the remote RAM, though; this is of no use to anyone other than me)

F4 selects remote I/O, then:

F7	downloads the current menu to the remote
F8	uploads the remote's menu

F5 selects device editing, then:

F7	cuts a device and puts it on the junk list; if there was a device on the junk list, it's gone now
Ctrl-F7	deletes a device forever

F8 pastes a device from the junk list. If there's no device on the junk list, creates a new one:

F9	lets you rename a device
F6	selects function (and message) editing
F7	cuts a function and puts it on the junk list; if there was a function on the junk list, it's gone now
Ctrl-F7	deletes a function forever
Alt-F7	wipes out the IR message data for the current function
F8	pastes a function from the junk list; if there's no function on the junk list, creates a new one
Ctrl-F8	inserts a new function, leaving junk list alone
F9	lets you rename a function
F10	tacks the IR message from the junk list onto the end of the current function, leaving the junk list unchanged, so you can combine it with any number of functions

Rd., Belmont, CA 94002, (415) 592-8097; DigiKey, P.O. Box 677, Thief River Falls, MN 56701; and Advanced Computer Products Inc., 1310 East Edinger, Santa Ana, CA 92705, (714) 558-8813.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Company, P.O. Box 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume II* covers December 1978 through June 1980. *Volume III* covers July 1980 through December 1981. *Volume IV* covers January 1982 through June 1983. *Volume V* covers July 1983 through December 1984.

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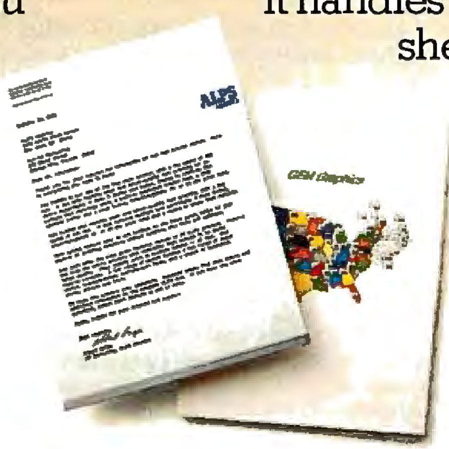

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Inquiry 214

Brian Wichmann and David Hill

Building a Random-Number Generator

A Pascal routine for very-long-cycle random-number sequences

Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin.
—John von Neumann (1951)

John von Neumann's classic comment presents the paradox of random-number generation: The random-number sequences that computers produce are not truly random at all, since true randomness depends upon having a random process available, such as tossing a coin. Because such a process is not available within a computer, we use a pseudorandom process to produce sequences of numbers that appear to be random and mimic well the behavior that we expect of true random sequences.

Such a process is not only easier to use than a truly random process, but it also produces numbers that can be repeated if necessary. In testing a program, for example, it can be troublesome if every run is necessarily different because of different random numbers. Pseudorandomness lets us use the same numbers over and over again for testing but use different ones for each production run.

We can test whether a particular pseudorandom method is adequate or not for its purpose by using conventional methods. Such testing is not easy, as we shall see later.

Many generators use a simple multiplicative rule to generate the next number based on a fixed prime number and a multiplier. For instance, if the prime number were 30,269 and the multiplier 171, you would have $x_{i+1} = (171 * x_i)$ mod 30,269 (i.e., multiply by 171, divide by 30,269, then take the remainder).

The sequence of values for x_i goes through all the values between 1 and 30,268 in a shuffled order before repeating itself. This is a consequence of using a prime and the choice of the multiplier.

Some microcomputers use such a simple method directly and, as a result, do not produce a sequence that will pass the more severe statistical tests. A poor generator may lead to the wrong conclusions as a result of its use. If you are a cautious user, you will not depend upon the built-in random number but will incorporate one into your program that you know has been well tested.

The Ideal Generator

What properties should a random-number generator have? First, it should have repeatability, so that when you move a program from one machine to another, you can guarantee exactly the same results. Second, it should be efficient; otherwise, your program may run too slowly. Third, the algorithm should be written in a high-level language so that you can port the code from one machine to another without difficulty. The algorithm presented here meets all these criteria.

The Portable Generator

The solution depends upon two techniques. First, consider the problem of using a high-level language. The simple generator given above can be written in Pascal as `x := (171*x) mod 30269`. In practice this coding will not work adequately on all machines. The values of x are restricted to the range 1 through 30,268 and therefore will fit into a 16-bit word. This is not true for $171*x$, so the expression will malfunction on many machines. You could perform the above calculation "double length," but this either requires machine code or is very expensive in both time and space. If we write x in the form $177*r+s$ where $0 \leq s \leq 176$, then $171*x = 171*s + 171*177*r = 171*s + 30{,}267*r = 171*s + 30{,}269*r - 2*r$. Since $30{,}269*r$ mod 30,269 is 0, $(171*x)$ mod 30,269 = $(171*s-2*r)$ mod 30,269. Therefore, the Pascal statement above can now be written as `x := 171 * (x mod 177) - 2 * (x div 177);`. There is one problem, however. The Pascal program can return a negative number if we do not add the following:

```
if x < 0 then
  x := x + 30269;
```

We now have a mechanism for making a simple generator for a 16-bit machine. We choose a prime just slightly less then 32,768 and then a multiplier (around the square root of the prime). By using the above coding trick, the problem of overflow can be eliminated with the equivalent of five or six additional (machine) instructions.

But such a simple generator on its own is inadequate. It will repeat itself too soon, and its statistical properties are not near enough to those of randomness. To improve it, we need a second technique that combines two or more generators to make a new generator that is statistically superior to any of its components. To understand this method, consider the random numbers $x1$ and $x2$ in the range $0<x<1$. We will call the fractional part

continued

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Dr. David Hill is a statistician at the Clinical Research Centre (Watford Rd., Harrow, Middlesex HA1 3UJ, U.K.). He is a former Honorary Secretary of the Royal Statistical Society.

Testing a generator is not straightforward, since the nature of randomness is that anything can happen and sometimes will.

of $x1+x2$ the combination of $x1+x2$. It is clear that if $x1$ and $x2$ are independent and uniformly distributed, then the combination of $x1+x2$ is also uniformly distributed over the same range of values. Moreover, if each of $x1$ and $x2$ is nearly random, the combination of $x1+x2$ will be much more nearly so than either of them individually.

The method of constructing our ideal generator is now clear. We take a few simple generators using the first technique until we obtain a combination that produces satisfactory statistical results. In fact, three generators had to be combined since combining only two did not produce totally satisfactory results. We have extracted our completed generator from the Pascal program, and it is shown as listing 1. [Editor's note: *Source code for a stand-alone Microsoft BASIC version of the Pascal routine, written by John Nash, is available on disk, in print, and on BIX. See the insert card following page 352 for details. The listing is also available on BYTEnet; see page 4.*]

Combining the generators works correctly only if they are independent. In fact, they cannot be completely independent since, if the three primes are p, q, and r, the cycle lengths are $p-1$, $q-1$, and $r-1$, and these necessarily have 2 as a common factor. They can, however, be made nearly independent enough for practical purposes if we make sure that they have no other common factor. This means that the cycle length of the combined generator is $(p-1)(q-1)(r-1)/4$, which in our case is about 6.95E+12. This means that if 1000 numbers were calculated every second, it would not repeat itself for over 220 years. Consequently, we have tested only a small part of the sequence for statistical soundness. However, the method of combining the generators results in theoretical grounds for expecting good results, so we are prepared to extrapolate our experience and infer that the sequence is satisfactory throughout.

Listing 1: *A Pascal fragment showing the random-number generator routine.*

```
program ...
  var
  x, y, z: integer; {global seeds}
   ...
function random: real;
  var
   temp: real;
  begin
  {first generator}
  x := 171 * (x mod 177) - 2 * (x div 177);
  if x < 0 then
    x := x + 30269;
  {second generator}
  y := 172 * (y mod 176) - 35* (y div 176);
  if y < 0 then
    y := y + 30307;
  {third generator}
  z := 170 * (z mod 178) -63 * (z div 178);
  if z < 0 then
    z := z + 30323;
  {combine to give function value}
  temp := x/30269.0 + y/30307.0 + z/30323.0;
  random := temp - trunc(temp)
  end;
  ...
  begin
  {Initialize seeds. For production runs, different values
  [between 1 and 30,000] should be used each time, preferably by
  some automatic method such as from date and time readings if
  available.}
    x := 1; y := 10000; z := 3000;
    ...
    end.
```

The Tests

Testing a generator is not a straightforward problem, since the nature of randomness is that anything can happen and sometimes will. If a generator always passes all its tests, it is a failure: It ought to fail on a due proportion of occasions.

The tests applied to the generator, along with results, are described in a National Physical Laboratory report (see reference 1). First, we tried a serial test on the generator's output. We know that a single-component generator would fail this test, since any very small value is always followed by the same value multiplied by the multiplier.

The second test consisted of simulated poker hands. Five calls of the generator were used to construct a hand. The number of hands with all different cards, one pair, two pairs, and so on, were accumulated.

The third test was for runs up and down. The tests for runs up are not independent of tests for runs down, so they are done separately. The first to the fifth digits were tested in the way specified by Grafton (see reference 2).

In general, the generator passed with flying colors. But that, of course, includes failing in approximately the right proportion of cases. Well, not exactly the right proportion, for that would be too good to be true, which would again be a failure to behave randomly.

Conclusion

We have explained the algorithm we developed but not the many blind alleys we encountered. Our initial requirement was for a portable generator to be included in a set of Pascal test programs (see reference 3). Initially, we were unsure that the objectives could be met at all. Retesting the algorithm whenever making even the smallest change made the work tedious. In all, the project took about three months of effort, a lot for 16 lines of code but well worth it. ■

REFERENCES

1. Wichmann, B. A., and I. D. Hill. "A Pseudo-Random Number Generator." NPL report, DITC, 6/82.
2. Grafton, R. G. T. "Algorithm AS 157: The Run-up and Run-down Tests." *Applied Statistics*, vol. 30, pages 81–85.
3. Wichmann, B. A., and Z. J. Ciechanowicz, editors. *Pascal Compiler Validation*. New York: Wiley-Interscience, 1983.

Brian Edginton

Installing Memory-Resident Programs with C

Using C programs to extend DOS

This project started as a challenge to make a friend's calculator program load and remain resident in memory on an IBM PC. Techniques for making an assembly language program stay resident have been presented in many articles and books, but writing the tools to make a C program resident was a new adventure. I developed all the examples in this article with Lattice's C Compiler 3.0 and Microsoft's Macro Assembler 4.0. I've tried to make the code as portable as possible, but some modification will be necessary for different compilers and languages. In the listings, I've noted any compiler-dependent variables. [Editor's note: *William J. Claff's article, "Writing Assembly Language Interrupt Routines," in BYTE's Fall 1986 special issue "Inside the IBM PCs" contains additional information on the topic of DOS extension via memory-resident programs.*]

What Is a Resident Program?

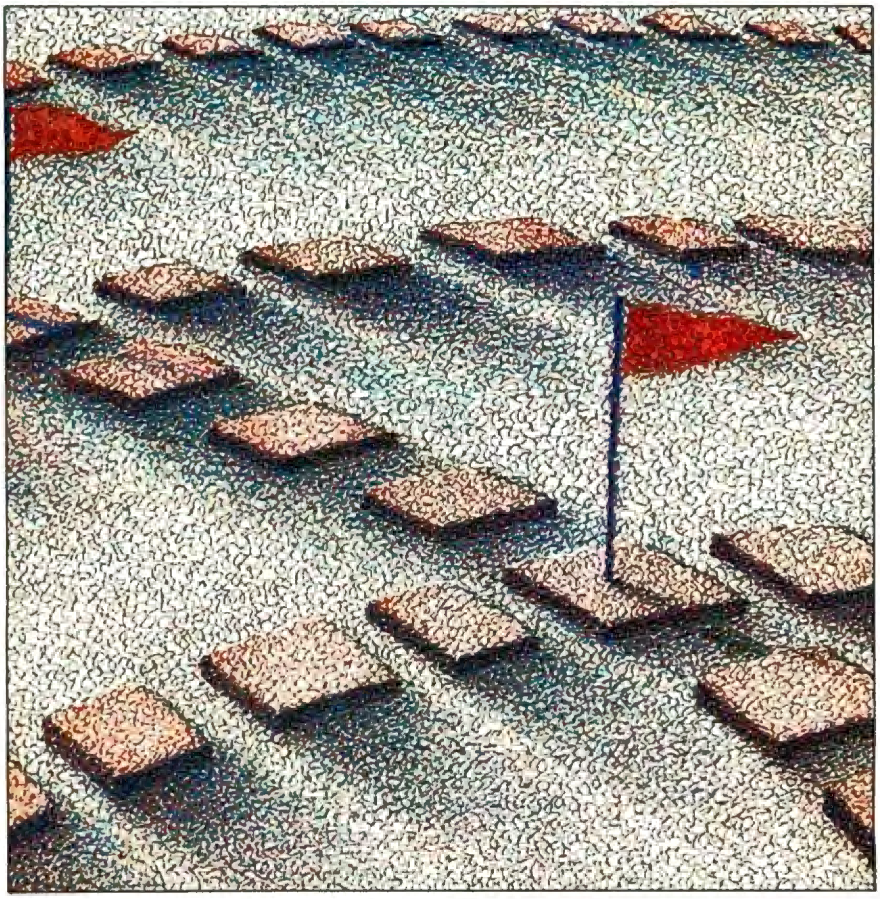
DOS uses a set of pointers called *storage blocks* to keep track of allocated and unallocated memory in the system. For each loaded program, these pointers indicate the address of its PSP (program segment prefix) and the program's length in segments. Also, a flag indicates whether or not the memory pointed to by the storage block is allocated. When a program module is loaded and executes an INT 27H (terminate but stay resident) or DOS function 31H (keep process), COMMAND.COM makes sure that this program becomes a part of DOS. This means that the storage block, PSP, and program module remain in memory and are not reallocated.

The principles behind making a program resident are straightforward: Find the length of the program, shove it into a register, and call a documented function. DOS function 31H requests that the program size in paragraphs is to be placed in the DX register and the return code, if any, in AL.

As shown in listing 1, it is a simple matter to make a program resident. If you have a utility like Norton's SI or SMAP, you can verify that the program is indeed resident by looking at the address location of the next program to be loaded. You can also examine the amount of free memory displayed by the CHKDSK utility before and after running the program.

Usually, you want to write a program that does more than just take up memory.

continued



Brian Edginton is the president of Edginton and Associates, where he is a programming consultant specializing in UNIX, C, networks, and Prolog. He can be contacted at 551 Ramona Ave., Salt Lake City, UT 84105.

ILLUSTRATION BY DAVE RIDLEY

Listing 1: *A simple terminate-but-stay-resident C program.*

```
#include <dos.h>
main()
{
extern int _TSIZE;       /* size of program in paragraphs */
   union REGSS input,output;

        input.x.ax = 0x3112;     /* 31 -> AH and Return Code */
        input.x.dx = _TSIZE;     /* program size (Lattice)   */
        intdoss(&input,&output); /* function call 31  */
        }
```

Listing 2: *A more involved version of listing 1. This program indicates its presence with a "signature" written to the* INT 67H *vector. In this way, it can determine if it has already been installed.*

```
#include <stdio.h>
#include <dos.h>

main()
{
        install();

        cpush();
        printf("Hello world\n");
        cpop();

}


install()
{
        extern int _TSIZE;              /* size of program in paragraphs (Lattice) */
        extern struct storage;
        union REGSS input,output;
        struct SREGS segregs;
        short nu_entry,nu_cs;

        /* test for signature of installation.  In this example we will
         * put the signature in at the int67 vector and test for it there.
         */
        input.x.ax = 0x3567;
        intdoss(&input,&output);
        if(output.x.es == 0xffff && output.x.bx == 0xffff){
                printf("This test already installed...\n");
                exit(0);
        }

        nu_entry = (short)main + 6;
        printf("%x - ax\n",storage.rax);

        segread(&segregs);      /* get current registers */
        nu_cs = segregs.cs;

        input.x.ax = 0x3560;
        intdoss(&input,&output);
        printf("ES:BX from int60 is %x:%x\n",output.x.es,output.x.bx);

        input.x.ax = 0x2560;    /* set vector register */
        input.x.dx = nu_entry;  /* address of new vector */
        input.x.ds = nu_cs;     /* current cs */
        intdoss(&input,&output);

        input.x.ax = 0x3560;
        intdoss(&input,&output);
        printf("ES:BX from int 60 is %x:%x\n",output.x.es,output.x.bx);
```

continued

```
        input.x.ax = 0x2567;      /* sign your work */
        input.x.dx = 0xffff;
        input.x.ds = 0xffff;
        intdoss(&input,&output);

        input.x.ax = 0x3100;
        input.x.dx = _TSIZE;
        intdoss(&input,&output);

        exit(0);
}
```

You want a program that responds to a system interrupt and supplies you with some sort of information. It should also be well behaved and operate within the constraints of DOS.

My design of this system had several goals: modular design for universal application, optimum memory usage, and correct processing of interrupts.

Modular design means that I can, with minor revisions, make this program load any module that meets the requirements for a resident interrupt-processing program. To determine these requirements, I made a careful analysis of what my compiler did to a program and what my linker did to the object modules supplied to it. If you are using some other compiler and/or linker, these requirements might be different. Listing 2 is an example of a completed sample system. Since we have little control right now over anything that happens above main( ), we'll start there and analyze what happens. Refer to listing 3, which is a disassembled version of the top-level code in listing 2.

Listing 3: *A disassembled form of the top-level code in listing 2.*

```
main()
{
0000                                PUSH   BP
0001                                MOV    BP,SP
0003   install();                   CALL   install
0006   cpush();                     CALL   cpush
       printf("Hello world\n");
0012   cpop();                      CALL   cpop
0015                                POP    BP
0016                                RET
}
```

We'll create the routines cpush( ) and cpop( ) later to help get into and return from the interrupts. Since main( ) is really just another function called by the compiler's entry module, which is what is loaded by EXEC, the BP register is saved and then set to the new SP. This is a requirement of any functions called from another routine that might pass any information on the stack; it lets the functions reference that information on the stack via the BP register while still letting new data be pushed on the stack as required.

You should design entry into a resident program so that any parameters are passed in the DOS communications area or in registers, *and not on* the stack. Once a program module is installed in memory, you want to ignore the call to install( ). Although this uses 6 bytes of memory, passing the address of the call to cpush( ) to the interrupt vector is the most efficient way to install the module. All function names are made common in a C compiler, so you can create the new vector IP by doing

nu_entry = (short)main + 6;

Casting main to a short keeps it consistent with the way the rest of the register structures are typed. The nu_entry now points to the desired entry point in the program. Since you did not need to use the compiler-generated PUSH BP and you are returning from an interrupt, you can ignore the POP BP and the RET that the compiler put at the end of main.

The install( ) function is straightforward. In this example, I borrowed an unused function call's vector to leave a signature or message to the calling program already installed. To increase the safety of this routine, you could first verify that the interrupt vector is filled with zeros. If it is not, check another vector until you find one with no vector already installed. Alternatively, you could indicate that the module is already installed by setting a flag in memory, but you would have to choose a byte that you are certain would not be used by some other routine.

Another method for routines that handle passed values (i.e., video calls, put and get char, and string calls) would be to detect a certain value and return an "already installed" message to the installation program. Listing 4 shows a segment of code that you could modify to perform this method of signature detection.

Next, you must decide how to best utilize the memory taken up by the program. Since I used function call 31H instead of INT 21H to terminate the program, loaded programs can exceed the 64K-byte limit imposed by the latter. I can use .EXE programs with stack and data segments defined—not just .COM programs. A .COM program uses as much memory as the machine has left when it is loaded; if the program is going to stay resident, it has to return its unused memory to the system.

I release the memory that contains the program's copy of the environment using routine d_env( ). On entry, the ES and DS (and SS and CS for a .COM program) segment registers point to the PSP at offset 0. Listing 5 shows the code for d_env( ). I load ES with the address of the segment containing the copy of the environment and call DOS function 49H (free allocated memory).

If the program is a .COM file, you can reduce its size using the routine shrink( ) (see listing 6). This function sets the memory used by a program to the size of the program module in paragraphs. If you write .COM programs, be sure that you allocate stack area before calling this function. If you use shrink( ), you should call it before calling d_env( ) so that the ES register contains the correct information for the call to function 4AH (modify allocated memory blocks). You could modify the code to perform both operations with one call; this would increase speed and reduce program size.

The last area I will cover concerning memory management is heavily influenced by my familiarity with the Lattice compiler. This compiler uses a file to set up the segment registers, handle stack and memory allocations, report errors like

continued

Listing 4: *A method of signature checking to determine whether a routine is already installed.*

```
calling(program)
{
        union REGSS in,out;

        ......
        in.x.ax = 0x0088;
        intdoss(int_num,&in,&out);
        ........
}

int_num

        switch((int)in.x.ax){
        case 0x88:
                return installed
        case 0xXX
                do something else
```

Listing 5: *Source code for the* d_env( ) *routine.*

```
; d_env is used to deallocate the memory used
; by a program's copy of the environment.

        TITLE      ENVIRONMENT DEALLOCATION
        SUBTTL     Copyright 1986 Brian Edginton
        NAME       D_ENV
        INCLUDE    DOS.MAC

        PSEG
        PUBLIC  D_ENV
        IF      LPROG
D_ENV   PROC    FAR
        ELSE
D_ENV   PROC    NEAR
        ENDIF

        PUSH    BP
        MOV     BP,SP
        MOV     ES,[DI+2CH]
        MOV     AX,4900H
        INT     21H
        POP     BP
        RET
D_ENV   ENDP
        ENDPS
        END
```

Listing 6: *Source code for the* shrink( ) *routine.*

```
        TITLE      PROGRAM SHRINKER
        SUBTTL     Copyright 1986 Brian Edginton
        NAME       SHRINK
        INCLUDE    DOS.MAC

        PSEG
        PUBLIC  SHRINK
        IF      LPROG
SHRINK  PROC    FAR
        ELSE
SHRINK  PROC    NEAR
        ENDIF

        PUSH    BP
        MOV     BP,SP
```

continued

$2000? That's Too Darned High!

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```
        MOV     BX, ????  ; PROGRAM SIZE + ANY
                          ; STACK YOU NEED.
        MOV     AX,0X4A00 ; CALL MODIFY
                          ; ALLOCATED MEMORY
        INT     21H       ; BLOCKS ROUTINE.
        POP     BP
        RET
SHRINK  ENDP
        ENDPS
        END
```

My main concern is with saving registers because of the amount of calls normally found in a C program.

Listing 7: *Source code for the* cpush( ) *and* cpop( ) *routines used in listing 2.*

```
; These routines emulate a push-all of the
; registers and segregs before an interrupt
; is executed, and then pop them in the
; same order.
; Note: cpopt is used for testing so we use
; a ret instead of an iret.


        TITLE    REGISTER MANIPULATION ROUTINES
        SUBTTL   Copyright 1986 by Brian Edginton
        NAME     STORE
        INCLUDE  DOS.MAC

        DSEG
; Register and stack storage structure follows.
S       STRUC
        RAX     DW      ?
        RBX     DW      ?
        RCX     DW      ?
        RDX     DW      ?
        RSI     DW      ?
        RDI     DW      ?
        RDS     DW      ?
        RCS     DW      ?
        RSS     DW      ?
        RES     DW      ?
        RIP     DW      ?   ; Storage for 2 words
        RBP     DW      ?   ; pushed for iret
        RFL     DW      ?   ; and flags.
        RRT     DW      ?   ; Return address
                            ; pushed for call.
S       ENDS
STORAGE S       <0,0,0,0,0,0,0,0,0,0,0,0>
        ENDDS


        PSEG

        ;  name - cpush()
        ;  Pushes all the registers and segregs
        ;  and flags onto the stack.  Use with
        ;  cpop() to restore in correct order.

        PUBLIC  CPUSH
        IF      LPROG
CPUSH   PROC    FAR
        ELSE
CPUSH   PROC    NEAR
        ENDIF

        POP     STORAGE.RRT
        POP     STORAGE.RIP       ; SAVE RETI IP,
        POP     STORAGE.RCS       ; SAVE RETI CS,
        POP     STORAGE.RFL       ; SAVE THE FLAGS,
        MOV     STORAGE.RAX,AX    ; AND TUCK AWAY
```

continued

stack overflows, handle command-line arguments to change the stack size, redirect I/O, and perform other incidental operations. The code for all this is in the c.asm file; its object module is in c.obj. This code is loaded before main( ) and cannot be efficiently deallocated by any means other than actually editing out unused portions of c.asm and recompiling the file. A knowledgeable programmer should be able to remove large portions of c.asm for many applications; I have reduced considerable space in mine.

Interrupts

Now that I've shown you how to load programs into memory and keep them resident, I want to examine the best possible way to maintain "nice" programs. My main concern is with saving registers and flags because of the amount of calls and subroutines normally found in a C program. (You can see an example of this in listing 1.)

Since I passed the address of cpush( ) to the interrupt vector, the program's first act when it is entered is a call to cpush( ). This call pushes a return address on the stack, one that would not be there if the code were generated in assembly language. This problem is repeated throughout the program, so it must be handled early on.

The three modules in listing 7 show one of the fastest and most efficient solutions I found. Upon entry into the program, I call cpush( ). This routine stores the short-call return address, the interrupting program's return CS and IP, and the FLAGS that are pushed onto the stack. It then stores the registers and segment registers in its own allocated memory. The short-call return address is then pushed back onto the stack and the function returns to the body of the program.

After the interrupt routine does its work (in the example given in listing 2, it prints "Hello world"), it calls cpop( ) to return to the interrupted program. The cpop( ) routine emulates a pop of all the registers that should have been pushed onto the stack upon entry into the interrupt handler and then does an IRET. (For debugging purposes, I have also included the code

continued

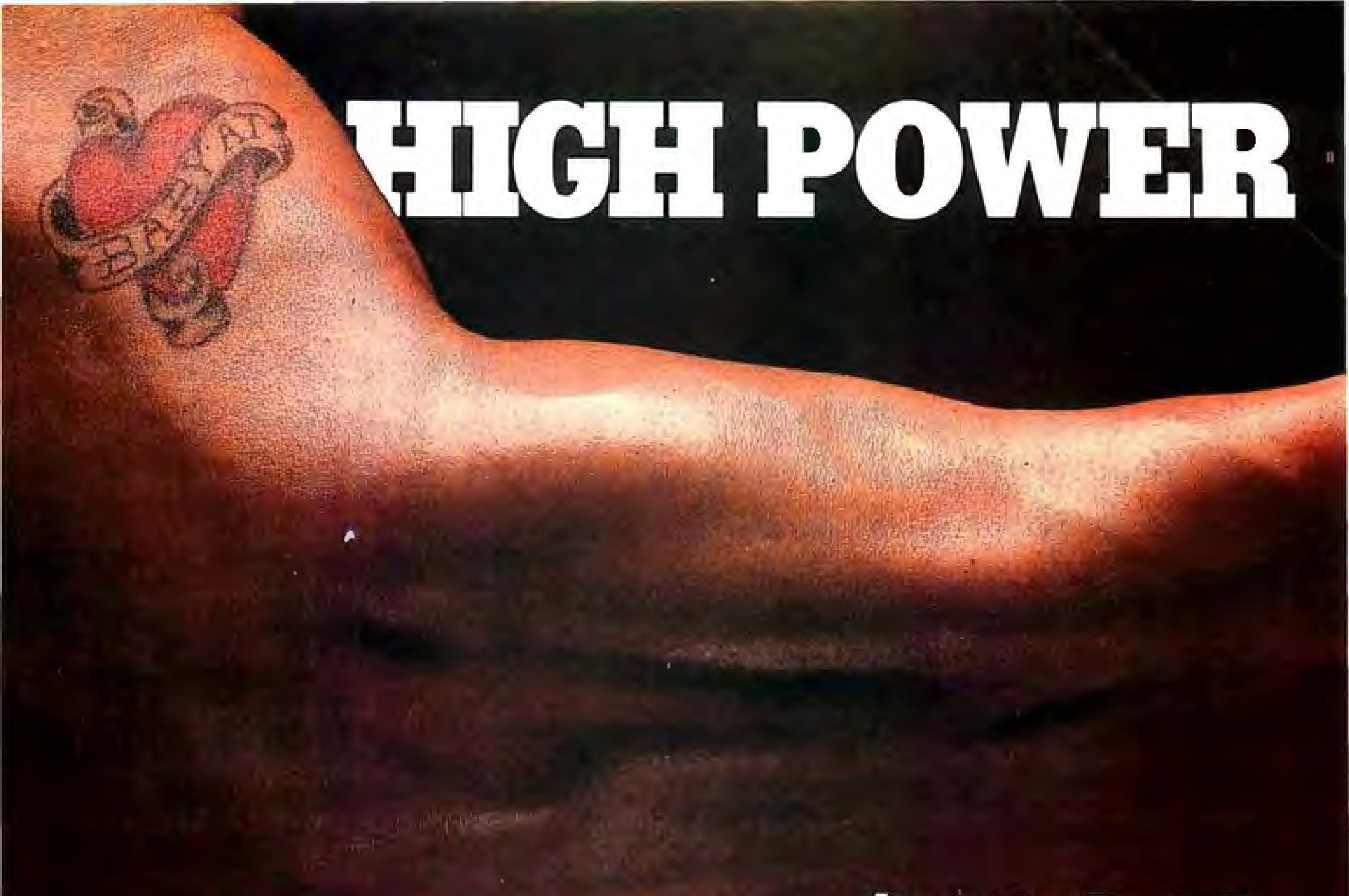
```
          MOV     STORAGE.RBX,BX   ; ALL REGISTERS.
          MOV     STORAGE.RCX,CX
          MOV     STORAGE.RDX,DX
          MOV     STORAGE.RDI,DI
          MOV     STORAGE.RSI,SI
          MOV     STORAGE.RDS,DS   ; GET THE SEGMENT
          MOV     STORAGE.RSS,SS   ; REGISTERS.
          MOV     STORAGE.RES,ES
          PUSH    STORAGE.RRT      ; PUT CALL RETURN
                                   ; ADDRESS ON STACK.
          RET
CPUSH     ENDP

          PUBLIC  CPOP
          IF      LPROG
CPOP      PROC    FAR
          ELSE
CPOP      PROC    NEAR
          ENDIF

          PUSH    STORAGE.RFL      ; RESTORE FLAGS.
          PUSH    STORAGE.RCS      ; RESTORE CS,
          PUSH    STORAGE.RIP      ; THEN IP.
          MOV     ES,STORAGE.RES
          MOV     DS,STORAGE.RDS
          MOV     SI,STORAGE.RSI
          MOV     DI,STORAGE.RDI
          MOV     DX,STORAGE.RDX
          MOV     CX,STORAGE.RCX
          MOV     BX,STORAGE.RBX   ; READY FOR IRET
          MOV     AX,STORAGE.RAX   ; WITH OLD IP AND
          IRET                     ; STUFF ON STACK.
CPOP      ENDP

          PUBLIC  CPOPT
          IF      LPROG
CPOPT     PROC    FAR
          ELSE
CPOPT     PROC    NEAR
          ENDIF
          PUSH    STORAGE.RFL      ; RESTORE FLAGS.
          PUSH    STORAGE.RCS      ; RESTORE CS,
          PUSH    STORAGE.RIP      ; THEN IP.
          MOV     ES,STORAGE.RES
          MOV     DS,STORAGE.RDS
          MOV     SI,STORAGE.RSI
          MOV     DI,STORAGE.RDI
          MOV     DX,STORAGE.RDX
          MOV     CX,STORAGE.RCX
          MOV     BX,STORAGE.RBX   ; READY FOR IRET
          MOV     AX,STORAGE.RAX   ; WITH OLD IP AND
          RET                      ; STUFF ON STACK.

CPOPT     ENDP
          ENDPS
          END
```

for cpopt( ), which is similar to cpop( ) except that cpopt( ) exits via a RET instruction.)

Summary

I've demonstrated a simple interrupt-processing program that remains resident in memory. Programs written using these techniques should have proper attention to good program structure and correct manipulation of pointers and addresses.

This project turned out to be more ambitious than I originally thought. The entry and exit routines posed the most problem; testing and debugging sometimes left the machine in a corrupted state. Be certain that your C programs can pass lint before using them; remember, you are creating an extension of DOS. I did notice that including structures in a program compiled with Lattice increased the address of the entry point by three. It makes a call after main( ) to set up the memory for the structs and/or unions. I am interested in feedback about improving any of these techniques. ■



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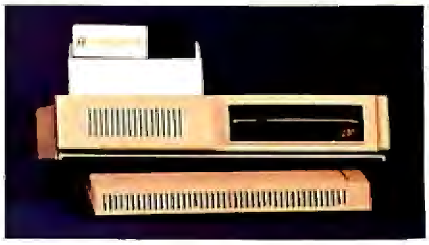

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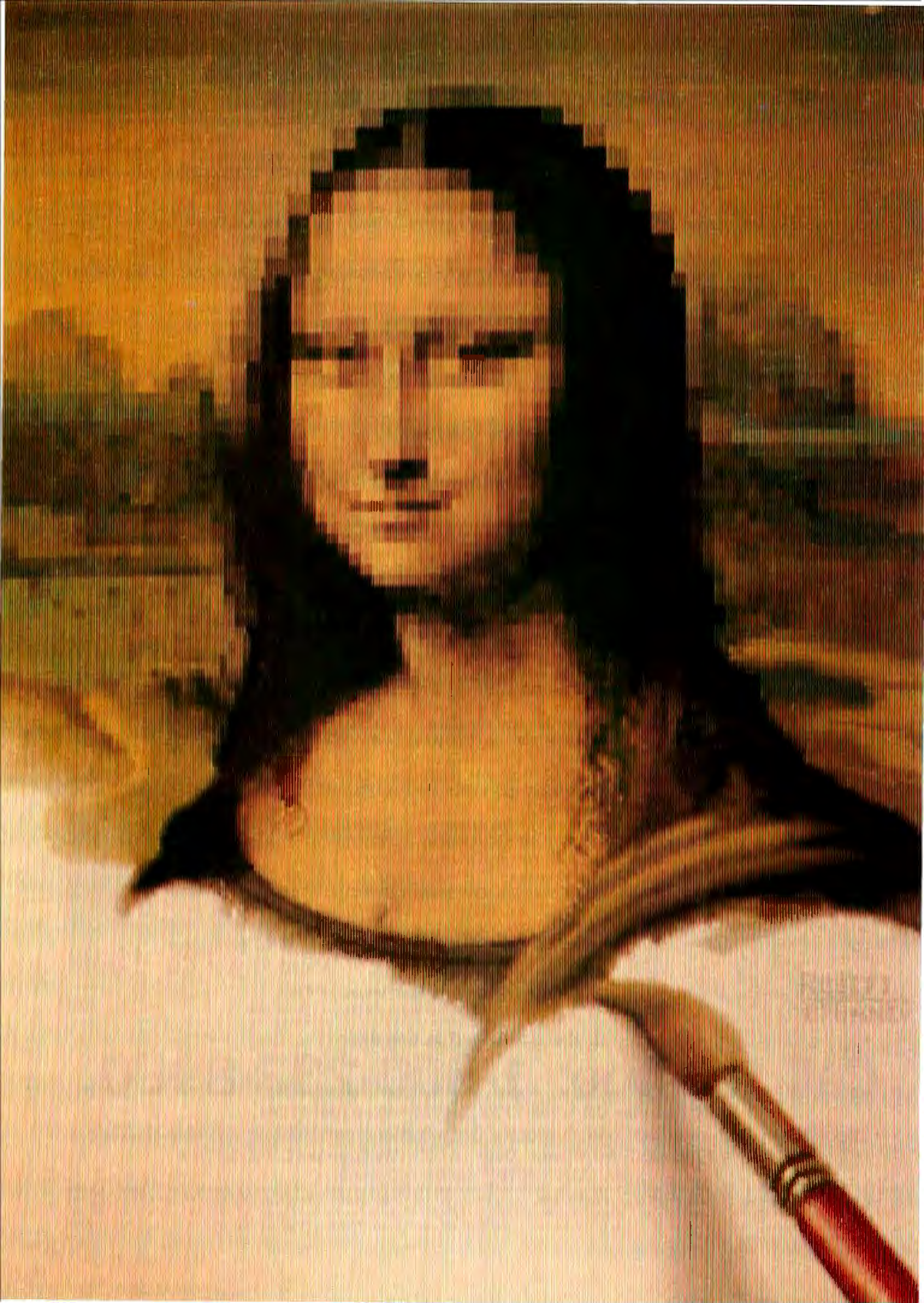


Image Processing

IN THE SIMPLEST SENSE, image processing means manipulating an image. This could be as mundane as changing the contrast on your TV set. With the advent of digital computers, however, researchers have found that there is literally more to most images than meets the eye.

This month's theme focuses on digital image processing, an exciting technology that breaks images down into a series of digital values representing such things as the brightness and color at every given point in the image. By manipulating this data via computer, researchers have been able to improve images, uncover new information in them, and even begin to interpret their meaning, the initial step in developing machines that can "see."

The first article, "Probing Space by Camera" describes the development of image processing at NASA's Jet Propulsion Laboratory, and its transition from a fanciful idea to an integral part of man's exploration of space. Perhaps the first real "spin-off from space," image processing's initial down-to-Earth application was in biomedical studies, an area where scientists are making astounding advances, as shown in the text box accompanying the article.

Our journey through space and time then takes us back to the *Mona Lisa*, who has been receiving a computerized face-lift thanks to image processing. In "Digital Image Processing in Art Conservation," Dr. John Asmus details his work with the most famous painting of all time. Then, on a more modern note, we will examine the controversial practice of "colorizing" classic movies, thanks to—or no thanks to, depending on how you look at it—image processing.

Ben Dawson, coauthor of the award-winning article on how image processing helped find the long-lost Titanic (see "Finding the Titanic," March 1986 BYTE), has written "Introduction to Image Processing Algorithms," a clear but in-depth look at the computational basis for image enhancement, complete with a set of C routines that you can adapt to your own computer system.

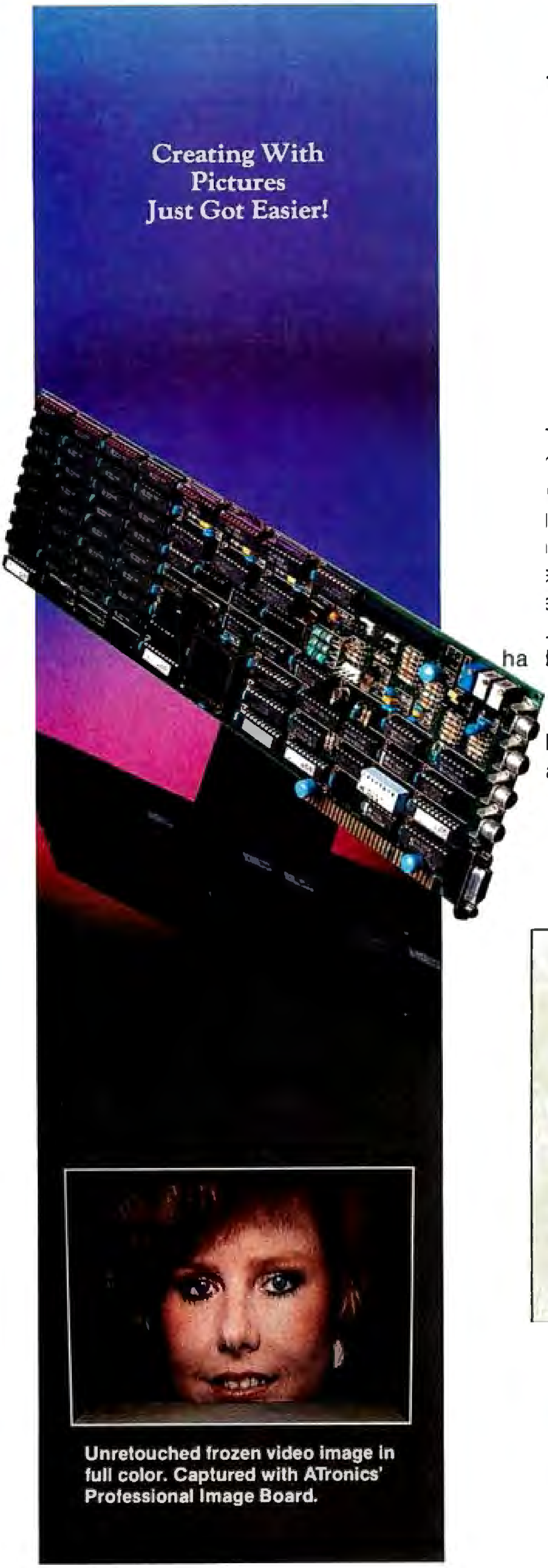
Charles McManis, who works for a maker of large, expensive workstations, has written "Low-Cost Image Processing," which tells you how to turn an Amiga into your own image processing workstation. He has also written a couple of C programs that are ready to run on the Amiga.

Image processing is not desktop publishing, although some of the devices involved with desktop publishing, such as image scanners and cameras, use image processing technology at their lowest levels to improve images after scanning. The article on PreScript describes a proposed standard for capturing and enhancing images that are to be incorporated into desktop publishing and other applications.

Nor does image processing include paint programs, by which you physically move bits around with the use of a pointing device. But as paint programs become more powerful, the lines—if you'll pardon the pun—are getting harder to draw between technologies. The TrueVision Image Processing System, for example, uses image processing at low levels to perform operations like tinting and shading. In this month's review section, Robert Tinney, BYTE's quintessential cover artist, reviews the TrueVision system, which he used to produce the cover and section art for this issue.

Image processing, once a game that could only be played on large, expensive computer systems, is the latest area of computer science to fall before the burgeoning power of small computers. Like data processing and word processing, image processing is beginning to crest into a widespread phenomenon; this month's theme will help you catch the wave early.

—Ken Sheldon, Technical Editor



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Probing Space by Camera

The development of image processing at NASA's Jet Propulsion Laboratory

Ken Sheldon

EARLY MORNING, JULY 31, 1964. The mood at NASA's Jet Propulsion Laboratory (JPL) was tense; the American space program was in trouble.

Since the onset of the space age in 1957, the Soviet Union had been racing ahead of the United States, scoring an impressive string of firsts: Sputnik I, the first man-made satellite to successfully orbit Earth; Sputnik II, which carried the first living creature (a small dog) into space; Luna I, the first space probe to fly past the moon; Luna II, the first probe to crash on the moon; and Luna III, which transmitted back to Earth the first images of the far side of the moon ever seen by man.

Meanwhile, the United States' early probes were disasters. They blew up on the launch pad. They failed to escape Earth's gravity.

The Ranger probes, designed to return photographs and data from the moon in preparation for landing a man on the lunar surface, had also been riddled with failures: Two of them failed to leave Earth orbit and came flaming back into the atmosphere; one crashed mutely on the moon, none of its equipment having functioned since lift-off; and two escaped Earth orbit but missed the moon by thousands of miles and refused to point their cameras in the right direction.

Ranger 6 had come heartbreakingly close. It performed flawlessly, leaving Earth orbit and impacting on the moon's Sea of Tranquillity according to plan, but a freak accident that occurred at lift-off prevented its television cameras from turning on or relaying a single image back to Earth.

As Ranger 7 lifted off from Cape Canaveral on July 28, 1964, a congressional investigation was under way, with some members of Congress calling for JPL—and the space program—to shut down. JPL researchers had been unable to determine the cause of the accident that crippled Ranger 6's cameras. And no one knew whether the changes they had made to Ranger 7's cameras would prevent the problem from recurring. No more Ranger probes were waiting in the wings; Ranger 7 was the space program's "last best hope."

On the morning of July 31, 1964, Ranger 7 neared its lunar destination. Reporters and JPL staff waited anxiously, the memory of Ranger 6's failure still fresh in their minds.

At 6:08 a.m., the word came from Goldstone Tracking Station to JPL: Ranger 7 was transmitting full-power video signals from the moon. In the 17 minutes before its impact onto the lunar surface at the Sea of Clouds, Ranger 7 transmitted the first highly detailed images of the moon—over 4300 of them—back to a cheering JPL. As NASA historian R. Cargill Hall says, "Ranger 7 was a resounding, a crashing success." (*Lunar Impact, A History of Project Ranger*, U.S. Government Printing Office, 1977.)

The Image of Ranger

Throughout the long days of waiting for a successful Ranger mission, Dr. Robert Nathan had been perfecting techniques that would improve the images sent back from the moon. Nathan, a crystallographer by training, had come to JPL from the California Institute of Technology, where his research involved creating images of the microscopic structure of crystals by computer processing their diffraction patterns. His assignment at JPL was to apply his knowledge of digital techniques to the data being sent back from America's early space probes.

Nathan had studied the images captured by the analog cameras on the Soviet Union's Luna III. The photographs were grainy, out of focus, and distorted by signal noise. He knew he could do better.

"Prior to that time, both the Americans and the Soviets were using analog techniques to transmit pictures from space, and the Soviets were using analog methods to enhance the pictures," Nathan says. "I could see right away that manipulating image data was too difficult if everything remained in analog form."

Nathan suggested digitizing the analog video images and adapting the techniques of one-dimensional signal processing to process the two-dimensional images with the help of computers. It was the germ of a great idea.

The Vidicon television cameras that sent video signals from Ranger 7 back to Earth were the best available at the time. But they had three problems.

The first problem was geometric distortion. The beam that swept electrons across the face of the tube in the spacecraft's

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camera moved at nonuniform rates that varied from the beam on the playback tube reproducing the image on Earth. As a result, the pictures were sometimes lopsided, stretched, or otherwise distorted.

Another problem with the cameras was photometric nonlinearity. When aimed at a uniform white or gray field, the cameras displayed a brightness in the center and a darkness around the edge caused by a nonuniform response of the phosphor on the tube's surface.

Finally, oscillation in the cameras' electronics was "bleeding" into the video signal and producing a rug-like noise pattern visible on the images' high-resolution playback.

Nathan designed a set of techniques to correct for the cameras' limitations. Correcting for the geometric distortion involved a "rubber sheeting" operation that "stretched" the images to match a preflight calibration and return them to their correct shape (see photo 1). The photometric error was measured on the ground and then filtered out of the images transmitted from space. To remove the oscillation noise, Nathan's team isolated an area of the image that should have been featureless, digitized the pattern there, and used that as a filter to subtract the pattern from the rest of the images (see photo 2).

The image-enhancement techniques developed by Nathan and others at JPL were used successfully on the images from Rangers 7, 8, and 9, which returned a total of 17,267 images of the moon. New techniques were discovered in the process: Nathan developed an image-enhancement technique known as deconvolution, which deblurred the images and improved resolution dramatically (photo 3). Thomas Rindfleisch used the Ranger images, the lunar shadows they revealed, and knowledge of the sun's angle to develop a method of photoclinometry. This technique produced elevation maps of the moon, which helped researchers select appropriate landing sites for later probes.

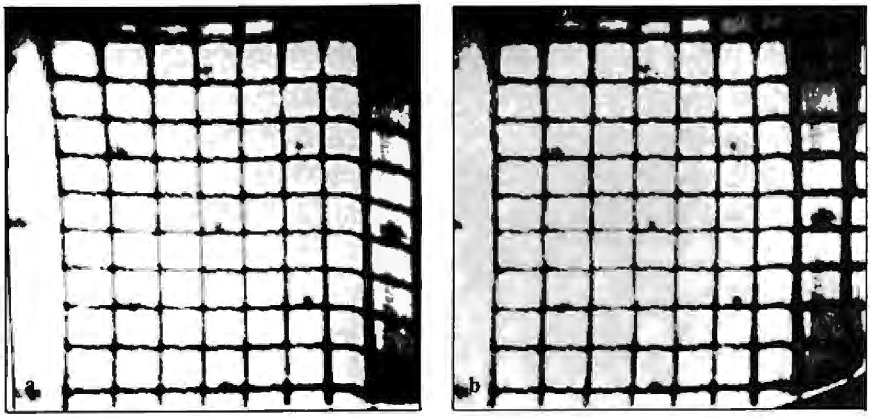

Photo 1: *Correcting for the geometric distortion of the Ranger cameras involved stretching the images to match a preflight calibration. (a) A calibration image from one of the Ranger's Vidicon cameras; (b) the image after stretching to correct for the camera's distortion. (All photos accompanying this article are courtesy of NASA/JPL.)*

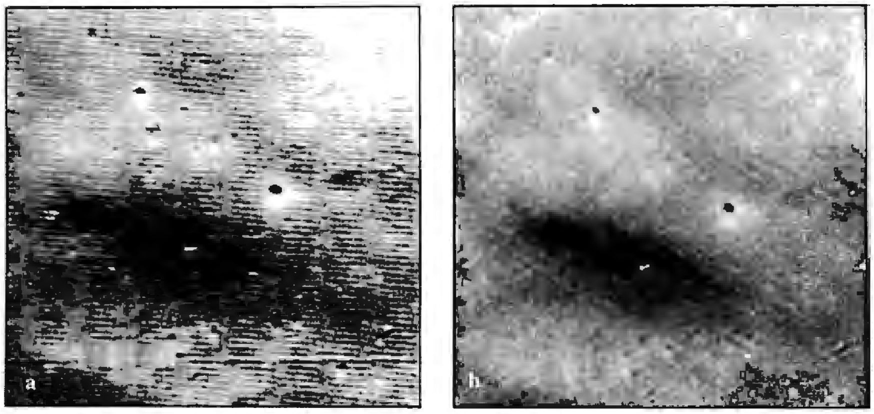

Photo 2: *To remove oscillation noise from Ranger images, JPL researchers isolated an area of the image that showed the noise pattern (a) and used that pattern as a filter to subtract the pattern from the rest of the image (b).*

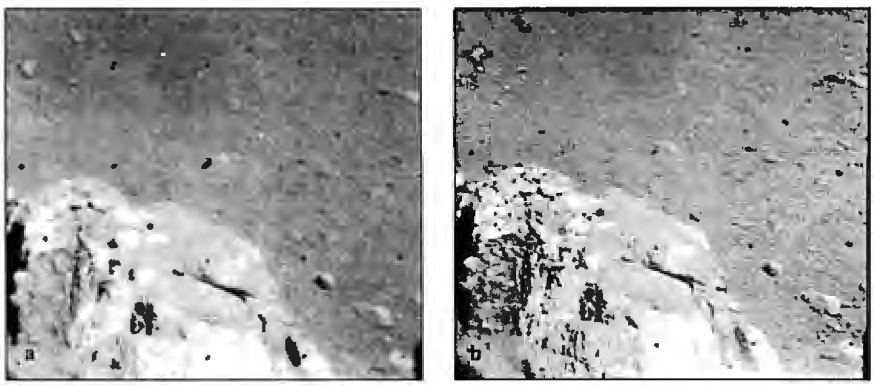

Photo 3: *Deconvolution, a technique developed during the Ranger missions, involves measuring a camera's tendency to blur high-frequency details and subtracting it from the transmitted images, as shown in these before (a) and after (b) images from a later Surveyor mission.*

On to Mars

Exactly four months after Ranger 7 lifted off from the pad at Cape Canaveral, Mariner 4 headed for Mars. It was the first of the Mars/Venus probes to carry a camera. It was also the first space probe to send its signals back to Earth in digital form, a format necessitated by the 48 million miles over which the data had to travel. At that distance, an analog signal would have been virtually indistinguishable from the background noise of space.

The data came in at the tedious rate of 8 bits (one pixel) per second. Nathan says, "It took eight hours for that very first frame of Mars to come in, and we didn't quite know what we were getting. Half of the image was dark sky, the other half was almost saturated white."

The researchers later realized that the problem was not with JPL's cameras but with Martian weather. Mariner 4 had arrived on an extremely cloudy day on Mars—a planetwide sandstorm, in fact—and the surface was hidden from the probe's cameras. Only later, on the tenth frame, did the sky clear up, and Mariner

4 sent back the first close-up images of the red planet's crater-pocked surface (see photo 4).

Image enhancement had proved its worth. In 1965, Nathan, Fred Billingsley, and Ben Martin of JPL's Central Computing Facility (where the image processing operations had been handled until then) convinced JPL to establish the Image Processing Laboratory (IPL) as a division of JPL, with its own computing facility built around an IBM 360/44.

With the establishment of the IPL, Nathan and Billingsley recommended that all future probes transmit their images back to earth digitally. However, plans for the next series of lunar probes, the Surveyor missions, were too far along for changes, and the probes transmitted analog video signals like those from the Ranger probes. Between 1966 and 1968, five Surveyor probes landed successfully—and softly—on the moon, transmitting back to the IPL over 87,000 analog images, which were digitized, enhanced, made into topographic maps, and so on (see photo 5). The images were invaluable in studying the nature of the moon's surface in preparation for the first manned landing there.

The Mariner missions were not over, however. Two probes remained, one each to Mars and Venus, and they carried digital equipment like that on Mariner 4. The cameras on the Mariner probes had a problem similar to that of the Ranger cameras: The images were marred by a noise pattern from the probes' power supply—they looked as if they were printed on herringbone tweed. Thomas Rindfleisch applied nonlinear algebra in a program called Despike, which performed a two-dimensional Fourier transform to produce a frequency spectrum with spikes that represented the noise elements (typically the highest frequency elements in an image). The program isolated the noise spikes, removed them, and transformed the data back into an image from which the herringbone pattern had been removed.

The Picture of Health

As the Mariner and Voyager probes continued, researchers at JPL began experimenting with the application of image-enhancement techniques to biomedical problems. Nathan applied the technology to electron microscope images of catalase (a liver enzyme). Research engineer Robert Selzer (now supervisor of the biomedical image processing group) ran x-rays of the human chest and skull through the computer, with a dramatic improvement in the visibility of blood vessels in the resulting images (see photo 6).

In 1967, Nathan and Selzer described their research at a UCLA School of Medicine forum sponsored by the National Institutes of Health. The NIH was so impressed with the results of their work that it offered to fund increased research in the area of biomedical image processing. Accepting the money took some maneuvering—although originally created to help the military with jet-assisted takeoff rockets, JPL had been exclusively a NASA facility since NASA's establish-

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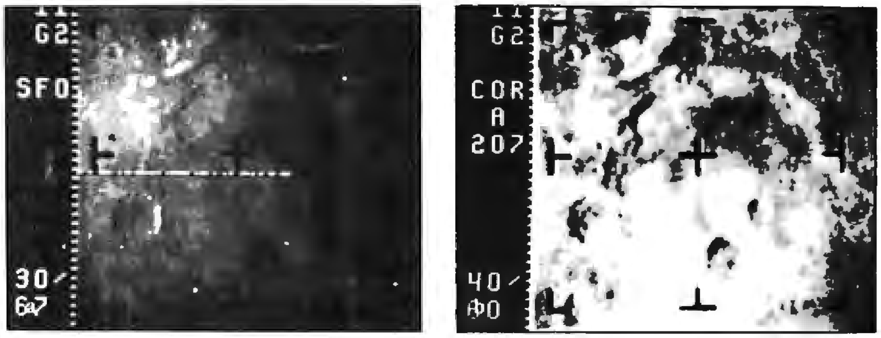

Photo 4: *(a) An image of Mars sent back by Mariner 4, among the first close-ups of the red planet seen by the human eye; (b) the same image after image enhancement.*

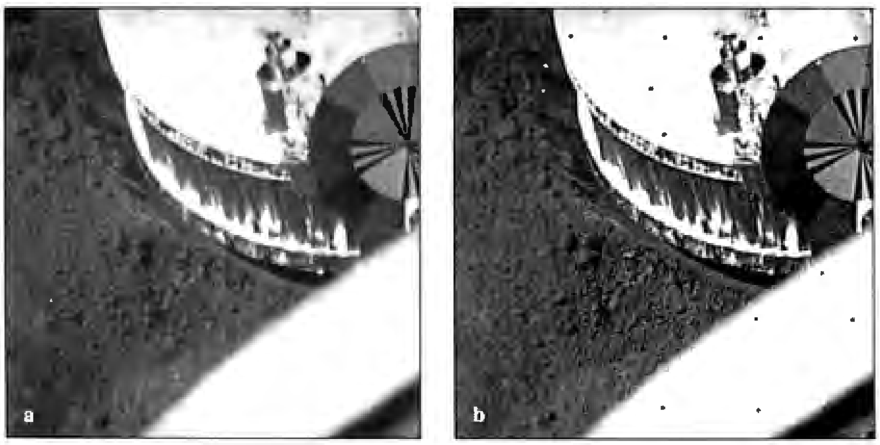

Photo 5: *By deconvoluting the images from the Surveyor probes of the moon (a) their resolution was dramatically improved (b).*

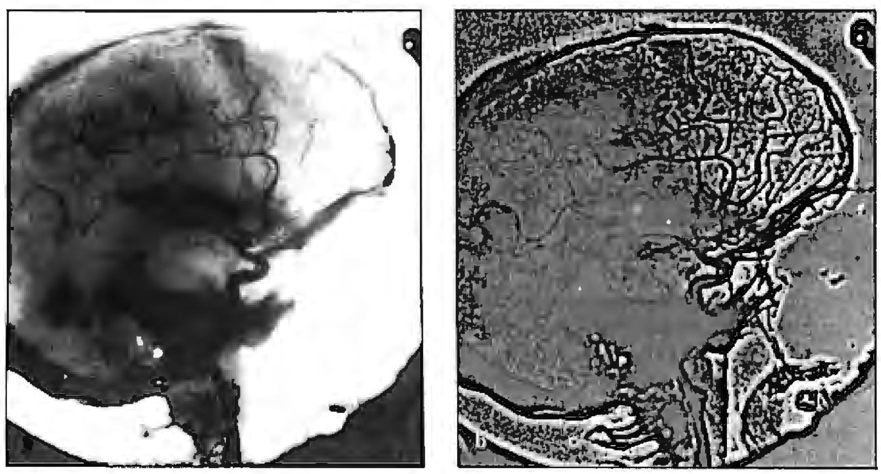

Photo 6: *Under the direction of Robert Selzer, the JPL's biomedical studies program helped pioneer the use of image processing in biomedical applications with images such as these. Note the dramatic improvement in the visibility of arteries in the front of the brain between these unprocessed (a) and enhanced (b) images of the human skull.*

From Outer Space to the Inner Man

Seeing inside the human body was first made possible by Wilhelm Roentgen's discovery in 1895 that x-rays (electromagnetic radiation of much higher frequency than visible light) could be used to create images of the body. When passed through the body, the rays are differentially absorbed by tissues, bones, and organs, and come out the other side to create an image on photographic film. Although the images are often blurred by patients' movement and can be difficult to read because organs are superimposed on top of one another, the photographic x-ray has long been one of the cornerstones of medical diagnostics.

Later discoveries used other types of energy to create images of the human body. Ultrasound, a kind of sonar for the body, uses sound waves that bounce off organs and echo back to a transducer that creates an image. Nuclear medicine uses a special camera that detects the emission of gamma rays from short-lived radioactive substances injected into the body. This technique lets physicians visualize organs, the passage of fluids through the organs, and various metabolic processes.

With the advent of the computer revolution, researchers began adapting digital techniques to these analog technologies. Although the original systems are still in use, several varieties of x-ray, ultrasound, nuclear medicine, and other radiologic systems now use A/D converters to create digital images, which have several advantages over analog images: Noise elements can be removed; contrast can be enhanced; several images of the same area can be "averaged" to remove extraneous elements; blurring caused by patient movement can be reduced; one image can be subtracted from another to show, for example, the contrasting material injected into the blood vessels of the heart, without bones, lungs, and other organs getting in the way (digital subtraction angiography); and the quantization, or measuring, of organs, tumors, etc., is much easier.

The latest imaging technologies are inherently digital. Magnetic resonance imaging (MRI) uses a strong magnetic field and the response of certain atomic nuclei (such as hydrogen) in the body to generate images. The Nobel prize-winning technology of computerized tomographic (CT) scanning uses an x-ray tube that travels around the body and transmits a thin x-ray beam to a detector traveling opposite it. A computer then reconstructs the digitized data to create a highly detailed "slice" through the body, as seen in photo A. Typically, several images are captured, providing a sequence of cross-sectional views through the area of interest.

Interpreting CT scan images can be difficult, even for expert diagnosticians.

Photo A: *A series of cross-sectional slices through the human body, generated by a computerized tomographic scan.*

Photo B: *A Pixar display of an actual human pelvis. In the top half of the frame, the muscles and organs are shown in solid red. In the bottom half of the frame, they are transparent so that the bones can be seen. © 1986 Pixar. All rights reserved.*

Photo C: *A VRT system display of an actual human pelvis using a conceptual internal light source to show up minute textural differences. © 1986 Pixar. All rights reserved.*

Since a series of CT scans covers a finite volume, however, researchers have been able to reconstruct three-dimensional images of the body from the digitized two-dimensional data by "stacking up" the images and displaying them.

At the Johns Hopkins Medical Institutions, Dr. Eliot Fishman, head of the Division of Computed Body Tomography, employs volume-rendering techniques (VRT) on a Pixar Image Computer to re-create three-dimensional images of elusive imaging problems such as acetabular (hip socket) fractures. Researchers at Pixar, a spin-off of Lucasfilm (which created the space scenes for the movie *Star Wars*, among others), have developed a system that merges computer graphics with image processing and lets physicians view high-resolution images of patients' internal structures. These images can be rotated in real time, thanks to a parallel-processing chip that performs image processing operations at 10 million instructions per second.

The Pixar's frame buffer is 48 bits deep; every pixel can be represented by 48 bits—12 each for the colors red, green, and blue and 12 bits that control the degree of transparency. Thus, a physician can instruct the system to display muscles and organs as solid red (photo B, top) or make the organs transparent so that bones can be more easily visualized (photo B, bottom).

According to Dr. Fishman, "Volumetric rendering differs from standard surface rendering of three-dimensional images in that all of the information from the original CT scans can be preserved rather than just the surface boundaries." The VRT system, a collaborative effort between Johns Hopkins, Pixar, and Philips Medical Systems, allows researchers to shade the internal structures with a conceptual light source that shows up minute textural differences (photo C). Note that these photos are not computer-generated graphics, but images of the pelvis of an actual patient, built up from CT scans of the patient.

As new advances are made in both computer and radiological science, the synergy between the two will open up new avenues of exploration for researchers into the mysteries of the human body and provide new ways for physicians to diagnose and treat illnesses.

ment in 1958 and was reluctant to accept money from any other organization. Eventually, JPL approved receipt of NIH funds to pursue three areas of research: electron microscope studies under Nathan; x-ray studies under Selzer; and light-microscope studies under Dr. Kenneth Castleman.

Since its inception, the Life Sciences/Biomedical Program has used image processing to study the progression of atherosclerotic disease in coronary arteries, measure the size and density of muscle fibers to aid in the diagnosis of neuromuscular disorders, develop an automated Pap smear test for the detection of cervical cancer, and evaluate the degree of tissue damage in burn victims. The burn research, under the direction of Victor Anselmo, uses patient data obtained from a multispectral scanner originally developed for NASA's Landsat geological satellite. (See "Introduction to Image Processing" by Jeffrey L. Star, February 1985 BYTE, for a description of Landsat.) Another application of image processing to biomedicine is described in the text box "From Outer Space to the Inner Man" on page 146.

Back to the Laboratory

When funding for Nathan's NIH project ran out, he began looking for other areas of research. He worked on developing an automated method of finding cancer cells in the human body via image processing. Later, he was contracted by NASA's Ames Laboratory in San Francisco to improve the resolution of ultrasound images, which were being used to study the possibly harmful effects of weightlessness on the heart.

Meanwhile, image enhancement had become an integral part of JPL's space probes. With the later Mariner missions to Mars and Venus, the Viking probes of Mars, and the Voyager's spectacular "grand tour" of Jupiter, Saturn, Uranus, and Neptune, the trend turned to digitizing the images as close to the source as possible and transmitting them back to Earth digitally. While the basic image processing techniques changed little, efforts were made to increase the speed, efficiency, and capabilities of the imaging systems on board the probes and on the ground.

But image processing was running into the same bottleneck that other computer-related fields had faced: It was still essentially a slow serial operation. In other words, the basic operations of filtering and geometric transformation were being handled in a step-by-step, one-at-a-time manner by the computer's CPU. As long as data from space probes had been transmitted at only 8 bits per second, Earth-bound computers could easily keep up with the influx of data. But as numerous weather, geological, oceanographic, and commercial satellites were launched and began transmitting data to Earth at high speed, the data was piling up, and researchers could not find the time to process all of it.

At that time, Nathan realized that image processing wasn't being used in other areas of research because the massive amount of data being handled in many real-world applications made the process impractical. The limitations on image processing were not caused by the algorithms but by the available hardware. He began asking whether there was some way of developing new hardware that could perform these operations in parallel, with many chips operating simultaneously. This led to his introduction into the science of VLSI by Dr. George Lewicki, who was in charge of the electronics research area at JPL.

In 1985, Nathan completed work on a VLSI chip with five multipliers and accumulators. A hybrid carrier with seven of the chips mounted on it lets a total of

continued

35 multiply/add operations be performed simultaneously (see photo 7). The VLSI chip uses a pipeline architecture so that each component performs certain functions and passes its intermediate results to the next component. Nathan estimates that the chip can enhance images 50 to 1000 times faster than present computers and perform filtering operations faster than a Cray supercomputer.

Nathan's VLSI chip was first used on the images from Voyager 2, which completed its encounter with Uranus and its moons in January 1986 and will rendezvous with Neptune in 1989. The spectacular pictures of the Uranian moons transmitted from the far-flung Voyager 2 were filtered and enhanced in a fraction of the time formerly necessary, thanks to Nathan's VLSI chip (see photo 8).

The chip will get a workout from future missions, such as Galileo, which will orbit the giant planet Jupiter for two years and send a probe down into the planet's crushing atmosphere; Mars Observer, which will undertake a thorough mapping of the Martian surface; and Magellan, which will pierce Venus's thick cloud cover and return detailed radar images of the surface.

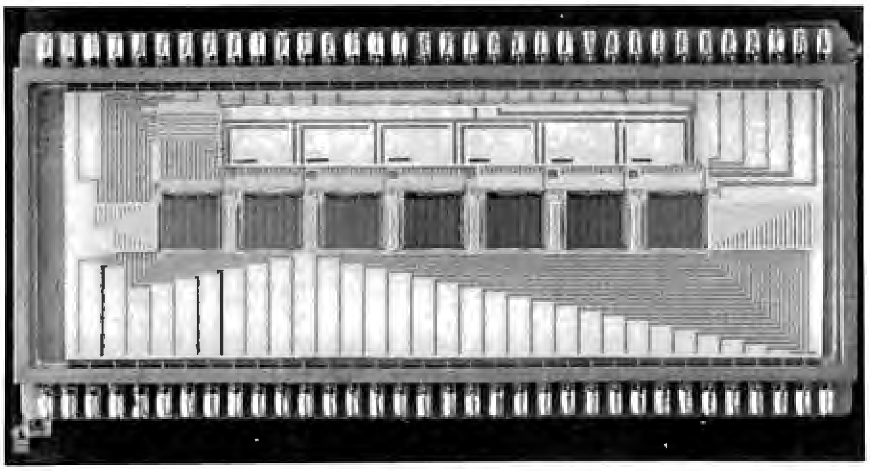

Photo 7: *A hybrid carrier designed by Dr. Robert Nathan holds five VLSI chips and allows up to 35 simultaneous multiply/add operations to be performed on image data.*

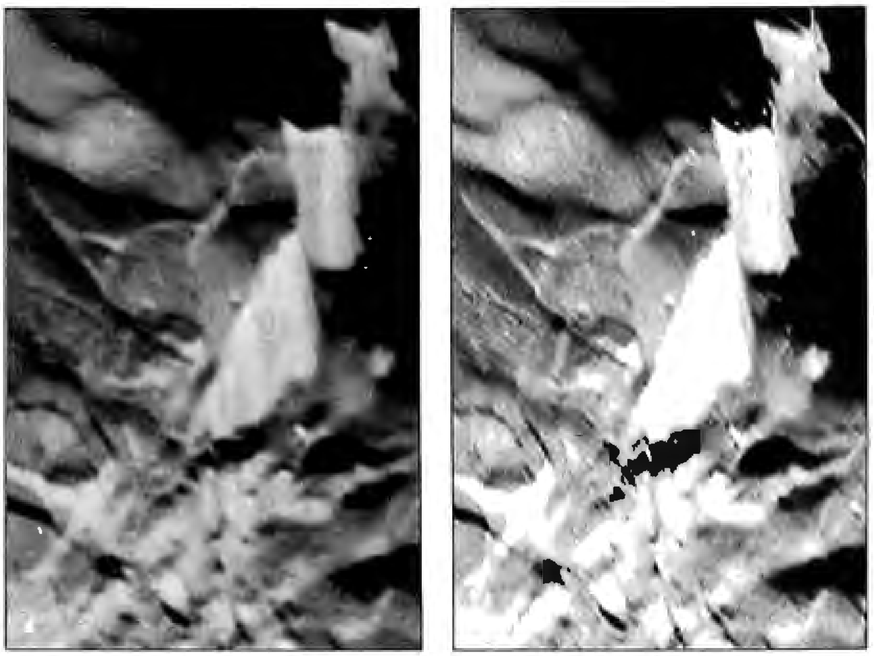

Photo 8: *Miranda, the smallest moon of Uranus identified before the flight of Voyager 2, is a 300-kilometer frozen ball of tortuously twisted rock. These Voyager images of Miranda, shown before (a) and after (b) enhancement by Dr. Robert Nathan's VLSI image processing chip, show cliffs that are approximately 20 kilometers (more than 12 miles) high.*

The Shape of Things to Come

As NASA probes explore the further reaches of this solar system and deep space beyond it, they encounter a number of obstacles. The light from the sun is dimmer, the signals that the probes send back are weaker, and the rate at which they send the signals must be slowed to distinguish the data from the background noise of space. The longer that signals take to pass back and forth from Earth to the probes, the less flexibility researchers have in taking photographs. By the time an image reaches Earth and a course correction can be beamed back to the probe, 30 to 90 minutes might have passed, even though the beam is traveling at the speed of light.

One way to rectify this problem is to apply the sciences of image understanding and artificial intelligence, providing the probes with the ability to decide for themselves what to photograph, what to send back to Earth, and what to ignore.

Such technology has been proposed for the Martian Rover, an unmanned robot that would explore the surface of Mars, take soil samples, map the terrain, and so on. Since the distance to Mars would make remote control of the Rover difficult, if not impossible—by the time you told it what to do, the Rover could fall into a hole or off a mile-high cliff—the use of image understanding and machine vision technology would be crucial to its success.

Since 1985, JPL researchers have been developing a Programmable Image Feature Extractor (PIFEX) system that would perform 10^{11} operations per second on 12-bit data and endow the Rover with real-time machine vision.

One Step Beyond

The theories and technologies behind image processing were in use before their advent at JPL. One-dimensional signal processing was a mature science, having been used extensively during World War II to clean up radar signals. Linear system theory was well known in applied mathematics. The makers of page readers were working in the areas of optical character recognition. And researchers in chromosome analysis had experimented with image analysis and pattern recognition as early as the 1960s. However, the scientists of JPL pulled those technologies together into a new science that has provided never-before-seen views of creation, from the elemental worlds of the atom, to hidden areas within the human body, to the farthest reaches of the solar system and beyond. ■

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Digital Image Processing in Art Conservation

New technology reveals secrets in classic works of art

John F. Asmus

MOST OF THE ARTISTIC legacy that resides in the world's museums is visual art such as paintings, drawings, prints, and etchings, or three-dimensional objects that have been carved or shaped, as in the case of statuary. Very little of this material still looks as it did when originally created by the artist or artisan. Paints fade and varnishes darken with time and exposure to heat and light. Chemical reactions take place between the artwork and its environment; the artwork may have been submerged in the sea, buried in the earth, or simply exposed to clean or polluted air. In many instances deliberate or accidental mishandling has caused damage, and in others the original artist, later artists, or restorers have covered over or modified the original subject.

Art conservationists analyze, interpret, and treat maladies that befall ancient works. Some common treatments include revarnishing and relining paintings, mending broken pottery and ceramics, and arresting corrosion on metal artifacts. A complete listing of the artworks and problems encountered in conservation is nearly endless, ranging from woven baskets to the Taj Mahal and from mildew to lipstick graffiti.

Technical developments of the past few decades have triggered a sequence of revolutions in art conservation and in allied disciplines such as archaeology, art history, and anthropology. Information and understanding in these fields have mushroomed as scientific and technical methodologies and tools have been introduced. Nondestructive internal analyses with x-rays and radiocarbon dating were adopted very early in these fields. Subsequently, the list of analytical aids has lengthened to include x-ray fluorescence, scanning electron microscopy, gas chromatography/mass spectrography, and neutron radiography. It extends even further to include photoacoustic spectroscopy, scanning transmission electron microscopy, trace element and various isotopic ratios, thermoluminescence, laser microprobe, and many more. The result has been to provide a scholarly foundation based on objective rather than subjective analyses.

In art restoration these innovations help distinguish authentic portions of the artwork (to be preserved) from earlier restoration materials (to be removed). Visualization of the subject's interior sometimes reveals structural problems, the artist's creative process, an underlying earlier work of art, or the artistic techniques of that era. Consequently, it should come as no surprise that one of the most widespread diagnostics in art restoration is the x-ray, just as it is in many other fields (e.g., medicine).

On the other hand, surface form, color, and texture are key features of most visual art. Inspection and understanding of these characteristics are more germane to the essence of visual art than are esoteric analytic measurements. Art conservationists use the human eye, the optical microscope, and the camera much more than even the venerable x-ray. Thus, visual inspection aids are most likely to be of direct relevance to the tasks associated with art conservation.

Digital computer image enhancement has proven highly useful in numerous fields. Remote sensing, astronomy, and medical diagnostics in particular have experienced quantum leaps in performance through the introduction of this technology. Art conservation also is beginning to benefit from the exploitation of these methodologies.

Beginning with Leonardo da Vinci

The marriage of image enhancement and conservation began, fittingly, with a work from history's greatest mediator between art and science, Leonardo da Vinci.

In the years preceding 1500, Leonardo had been employed in the service of Duke Ludovico of Milan. In addition to his duties as a military and civil engineer, court painter, and producer of entertainment spectaculars, he executed the famous *Last Supper* mural for the Dominican church of Santa Maria delle Grazie. This led the emerging city-state superpower of Florence to hire Leonardo to paint an even grander mural to decorate its legislative chamber, the Hall of the Five Hundred in Florence's Palazzo Vecchio.

Unhappily, Leonardo encountered technical difficulties with his paints and political problems with his sponsors. His greatest commission, the *Battle of Anghiari* mural, was left unfinished. The Florentine Republic fell in battle and subsequently from power. Giorgio Vasari, art-

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John F. Asmus (Institute for Pure and Applied Sciences, University of California at San Diego, La Jolla, CA 92093) is a research physicist.

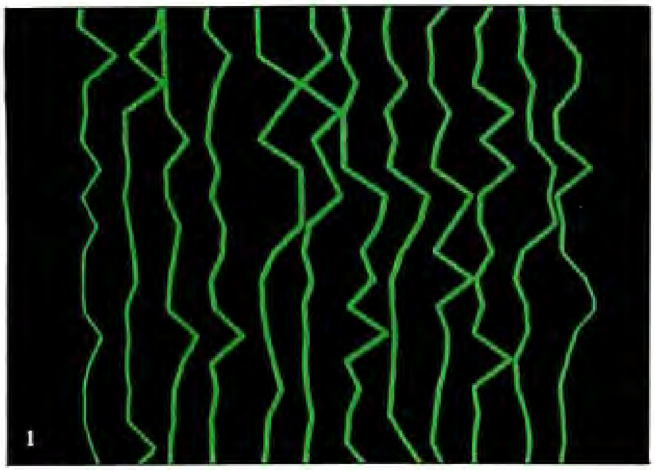

Photo 1: *Unenhanced ultrasonic C-scan image from the east wall of the Palazzo Vecchio showing the inhomogeneous nature of the masonry structure.*

Photo 2: *An averaged ultrasonic C-scan image from the Palazzo Vecchio showing a coherent internal stratum, possibly related to Leonardo da Vinci's long-lost* Battle of Anghiari *mural.*

Photo 3: *X-ray image of a Rembrandt painting showing the overlap of the two heads from the underlying and surface paintings, respectively. (Courtesy J. Twilley.)*

ist of the Medici regime that followed, repainted the walls of the chamber with his own murals, depicting military victories that glorified the new rulers. Vasari rewrote history and the Leonardo painting was never again seen.

In 1975, the city of Florence invited my organization, the University of California at San Diego Project for Art/Science Studies, to search for the remains of the Leonardo mural. During the preceding decades historical evidence had been accumulating that Vasari might not have destroyed Leonardo's work but simply covered it over before repainting the hall. My organization's commission was to develop a nonintrusive technique to "look" beneath the hundreds of square meters of Vasari wall paintings for a deeper stratum of a few square meters that had been executed by Leonardo. Once located, the Leonardo work could be removed for display without disturbing the Vasari paintings by, for example, quarrying the palace wall from behind.

We considered searching with thermovision, x-rays, neutron activation, electrical conductivity, and microwaves. Finally, following analyses and laboratory simulations, we chose ultrasonic echolocation (similar to sonar).

Throughout 1976 and 1977, we recorded tens of thousands of ultrasonic echoes for a carrier frequency of 1 megahertz across the surfaces of the Vasari wall paintings in the Hall of the Five Hundred (see reference 1). The masonry materials of the palace walls consist of brick, stone, and mortar and are highly inhomogeneous, so these ultrasonic records were extremely noisy. Photo 1 shows a typical unprocessed ultrasonic C-scan image of the interior of the wall. (A C-scan is a two-dimensional image of the ultrasonic echo return intensity from a particular depth or range.) Such records could contain evidence of a flat "island" of paint embedded within the palace wall.

The break came in early 1977 when my research team began digital image processing of the C-scan ultrasonic images. We realized that the signals from the random inhomogeneities of the masonry materials would be spatially incoherent. To combat this, we divided the wall into a grid of lines 1 foot apart. We then took ten readings near (but not exactly on) each intersection of the lines and averaged the readings for that point. Thus, we hoped to improve the signal-to-noise ratio and allow the coherent return from any extended subsurface structure (such as a walled-in painting) to emerge.

In fact, we found this to be the case. As shown in photo 2, we replaced the amplitude of the ultrasonic return from each pixel location by the average of ten ultrasonic returns from the immediate vicinity. The resulting amplitude at each pixel location is represented by the lateral deflection of the scan line; straight vertical lines indicate the absence of any coherent return (and therefore any planar substructure). The entire C-scan has been superimposed on a picture of the Vasari murals at that location. As you can see, a strong contiguous return has emerged in the lower area where the two murals meet. This position is consistent with one of the predicted locations of the Leonardo painting as gleaned from an analysis of historical records. We believe this is the most plausible place to search for the lost Leonardo mural painting.

Clarifying Images

As I mentioned earlier, much of art conservation practice involves the inspection and interpretation of photographs and radiographs. Frequently, an x-ray is made of a painting in order to reveal an earlier composition hidden beneath the one that is visible on the surface. In general, the

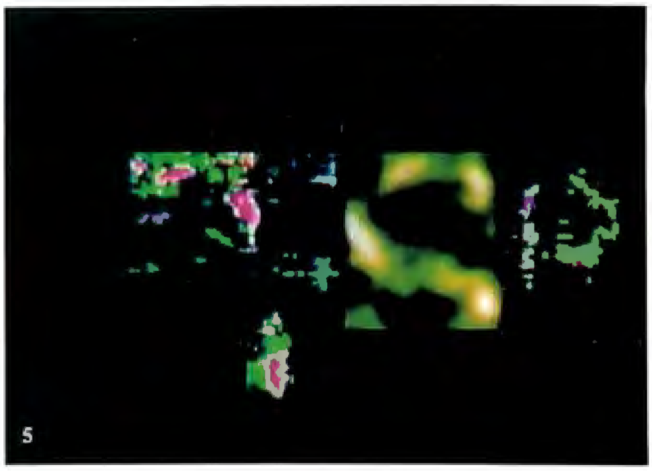

Photo 4: *Handle of a carved Tahitian walking stick. (Courtesy C. Tyler.)*

Photo 5: *Computer-enhanced image of the handle area of the walking stick.*

Photo 6: *A typical signature of the artist Paul Gauguin.*

resulting x-ray image will be a mixture of the surface image, the underpainting image, and the x-ray transmission properties of the support structure (canvas or wood). The x-ray of a Rembrandt painting shown in photo 3 reveals such multiple features.

A group headed by J. R. Druzik, after unsuccessfully trying pixel averaging on an x-ray of a Jan Erasmus Quellinus painting, found that fast Fourier transform filtering removed a quasi-periodic wood-grain pattern quite effectively (see reference 2). They then proceeded to subtract a gray-level-processed image of the top painting from the filtered and gray-level-processed x-ray, to obtain a clearer image of the underlying painting.

With the completion of the ultrasonic image processing for the *Battle of Anghiari* search, my UCSD group concentrated on clarifying inscriptions and drawings. These projects used the same operations that the Druzik group independently applied to radiographs.

A typical problem involved the hand-carved wooden walking stick shown in photo 4. The object's owner noticed that the handle bore some faint traces of scratches that appeared to have been largely worn away through use. On the assumption that the scratches may have been the remains of an inscription, we digitized (300 by 400 pixels) the central portion of the image in photo 4. To remove the visual interference of the wood grain, we then applied FFT filtering, followed by a 5- by 5-pixel averaging to partially fill breaks in the lines. Finally, line-by-line averaging and differencing leveled the effect of the curvature of the shaft on the image intensity.

The results of these operations are presented in photo 5, which suggests that the scratches are the remains of three letters. Since the cane was from Tahiti, longtime workplace of the artist Paul Gauguin, we compared this three-figure pattern with Gauguin's signature (see photo 6). Considering that the former was carved in wood and the latter painted, the similarity is striking. Further, Gauguin's ill health caused him to use a cane toward the end of his life. This type of evidence certainly does not prove that this stick was carved by Gauguin, but it does suggest moving on to physical tests to determine the age of the wood and its type.

Paintings and the Whole Moon Catalog

I have thus far discussed images that are essentially single-banded or monochromatic. Such images represent the mere tip of the iceberg: The vast majority of museum artifacts are polychromatic. On the other hand, color image processing is considerably more challenging than monochromatic image processing. Not only do full-color images involve three simultaneous bands (red, green, and blue), but the issues of saturation, hue, and visual perception also come into play.

In 1974 a group of moon watchers assembled and formed the La Jolla Consortium to coordinate the diverse efforts aimed at producing a "Whole Moon Catalog" from the body of remote sensing data that had accumulated. By 1977, consortium members Lawrence Soderblom and Eric Eliason had developed a 32-bit image comparison computer system. In 1978 another member of the group, James Arnold, suggested using the system to recover the original appearances of fine paintings covered by old yellowed varnishes. Toward the end of that year, the first tests of such a technique were performed at the United States Geological Survey Image Processing Center in Flagstaff, Arizona.

The initial subject was a copy of da Vinci's *The Virgin of the Rocks* before and

continued

after varnish stripping by D. M. Domergue, a conservator of paintings. We digitized both images and played them back through the Flagstaff system, then attempted, by trial and error, to develop an algorithm to modify the RGB statistics of the varnish-covered image so that it looked like the stripped image. Such an algorithm could then be used to "correct" other paintings.

Unfortunately (for our project), data from the Voyager 2 flyby of Jupiter began coming in to Flagstaff, and we lost access to the system. At that time the Flagstaff system was not interactive. Because of this, discovering the varnish-erasing algorithm would take several passes through the experimental process—each of which had a turnaround time of about 24 hours.

However, other opportunities were at hand. The California Space Institute had been established and an IDIMS (Interactive Digital Image Manipulation System) was installed at our site. The 8-bit 512 by 512 IDIMS image was somewhat of a limitation after the Flagstaff experience, but the interactive capability later became indispensable.

The Mysteries of *La Gioconda*

Probably the most famous and admired painting in Western civilization is Leonardo da Vinci's *Mona Lisa* (or *La Gioconda*) located in the Louvre of Paris. At present, the image of the lady is barely a shadow of its original appearance. It is covered by a thick green-brown varnish with extensive craquelure in both the varnish and paint layers. Lord Kenneth Clark believed that the hands and eyebrows were repainted after 1550 by a restorer (see reference 3). The da Vinci scholar Carlo Pedretti has noted that the darkened lower half of the painting gives the incorrect impression of a thick (possibly pregnant) torso (see reference 4).

Pedretti identified several ambiguities in the *Mona Lisa* that would be suitable topics for our image processing work. He agreed to obtain a high-resolution, large-format color photograph of the painting from the Louvre for digitization. For the next three years we worked sporadically on image processing of inscriptions while awaiting the high-quality photograph of the *Mona Lisa* from the Louvre which was always to be in the mail "next week."

Then, in 1981, Walter Cronkite announced that he wanted to include a segment on our image processing of the *Mona Lisa* in his first "Universe" television program. I explained with regrets that we had no high-quality photograph of the *Mona Lisa* with which to work. Cronkite called the Louvre, and within a week our three-year wait was over.

Photo 7: *Leonardo da Vinci's* La Gioconda, *more familiarly known as the* Mona Lisa.

Photo 8: *Detail from the digitized* Mona Lisa *showing the extent of the craquelure, tiny crackle lines in the painting's varnish.*

The photograph of the *Mona Lisa* was digitized at NASA's Jet Propulsion Laboratory into 6 million pixels in each of the three color bands. We then measured the spectral transmission for an ancient varnish specimen believed to be similar to that covering the *Mona Lisa.* For Cronkite's "Universe" program, we deconvolved (subtracted) the varnish spectral transmission from the image: The sky changed from brown to blue, the skin from yellow to alabaster, and the gown gained a deep greenish tint. Finally, an art historian demonstrated the interactive potential for analysis with zooming, panning, and split-screen techniques for comparisons. The main limitation to emerge from that demonstration was the 512 by 512 resolution of the system.

Toward a Perfect *Mona Lisa*

In order to study the *Mona Lisa* further, create an image simulating its original appearance, and evaluate applications of image processing technology in the art restoration field, we have continued our efforts beyond the initial 1981 test (see reference 5).

The original high-resolution large-format color transparency of the *Mona Lisa* acquired from the Louvre measures approximately 10 by 12.5 centimeters. Photo 7 shows the original image. Photo 8 is a close-up of the image revealing the extent of the craquelure.

A scanning microdensitometer with a 0.02-millimeter aperture was used to scan the central portion of the photograph to produce three digital files, one for each primary color (red, green, and blue). Each computer file of digital data contained 2600 scan lines, with 2200 pixels per line. Each pixel carried an integer value in the range 0 to 255 corresponding to the pixel brightness for each of the three primary colors, with 0 representing black and 255 representing the maximum brightness of the color.

The vast amount of digital data generated by scanning the color transparency (2600 by 2200 pixels) could not be handled in a routine fashion. This restricted our analyses to a 1024 by 1024 subimage at full resolution covering the head and neck, and to the full image whose resolution was reduced by a factor of two in each direction. Image analysis and display operations were performed at the IBM Palo Alto Scientific Center using the interactive IBM 7350 Image Processing System (IPS) and the IBM 5080 workstation attached to an IBM 3081 computer. Some of the experimental software used in this investigation was originally developed for processing image data from the earth observation program. Some techniques, such as parallel-piped classification (see reference 6), principal component transformation (see references 7 and 8), and regional enhancements, provided only minimal improvement of the images. Several other approaches, described and illustrated in the following paragraphs, produced significant results.

Color Correction

The information content of image-band data can be represented statistically by a histogram showing the number of pixels versus pixel brightness level. Such histograms rarely exhibit the standard bell-shaped curve of a Gaussian distribution. However, you can compute the mean and standard deviation of the distribution and use these values to generate the slope and the intercept of a line. This line is then used to translate pixel values into gray levels of the primary color specified for the visual display of the band data. You can modify the intensity distribution of the displayed image by adjusting the *y*-axis intercept of the line (i.e., by adding a bias to the translation table).

By measuring the optical absorption of a varnish specimen and determining that it is approximately proportional to the inverse wavelength of light at that color, we were able to make comparable modifica-

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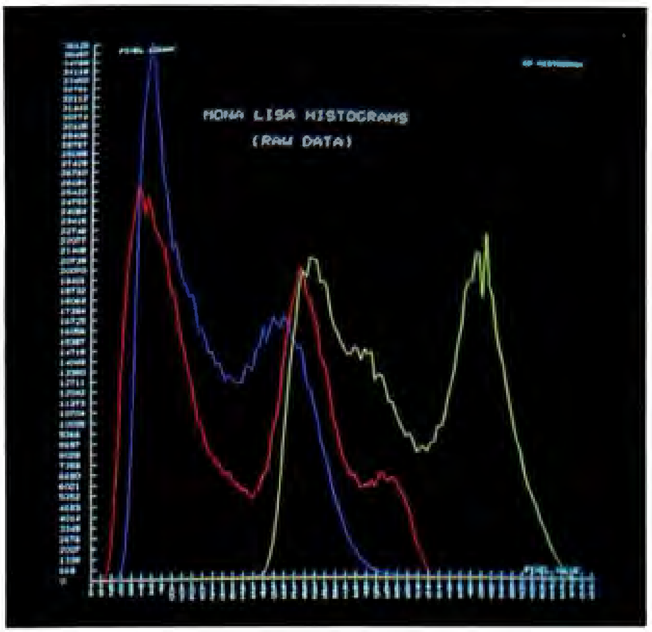

Photo 9: *Pixel histograms for the RGB bands of the digitized* Mona Lisa.

Photo 10: *A photograph of the color-corrected, digitized* Mona Lisa *painting displayed on a 1024 by 1024 color monitor. This procedure yields an image with a normal color rendition, but with a considerable amount of glint in the hair region.*

Photo 11: *Frequency-domain characteristics of the head-neck region of the original* Mona Lisa *digitized with a blue filter; also the filter used to reduce the glint. Clockwise from top left: (a) original blue-band digitized image in gray scale; (b) scales used for (c), (e), and (f); (c) phase spectrum image; (d) Fourier filtered blue-band digitized image in gray scale; (e) two-dimensional filter; and (f) power spectrum image.*

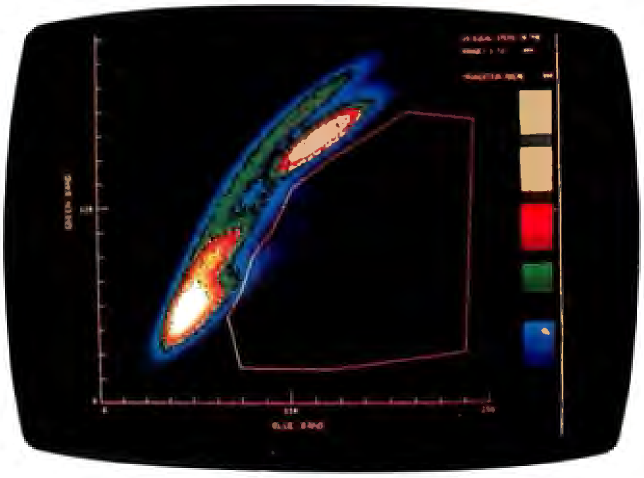

Photo 12: *A bi-scatter plot of pixel values in the head-neck region. Pixels represented by combinations within the polygon are good candidates for data manipulation.*

tions to the biases for the RGB bands (see photo 9). In other words, we calculated the factor by which the varnish attenuated a color, then divided the intensity of each pixel of that color by the attenuation factor—which effectively restored the pixel to its original value. Thus, each blue pixel was divided by 0.4, each green pixel by 0.2, and each red pixel by 1.0 (i.e., left unchanged).

The resulting *Mona Lisa* image is shown in photo 10. Most art professionals who have viewed this transformed image agree that it effectively compensates for the undesirable filtering of the discolored varnish and that the colors are more natural. Unfortunately, the photographic lighting, together with the craquelure, produced a front-surface glint. Under the bias adjustment, the most severe glint is transformed into unsightly blue stripes, primarily in the hair. We chose the next operations to delete this artifact.

Frequency-Domain Filtering

Because the craquelure-induced glint effects are periodic in nature, a plausible approach to their removal was through FFT filtering techniques. This approach generated a two-dimensional matrix whose complex elements represented the phase and amplitude of various spatial waves responsible for the image. We then developed a two-dimensional filter to attenuate the waves responsible for the glint. Performing the inverse Fourier transformation of the product matrix from the transformed image and the filter yielded an image with reduced glint.

An illustration of this process appears in photo 11. One band of the original image is shown in the top left corner. Phase information contained in the Fourier coefficient matrix appears in the top right, and power information in the bottom left corner. (By "power" I mean strength of response to the fast Fourier transform. Large, low-frequency elements such as the nose and eyes have a strong response, whereas detailed, high-frequency elements like brush marks and craquelure have a weak response.)

Based on the information contained in the power spectrum image, the operator interactively develops a two-dimensional filter by combining wedges and rings, as shown in the second half of the bottom left image. Frequencies falling in the white area are accepted, and those contained within the dark area are suppressed. The inverse Fourier transform of the accepted waves results in the gray-scale image in the bottom right corner. Note the significant reduction of glint in the hair.

Selective Data Manipulation

Another procedure for further reducing the craquelure-induced glint is the selective manipulation of the three-band values of selected pixels—in other words, repainting each pixel of an undesired color to the desired color. Such a simpleminded approach would be subjective, cumbersome, and time-consuming. We approached this problem by analyzing the statistics of the undesirable pixels in a tabular and graphic form. Similar information was also collected concerning the desired values in the same area.

We generated a three-dimensional histogram (bi-scatter plot) representing the number of pixels with a given brightness combination in two bands (blue and green) with the greatest cosmetic defect (see photo 12). A polygon based on the approximate level and range of brightness information was drawn around those values, thereby defining a mask that could be applied to the data. Photo 13 shows the result of applying this operation to the *Mona Lisa* files that had been obtained from the color-correction and FFT operations (compare photo 10). Clearly, the hair glint has been eliminated. An enlargement of the face (see photo 14) also reveals a significant reduction in paint-layer cra-

continued

Photo 13: *This image shows the* Mona Lisa *following frequency-domain filtering, color correction, and correction using the bi-scatter plot of photo 12 and a mask. An obvious decrease in glint is evident, especially in the hair (compare with photo 10).*

Photo 14: *An enlargement of a portion of photo 13, showing the significant reduction in craquelure effect (compare with photo 8).*

Photo 15: *The digital data from the* Mona Lisa, *as modified by the regional-contrast-enhancement and histogram-equalization procedures.*

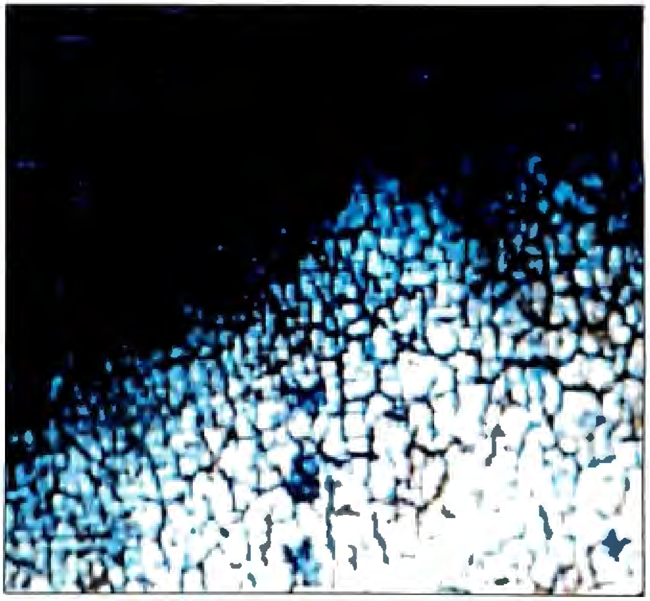

Photo 16: *This enlargement of the false-color image in photo 15 shows a series of dots that may be part of a neck adornment.*

quelure compared to that of photo 8. The sequential application of these three transformations illustrates how this painting has changed through the years.

The Necklace and the Overhang

A not-too-surprising occurrence accompanied the first viewings of the corrected *Mona Lisa.* Some noticed the faint outline of a necklace. This pattern included three or four equally spaced and distinct dark spots. Others saw a faint ridge-like mountainous structure within the mountain gap to the viewer's left of the sitter's right eye.

The revelation of new details caused by lifting the dark veil from the image should not be surprising, but it raises a perplexing question: Were these artifacts part of Leonardo's original composition; changes made by him; the result of restorations, damage, or deterioration; or simply a Rorschach phenomenon? We have sought to explore this issue through the application of still other image processing operations.

Regional Contrast Stretching

An image feature that has been painted over or removed by chemical or abrasive methods may manifest itself as subtle intensity variations. To enhance such indicators, we performed a regional contrast stretch. We selected a region for intensity enhancement and computed the statistics of that region in the three bands. The statistics were then used to perform a "histogram equalization" of the entire image. The result is to "stretch" the intensities in the region of interest so that the full dynamic range of the display device could be used to analyze that region. Clearly, other parts of the image would be degraded. Photo 15 shows such an enhancement based on the statistics of the neck region. The enlargement of the lower neck shown in photo 16 reveals the geometrical structure of these "necklace beads."

Local Intensity Enhancement

The standard edge-enhancement procedure, based on the double-differentiation Laplacian operator on a 5 by 5 area, could be used to bring out further details. A better procedure is the one commonly referred to as local intensity enhancement. Under this procedure a new pixel value is computed from the mean and standard deviation of the pixels in a square surrounding it and from a desired mean and standard deviation for the entire image. We used a 31- by 31-pixel square for computing the local statistics. After several trials, we selected intensity count values of 128 and 20 for the desired mean and standard deviation, respectively.

Photos 17 and 18 show the result of applying this procedure to data in all three color bands. Careful inspection reveals a number of interesting features. Most dramatic is a modulation in the craquelure intensity. Virtually every important outline exhibits a smooth border as if some restorer had either touched up or overcleaned the outlines. The suspected necklace beads also appear. Finally, you can see that the lady is smaller than her outline. Note that the starchy veil is lifted above both her hair and the upper arm on her left (our right).

Level-Slicing Operations

One class of image processing operations involves grouping small ranges of pixel levels and arbitrarily assigning them a display color (pseudocoloring) or shade of gray (gray-level mapping). We applied this technique to the blue band of the image and noted an interesting structure in the mountain gap to the left of the figure's right eye. An enlargement of this area (see photo 19) shows a contour and structure resembling a continuation of the mountains into the gap. Compare this to photo 20, an edge-enhanced version of the

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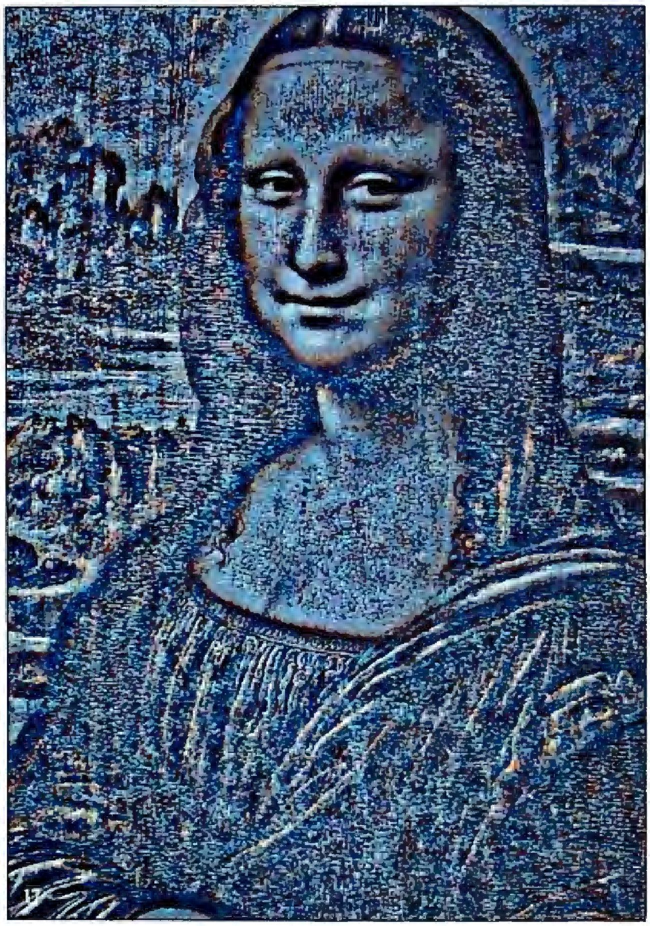

Photo 17: *The digital data from the* Mona Lisa *(linearly reduced by a factor of 2) as processed by a local-intensity-enhancement algorithm. The unexpected smooth zones follow major outlines of the painting and may indicate the work of a restorer.*

Photo 18: *An enlargement of a portion of photo 17, revealing possible restoration around the mouth.*

Photo 19: *A pseudocolor transformation of the blue band of the* Mona Lisa *image shows evidence of a possible mountain ridge or steep, hollow basin to the left of the figure's right eye.*

Photo 20: *An edge-enhanced version of the* Mona Lisa *isolates the contour of the gap to the left of the eye. Compare this with the structure revealed in photo 19.*

original image that isolates the contour of the gap as seen by the eye.

History and Speculation

When an artist executes a painting, changes are frequently made by painting over earlier portions of the composition. With aging, such underlying patterns begin to show through and are known as *pentimenti*. This could be the case with the dark spots revealed below the sitter's neck, which resemble the beads of a necklace. These spots do not appear to be related to damage; the major structural problem of the panel (a vertical crack visible above the head in photo 13) is several centimeters to the left of the spots.

Further, there are reasons for believing that Leonardo may have begun the work with a necklace. The first concerns the relationship between the *Mona Lisa* and Raphael's painting *La Muta* (see photo 21). Many scholars contend that numerous similarities between the paintings indicate that Raphael gained inspiration from an early viewing of the *Mona Lisa* around

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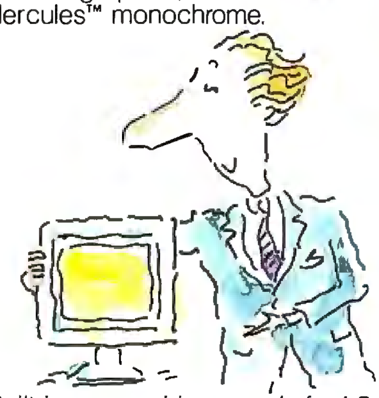

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Photo 21: *Raphael's painting* La Muta, *believed to have been inspired by his early viewing of the* Mona Lisa, *which may once have worn a necklace of beads similar to* La Muta's.

Photo 22: *The office of the vice president of the United States, in the Old Executive Office Building. Image processing of present-day photographs and 19th-century images of stencils on the walls is helping to restore the room to its original condition.*

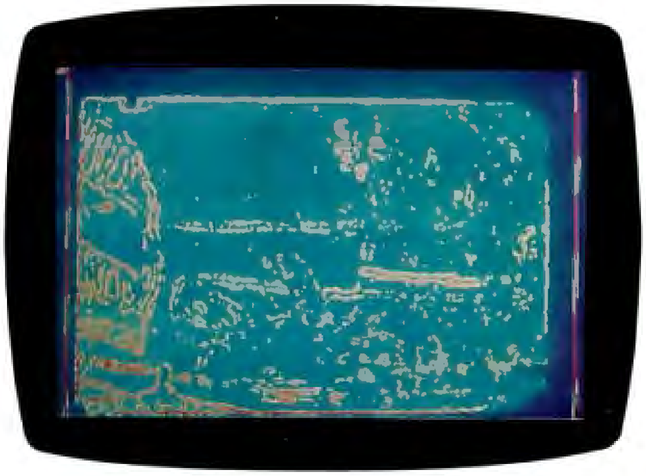

Photo 23: *An image-processed ice-age French cave painting.*

1505. There is the remarkable coincidence that the spots lie precisely on the vertical bisector of the face just as in the case of the left side of *La Muta*'s adornment. A survey of Leonardo's paintings reveals that figures in those predating the *Mona Lisa* have neck adornments, while figures in the later paintings do not. This finding raises the possibility that Leonardo began simplifying his style during, rather than before, the *Mona Lisa* work.

The Mountain Gap

As illustrated by photo 19, the image processing operations brought out a suggestion of a mountain ridge or a steep hollow spanning the mountain gap to the left of the lady's head. This makes a great deal of sense. Most of Leonardo's paintings have range upon range of mountains fading off into the haze rather than the abrupt outline in the *Mona Lisa*. Changes in craquelure along the outlines (see photo 17) may indicate that a restorer enhanced the outlines deliberately. Thus, faint distant mountains could have been erased.

Finally, there is the problem of the overhang at the left side of the gap. The great distance to the mountains suggests a structurally impossible massive overhang. If faint mountains do belong in the gap, the structural problem vanishes, and the painting better matches the geometry of some early copies (see reference 9).

The Future for Image Processing in Conservation

Only a small fraction of the conservation laboratories worldwide have substantial budgets for research. Consequently, only a few have been able to avail themselves of large image processing facilities. Some exceptions are the National Gallery of Art's efforts with the University of Michigan, and the digital recording of one of Leonardo's codices at NASA/JPL by the Armand Hammer Foundation.

However, most researchers' computerized conservation efforts will depend on the diffusion of image processing technology into the microcomputer realm. Hardware is now available for IBM PC AT-compatible computers for handling 1024 by 1024 images. Examples of appropriate software include PCIPS by IBM, IMIGIT by Chorus, and Image-Pro by Media Cybernetics.

Museums are beginning to introduce PC-based systems. The National Gallery in London has developed an approach to the monitoring of deterioration of paintings. The National Gallery of New Zealand is upgrading its AT data retrieval system for image processing. Our UCSD program is also attempting to widen the

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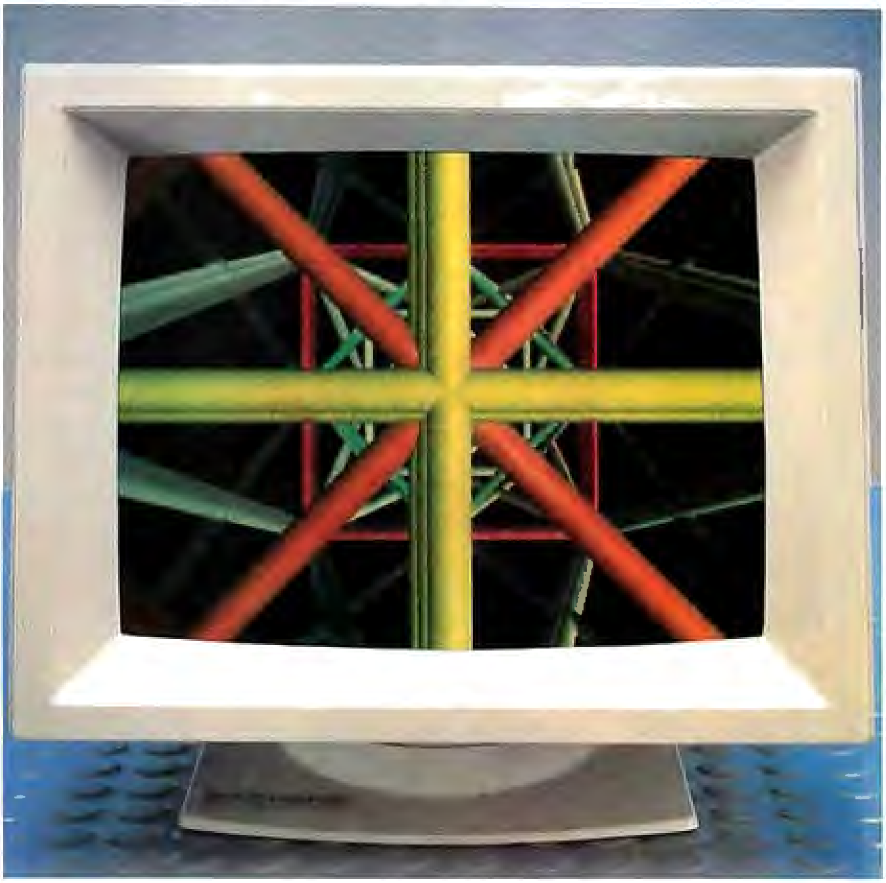

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A Film of a Different Color

Ken Sheldon

Vincent Canby, film critic for the *New York Times* calls it a "ghastly process," like "watching a movie through a large, not awfully clean fish tank." The late Cary Grant tactfully called it "a curious experience" and "extremely interesting." Woody Allen thinks it's "an ugly practice, totally venal." Nancy Reagan called it "a clever idea."

These folks, and many others, are talking about a controversial process known as "colorization," in which classic black-and-white films are being colored via computer and rereleased for the home video market.

Although some have their doubts about the desirability of coloring old movie classics such as *The Maltese Falcon, It's a Wonderful Life*, and *Miracle on 34th Street*, the two companies currently involved with the technology—Colorization Inc. of Toronto and Color Systems Technology of Hollywood—do not. The companies cite research indicating that home video watchers, especially those under age 20, just won't watch black-and-white films but will snatch up color versions of the same movies. "Today's viewing public seems to have a psychological resistance to watching black and white on television," says Wilson Markle, president of Colorization Inc.

Making video images palatable for home audiences is nothing new to Wilson Markle. In 1971, he was contracted by NASA's Jet Propulsion Laboratory to "clean up" the televised images of the moon being sent back from the Apollo missions. NASA knew that good clear pictures from space would be invaluable in selling the space program to the American public and ensuring its continued funding.

In 1983, Markle founded Colorization Inc., now owned in part by Hal Roach Studios of Los Angeles, which owns a library of over 2000 old black-and-white films. Among these are such classics as the Oscar-winning Laurel and Hardy film, *The Music Box*, which was recently colorized. In addition to privately owned films, thousands of films now in the public domain are available for coloring and rerelease. The technology has also been used to convert historic newsreel footage for docudramas on individuals such as Dwight D. Eisenhower, Martin Luther King, and Benito Mussolini.

Computer Paint-by-Numbers

The colorization process begins with the transfer of the original 35mm movie film to a 1-inch videotape, where it is cleaned up using analog and digital image processing techniques. A film technician (or "art director") then freezes the first frame of every new scene in the movie—every time the camera angle changes, a new character enters the scene, and so on.

The art director assigns colors to each object in the frame, using a graphics tablet and knowledge about the movie's script, the sets, the hair color of the stars, and the like. The two components of a color television signal are luminance (the black-and-white values) and chrominance (the color information), which consists of hue (the actual color) and saturation (the amount of color). In the colorization process, the original film provides the luminance values, while a Dubner Graphics Computer provides the hues from a palette of 16,700,000 possible colors. The art director chooses 4096 colors for each film, and the system allows up to 64 colors in each scene. The limitation is based on the fact that the system operates in real time; for the illusion of motion, the human eye requires 30 frames per second. Each frame consists of two "fields," which are "interlaced" to provide a complete frame. Thus, the system is actually producing 60 images per second.

The computer also derives the saturation from the luminance. It assigns a

prospects for microcomputer image processing in art conservation. We are presently using an IBM PC XT system to merge images of the vice president's office in the Old Executive Office Building (see photo 22) with historical images of fragments of the original stencil designs from the 1880s. (The purpose is to assist in planning the actual restoration of the room.) Our other current effort on a PC is to enhance the ice-age rock-art images of the French caves in and around Lascaux (see photo 23).

In addition to the economic and technical issues already mentioned, there is the question of psychological resistance to image processing from within the conservation community and, indeed, the

saturation of 0 wherever there is black or white (since no colors are needed there) and the maximum saturation (the greatest amount of color) somewhere in between the black and white values.

After the art director has assigned colors to the first frame, the computer digitizes the frame and compares it to the next frame in the sequence. Pixels that are unchanged (the majority) have the same color assigned to them as in the previous frame. Pixels that change are compared to pixels around them and to pixels with the same luminance in the previous frame, and are assigned a new color. The wrinkles in a jacket, for example, automatically have the appropriate shade added to them as they move. The art director makes "mid-course corrections" for any unforeseen changes in the scene that the computer cannot handle.

Even with a high-powered graphics computer, the process is tedious; it takes about 4 hours to "track" a minute of film. A film like *It's a Wonderful Life*, with some 1100 first-frame scenes to be "hand-painted," can cost several hundred thousand dollars to color—but that's a pittance compared with the cost of producing a new motion picture.

Despite the controversy surrounding colorization (or perhaps because of it), the list of films being colorized grows every day. It includes such classics as *Casablanca*, *Citizen Kane*, the Alfred Hitchcock and the Abbot and Costello television series, the entire Otto Preminger film library, and many more. With the growing power of microcomputers and the availability of image processing hardware for them, you may soon be able to color your old home movies and revive some classics of your own.

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general public in some areas (see text box above). (In a private communication to me, J. Arnold, one of the pioneers of the now-ubiquitous radiocarbon dating method, recalled meeting both apathy and antagonism upon its introduction.) After the UCSD group delivered a paper on the *Mona Lisa* results at a recent conservation-related conference, a leading conservation scientist expressed strong misgivings about image processing in art. She concluded: "And, further, you'll never convince me that Leonardo painted those trees in the background blue." Of course "those trees in the background" of the painting are really mountains; the yellow-green cast of the aged varnish had misled even this prominent professional. ■

ACKNOWLEDGMENTS

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Introduction to Image Processing Algorithms

An overview of the basics, with code to get you started

Benjamin M. Dawson

IMAGE PROCESSING is the science of modifying and analyzing pictures. Image processing algorithms are step-by-step procedures for performing image processing operations. People often implement such algorithms using computers, which are flexible and have relatively low processing and memory costs. The algorithms are expressed as, and become nearly synonymous with, programs for the computer. However, the algorithm can also specify other operations such as how to acquire the image. Special image processing hardware often supplements the computer.

To help you understand and try some of these algorithms, I will describe a generic image processing system that you could assemble from a personal computer and an image-processing or graphics board. I wrote a simple image-processing package (SIMPP) that runs on such a system and contains programs for many of the algorithms described. With this hardware and software and some ideas about which algorithms to use, you can start to do interesting image processing.

Generic Image Processing Hardware

A minimal generic image processing system consists of an image-acquisition device, an image memory, a computer (with disks, keyboard, etc.) that can access this memory, and a device that can display the contents of memory. This system acquires, processes, and displays monochrome (gray-tone) images. You can display image memory values in color by adding output lookup tables.

The image-acquisition device puts an image into the image memory. This usually involves digitizing—scanning a continuous image (such as a photograph) and breaking it into an array of digital intensity values called pixels (picture elements). Most image processing systems have, for example, an A/D converter that transforms the signal from a video camera into a pixel array in the image memory. If the image is already represented as pixels, as in a computer graphics image, image acquisition consists of simply moving the image from disk to the image memory.

The acquisition device can write to the image memory, which can be read and written to by the computer's CPU, and read by the display device. If the image memory stores an entire video image, it is often called a frame buffer or frame store. For acceptable intensity and detail resolution, an average monochrome image must be represented by an array of at least 256 by 256 pixels, and each pixel must have at least 6 bits of value. In the examples to follow, assume that a pixel has an 8-bit byte, which means that it can have 2^8 (256) different gray-level intensities.

The computer processes the pixels in the image memory. The display device converts the processed pixels back into spatially organized image intensities. The display device is usually a D/A converter that drives a monochrome or color TV monitor, although people have used line printers or other devices.

A lookup table (LUT) changes a pixel's value based on the values in a table. This hardware consists of a memory that has a storage location for each possible pixel value. An input pixel value is used as an address into this memory, and the output is the value at that address. The input value "looks up" the output value. An LUT computes an arbitrary function of one or more variables, with a domain and range limited to the possible pixel values. For example, an input value of 32 to the function $4x-13$ gives a result of 115; rather than redoing the calculation each time, the system can "look up" the correct result in the LUT.

An image processing system can have three LUTs that map the image memory to the display device. These LUTs output values to the red, green, and blue channels of a color monitor, based on some input pixel value. This lets you display different gray levels from the monochrome image in various arbitrary colors, a technique often called pseudocolor.

Several manufacturers provide the acquisition device, image memory, output LUTs, and display device on one computer board. You can make an image processing system by combining one of these boards (or a graphics board if you don't need "live" video input) and a standard personal computer. As an example, I used an IBM PC AT computer and an Imaging Technology Series 100 image processing board. You could even start with an EGA (Enhanced Graphics Adapter) board as

continued

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Table 1: *The Simple Image Processing Package (SIMPP) routines. Note that the arguments x,y specify the start of an area to process and dx,dy specify its size.*

Interface Routines

sim__open( ) = Opens and initializes image processing hardware.

sim__close( ) = Closes image processing hardware.

acquire( ) = Puts an image into the image memory.

write__LUT(color,loc,val) = Sets the location, loc, in the LUT specified by color, to the value val. This routine is optional.

read__pixel(x,y) = Returns the value of a pixel in frame memory located at coordinates *x,y*.

write__pixel(x,y,v) = Writes a pixel of value v into the frame memory at location *x,y*.

Primitive Operations

read__hline(x,y,n,b) = Reads a horizontal line of pixels starting at location *x,y* and of length *n*. Places values in buffer *b*.

write__hline(x,y,n,b) = Writes the values in buffer *b* to a horizontal line of image memory starting at location *x,y* and of length *n*.

read__vline(x,y,n,b) = Reads a vertical line of pixels starting at location *x,y* and of length *n*. Places values in buffer *b*.

write__vline(x,y,n,b) = Write the values in buffer *b* to a vertical line of image memory starting at location *x,y* and of length *n*.

read__area(x,y,dx,dy,b) = Reads an area into buffer *b*.

write__area(x,y,dx,dy,b) = Writes an area from buffer *b*.

copy__area(x,y,dx,dy,xd,yd,dxd,dyd) = Copies the image area into the destination area starting at *xd,yd* and of size *dxd,dyd*.

Point Processing

ptransform(x,y,dx,dy,t) = Transforms the area using transformation table *t*.

histogram(x,y,dx,dy,h) = Computes the histogram *h* of area.

plot__histo(x,y,dx,dy,h,v) = Plots the histogram *h* in specified area and using pixel value *v*.

clip__histo(h,t,low,high) = Scans the histogram *h* from first to last and last to first index and finds the first bin counts greater than *t*. Returns these bin numbers in low and high.

Area Processes

convolve(x,y,dx,dy,m,n,kernel,output) = Convolves the image area with a kernel of size *m,n* and specified by array kernel. The output routine controls the treatment of negative convolution values.

label(x,y,dx,dy,bin0,bin1,minpix,blabel,elabel) = Labels the binary image in the specified area. The binary image values are bin0 and bin1. The area must have more than minpix pixels. Labels are assigned values starting with blabel and ending with elabel.

Geometric

rotate(x,y,dx,dy) = Rotates the image area clockwise by 90 degrees.

stretch(x,y,dx,dy,xs,ys) = Stretches (enlarges) the image area by *xs* and *ys*. The image is stretched into the same areas starting from the upper left corner.

continued

image store and display device, although the number of bits per pixel and the display's resolution and color capabilities limit what you can do.

Software Interface to the System

Six software routines interface the image processing hardware to SIMPP and your programs (see table 1). The sim__open( ) routine opens the hardware and could initialize the hardware, clear the image memory, or whatever you want. The sim__close( ) routine closes hardware.

You use acquire( ) to read an image into the image memory. You assume that the entire image memory is filled by this operation. The write__LUT(color,loc,val) routine writes the value val into location loc in the output LUT specified by color (e.g., red, green, or blue). This routine is optional.

The read__pixel(x,y) routine returns the pixel value at horizontal location *x* (column) and vertical location *y* (row) in the image memory. And write__pixel (x,y,v) writes the value v into location *x,y*. Note that these routines assume that *x* starts at 0 at the left of the image and increases to the right, while *y* starts at 0 at the *top* of the image and increases downward. This odd coordinate system is called "video coordinates" because it is based on the way a television image is scanned. Pixel values start at 0 (black) and go through grays to the maximum pixel value (white).

You will need to write versions of these six routines—which will vary depending on your CPU, image processing board, and so on—if you want to use the SIMPP programs. If you don't have output LUTs, you can compile SIMPP not to use the write__LUT function.

Classifying Algorithms

You can classify image processing algorithms in many ways. If an algorithm changes a pixel's value based only on that pixel's value, it is called a *point process*. If the algorithm changes a pixel's value based on the value of that pixel and the values of neighboring pixels, it is called an *area process*. If the algorithm changes the position or arrangement of the pixels, it is called a *geometric process*. Algorithms that change pixel values based on comparing two or more images are called *frame processes* because video images are called frames.

The goals of image processing include enhancement or modification of the image to improve its appearance or highlight information, measurement of image elements, classification or matching of image elements, and recognition of items in the image. Image measurement makes few

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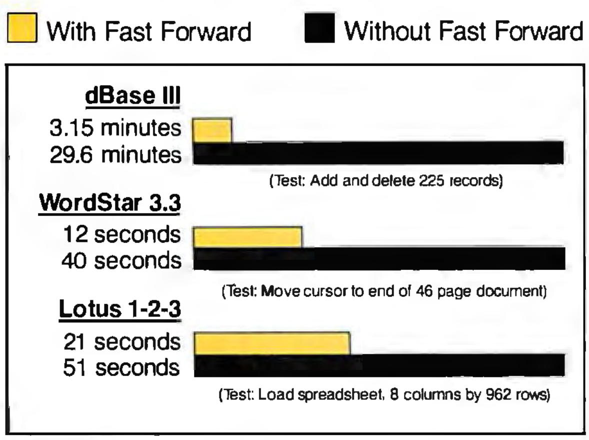

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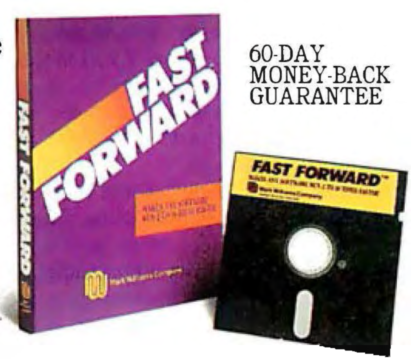

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Utility

clear__area(x,y,dx,dy,v) = Clears the area to pixel value *v*.

save__image(x,y,dx,dy,fname) = Saves the image area in disk file fname.

read__image(x,y,dx,dy,fname) = Reads the disk file fname and displays it in the specified area.

Listing 1: *A C code fragment for a simple point-process algorithm.*

```
/*  Point process area starting at x,y = 0,0 and of size *
 *  XSIZE,YSIZE.                                          */
  for (y = 0 ; y < YSIZE ; y++) {
        for (x = 0 ; x < XSIZE ; x++) {
                write_pixel(x,y,  pfun(read_pixel(x,y),x,y) );
        }
  }
```

assumptions about what things are in the picture, while classification and recognition require successively more knowledge about what can appear in an image. For example, you can measure how many pixels in a remote sensing (satellite) image of the earth have a certain range of values. If you know that wheat corresponds to these values, you can classify the image into wheat and nonwheat areas. If you provide the machine with knowledge about the structure of wheat fields, it might be able to recognize these fields in the image. You could also use pseudocolor to highlight the recognized areas.

Additional ways of classifying image processing algorithms include image-based versus symbolic methods, linear versus nonlinear, and the knowledge level used. Image-based algorithms transform pixel values into other pixel values or locations using numerical or logical operations, while symbolic algorithms symbolically manipulate knowledge about pixel structures.

The knowledge level used in an algorithm can range from simple assumptions about the physics of image formation to specific world knowledge about possible items in a scene. The above example of the wheat-field measurement, classification, and recognition illustrates the knowledge-level dimension. I will discuss only algorithms that are image-based, require minimal knowledge about the image contents, and are therefore not recognition algorithms.

You can now "hang" some example algorithms on this classification framework and your conceptual or real hardware. Since the goal is understanding, I make no claims that the examples are complete or efficient. In particular, if you are using SIMPP and a personal computer to try the examples, you will find the area processes to be rather slow. If this bothers you, plenty of expensive hardware is available to speed the processes up—or you can go to lunch while the computer works and dream about such hardware.

Point Processes

A point-process algorithm scans through the image area and uses the pixel value at each point (and perhaps the point's address) to compute a new value for the point. The algorithm is expressed as a C code fragment in listing 1. [Editor's note: *The listings from this article, IPLISTS.C, and the complete SIMPP programs, written in C, are available on disk, in print, and on BIX. See the insert card following page 352 for details. Listings are also available on BYTEnet. See page 4.*]

If the transformation pfun( ) is only a function of the pixel value, then the function can be implemented by a lookup table to save computation. The SIMPP routine ptransform implements the software equivalent of the LUT hardware.

You can use point processes to enhance or modify pixel values. For example, adding 40 to each pixel brightens the image (photo 1) and could improve the display's appearance. The transformation function is simply pfun(v) = v+40.

If the pixel value and its location are used, then you can use the point process to correct shading or smoothly change pixel values in an image area. Shading is an image artifact caused by slow spatial shifts in scene lighting or camera bias and sensitivity. A point process that computes the inverse of the shading functions can eliminate (correct) much of this shading.

continued

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Photo 1: *The right half of this image has been brightened by adding 40 to each pixel value.*

Photo 2: *An image of a bride, before image processing.*

Photo 3: *The result of modulating the contrast of photo 2 by a Gaussian curve, which provides an "aura" effect in the center.*

Photo 4: *An image of Athena's terrace in Yellowstone National Park, overlaid with its histogram. Red arrows indicate the lowest and highest "bins," as found by SIMPP's* clip_histo *routine.*

Photo 5: *Improved contrast of photo 4 results from histogram-based contrast stretching.*

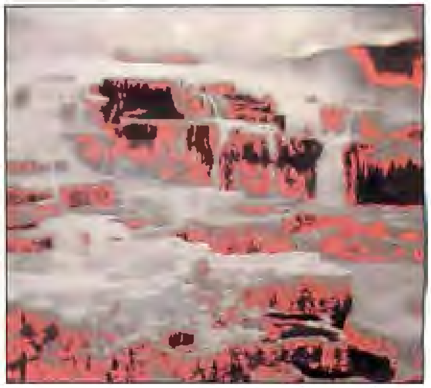

Photo 6: *Using the output LUTs, pixel values between 75 and 95 have been highlighted in red. This tends to outline dark areas of the image.*

Of course, this requires that you estimate the shading functions.

By smoothly changing the pixel values in an area, you can highlight or adjust the contrast of areas. This can produce results similar to the photographic darkroom techniques of burning and dodging (methods of adjusting the contrast locally). Photo 3 shows the result of applying the following point transformation to the image shown in photo 2:

```
output_value = input_value*k*
  exp(-(x*x/l + y*y/l))- m
```

where k, l, and m are constants that adjust the extent and amount of change, x ranges from -XSIZE/2 to XSIZE/2, and y ranges from -YSIZE/2 to YSIZE/2. This increases the contrast at the center of the image and fades the edges.

To generate an *intensity histogram* you count the number of times a pixel intensity occurs in an image area. If you are using 8-bit pixels, 256 pixel values are possible. You scan the image area and increment the values in a 256-word array h[ ] based on the pixel value. Listing 2 gives a code fragment for this algorithm.

The histogram is an example of image measurement. Since it examines a single pixel at a time, you can also classify it as a point process—one that doesn't change the pixel's values, however.

The information provided by the histogram is useful for image enhancement and classification. Photo 4 shows the histogram of an image over the image (created using the SIMPP plot_histo routine). The array values (called the histogram "bins") go from an intensity of 0 on the left to 255 on the right of the plot, and the height of the lines represents the number of pixels of each intensity. As you can see, this image has few high or low pixel values.

You can use this information to improve the image contrast. Starting at intensity 0, search the histogram for the first bin with more than a specified number of pixel counts, say 30. You do a similar search starting at the highest index. The histogram bins between these two values represent most of the pixels in the image. You set up a point process that sets pixel values below the low bin (left arrow in photo 4) to 0, and above the high bin (right arrow) to 255. The pixels with values in between are multiplied to increase their value so that they span the range of 0 to 255. Listing 3 shows a code fragment that performs this operation.

The image with improved contrast is shown in photo 5. This is a simple form of contrast enhancement. Note that you have lost some information—the pixel values below low_bin and above high_bin have been set to constants. In general, image processing operations lose information in return for selecting or accentuating other information.

This algorithm used three simpler algorithms: a histogram, a histogram clip, and a point process. Most algorithms are com-

continued

pounds of other algorithms. Therefore, you must know which algorithms to apply and in what order to apply them in order to reach a processing goal.

Pseudocoloring of a monochrome image is another example of a point process. In this case, the pixel value is the argument (input) for three different functions, and the output of these functions drives the red, green, and blue guns of a color monitor. This lets you color a monochrome image in any way you want. Of course, if you have 8-bit pixels, you can display only 256 colors at a time.

In photo 6, I used pseudocoloring to highlight a range of pixel values by displaying them in color, while the rest of the pixel values are displayed as gray tones. The code for doing this (see listing 4) first sets all three output LUTs to "linear" values (input = output) and then selectively changes a specified band of pixel values to be displayed in red.

Note that changing the output LUTs will change the appearance of the entire image, but not the pixel values in the image memory. The output LUT transformation may be easily changed, but you cannot apply it to only a portion of the image.

Area Processes

An area process uses neighborhood information to modify pixel values or assert the existence of some property at the image points. Area processes are typically used for spatial filtering (such as filtering out repeated elements) and changing an image's structure. They can "sharpen" the image's appearance by accentuating intensity changes and can also provide many other useful enhancements. Some of these include finding objects by matching images, measuring image properties, making assertions about object edges in the image, removing noise, and blurring or smoothing the image.

Convolution is a classic image processing algorithm commonly used for spatial filtering and finding image features. Despite its name, convolution is not difficult to understand. But it is computationally expensive. Consequently, some implementation issues must be considered.

The convolution operation replaces a pixel's value with the sum of that pixel's value and its neighbors, each weighted (multiplied) by a factor. The weighting factors are called the convolution kernel. Suppose that you use a 3- by 3-pixel neighborhood and kernel. You label the image points $p(x,y)$ and the kernel points $k(x,y)$ where $x = 0, 1,$ or 2. Then the center pixel, $p(1,1)$, is replaced by the linear sum of the points times the kernel values

$$\begin{aligned} p(1,1) = {} & p(0,0)*k(0,0) + p(1,0)*k(1,0) \\ & + p(2,0)*k(2,0) + p(0,1)*k(0,1) \\ & + p(1,1)*k(1,1) + p(2,1)*k(2,1) \\ & + p(0,2)*k(0,2) + p(1,2)*k(1,2) \\ & + p(2,2)*k(2,2) \end{aligned}$$

or

$$p(1,1) = \sum_{m,n=0}^{2} k(m,n)*p(m,n)$$

(This is actually a correlation operation—for convolution you would reverse the order of the kernel values. Correlation is slightly easier to understand and many image processing convolution kernels are symmetric and, therefore, equivalent to correlation. Further discussion of this is outside the scope of this article—see the bibliography for more information.)

To convolve an image area, you repeat this operation at every pixel position in the image. You can think of this as sliding a kernel matrix over each row of pixels in the image matrix. At each point, you multiply the kernel values with the image values "under" it, sum the result, and replace the pixel at the center of the kernel with that value. The equation then becomes

$$p(x,y) = \sum_{m,n=0}^{2} k(m,n)*p(x+m,y+n)$$

Convolving an area of size X by Y with a kernel of size n by m requires $X*Y*n*m$ multiplies and adds. Thus, a 256 by 256 image with a 3 by 3 kernel requires 589,824 multiply/add operations; this can take a long time on a computer without fast multiplication hardware. (See figure 4 of "Finding the Titanic," on page 108

continued

Listing 2: *A C code fragment for the histogram algorithm.*

```
/* Use long values as sum could be over 16 bits */
  long h[256];
/* zero histogram array */
  for (i = 0 ; i < 256 ; i++) h[i] = 0L;
/* Scan area and count pixel values */
  for (y = 0 ; y < YSIZE ; y++) {
        for (x = 0 ; x < XSIZE ; x++) {
                h[read_pixel(x,y)] = h[read_pixel(x,y)] + 1L;
        }
  }
```

Listing 3: *A C code fragment that uses the histogram algorithm to perform contrast stretching.*

```
  long h[256];

/* Histogram area, result into array h */
  histogram(x,y,dx,dy,h);                /* SIMPP routine */
/* Find the low and high bins based on minimum count of 30 */
  clip_histo(h,30,&low_bin,&high_bin);     /* SIMPP routine */
/* Compute the factor for stretching the in between values */
  step = 256.0/(double)(high_bin-low_bin+1);  /* step delta */
  step_value = 0.0;                      /* Step value */
/* Form a translation table (LUT), tran[] for enhancing
    contrast */
/* Values below low_bin are set to minimum pixel value */
  for (i = 0 ; i < low_bin ; i++) tran[i] = 0;
/* Values between low_bin and high_bin are stretched to range
    from 0 to 255 */
  for (i = low_bin ; i <= high_bin ; i++) {
      tran[i] = step_value;
      step_value += step;
  }
/* Values above high_bin are set to maximum pixel value */
  for (i = high_bin+1 ; i < 256 ; i++) tran[i] = 255;
/* Now point process area using the translation table,
    tran[] */
  while (dy--) {
      for (i = x; i < x + dx; i++) {
              write_pixel(i,y,  tran[read_pixel(i,y)] );
      }
  }
```

of the March 1986 BYTE, for an example of such a 3 by 3 convolution.)

When you implement the algorithm, consider the following issues. First, you can't just put the result of the convolution back in the frame memory. If you did, then the next convolution, say one position to the right of the first, would use results from the previous convolutions for part of its input values. In effect, this produces a recursive or infinite impulse response filter. While this might be useful, it is difficult to understand and predict the filter response. To avoid this, you can either buffer the output pixel values in a temporary array and write them to the image memory when you have finished using an area, or you can write them out to a non-overlapping part of the image memory.

You might have noticed another problem: If the kernel is scanned over the image and you replace only the value under the center of the kernel, what do you do when you get to the edges of the image? For example, if you use a 3 by 3 kernel, a 1-pixel border (box) will be around the image where you cannot perform the convolution. The result of the convolution will always be a border of "garbage" equal to half the kernel size around the outside. You can just ignore this border of garbage, set it to 0, or copy the nearest meaningful value into it. The kernel size is usually odd. If not, the borders are asymmetric, because in a digital image you can't put a pixel back in the middle of an even set of pixels.

A third issue is that the result of the convolution on any pixel could exceed the number of bits allotted to that pixel—as large as the number of kernel elements times the number of bits in a pixel. In your generic system, for example, that would be 3 by 3 by 256, or 2304, for which you would need 12 bits per pixel—but you have only 8 bits per pixel. You must keep enough accuracy in your calculations to allow for this range. You can scale the convolution result (for example, divide each result by 2) if it is to go back into the image memory.

In a related issue, kernel values, and therefore the convolution output, can be positive or negative. Negative intensity is mathematically useful, but not physically reasonable in this case—you can't display negative intensity. You might want the option to modify the convolution output such that only positive values, or only negative values (negated to positive values), or absolute values, or signed values are output. This also means that an additional sign bit must be kept in the calculations. Thus, for 8-bit pixels and a 3 by 3 kernel, you need 12 bits for the sum and an additional bit for the sign.

At this point, you might agree that, while convolution is relatively simple, the implementation issues complicate it. This is unfortunately true of quite a few other image processing algorithms. For example, the issues of internal accuracy and what to do at the edge of the image appear in most other area processes. You must understand these issues to effectively implement and use the algorithms.

In the code fragment for a 3 by 3 convolution (see listing 5), you use a separate source (starting at x,y and of size dx,dy) and destination (starting at x_out, y_out and of the same size as dx,dy) areas in the image memory to avoid overlapping the output convolution values with the inputs to the convolution. The SIMPP convolution routine uses a more elaborate line-buffering method to allow an area to

continued

Listing 4: *This sample C code selectively changes a specified band of pixel values to be displayed in red, an example of a pseudocolor algorithm.*

```
/* Change the output LUTs to display the pixel values *
 * ranging from v_begin to v_end in red.           */
LUT_highlight(v_begin,v_end)
{
  int i;

/* Set output tables to "linear".  This will display
   the image in normal, monochrome fashion */
  for (i = 0 ; i < 256 ; i++) {
       write_LUT(RED,i,i);
       write_LUT(GREEN,i,i);
       write_LUT(BLUE,i,i);
  }
/* Set the desired range so that ONLY red is displayed */
  for (i = v_begin ; i <= v_end ; i++) {
       write_LUT(RED,i,255);   /* Full red */
       write_LUT(GREEN,i,0);   /* No green */
       write_LUT(BLUE,i,0);    /* No blue */
  }
```

Listing 5: *A C code fragment for a 3 by 3 convolution algorithm that uses separate source and destination memories to avoid overlapping the output convolution values with the inputs to the convolution.*

```
/* Set up kernel for "sharpening" (high-frequency boosting)
   the image */
  static int kernel[9] = {-1,-1,-1,
                          -1, 9,-1,
                          -1,-1,-1,};

/* Increment starting position and decrement image size
   to accommodate the convolution edge effects */
  x++; y++; dx--; dy--;
/* Set up address offsets for the output */
  xx = 0; yy = 0;
/* Scan through source image, output to destination */
  for (i = y ; i < y+dy ; i++) {
     xx = 0;                   /* Reset x output index */
     for (j = x ; j < x+dx ; j++) {
     sum = 0;                  /* Zero convolution sum */
     k_pointer = kernel;       /* Pointer to kernel values */
/* Inner loop to do convolution (correlation!) */
     for ( n = -1 ; n <= 1 ; n++) {
       for (m = -1 ; m <= 1 ; m++)
            sum = sum + read_pixel(j+m,i+n)*(*k_pointer++);
     }
/* Output processing */
     if (sum < 0) sum = 0;
     write_pixel(x_out + xx, y_out + yy, sum);
     xx++;             /* Increment output X address offset */
   } yy++;             /* Increment output Y address offset */
  }
```

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Photo 7: *An image of Devil's Tower National Monument in Wyoming, before image processing.*

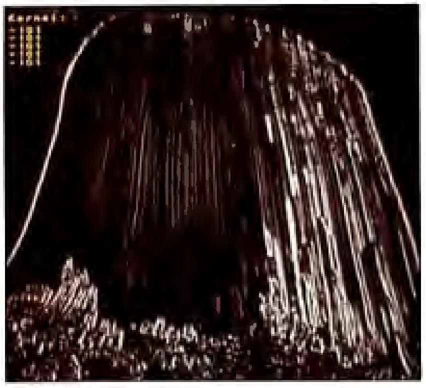

Photo 8: *Convolution of photo 7 with a kernel (shown in the upper left corner) that amplifies vertical edges.*

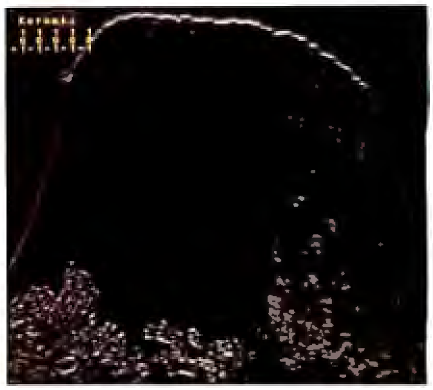

Photo 9: *Convolution of photo 7 with a kernel (shown in the upper left corner) that amplifies horizontal edges. As you can see, this image doesn't have many horizontal edges.*

Photo 10: *An image of rocks and trees in Yosemite National Park, before image processing.*

Photo 11: *Convolution of photo 10 with a Laplacian kernel (shown in the upper left corner). Edges are now outlined in white, and all other areas are dark.*

Photo 12: *The result of convolving the image in photo 10 with a sharpening kernel. This kernel (shown in the upper left corner) adds a Laplacian convolution to the original image in order to boost the higher spatial frequencies.*

be convolved into itself ("in place"). The output values are not scaled and negative output values are set to 0.

When I apply convolution to a problem in image processing, I generally think of it as either a matched filter or a spatial filter. In a matched filter, the convolution kernel is essentially a small image of what you want to amplify or detect. For example, suppose you want to amplify vertical edges in the image. An edge is represented in the image by a sudden increase or decrease in image intensity. A kernel like this

$$\begin{matrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{matrix}$$

looks like a little vertical edge. Note the effect of the negative values: In a uniform image area, where all pixel values input to the convolution are the same, the convolution output will be 0 (since the sum of any number times each of the 15 kernel elements is 0). I have padded the kernel with a vertical row of zeros to make it an odd size in both directions. This changes the properties of the kernel but is a computational convenience. The result of applying this kernel to the image shown in photo 7 is displayed in photo 8.

A similar kernel for amplifying horizontal edges would look like this:

$$\begin{matrix} -1 & -1 & -1 & -1 & -1 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 \end{matrix}$$

The result of applying this to the same image is shown in photo 9.

You can use larger kernels with a pattern (e.g., for the letter A) to detect similar patterns in the image. In this case, the kernel is often called a template, and you are really doing a correlation, as noted previously. Detection usually involves amplification of the desired feature followed by a yes/no decision that asks, "Is the result above or below a certain threshold point?"

A second view of convolution is that it performs spatial frequency filtering. In sound, frequency is the number of times per second a waveform repeats. In images, spatial frequency is the number of times per unit distance that a pattern repeats. As with a one-dimensional signal, an image can be broken down into a series of sine and cosine waves (or some other set of waveforms), and the spatial frequency specified for each. You can accomplish this by using a fast Fourier transform. The transform must be done both horizontally and vertically because you have spatial frequencies in both directions.

If you want to select and, perhaps,

detect a certain band of frequencies, you can build a kernel that selects that frequency. Quickly changing image intensities are represented by high spatial frequencies, while slowly changing intensities are represented by lower spatial frequencies. To select high spatial frequencies we could use the following kernel:

$$\begin{matrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{matrix}$$

This is often called a Laplacian filter because it approximates an unoriented second-derivative operation. The results of applying it to the image in photo 10 are shown in photo 11. Since edges have high spatial frequencies (sudden intensity changes), this kernel selects edges of any direction. It might be used as an "edge detector" for image analysis.

If you slightly modify the laplacian kernel by making the center kernel element 9 instead of 8, the result is the same as if you added the output of the laplacian convolution to the original image (since a kernel with a 1 in the middle would give you the source image back unchanged). This kernel selectively boosts high frequencies (edges), and the resulting image (photo 12) looks sharper and noisier. On the other hand, if you use a kernel that matches lower spatial frequencies, you will blur the image.

The power of convolution lies in using information in an area to make assertions about some property at an image point. For example, the edge operators shown above improve the estimate of "edgeness" at an image point by using the fact that physical edges extend over some distance. The art of convolving is in picking the right kernel. While these views of what the kernel does can get you started, experience and theory are necessary for creative convolving.

Nonlinear Area Processes

Convolution is easy to implement, use, and analyze because it is a linear operation—it requires only sums of first-degree products.

Nonlinear operations, while a bit harder, are also useful and can be more powerful than a convolution. By "powerful" I mean that they provide a better signal-to-noise ratio for detecting image elements or detecting features with less computation. Consider the following two examples of nonlinear area processes.

The Sobel filter compares the result of two convolutions to estimate the strength and orientation of edges in the image. If the two kernels, X and Y, are

continued

Photo 13: *The result of a Sobel operation on a map of the United States. Edge orientation is represented by color, and edge strength by color intensity. (Photo courtesy of Imaging Technology Inc.)*

Photo 14: *An image of flowers with a large amount of random noise, which looks like salt and pepper scattered on the picture.*

Photo 15: *Most of the noise in photo 14 was removed using a 3 by 3 median filter (shown in the upper left corner).*

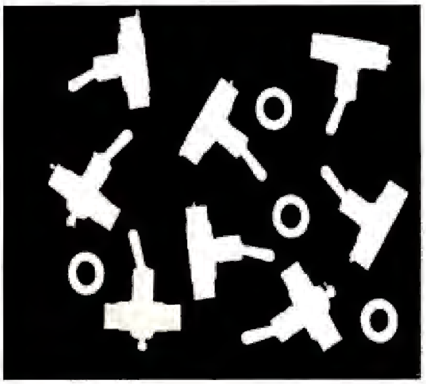

Photo 16: *A silhouette image of switches and grommets, obtained by placing the objects on a light table.*

Photo 17: *A binary image of photo 16, made using a point process.*

Photo 18: *The various objects in photo 17 have been labeled with different pixel values. Lookup tables were then used to show the different values in color, a technique known as pseudocoloring.*

$$X: \begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix} \qquad Y: \begin{matrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{matrix}$$

then the edge strength and orientation are represented by

$$\text{strength} = \sqrt{X*X + Y*Y}$$
$$\text{orientation} = \arctan(Y/X)$$

This is a first derivative (oriented) edge finder, and the vector field it produces cannot be directly shown on a two-dimensional image. Photo 13 represents edge strength by intensity and orientation by color. The Sobel is a good edge detector and is frequently used as the first step in machine-vision algorithms. Since the Sobel algorithm is computationally intensive, various approximations have been developed to implement it (see "Low-Cost Image Processing" by Charles McManis on page 191 for an example).

The median filter replaces the pixel at the center of a neighborhood of pixels with the median of the pixel values. The neighborhood values, including the center pixel, are sorted into ascending order and the median (middle) value is used to replace the center pixel. The effect of a median filter is to remove spot noise. The result of a median filter on photo 14 is shown in photo 15.

Classification

To classify image elements you need to supply your computer with additional knowledge as to what constitutes an image element. This knowledge can get elaborate, but a simple rule will suffice as an example: An element is a connected group of pixels with the same value. By connected, I mean that if the pixel has the same value as a neighbor at 0, 90, 180, or 270 degrees, it is part of the element group.

To simplify the computation you can "binarize" the image shown in photo 16. That is, you convert all pixel values below a threshold value to 0 and all those above the threshold value to 255 (photo 17). This is often done in machine vision, as you can control the lighting and objects to be viewed. You search this image from top to bottom, looking for areas that have more than *N* connected pixels. By requiring that the area have more than *N* pixels, you ignore the small spots of noise introduced by thresholding. Each area is labeled with a different pixel value. In photo 18, I have used pseudocolor to indicate the image elements I have classified. You can also record the number of pixels in an element and use this for further classification.

The most difficult part of implementing this example is finding all the connected pixels in an element. The simplest imple-

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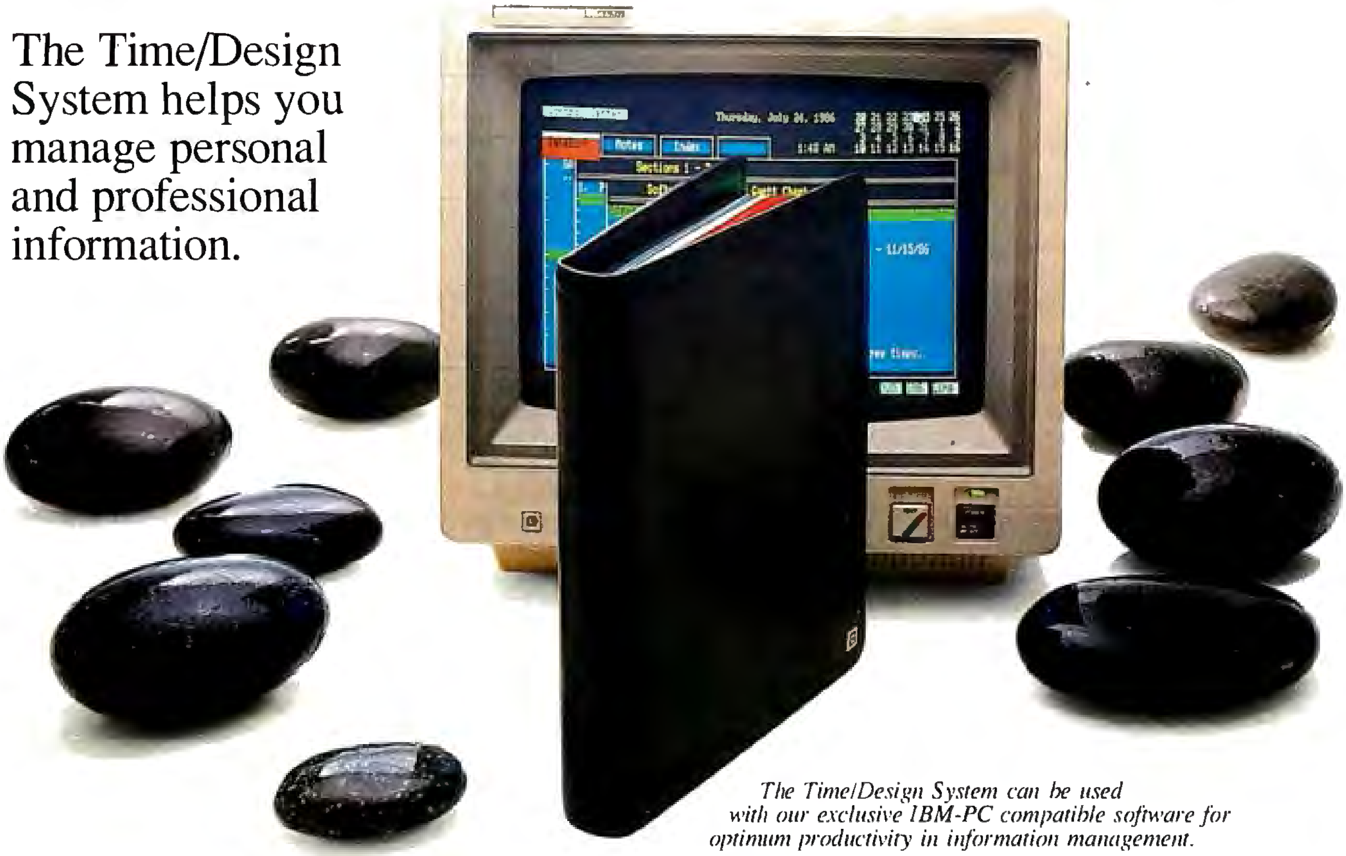

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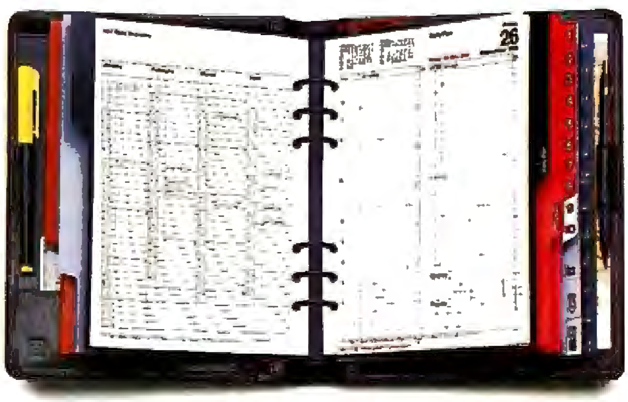

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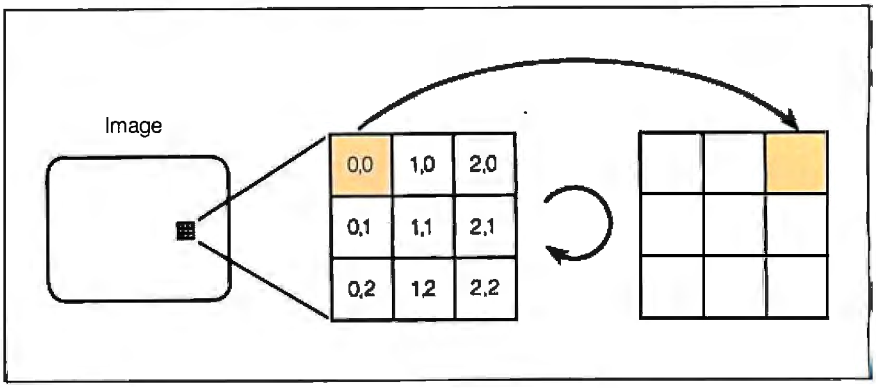

Figure 1: *In a geometric process of rotation by 90 degrees, a pixel at location 0,0 is mapped by the formulas $x' = (YSIZE-1)-y$ and $y' = x$ to the new location 2,0. ($x' = (3-1)-0 = 2$ and $y' = 0$.)*

mentation uses a recursive search (see listing 6) to find all connected pixels.

The program in listing 6 will quickly run out of stack space on most machines. In SIMPP, I used a more elaborate combination of recursion and iteration to reduce the chance of stack overflow. Listing 6 does not show boundary checking or deletion of elements with less than N pixels. You can easily add these.

Even though this algorithm changes the value of individual pixels, it does so based on an area property (connectedness), so I think of it as an area process. Most image-element classification schemes use both area and point processes to develop a list of properties that describes a multidimensional space. This space is then partitioned to perform the classification—similar to the way an image is thresholded to binarize it.

Geometric Processes

Geometric processes change the spatial arrangement of pixels. They are often used to correct for distortions caused by the camera optics or viewpoint, or to enlarge an image area of interest. Typical geometric processes rotate, stretch, translate the image position, or warp the image. Geometric algorithms can be expressed by a set of equations (a matrix) that maps a pixel at location x,y into a new address, x', y'. For example, to rotate a square area clockwise by 90 degrees, the pixels are mapped by: $x' = (YSIZE-1)-y$ and $y' = x$, as shown in figure 1.

Another simple implementation for rotation is to read horizontal lines of pixels from the source image and write out entire lines at the desired new angle. This doesn't work if the image is rotated in place—that is, if you use the same image memory area for source and destination. The problem is the same as with convolutions: The output pixels will be reused as inputs and the image will be jumbled. As before, you must use nonoverlapping source and destinations or copy the image into a memory buffer and use that as the source image.

The SIMPP rotate routine copies the image area to a memory buffer and then writes it out vertically to rotate the image by 90 degrees. The rotated area is limited to the maximum buffer size available. This is usually 64K bytes (2^{16}) on a 16-bit computer. If the CPU prefetches data, as the 8086 microprocessor does, then reading the last word in the 64K buffer can cause a prefetch beyond the end of the buffer, resulting in a hardware error if no memory is there. To be safe, reduce your buffer size to a few bytes less than the maximum buffer size allowed.

Most geometric transforms end up with gaps between the output pixels if you start with source pixels and place them in the destination area according to the transformation equations. (This is a problem with digitized images that would not occur with continuous-tone images such as photographic prints.) For example, if you enlarge an image area by a factor of 2 in x and y, the source pixels will be mapped to every other destination pixel and row. The solution is to invert (reverse) the mapping equations and scan the destination area. At each point in the destination, you use the inverted equations to fetch a source point. If you request a source point that lies between pixels in the source area, you must approximate the value by using the value at the nearest source pixel or by interpolating source values.

The code fragment in listing 7 shows how you can enlarge an image in the x and y directions by arbitrary factors. This uses the nearest neighbor to approximate values between source pixels and requires that the source and destination images do not overlap.

The nearest-neighbor approximation will produce sudden intensity changes in the image, giving it a blocky appearance.

continued

Interpolation produces smoother results. The SIMPP stretch routine uses interpolation and an internal buffer.

In many image processing systems, a pixel represents a rectangular rather than a square area, often because the processes deal with rectangular video images. To improve accuracy, you can compensate for rectangular pixels by adjusting the transformation equations. The implementation should also check for addresses beyond the limit of the image area.

Listing 6: *A C code fragment for an algorithm that searches for pixels with the same value as a neighbor at 0, 90, 180, or 270 degrees.*

```
/* Variables used in labeling */
  static int count;
  static int newval = 1;

/* Search image area for target values == 255 */
  for (y = 0 ; y < YSIZE ; y++) {
    for (x = 0 ; x < XSIZE ; x++) {
/* If we find a target value, recursively label
   the connected pixels with a new value (newval) */
      if (read_pixel(x,y) == 255) {
              count = 0;      /* Zero pixel count */
              recursive_label(x,y);
              newval ++;
      }
    }
  }

  recursive_label(x,y)
  {
      write_pixel(x,y,newval);      /* Replace with newval */
      count++;                      /* Increment count */

/* Recurse left */
      x--;
      if (read_pixel(x,y) == 255) recursive_label(x,y);
/* Recurse right */
      x += 2;
      if (read_pixel(x,y) == 255) recursive_label(x,y);
      x--;
/* Recurse up (remember: video coordinates!) */
      y--;
      if (read_pixel(x,y) == 255) recursive_label(x,y);
/* Recurse down */
      y += 2;
      if (read_pixel(x,y) == 255) recursive_label(x,y);
  }
```

Listing 7: *A C code fragment that enlarges an image in the x and y directions by arbitrary factors, an example of a geometric algorithm.*

```
  int xs,ys;    /* Start of source */
  int x,y;      /* Start of destination */
  int dx,dy;    /* Size of destination area */
  double a,b;   /* x,y scale factors */
  xa,ya;        /* x and y addresses for source */

  for (i = 0 ; i < dy ; i++) {
    for (j = 0 ; j < dx ; j++) {
      xa = xs + (int)((double)j/a);   /* x address */
      ya = ys + (int)((double)i/b);   /* y address */
/* Write out new value to destination */
      write_pixel(x+j, y+i, read_pixel(xa,ya));
    }
  }
```

Frame Processes

Algorithms that use more than one image are sometimes called frame processes. A simple example is to subtract one image from another. The resulting differences can be used to compare the two images (e.g., to look for missing parts on a machine or circuit board). You can also use frame processes to improve image quality and to detect motion.

If you use a television camera to view a static image (e.g., a microscope image) you can sum *N* successive image frames to reduce noise introduced by the camera. This requires a frame memory with enough bits per pixel to accommodate the sum. Dividing the sum by *N* produces an averaged image. If the noise is Gaussian and uncorrelated from frame to frame, the improvement in signal-to-noise will be of order square root of *N*. A typical low-cost video camera has about 3 bits of noise, so averaging with an *N* of 8 or 16 will noticeably improve the image that is output to your display.

To detect motion, you can subtract video frames to approximate a time differentiation. You could use this operation for surveillance or motion measurement. This operation could require image processing hardware that can do the subtraction in real time, that is, at video rates.

Conclusion

As researchers try to give machines the ability to see, image processing becomes an increasingly important science. This quick tour of the algorithms and implementation will hopefully encourage you to learn more about image processing. You will find that you need to understand many other theoretical and technical issues (e.g., sampling procedures, lighting, and algorithm stability) to master image processing. A number of texts can help you (see the bibliography), but you can gain practical experience only by trying the algorithms. ■

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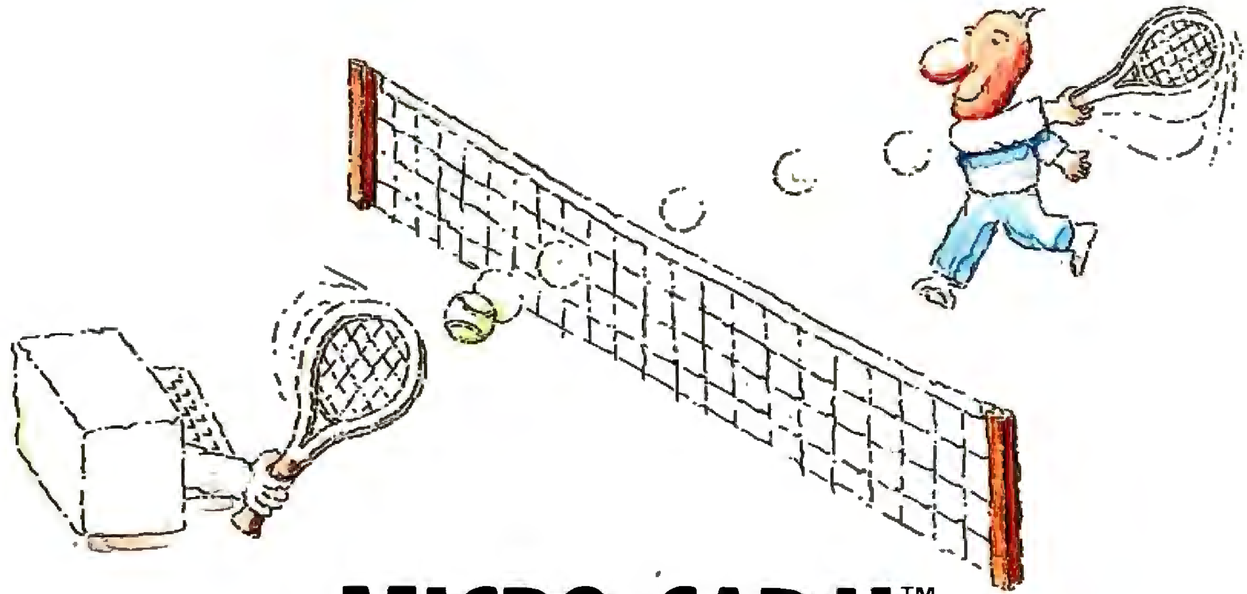

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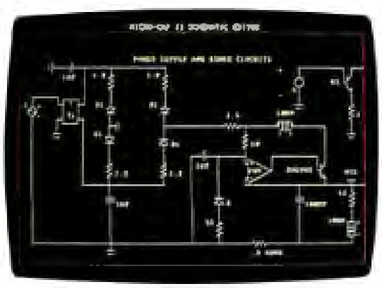

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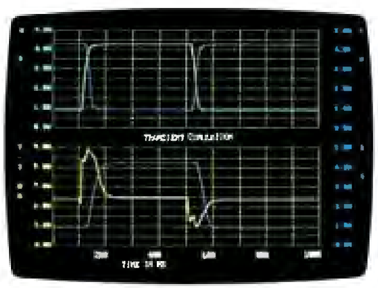

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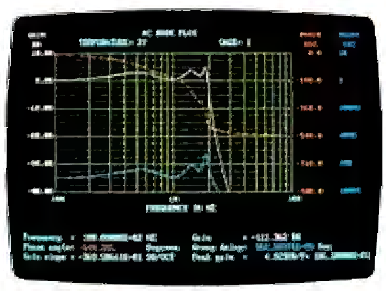

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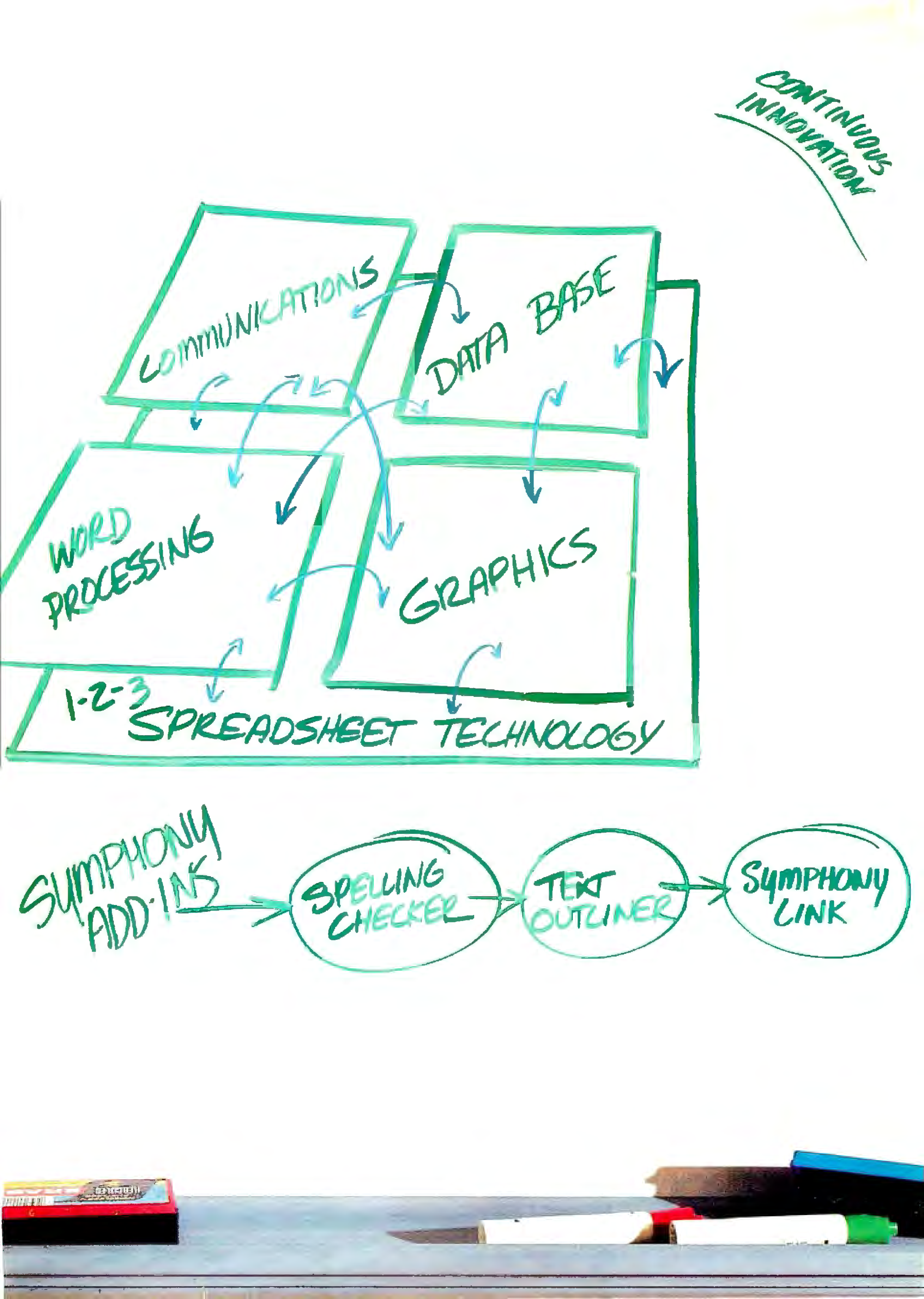
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Low-Cost Image Processing

An inexpensive but powerful image processing workstation can be built around the Amiga

Charles McManis

IMAGE PROCESSING consists of using a computer to manipulate digitized continuous-tone images. An image processing workstation must provide three basic facilities: the means to digitize, display, and manipulate the image data. The workstation might also provide a means of storing and distributing that data.

Not long ago, an image processing workstation could easily cost over $100,000. Now, with some innovative hardware and software, you can build a capable system for less than $2500. I will describe such a workstation based on the Amiga 1000 personal computer.

The Workstation

The hardware for this workstation consists of an Amiga 1000 computer with 1 megabyte of RAM and two disk drives, a Digi-View video digitizer, and a black-and-white video camera. Optional equipment includes such items as a 35mm camera or videotape recorder for capturing your output and a copy stand for increasing the stability of the digitizing setup.

The Amiga computer provides the basis for the workstation. It is uniquely suited to image processing because of its high-resolution graphics, easily expandable memory, and ability to address large data arrays.

The Amiga's custom graphics chips can display an image that has 640 columns by 400 rows of 4-bit pixels. At this writing, this is the highest display resolution that is standard with a personal computer. The only other personal computer that comes close is an IBM PC equipped with the Enhanced Graphics Adapter, which has a maximum resolution of 640 columns by 350 rows of 6-bit pixels. (Thus, each pixel can have 64 possible colors.) While this setup appears to have a better pixel dynamic range (6 bits versus 4 bits), you can map the Amiga's pixels through the use of a palette RAM to any 16 of 4096 possible colors. The EGA's 64 colors are fixed, making it difficult to display either monochrome or color continuous-tone images acceptably.

The Amiga's architecture allows for easy access to large amounts of memory. This might be the most important aspect of using an Amiga as an image processing workstation. First, the Amiga uses a Motorola 68000, which addresses memory as a linear array of words. This feature lets you load an image completely into memory and treat it simply as a large array via a high-level language or an assembly language program. Second, adding memory is simply a matter of plugging a card into an expansion-bus connector on the side of the machine. For this article I have been using an Alegra 512K/2M that can be configured with either 512K bytes or 2 megabytes of RAM; mine has 512K. You can buy 2- and 4-megabyte cards, and you can often daisy-chain cards or plug them into expansion boxes to fully populate the 8 megabytes of address space reserved for user RAM.

On the IBM PC, adding multiple megabytes of memory is a simple matter of plugging memory cards into the internal bus. However, the original PC (and even the PC AT with current versions of MS-DOS) cannot directly access more than 640K bytes of RAM. (Various software and hardware manufacturers provide ways around this, but these all tend to be nonstandard, are hard to call from a program, and slow down access to memory.) Manipulating images in the restricted 640K-byte address space is difficult at best.

The Amiga is also easier to program for image processing applications because of the way it addresses memory. Specifically, to declare an array of 128,000 bytes on the Amiga in C, you can use the following syntax:

```
unsigned char     *image;
image = AllocMem(128000,0);
```

Due to the nature of the architecture, arrays larger than 64,535 bytes are difficult to manipulate on the IBM PC and compatibles. Fortunately, this will not be the case for 80386-based machines.

Thus, the Amiga's cost, architecture, and inherent graphics capabilities give it the most favorable price/performance position for image processing applications.

Capturing Images

Before you can display and manipulate an image, you need to *have* an image. You solve that problem with a piece of hard-

continued

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Image processing applications could be written in BASIC, but they would be slow.

ware such as the Digi-View from NewTek. This device connects a standard black-and-white video camera and the Amiga's parallel port. When you combine some software and this hardware, the complete digitization setup costs less than $400, including a black-and-white camera. (NewTek sells a Panasonic CCTV Model WV-1410 camera, which it provided along with the Digi-View for this article.) This package can digitize black-and-white images at resolutions of 640 by 400 or 320 by 200, with 16 shades of gray, or color images with resolutions of 320 by 200.

This setup has two color modes for digitizing. The first uses the Amiga's 32-color palette to display color images; the second uses the Amiga's "Hold and Modify" mode to display an image with 4096 colors on the screen. I used the 640 by 400 black-and-white mode exclusively.

The Software

Two types of software contribute to the Amiga's viability as an image processing workstation. The first type includes the common image processing languages such as C, FORTRAN 77, and LISP. Some of the newer languages are also available for the Amiga, including FORTH, Modula-2, and Pascal. You could also write image processing applications in the BASIC dialect supplied with the machine, but such programs would tend to be rather slow.

Several tools exist for manipulating image and graphical data. Some of these were written by Electronic Arts and contributed to the public domain along with the Interchange File Format specification. Others were designed for graphics manipulation but are useful here as well. All the IFF tools that I used are on the IFF distribution disk, which is available from Commodore and many bulletin boards around the country. Information on how to acquire a copy appears at the end of this article.

The IFF standard is complex because it is so flexible—it will describe music, text, animation, and so on. The IFF tools ILBM2Raw and Raw2ILBM (ILBM stands for interleave bit map) convert the complex IFF format images into a much simpler "raw" format, and vice versa. The raw format for 640 by 400 images consists of 4 bitplanes, each of which is 640 by 400 bits, followed by a 16-word color-map array with no header or other information.

As adjuncts to the tools from the IFF disk, I wrote two C routines, ReadImage( ) and WriteImage( ), to handle images in the raw format. These routines provide for reading and writing raw images, while Pixel( ) and SetPixel( ) provide for reading and setting individual pixels in an image. [Editor's note: *The programs described in this article are available on disk, in print, and on BIX; see the insert card following page 352. They are also available on BYTEnet; see page 4. The files are IMAGEIO.C and EDGE.C. You will need an Amiga and Lattice C to use them.*]

When you are finished processing a file, you can convert it back to IFF form and use it with other programs.

Using the System

The typical flow for image processing research is generally a six-step process. The steps are acquiring a digitized image, developing an algorithm to process it, processing the image, comparing the output with the desired results, modifying the algorithm, and looping back to the third step until you are satisfied.

I will cover each step to demonstrate how to use the Amiga as an image processing workstation.

Acquiring the Image

Operation of the Digi-View is straightforward. After starting the high-resolution

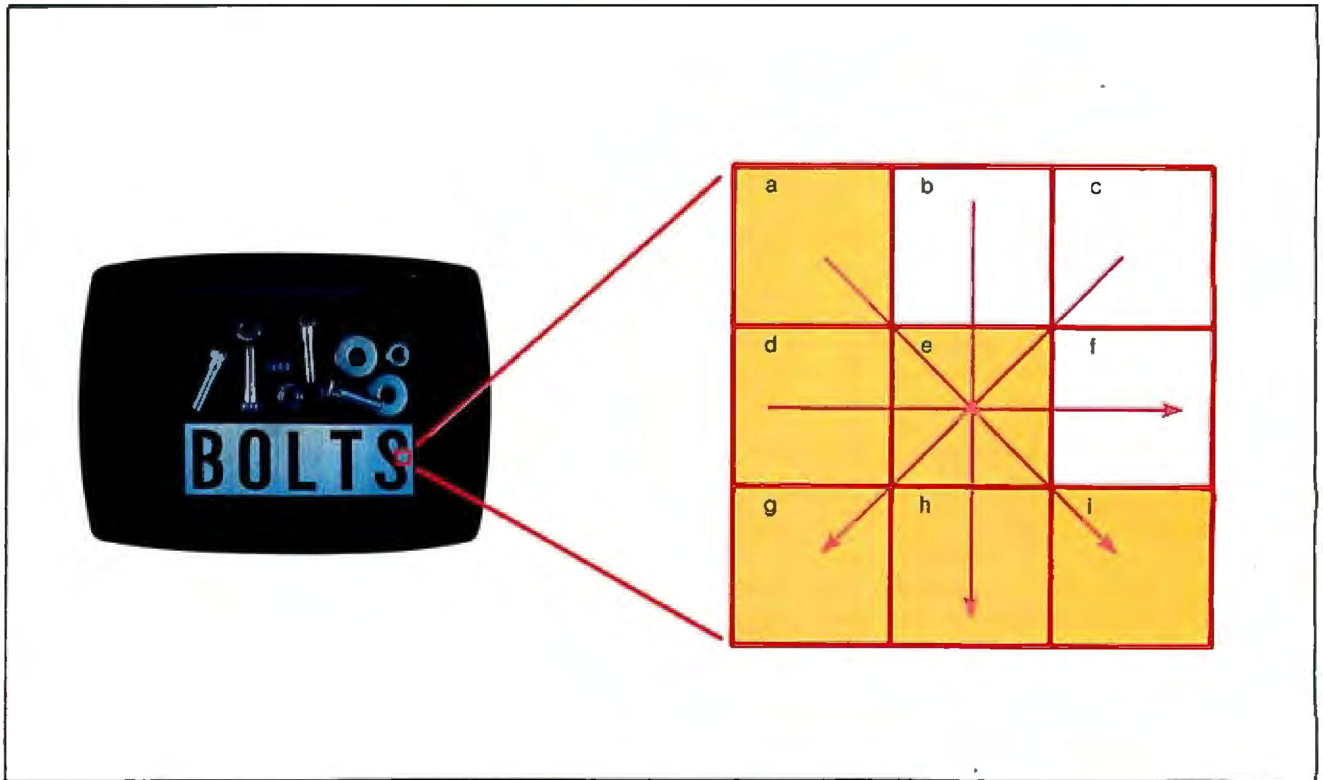

Figure 1: *The Sobel algorithm for image processing breaks arrays of pixels into 3 by 3 subarrays.*

version of the Digi-View software, you focus the video camera on the image to be digitized. Then select the Digitize option, and the image will be digitized into memory.

At this point, the software lets you manipulate the image data in several useful ways. These include adjusting the image's contrast, brightness, and sharpness. Once the image is adjusted to your satisfaction, you save it with the Save IFF option in the Project menu. The IFF format is needlessly complex for the purposes of image processing, so you then use the ILBM2Raw IFF tool from the Amiga's command-line interface to convert the image into the simpler raw form.

Developing the Algorithm

For this article, I have used a derivative of the Sobel edge-detection algorithm. The classic Sobel algorithm creates an edge image by calculating the two-dimensional derivative of the source image. The algorithm calculates this derivative by looking at each pixel in the source image and its eight nearest neighbors. The pixel of interest and its neighbors are treated as a 3 by 3 array (see figure 1). Using row and column coordinates, you can draw exactly four unique lines through the pixel at the center of this array. These are a-e-i, b-e-h, c-e-g, and d-e-f.

The algorithm averages the intensities of the three pixels on either side of each of these lines (for the line d-e-f, for example, it would compare the average of the pixels a, b, and c with the average of pixels g, h, and i). The algorithm then replaces the center pixel with the largest absolute difference of the four averaging operations. After completely building a new edge image in this manner, the program runs the image through a threshold filter. The filter examines each pixel and assigns a 0 or 1 to it, depending on whether its value is above a given threshold. In this binary image, all "on" pixels represent edges greater than the given threshold.

Unfortunately, this algorithm has two serious drawbacks. The first is its slowness; analyzing each pixel during the thresholding operation requires 16 additions and 8 divisions followed later by one magnitude comparison.

The second problem is noise. The Digi-View provides remarkably clean images, but the camera is susceptible to a certain amount of Gaussian noise (caused by the occasional spontaneous emission of electrons from the excitation of the phosphor on the face of the Vidicon tube). This noise manifests itself as individual pixels with intensities that are much higher or much lower than their neighbors. When

continued

you are using the Sobel algorithm, this noise can throw off the averages for the three pixel groups.

One solution to the noise problem is to obtain an image with less noise. NewTek has modified the newer version of the digitizing software to accomplish that by averaging several frames arriving from the camera. The other solution would be to increase the size of the pixel array to 5 by 5; however, this would slow it down still further.

To combat the speed problem, I modified the Sobel algorithm to consider the endpoints of each line, rather than the averages used in the original algorithm. The new algorithm compares the absolute magnitude of the change in intensity between these two points to a user-specified threshold value. If this threshold is exceeded, the algorithm sets the corresponding pixel in the destination image to indicate an edge and does no further analysis on that pixel. If none of the four possible

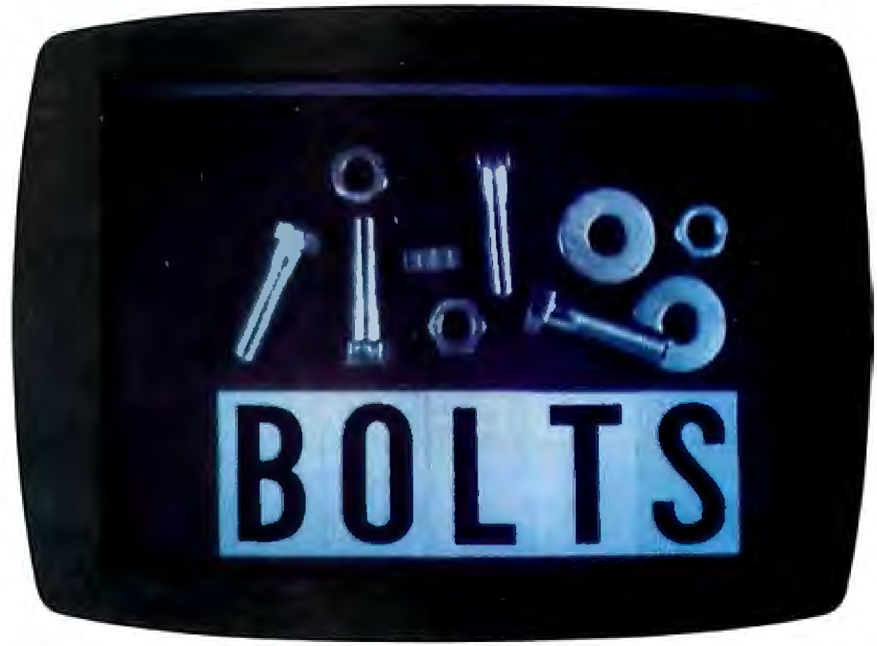

Photo 1: *The original image as digitized by the Digi-View.*

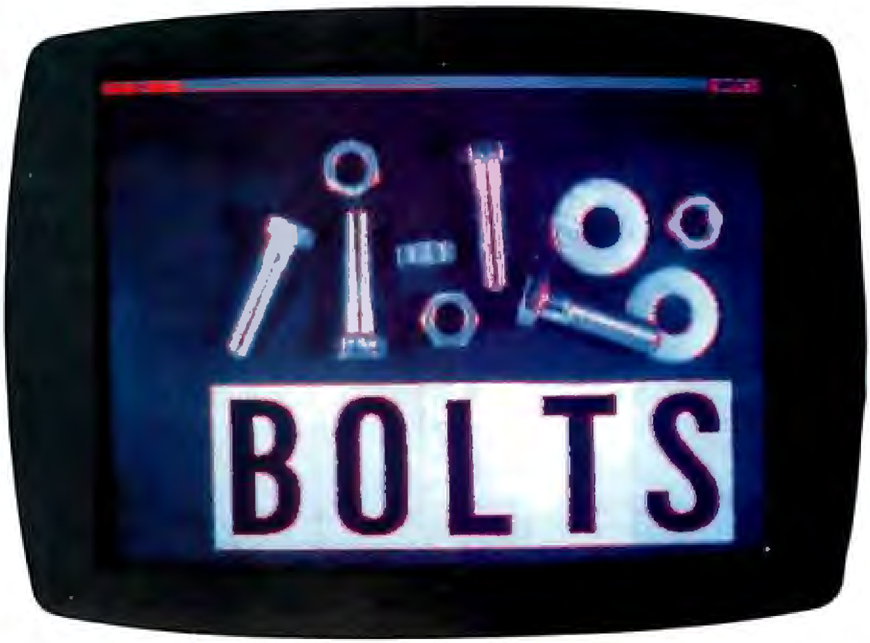

Photo 2: *The image of photo 1, edge-detected by the image processing program described in the text, with the threshold set to 2.*

magnitudes exceeds the threshold, the pixel value of the source image is copied into the destination image. This yields a resultant image with the edges detected by the algorithm overlayed onto the original image. It also yields a processed image in about one-sixth the time.

Process the Image

The program that implements this algorithm and processes the image is called EDGE.C. It uses the routines from the IMAGEIO module to manipulate the image in memory and to move the image to and from the disk.

Comparing Output with Desired Results

Photos 1, 2, and 3 show the input, the output with a threshold value of 2, and the output with a threshold of 4, respectively. I first ran these images through the Raw2ILBM tool to convert them to IFF format and then used SeeILBM to display them.

As you can see from the photos, the program tracks sharp changes in intensity as edges. With additional software, you can combine the edges into wire-frame drawings of the objects in the image. This is one way to reduce the amount of information a vision system would need to process in order to identify objects in its field of view.

Modifying the Algorithm and Continuing

This edge algorithm is not perfect—it sometimes detects edges that are just spots and might miss gradual edges. The algorithm also does not use information such as which line of symmetry the edge lies on or how large a difference the edge represents. Both would be useful clues that a vision system could use to identify edge directions and ignore false edge indications.

Saving Your Work

You can approach this aspect of the setup in three ways. The most straightforward is to use the Amiga as a viewing device and store the processed images in disk files.

The Amiga has a composite video output port that conforms to the NTSC video specification. You can use this to record what is on the screen onto a video tape—display an image, record it, pause, set up a new image, record it, pause, and so on. Then you can take the videotape on the road and use it as a magnetic "slide carousel." This is much more convenient than lugging around a heavy computer, monitor, disk drive, software, and so on.

You can also approach the hard-copy issue in three ways. The first is to photograph the screen with a camera. I used this technique for the pictures in this article. The second is to use a "video printer" such as the Polaroid Palette. This has the added benefit of ensuring a good exposure since it eliminates errors due to screen reflections or alignment. The last is to use the Amiga's ability to dump graphics to any graphics printer connected to the printer port. Depending on your printer, this can be the least satisfactory method.

The program tracks sharp changes in intensity as edges, which, with additional software, could be combined into wire-frame drawings.

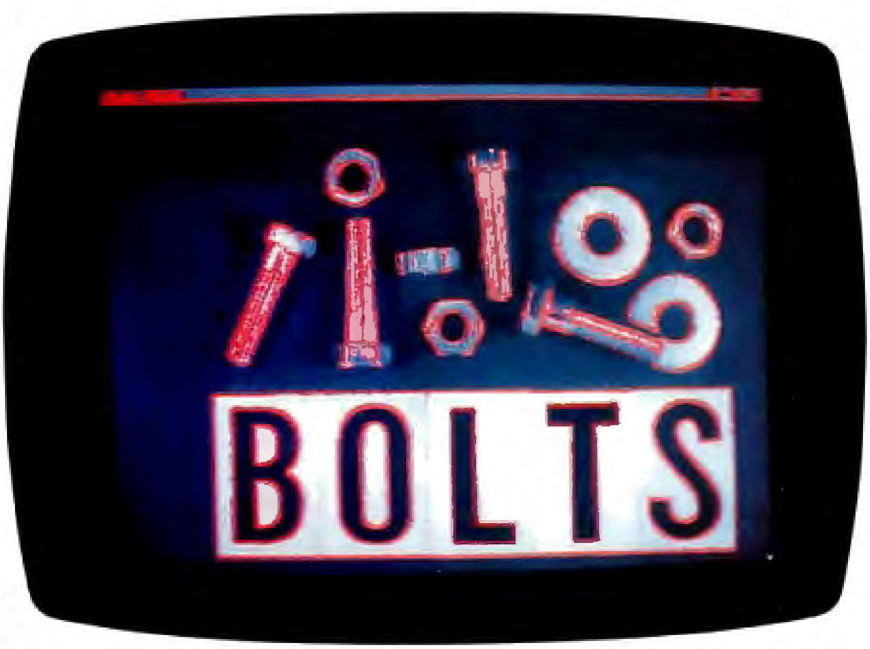

Photo 3: *The image of photo 1, edge-detected by the image processing program described in the text, with the threshold set to 4.*

A Powerful Combination

The combination of the Amiga and the NewTek digitizer is a powerful one. I have covered only the case of black-and-white images, but the hardware is capable of color, which adds another level of complexity to the system. The existing system provides enough power for many different types of image processing applications.

It also provides an easy path to increase that power. Multi-megabyte memory cards, math coprocessor cards, hard disks, and even 68020 accelerator cards are all available for the Amiga. They all increase the machine's speed and capabilities.

About the System

The IFF tools mentioned in this article are available from BIX, BYTEnet Listings, Commodore, or Fred Fish (who maintains a library of public domain software for the Amiga). To get them from Commodore, send a check for $20 and a note requesting the "Standard for Interchange Format Files (EA IFF) Documentation and Disk" to Commodore Business Machines, 1200 Wilson Dr., West Chester, PA 19380, attention: Kim Montgomery.

To get the tools from Fred Fish, send a check for $6 and a note asking for "Volume 16" to Fred Fish, 1346 West 10th Place, Tempe, AZ 85281. Your local users group or dealer might also have the tools as "Fish Disk 16." All of these tools are in the public domain.

The other software I used in this article includes the C compiler 3.10 from Lattice Inc., and the Digi-View software 1.0 that came with the Digi-View.

The hardware was an Amiga 1000 with an Alegra 512K RAM expander and a MicroBotics MAS-20 hard disk drive, the Digi-View unit, and a Panasonic CCTV Model WV-1410 video camera. I took photos with a Canon AE-1 35mm SLR camera, using Kodak Ektachrome 100 film shot at 1/15 second with an F-stop of 2.8. ■

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PreScript

A proposed standard would streamline the process of capturing and manipulating image data

Ken Sheldon

DESKTOP PUBLISHING, the ability to produce high-quality publications using a microcomputer, essentially boils down to combining words and images on pages. Every desktop publishing software package deals with these two types of information in its own way, and each provides different features and capacities.

Typically, you incorporate text into a desktop publishing program by entering it directly from the keyboard or importing a standard ASCII text file created by a word processor. The method of importing *images*, however, varies widely from package to package and computer to computer.

True desktop publishing programs let you import an image file into your document, and the format of these image files varies widely depending on the package and your computer. Other packages allow you to scan an image (using, for example, a camera or page scanner) from within the application and place the image directly into the document on which you are working.

Camera and scanning devices usually perform some low-level image processing, such as improving the contrast, to make the images more presentable. Some desktop publishing packages allow you to enhance the images further after capturing them; other packages force you to scan the image and "take it or leave it." You can, of course, attack an image file at the bit-map level and perform your own image processing to enhance it before importing it into your desktop publishing program, though this will be beyond the interest and abilities of many users.

Enter PreScript

In the face of this conglomeration of features and capabilities, Datacopy Corporation has proposed a standardized high-level language for importing image data into desktop publishing and other application programs. The proposed standard, called PreScript, consists of three parts: high-level language calls that reside in the application program; an interpreter that translates the commands for a particular image processing system; and an intelligent image processing system that controls the scanning process and contains its own microprocessor that handles the algorithms for image processing.

PreScript, which is invisible to the user of an application, sends commands to the PreScript interpreter through an SCSI port. The interpreter passes the commands, translated for a particular image processing system, to a signal processing router/scheduler (SPRS) in the form of an image description table. This table dictates the specific image processing functions and the order in which they are to be performed on the image data.

The SPRS manages the flow of image data between the various image processing algorithms and also interfaces with the controller of the camera or scanner. A microprocessor performs the actual image processing operations, with the help of optional coprocessors (e.g., pipeline processors, which are ideal at performing the many repetitive operations required to enhance image data). Depending on the manufacturer, the "intelligence" for the image processing functions may reside within the scanning device, in a chassis that sits between the scanner and the host microcomputer, or on an expansion board in the computer.

The PreScript standard currently describes a list of commands and image processing algorithms that are to be built into such PreScript-capable systems (see table 1). In addition, application programmers can develop new algorithms that may be downloaded to the intelligent scanner and called via PreScript.

Figure 1 shows a typical image-capture problem: The scan area contains two types of images, a continuous-tone photograph (window 1) and a line drawing that overlaps the photograph (window 2). Suppose you want to double the size of the photograph, halftone the photograph, reduce the line drawing to one-half its size, enhance the line edges to reduce breaks caused by the scanning and reduction process, and then perform a thresholding operation that "binarizes" the entire image (converts all pixels into either black or white).

For the application programmer to provide you with this capability could take from several hundred to several thousand lines of code. With a PreScript intelligent system, however, the programmer would need only include the

continued

Ken Sheldon is a technical editor for BYTE. He can be reached at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Table 1: *The entire PreScript built-in vocabulary, which includes both symbols and words. Most commands are highly descriptive of the functions they perform.*

```
{..any letter..}
[..any digit..]
%
$
(  )
[  ]
#nn
Add
Archive
Archive_Reset
Archive_Restore
Area_Compensation
Compression
Convolution
Def
Device_Frame_Get
Device_Frame
Device_Select
Div
Dup
Edge_Mask
Error_Diffusion
Gamma_Correction
Halftone
Inch
Invert
Mask
Mirror
Mul
Roll
Scaling
Scan
Sub
Swap
Synonym
Threshold
Window_Frame
Window_Select
```

following PreScript commands in the application:

```
1 Device_Select
1 Window_Select
10 10 200 200 Window_Frame
2 2 Scaling
Mask Halftone
2 Window_Select
40 40 300 300 Window_Frame
0.5 0.5 Scaling
Edge_Mask Convolution
128 Threshold
Scan
```

These commands select the scanning device, the windows (their size and location), and the scaling (enlargement or reduction) for each window. They also determine the image processing algorithms to be performed on each window and instruct the device to begin the scan.

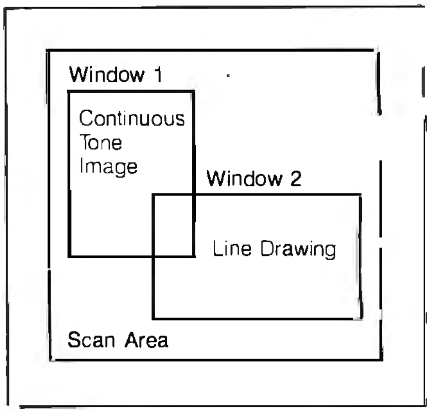

Figure 1: *A typical image-capture problem that might be addressed by PreScript.*

After the image processing system performs the desired operations on the image data, it sends the data back to the application program through the SCSI port. Although PreScript does not specify the file format into which the image data is placed, Datacopy's application software will support the Tag Image File Format (TIFF) now used by Aldus, Microsoft, and other software publishers. Use of the TIFF standard by software publishers will allow, for example, an image captured with an IBM PC-based system to be transferred to a Macintosh, where it can be incorporated into desktop publishing programs that also support TIFF, and vice versa.

Standard Advantages

Using PreScript would allow application developers to incorporate image enhancement technology into their programs without having to develop from scratch the algorithms to work with a variety of scanning devices and computers. Programmers will simply tell the scanner/image processing firmware what to do, not how to do it. In this regard, PreScript is nonprocedural, as opposed to a procedural page-description language such as PostScript.

The widespread acceptance of PreScript by the makers of scanning devices and application programs would mean that you could use your application programs with a variety of scanning devices. You would have more control over the way image data appears in newsletters, reports, and other publications.

PreScript is available for licensing from Datacopy Corporation to OEMs and developers of desktop publishing and other application programs. ■

Our thanks to NASA for supplying this computer enhanced ultraviolet photo taken by Skylab IV of a solar prominence reaching out 350,000 miles above the sun's surface

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C Benchmarks

	Microsoft C 4.0	Lattice C 3.0	Computer Innovation C 2.3	Aztec C86 3.2	Wizard C 3.0
Sieve of Eratosthenes (register)	82.9	151.4	172.3	88.0	91.9
Copy Block	86.9	231.7	199.0	123.8	189.5

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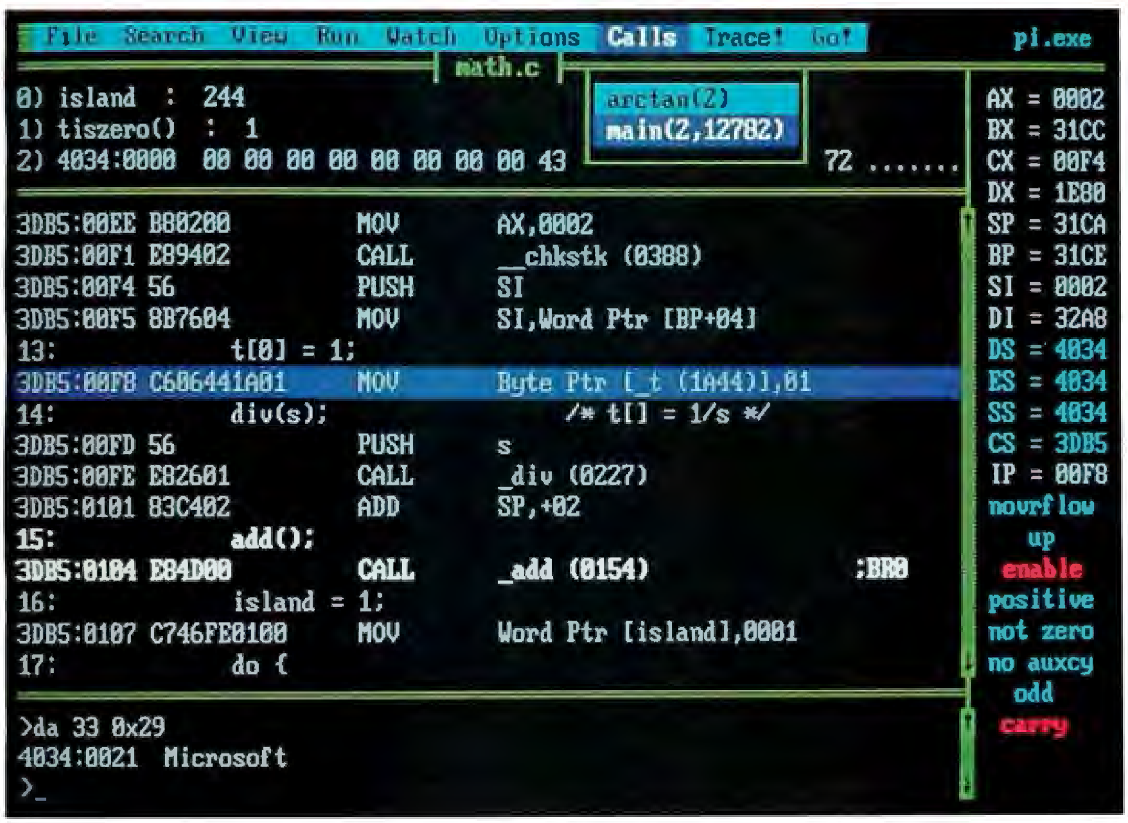

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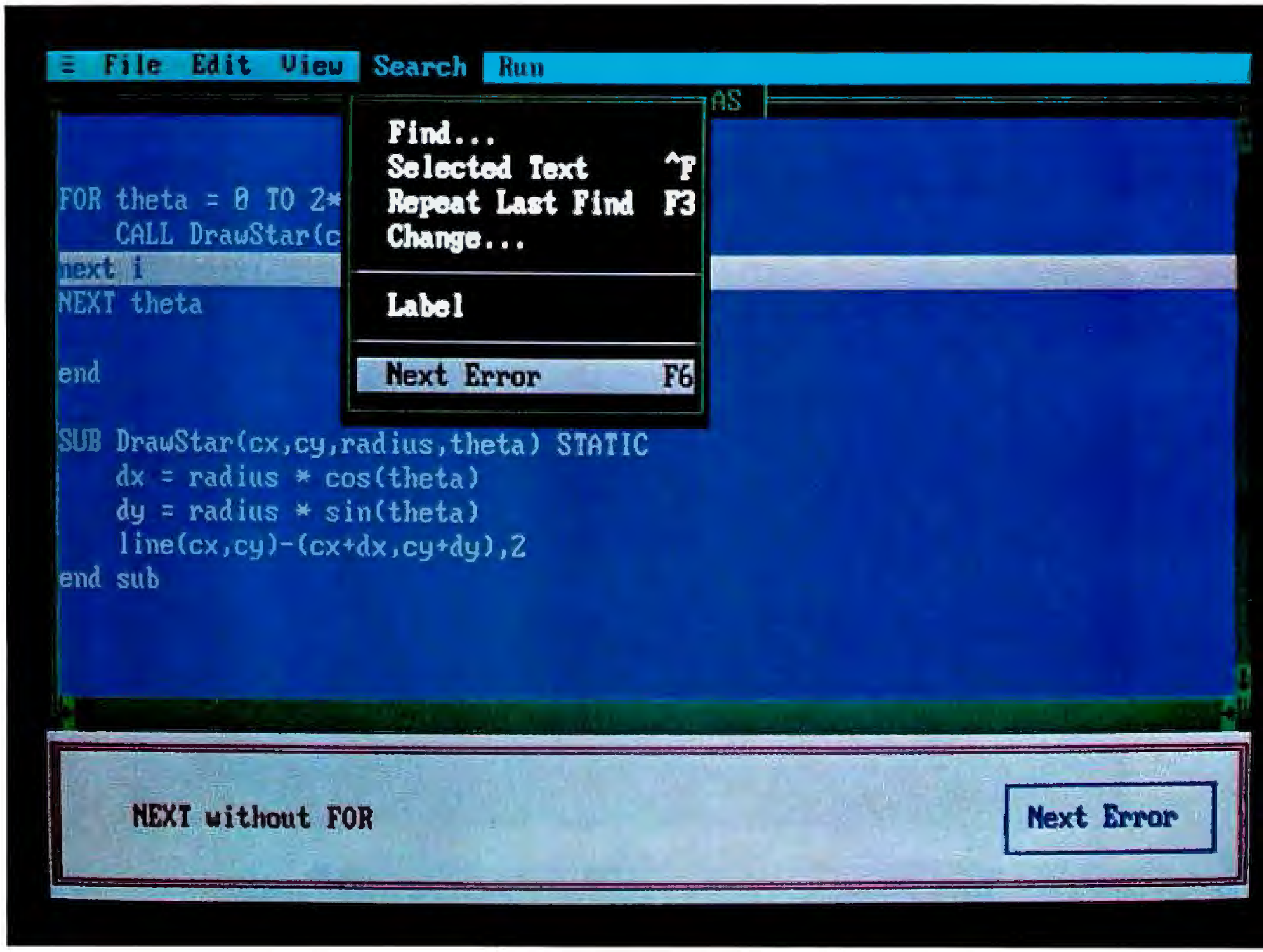

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Results of Sieve Benchmark	BASICA 3.1	Microsoft QuickBASIC 2.0
Seconds per iteration	78	0.52

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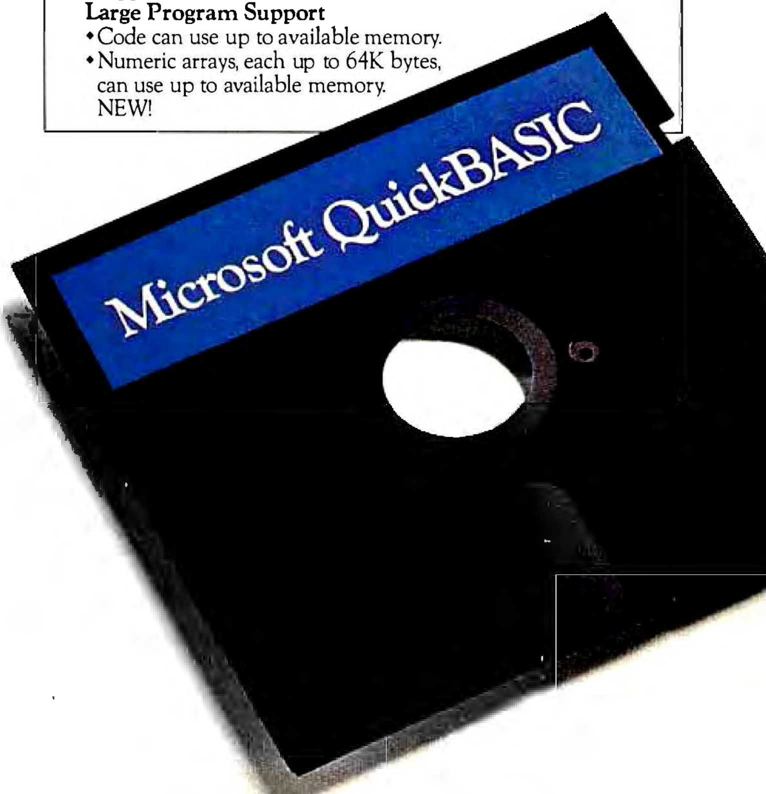

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Reviews

BASED ON PERFORMANCE ALONE, it's often difficult to distinguish one IBM PC AT compatible from another. Stan Miastkowski finds that the three 8-MHz systems reviewed this month—the NCR PC8, the Victor V286, and the QIC AT-Plus 1800—are set apart by other factors. Each comes equipped with different options and software, and their prices vary considerably.

To complement our image processing theme, BYTE illustrator Robert Tinney reviews AT&T's TrueVision video image processing system. For Robert's work as a print illustrator, the system proved to be an invaluable tool for sketching, though less satisfactory for finished artwork.

Laser printers are as common as PC AT clones these days, and reviewer Arthur Little evaluates four models: the Canon LBP-8, the BDS Model 630/8-E, the QMS Kiss, and the Quadram QuadLaser. The QMS Kiss stands out as the best value, while the others offer distinctive features that make them more appropriate for specific applications.

Our language reviews this month start off with PC Scheme, a PC-based implementation of the Scheme dialect of LISP. Reviewer William G. Wong finds the program useful for some symbolic and graphics applications. With a few enhancements, William says, the package could serve well as a general-purpose language.

Also written for MS-DOS-based systems is Concurrent PC DOS, Digital Research's multiuser multitasking operating system. The system requires more skill to use and set up than a single-user system, according to reviewer Wayne Rash Jr., but it's an inexpensive way to get multitasking capabilities.

The ability to create personalized operating systems is provided by Wendin's Operating System Toolbox, which offers about 300 files with C source code and assembly code. Jason Levitt strongly recommends the OST as an educational tool and for creating a user interface. The package's problems, he maintains, are not its fault but those of MS-DOS and the 8088.

In application reviews this month, Larry D. Allen examines Software Publishing's PFS:First Choice, an integrated package for IBM PC compatibles that offers word processing, spreadsheet, file-management, and telecommunications capabilities. Designed for first-time computer users, Larry finds that the $149 package can be quickly learned but might also be easily outgrown.

WriteNow for the Macintosh, a word processor from T/Maker, impressed reviewer Mick O'Neil with its outstanding performance and a variety of advanced features. Only a few missing features—there's no glossary, for instance—keep Mick from pronouncing it the complete word processor for the Macintosh.

For the Atari ST, Rusel DeMaria looks at CAD-3D, a three-dimensional modeling package. A bargain at $49.95, the package lets you manipulate three-dimensional objects in up to four simultaneous views and offers superb, though slow, animation. Because it lacks a few features like autodimensioning and labeling, Rusel concludes that it's more appropriate for design and animation than for drafting.

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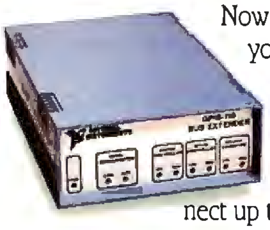
The Extender: More devices, greater range.



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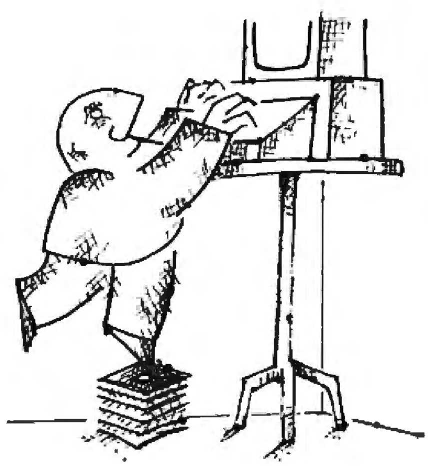

Always lively, BYTE's review department has been more hectic than usual lately. Part of the commotion results from recent staff changes, but a large part comes from new projects, changes in review procedures, and what seems like a growing barrage of new products.

Most of the changes we're undertaking are aimed at continuing to evaluate as many of these products as possible without skimping on technical depth and at making these reviews more timely—a bear of a problem for a monthly publication with long lead times. To attack both these problems, we will be making more use of BIX, a strategy that former review editor Jon Edwards began almost a year ago.

Until now, the byte.reviews conference on BIX has been used chiefly to publish reviews that we've been unable to include in the magazine because of limited space. Now that conference will hold all reviews, both published and unpublished, beginning with reviews appearing in the January 1987 issue. We will also continue to post reviews that we simply can't squeeze into the magazine. In some instances, charts and tables that appear on BIX may not be formatted as they are in the magazine. But the information on BIX will be as complete as that in the magazine, and we think that the early chance to read reviews will more than justify any inconvenience.

Since limited space in the magazine often curtails the number of letters we can publish here, we encourage you to post your reactions to these products and reviews in the byte.reviews conference. In some instances, we'll be able to incorporate this additional feedback into the magazine, giving our non-BIX-subscribing readers the benefit of information from users other than the reviewer who may have valuable feedback on a product.

We will also use BIX to post information on product reviews that we've scheduled for future issues. Again, your comments on these upcoming reviews are welcome, as are suggestions for future reviews; watch BIX and these pages for further information.

Over the past several months, with the introduction of faster machines and peripherals, as well as add-ins and software that take advantage of that speed, we've also become aware that BYTE's venerable benchmarks demand revision to accommodate developments in technology. Dennis Allen, technical editor in charge of review standards, has taken on the job of evaluating BYTE's existing benchmarks and updating them as necessary. Dennis will also be establishing our benchmarks in new areas such as graphics. To aid this process, he has started another BIX conference, called benchmarks, to examine the goals and philosophy of benchmarks and discuss specific tests for systems, peripherals, languages, applications, and utilities. The conference is open to all, and your participation is encouraged.

To further upgrade the quality of our reviews, Dennis is also coordinating a telephone survey of a randomly selected group of BYTE subscribers. We'll query you about your satisfaction with current reviews and ask about changes you'd like to see. If you're not among the chosen, feel free to drop us a note in the mail.

All this, we think, will ensure the most thorough, accurate, and timely coverage of new products that BYTE can provide. And our product reviews will begin bearing the fruit of this effort immediately. For instance, a comprehensive roundup of 9-, 18-, and 24-pin dot-matrix printers will incorporate BYTE's new printer benchmarks. In addition to testing throughput and bit-mapped graphics capabilities, the benchmarks will be accompanied by tests for sound levels, alignment, and other features. Technical editor George Stewart has been wrestling with these printers for weeks, and we'll bring you his results next month.

In another issue this spring, Stephen Satchell will follow up his December 1986 review of external modems with a review of high-speed internal modems. Responding to reader feedback, Stephen has refined his tests, and we look forward to seeing his results. We're also beginning a series of reviews of 80286-based machines faster than the hordes of 6- and 8-MHz IBM PC AT compatibles, many of which we've already reviewed. Look for evaluations of systems that purport to run at 10, 12, and 16 MHz and offer other features that distinguish them from the rest of the clones.

Calls to companies during the weeks following November's COMDEX have yielded little in the way of getting our hands on even faster machines: 80386 computers, accelerator boards, motherboards, and coprocessor boards. Nearly all companies cite a delay of at least a month or two in shipping schedules, due mainly to a short supply of Intel's 80386 microprocessor. Software companies are pursuing the market nonetheless. Last week we received copies of MetaWare's High C Compiler for the 80386 and Phar Lap Software's 386/ASM, 386/Link, and RUN386 packages. These are now in the hands of BYTE editors, and we expect to give you an early report on the software next month, with full reviews to follow shortly afterward.

However, the Intel family of microprocessors is not the only one vying for attention. New 68000-based systems from Commodore, Atari, and others have grabbed our attention and that of developers, too, judging from reports from those who attended the MacWorld Expo in January. In addition to presenting the new Amiga 2000 in this month's Product Preview, we'll be evaluating the new Macintosh-compatible portables whose prototypes were shown at the MacWorld Expo: Colby Systems' Lap Mac, Dynamic Computer Products' as-yet-unnamed portable, and Intelitec's MX Plus. All three, reports BYTE's Assistant Managing Editor Glenn Hartwig, use Macintosh motherboards that the companies obtain by buying Macs and dismantling them.

As always, we welcome your comments and suggestions.

—Cathryn Baskin
Senior Technical Editor, Reviews

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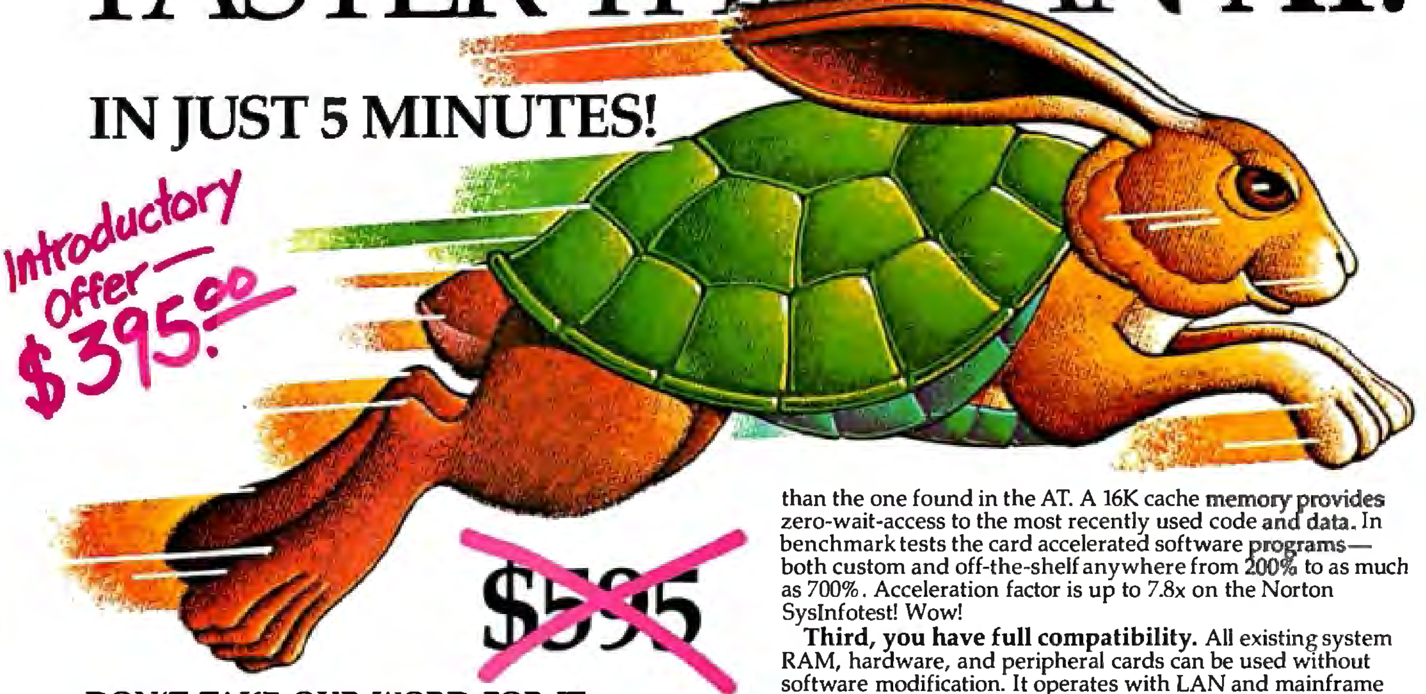

DON'T TAKE OUR WORD FOR IT. USE THE BREAKTHRU 286 SPEEDUP BOARD FOR 60 DAYS. IF YOU ARE NOT TOTALLY SATISFIED RETURN IT FOR A FULL REFUND.

It sounds great; the idea of a speedup board that you can just plug right in as easily as putting bread in a toaster. How wonderful to be able to convert a PC or XT to a $4000 AT without the expense. But even when you get ready to spend $595.00 you want to be sure your choice is the very best.

Here at PCSG we sell our IBM PC disk access speedup software by the thousands. But software doesn't do anything about speeding up the microprocessor (or CPU) speed. As you know the microprocessor is the brain of the computer that controls all the operations like screen updates and calculations like a spreadsheet makes.

Faster and smarter than an AT–
PCSG guarantees it.

We wanted to offer a speedup card that would be the complement to our disk speedup software, (incidentally included at no extra charge.) We wanted it to be literally the most advanced, compatible and feature rich board available today. We could only be satisfied with a board that was the finest example of the engineering art.

There is no question we have met our every objective by developing and manufacturing the *BREAKTHRU 286* card. This is the best designed and most functional speed up card available today. We guarantee it.

HERE IS WHAT MAKES IT SO SPECIAL.

First, it installs so easily. It is a half slot card, only five inches in length. You don't even have to give up a full slot. What's more, unlike competing products it works in the Compaq and most clones. The instructions are so simple we considered showing a picture of a child putting it in. Easy diagrams show how you just place the card in an open slot, remove the original processor and connect a single cable. There is no software required. From that moment you are running faster than an AT.

Second, it is advanced. The *BREAKTHRU 286* replaces the CPU of the PC or XT with an 80286 microprocessor that is faster than the one found in the AT. A 16K cache memory provides zero-wait-access to the most recently used code and data. In benchmark tests the card accelerated software programs—both custom and off-the-shelf anywhere from 200% to as much as 700%. Acceleration factor is up to 7.8x on the Norton SysInfotest! Wow!

Third, you have full compatibility. All existing system RAM, hardware, and peripheral cards can be used without software modification. It operates with LAN and mainframe communication products and conforms to the Lotus/Intel/Microsoft Expanded Memory Specification (EMS). Software compatibility is virtually universal.

Fourth, it is the best there is. There are several other boards on the market. Some are priced about the same as the *BREAKTHRU 286* and some are cheaper. We at PCSG have compared them all, but there simply was no comparison. What we discovered is that many cards being sold offer only a marginal speed up in spite of their claims. We found some to be merely versions of the obsolete 8088 or 8086, and others to be just poorly engineered. The 8MHz *BREAKTHRU 286* is unequivocally the best executed and most completely reliable speedup board manufactured today.

PCSG has since early 1983 dominated the lap portable market with ROM software such a Lucid spreadsheet and Write ROM that reviewers rated as excellent. We were proud to successfully enter the IBM PC market last year with disk access speedup software. Now we are so pleased with the *BREAKTHRU* speedup card. We use them on our own PC's to make them faster than AT's. We are really excited about this product.

PCSG makes the unabashed statement that the *BREAKTHRU 286* card represents more advanced technology than boards by Orchid, Quadram, Victor, Mountain, P.C. Technologies, Phoenix . . . we could go on.

But an ad can't let you experience it for yourself. That's why we sell the *BREAKTHRU 286* on a 60 day trial. If you aren't completely satisfied return it within 60 days for a full refund. It is priced at $395. Call today with your MasterCard, Visa, American Express or COD instructions and we will ship your card the very next day.

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A Trio of 8-MHz PC AT Compatibles

Stan Miastkowski

Options, software, and price separate these three machines

In this review, I'll look at three IBM PC AT clones: the NCR PC8, the Victor V286, and the QIC AT-Plus 1800. Although all three systems are similar, each has its own distinctive quirks, and their prices vary drastically.

All three machines that I reviewed were configured with 512K bytes of internal memory, a single 1.2-megabyte floppy disk drive, and an internal full-height 20-megabyte hard disk drive. All had built-in battery-backed clock/calendars. The only major difference in equipment was in the PC8, which came with NCR's own color card and RGB monitor. The AT-Plus 1800 was equipped with a combination monochrome/color card but no monitor, and the Victor V286 had neither a display card nor a monitor. I used a standard monochrome display for reviewing the Victor V286 and AT-Plus 1800 machines, and I swapped the QIC mono/color card between the AT-Plus 1800 and Victor V286 machines. [Editor's note: *See pages 210 and 211 for rent prices and standard configurations of all three machines.*]

The three computers are quite similar to the IBM PC AT in size and appearance. All have the familiar key-operated system locks. As with most PC AT clones, all three take up a great deal of desk space and are best used on large work surfaces or with the system units placed vertically (preferably on the floor). In fact, the nameplate on the PC8 is placed so that it reads horizontally only when the system unit is standing vertically. All three companies thoughtfully provide long keyboard cords for this system-unit-on-the-floor configuration.

The NCR PC8

The PC8 ($3895 and up) is at the top of NCR's line of personal computers; it is the "big brother" to the IBM PC-compatible PC6. [Editor's note: *See the review of the NCR PC6 by Arthur Little in the August 1986 BYTE.*] And "big" is an understatement. The PC8 is the largest and the heaviest of the three systems reviewed. The system unit, though only slightly larger than the other two, weighs nearly 50 pounds. Add the optional RGB monitor and you have a system that tilts the scales at 93 pounds. Ultra-heavy construction is obvious throughout, and the PC8's extra weight can be attributed to the heavy-gauge steel in the case and surrounding the internal components.

The PC8's keyboard is unique in a couple of ways. First, it has a cursor-movement pad separate from the numeric keypad, much like the new IBM "enhanced" keyboard. The separation of the right/left and up/down arrow keys makes cursor control much easier when your eyes are not on the keyboard. The PC8 keyboard also has 30 function keys. Function keys numbered 1 through 10 are standard, keys 11 through 20 are equivalent to shifted function keys 1 through 10, and keys 21 through 30 are equivalent to control function keys 1 through 10. This can be quite handy for involved programs that use many function-key commands. The major oversight on NCR's part is not including a template or some other way of marking the keys. Remembering which of 30 different keys does what can be a major problem, and you're back to keys 1 through 10 if you use a program like WordPerfect that uses Alt/function-key commands.

The PC8 does not have switchable clock speeds; it runs at 8 MHz only. This is becoming less of a hindrance because programs and peripherals that have problems running at 8 MHz are getting rare.

A word about monitors: NCR has a preference for large displays. Its optional high-resolution monitors measure 15 inches (monochrome) and 14 inches (RGB). The RGB display that came with my review unit was a behemoth. Though it looks impressive at first, I found that the combination of the large tube and the nonstandard font used in the system's character-generator ROM made for sore eyes after a couple of hours. Pushing the monitor farther away helped a bit, but I'd hate to have to use the RGB display for eight hours a day. A standard mono-

continued

Stan Miastkowski is an associate news editor for BYTE and editor in chief of the McGraw-Hill Microcomputer Handbook. *He can be reached at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

chrome display is considerably easier on the eyes.

The Victor V286

The V286 ($2195 and up) is a well-constructed AT clone. Of the three systems reviewed, it's the most complete in its off-the-shelf configuration. Both a serial port and a standard parallel printer port are built into the system board, with jacks accessible on the rear panel. The only drawback is that, like the IBM PC AT it emulates, the serial port uses a small DB-9 connector instead of the previously standard DB-25. You might have to hunt around to find a serial cable that fits.

The V286 also has the most on-board memory-expansion capability of the three computers. Standard memory consists of 512K bytes, and sockets are included for another 512K. Of the two dual-speed systems, the V286 is the only one that's easily switchable between 6-MHz and 8-MHz clock speeds (via a slide switch on the rear panel).

The V286 keyboard is the standard PC AT type with ten function keys. Its one unique feature is an extended palm rest in front of the first row of keys. Though this is supposed to be an ergonomic feature for touch-typists, I found it difficult to get used to since I use my palms on the edge of the keyboard to orient my typing fingers.

The QIC AT-Plus 1800

The AT-Plus 1800 is the lowest-priced computer of this trio. The basic unit retails for $1295. For that price you'll get a system that still needs a monitor card and monitor, I/O ports, and software. But even when you add all these, you'll still end up with a low-cost system. The unit I reviewed came with the Everex Edge, a combination monochrome/color board with features like Hercules compatibility and a number of useful utilities that allow you to display 48-row by 132-column text.

The AT-Plus 1800 is a no-frills, well-constructed system. Its major idiosyncrasy is the effort needed to change the clock speed. The system comes with the 8-MHz crystal installed. If you want to switch to 6 MHz, you'll need to replace the crystal, which is mounted in a socket. A crystal for 6 MHz is included, and access isn't difficult. However, you'll need to slide off the system unit cover to get to it. Then there's the problem of keeping the tiny crystal somewhere where it won't be misplaced.

Setup

The unpacking and setup chores for these machines varied greatly. The setup of the NCR PC8 was the most time-consuming

continued

PC8

Company
NCR Corp.
Personal Computer Division
1700 South Patterson Blvd.
Dayton, OH 45479
(513) 445-7478

Size
6¼ by 21¼ by 17 inches; 50 pounds (system unit and keyboard)

Components
Processor: 8-MHz 80286
Memory: 640K bytes (basic system), expandable to 1.2 megabytes with 512K-byte memory-expansion board
Mass storage: One double-sided 360K-byte floppy disk drive and one 20-megabyte hard disk (basic system); one 1.2-megabyte floppy disk drive and one 20-megabyte hard disk drive (enhanced system)
Display: 15-inch monochrome or 14-inch RGB (both 640 by 400 pixels and 80 characters by 25 lines); both optional
Keyboard: 112 keys; 30 function keys; indicator lights for Caps Lock, Num Lock, and Scroll Lock keys
Expansion: Eight slots: six IBM PC AT–compatible; two IBM PC–compatible
I/O interfaces: One serial port and one parallel printer interface (enhanced system)

Software
NCR-DOS (MS-DOS 3.1–compatible); GW-BASIC; User Diagnostics disk; Getting Started disk

Options
RAM expansion kit; 30-megabyte hard disk drive; 64-megabyte hard disk drive; 720K-byte 3½-inch disk drive; high-resolution monochrome or RGB monitor; standard-resolution monochrome or color monitor; tilt-and-swivel monitor stand

Documentation
Owner's manual; NCR-DOS manual; GW-BASIC manual; *Getting Started* manual

Price
Standard system with single 360K-byte floppy disk, 20-megabyte hard disk, and 640K bytes of memory: $3895
Enhanced system with single 1.2-megabyte floppy disk drive, 20-megabyte hard disk drive, and 640K bytes of memory: $3995

Victor V286

Company
Victor Technologies Inc.
380 El Pueblo Rd.
Scotts Valley, CA 95066
(408) 438-6680

Size
5¾ by 21¼ by 17 inches; 43 pounds (system unit and keyboard)

Components
Processor: 6-MHz or 8-MHz 80286 (switch-selectable)
Memory: 512K bytes, expandable to 1.2 megabytes on motherboard
Mass storage: One double-sided 1.2-megabyte floppy disk drive; 20-megabyte hard disk drive (optional)
Display: Monochrome (80 characters by 25 lines) or RGB (640 by 200 pixels); both optional
Keyboard: 83 keys; 10 function keys; indicator lights for Caps Lock, Num Lock, and Scroll Lock keys
Expansion: Eight slots: six IBM PC AT–compatible; two IBM PC–compatible
I/O interfaces: One serial port and one parallel printer port; both built into motherboard

Software
MS-DOS 3.1; VBASICA; diagnostics program; setup program

Options
20-megabyte hard disk drive; memory-expansion board; monochrome card or monitor; color card or monitor

Documentation
User's guide; MS-DOS 3.1 reference guide; VBASICA manual

Price
Basic system (single 1.2-megabyte floppy disk drive and 512K bytes of memory): $2195
Basic system with monochrome card and monitor: $2495
Basic system with color card and monitor: $2795
Enhanced system (single floppy disk drive, 512K bytes of memory, and 20-megabyte hard disk): $2995
Enhanced system with monochrome card and monitor: $3195
Enhanced system with color card and monitor: $3595

AT-Plus 1800

Company
QIC Researcl
489 Valley Way
Milpitas, CA 95035
(408) 942-8086

Size
6 by 21¼
(system unit a

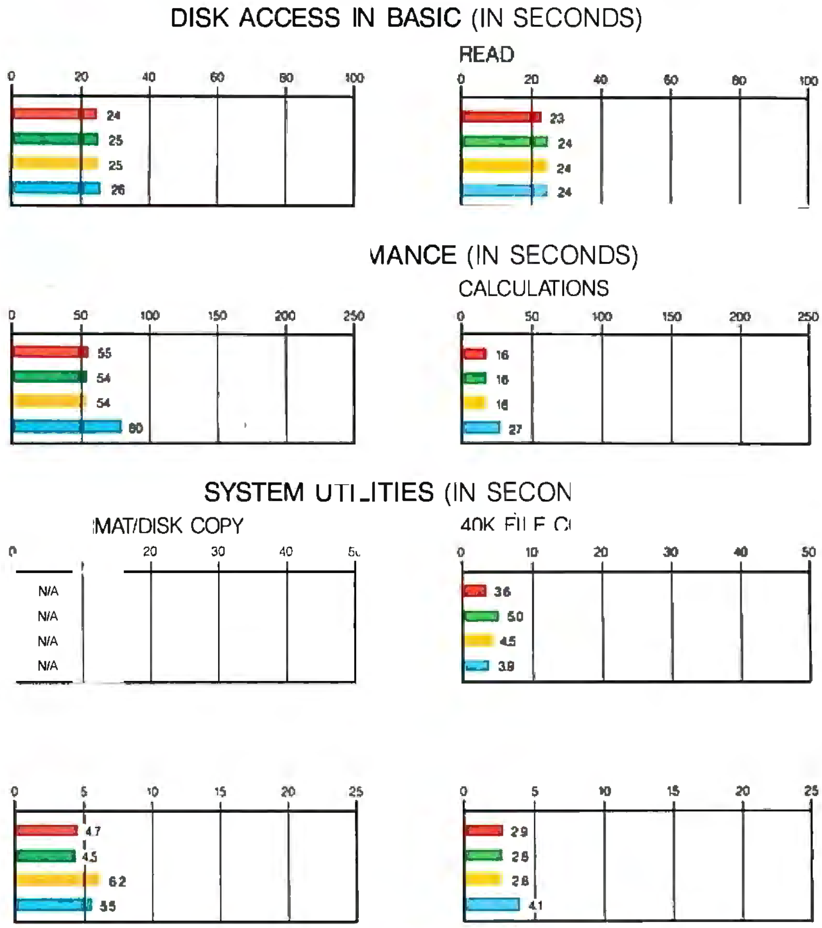
Components
Processor: 6- -MHz 802
selectable by cnanging crystal
Memory: 512K bytes, expandable
megabyte on motherboard
Mass storage: One dot
megabyte floppy disk driv
byte or 30-megabyte harc
Display: Not included
Keyboard: 83 keys; 10 fu
indicator lights for Caps L Num
Lock, and Scr
Expansion: Ei IBM PC A
compatible; tw PC- ompatible
I/O interfaces: include

Software
Setup disk

Options
MS-DOS 3.1; 20-megal
megabyte hard disk dr
card; monochrome/col
card; multifunction car
expansion board; cartr
tape hard-disk backup

Documentation
Operations manual

Price
Basic system with
floppy disk drive a
memory (no I/O int
adapter): $1075
Expanded system floppy
disk drive, 512K by ory, 20-
megabyte hard dis
card, monochrome
DOS 3.1 (no monit



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 th Sieve of Eratosthenes prime-nur enchm rk.
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All three systems had compatibility problems. None would run version 2.12 of Flight Simulator, a de facto standard IBM PC–compatibility test.

due to the large number of individually boxed components. Even though the setup instructions were clear, it took well over an hour to get the system put together. The Victor V286 and QIC AT-Plus 1800 were much simpler. With them it was simply a matter of installing the display board and plugging in the monitor, AC power, and keyboard. Setting up all the units required that their system unit covers be removed. All of them slide off, but you need to remove screws. Once you have the hardware set up, you have to run the respective setup program that configures the hard disk and tells the system what options it contains.

Compatibility

All three systems had compatibility problems. None would run version 2.12 of Microsoft Flight Simulator, the de facto standard IBM PC–compatibility test. In all three cases, the systems just locked up. Although they failed this classic test, I encountered few problems with other software, especially contemporary programs without copy protection. All ran flawlessly at 8 MHz. Older programs with copy protection, such as an early version of Lotus 1-2-3, had some problems at 8 MHz. In most cases, setting the clock speed back to 6 MHz cured the problem. The PC8 runs only at 8 MHz, so it cannot be made compatible with software that demands a 6-MHz speed.

Option cards can have similar problems. Once again, older cards are the main culprits. Most cards designed for the IBM PC simply won't work with the new high-speed clones. Changing the clock speed to 6 MHz on the Victor V286 and QIC AT-Plus 1800 will sometimes solve the problem, but more often than not it won't. The same goes for early PC AT–style cards.

Nearly all cards made in the last year or so work at 8 MHz with no problems. A word to the wise: If you intend to purchase one of these clones, don't assume that your current cards will work. If you're planning on purchasing new cards, be sure you can get your money back if they don't work.

Keyboards

Working with the keyboards of these three systems proved that this essential human-to-computer interface isn't a high priority among system designers. Although the PC8 keyboard has extra function keys, it joins the other two in having a touch that's just plain mushy. Although the touch of a particular keyboard is a very subjective call, I think that all three keyboards don't have strong enough springs under their keys. Most serious typists prefer the tactile feedback of a stiffer keyboard. All the keyboards reviewed here have a decidedly cheap feel to them, and I wouldn't want to use any of them for my day-to-day writing.

Software

The software included with the three systems varies greatly. The AT-Plus 1800 that I reviewed didn't come with an operating system, but I used MS-DOS 3.1 with no problems. The system had hard disk setup, format, and head-parking utilities included on a single floppy disk. A second disk had a setup utility for configuring the system.

The AT-Plus 1800 was the only system of the three that doesn't come with a diagnostics disk. Although the lack of specific system-tuned diagnostic programs is a slight handicap, numerous commercial diagnostic programs, such as The Norton Utilities, are available if you have a need for that feature.

Both the V286 and PC8 systems come with extensive software. Included are setup programs, diagnostics, operating systems, and BASIC. Both systems run versions of MS-DOS 3.1. NCR calls its operating system NCR-DOS, and Victor keeps the MS-DOS name. Both run identically to the IBM release and include the standard utilities. Both computers also include GW-BASIC, although Victor has named its version VBASICA.

The PC8 also comes with a Getting Started disk, essentially a guided tour of the machine and its capabilities. Though a nice touch for those with little computer experience, it doesn't contain useful information for advanced users.

Documentation

All three machines come with extensive documentation and, although the quality varies, it's all usable.

NCR's documentation is the most disappointing, especially for those who are more technically inclined. The NCR-DOS and GW-BASIC manuals are useful, but the owner's manual is a hair-pulling example of worthwhile information hidden in a torrent of words. The "Technical Data" section at the end of the book is just a couple of pages of information that is nearly useless.

The V286 documentation is extremely well done. The only problem is a lack of technical information. Victor's telephone-support staff was very helpful with my advanced questions, but I had to pay for a long-distance call.

Because the AT-Plus 1800 doesn't come with either an operating system or BASIC, its documentation is the smallest of the group. Considering the system's bargain-basement price, I was more than a little surprised to find the operations manual to be by far the best of the group. Technically inclined users will find detailed information on everything from keyboard scan codes to connectors and I/O addresses. In a pinch, this type of information can be invaluable if problems develop.

Performance

Comparing the performance of these three systems is an exercise in splitting hairs. As the benchmarks show, all the systems are nearly identical in performance, with differences of a second or less on many of the benchmarks (see page 211). But differences of a few tenths of a second don't add up to much over the course of a day at the keyboard.

Weighing the Pros and Cons

Which of these three PC AT clones is the best? Unfortunately, given the similarities in features and performance, that question is a difficult one to answer. Your decision should be based on price, reputation, product support, and service.

Although the NCR PC8 is the most solidly built of the systems, the slight edge in quality doesn't outweigh the fact that it's the most expensive. The Victor V286, though not the least expensive, is the most complete of the systems. And my prior experience with the support offered by Victor has shown that it will bend over backward to help its customers.

The QIC AT-Plus 1800 is the least expensive of the systems. But because making it into a useful system requires choosing from a wide range of peripherals, it's not a system for the completely inexperienced or for those who want the closest thing to a "plug-in-and-go" system. QIC is by far the smallest company of the three mentioned here. Although my experience with its customer service was positive, you might want to consider its long-term support potential. However, if you're an experienced computer user on a tight budget, the AT-Plus 1800 is by far the best value. The choice is yours, and with more PC AT clones appearing regularly, it's not going to get any easier. ■

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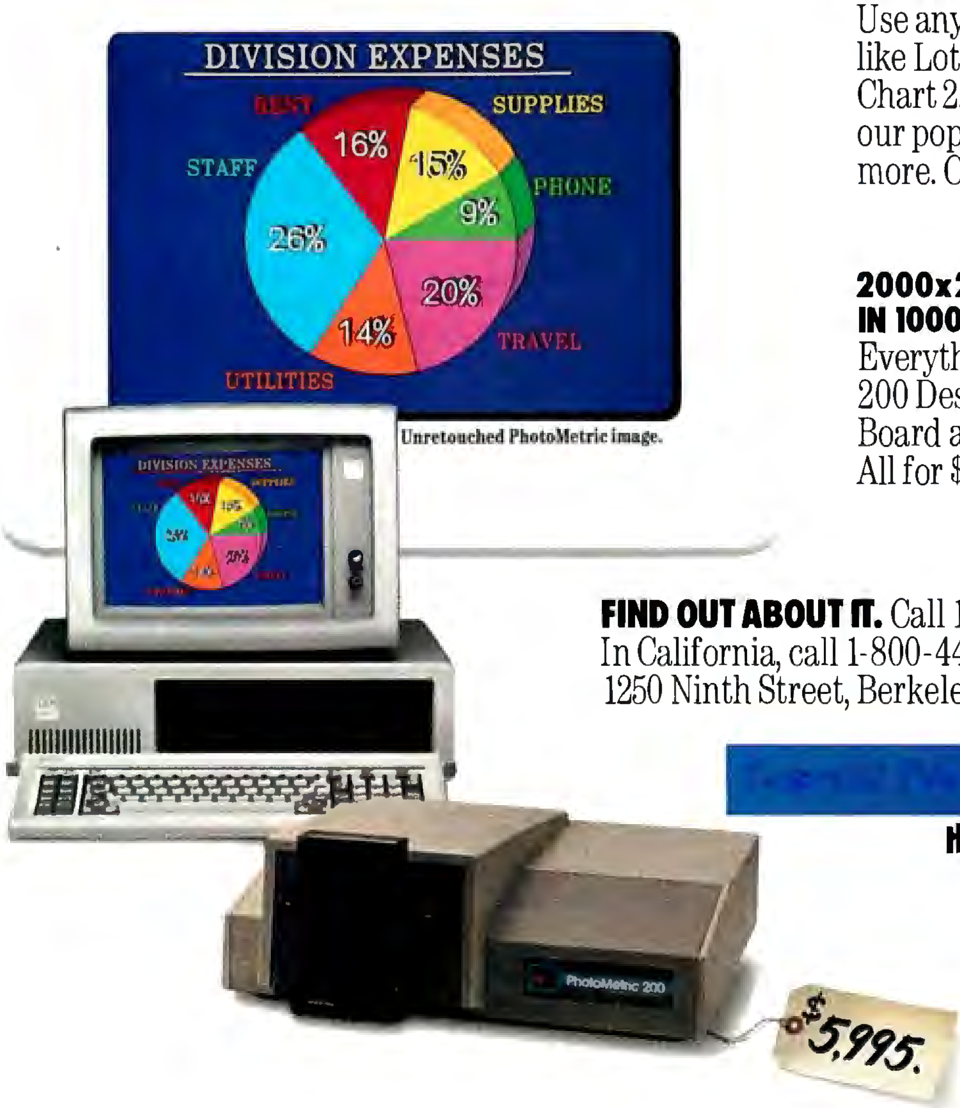

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AT&T's TrueVision Image Processing System

Robert Tinney

AT&T's TrueVision image processing system, a plug-in board and software combination, uses a video camera, an IBM PC or compatible, and a graphics tablet or mouse to capture, digitize, and manipulate real-time images on a color monitor. The system produces pictures that are clean, sharp, and as good as regular television pictures. I jumped at the opportunity to use the system to produce several sketches and finished illustrations for this issue of BYTE (see pages 82, 140, 204, and 248).

I should emphasize that since I'm an illustrator, I'm more interested in the painting than the video capabilities of this system, which is basically designed for producing video images. The system lets you, for instance, overlay text on video with flair and variety. Also, since my expertise is art and not computers, this review is more application-oriented and focuses less on the system's technical aspects.

A package for digitizing and manipulating video images

TARGA and TIPS

AT&T offers a variety of TrueVision products from its Electronic Photography and Imaging Center in Indianapolis, Indiana. The TrueVision system I reviewed consisted of the TARGA 16 full-length board and TIPS software, also available from AT&T. The TARGA (TrueVision Advanced Raster Graphics Adapter) series consists of five cards that range in price from $1595 to $4995. At $2995, the TARGA 16 is the mid-priced board of the series. It's a combination frame grabber and buffer, featuring 512- by 482-pixel resolution and simultaneous display of 32,768 colors.

TIPS (TrueVision Image-Processing Software) is a product of Island Graphics in Sausalito, California. TIPS is not copy-protected and comes on two floppy disks that are easily transferred to hard disk. The software differs somewhat among the various boards; the version for the TARGA 16 board retails at $1250. As you can see, neither the hardware nor the software for this system is inexpensive, particularly when you figure in everything needed for a complete system, such as mouse or graphics tablet. Still, considering what similar graphics capabilities would have cost only two or three years ago, the price is reasonable.

For this review, I used the TARGA 16 and TIPS with the following equipment: an AT&T PC 6300 equipped with a 20-megabyte hard disk, one floppy disk drive, and MS-DOS 2.11; an AT&T monochrome monitor; a 20-inch Sony Trinitron KV-2011CR television set with both analog RGB and composite modes; a JVC GX-N8PC(U) color video camera with an RGB attachment; and a Summagraphics MM1201 SummaSketch graphics tablet with a 12- by 12-inch drawing area.

The documentation states that the TrueVision system runs on an AT&T PC 6300, PC 6300 Plus, or an IBM PC, XT, AT, or compatible with at least 512K bytes of RAM. The system also ran on my own PC AT clone, which I will describe later in this review. A computer with dual 360K-byte floppy disks can run the system, but the user's guide recommends a hard disk for greater storage capacity, speed, and flexibility in manipulating images. The TIPS software also works with a Lotus/Intel/Microsoft expanded-memory board with at least 1.5 megabytes of memory. The extra RAM is used to provide an Undo option for the last action taken and for full-screen rather than partial-screen manipulation for certain other functions.

To get the system up and running, you plug the TARGA board into your computer, connect a video source (such as a video camera or VCR with a 9-pin connector) to the input port of the board, and plug a color monitor (RGB analog or composite with a 9-pin connector) into the board's output port. You must also hook up a standard monochrome or color monitor in the usual way for displaying error and other operating messages. A serial port on the computer is required for a graphics tablet or other pointing device.

Using the System

I began familiarizing myself with the TrueVision system by going through the tutorial section of the TIPS user's manual. The documentation is clear, and manipulating the digitizing pen quickly becomes intuitive. I didn't find it at all awkward to relate the pen movement on the pad to the cursor movement on the screen. If you've ever used a mouse, you know that hand/eye/screen coordination comes quickly and naturally.

It's not so easy to get comfortable with screen flicker, however. After I worked with the system for about an hour I found myself squinting at the screen, and I realized that the flicker was tiring my eyes. This never became a major problem (no headaches), but it was an annoyance. The flicker was caused by the TARGA sending an interlaced signal to the monitor, although the board can support noninterlaced signals at lower resolutions (512 by 256 or 256 by 256 pixels). The Sony monitor that I used performed admirably in all other respects. Its colors were crisp, objects were sharp-edged, and the range of intensities was excellent (the blacks were very black, and the whites were very white).

The TIPS user interface is a hierarchy of menus and submenus that are visible when in use but hidden during most actual operations. You give the system almost all commands through menu selections, including grabbing video images

continued

Robert Tinney (1864 North Pamela Dr., Baton Rouge, LA 70815) is an illustrator who has designed many of BYTE's covers since its first issue in 1975.

AT&T TrueVision Advanced Raster Graphics Adapter (TARGA 16)

Type
High-resolution color video digitizer and display board

Company
AT&T
Electronic Photography and Imaging Center
7351 Shadeland Station, Suite 100
Indianapolis, IN 46256-3921
(800) 858-8783

Size
4 by 14 by ¾ inches (without Overscan option)

Features
512- by 482-pixel resolution; palette of 32,768 colors; ability to overlay computer-generated graphics on a video image; image-capture rate of 1/60 second per field or 1/30 second per frame; comes with installation and demonstration programs on disk

Necessary Hardware
IBM PC, XT, AT, or compatible with at least 256K bytes of RAM; hard disk drive recommended; analog RGB monitor (recommended), composite video monitor, or color TV with RF adapter; standard monochrome or color monitor; video disk player, video camera, VCR, or other video source that generates standard NTSC composite video or RGB signals (optional)

Necessary Software
MS-DOS 2.0 or later

Options
Overscan option (for video output): $200 when ordered with board or $300 if purchased later; TARGA Software Tools (C language utility library): $25 (free if requested when you purchase the board); PC Carousel (slide-show package): $150; TV Picture Power (image database): $995

Documentation
125-page manual including user's guide and technical reference manual

Price
$2995

AT&T TrueVision Image-Processing Software (TIPS) version 3.1

Type
Video digitizing and editing package

Company
AT&T
Electronic Photography and Imaging Center
7351 Shadeland Station, Suite 100
Indianapolis, IN 46256-3921
(800) 858-8783

Format
Two 5¼-inch floppy disks

Computer
IBM PC, XT, AT, or compatible with 512K bytes of RAM and two floppy disk drives or one hard disk drive (recommended); TARGA 16 board; standard monochrome or color monitor; composite video monitor, analog RGB monitor (recommended), or TV with RF adapter; any NTSC analog RGB or composite video input source; AT&T Mouse or Microsoft Mouse; Summagraphics MM961 or MM1201 or Bit Pad One-compatible graphics tablet; Lotus/Intel/Microsoft expanded-memory board with at least 1.5 megabytes of memory (optional)

Language
C

Options
TrueVision fonts for TIPS (additional 30 fonts): $100

Documentation
220-page user's manual including tutorial, user's guide, and glossary

Price
$1250

with a camera and moving digitized images to and from disk. There are some exceptions; for example, you can change brush colors without retreating to a menu, and you can quickly access the zoom function sans menu. Using the menu structure is very fast, however, particularly after you get a feel for its layout. It is an icon-based system, as you would expect in a graphics program, and zipping through the various levels is just a matter of clicking on one symbol and then another.

Displayed along with the menus is the color palette, which shows 256 colors out of the 32,768 available. You can adjust this palette endlessly to your requirements; if you need to work with more than 256 colors, you merely save the current palette to disk and begin building another one. Switching back and forth among various palettes takes only a few seconds.

Image Manipulation

TIPS places a wealth of functions for manipulating an image at your disposal. Their sheer number and the subtle, and sometimes unexpected, ways in which they can interact makes cataloging and describing them difficult. I've used the system for 3½ weeks, and I'm sure I haven't fully explored many capabilities. What I'll do here is comment on the major functions and hint at some of the rest.

• **Drawing Functions.** The system lets you automatically draw rectangles and ovals (either filled or outlined), straight lines, triangles, curves, arcs, parallelograms and, of course, freehand shapes. The speed is good; even in freehand mode it's difficult to make the cursor lag behind your pen movements unless you select a really large brush. All the above can be done in nearly any color imaginable, as well as in any number of patterns. A menu of patterns comes with the system, and you can create your own or build a library of them if you prefer.

The zoom function deserves special mention, since I found myself doing much of my drawing with it. The function has three levels, and you access all of them from the keyboard by striking the appropriate single key. The first zoom level is twice normal size, the second is four times normal size, and the third is eight times normal size. All drawing functions (and most of the others) are available in zoom, which allows pixel-by-pixel editing at all levels. One nice feature is that any level of zoom automatically pans over the entire screen, following your cursor movements. This eliminates the need to continuously punch in and out of zoom when moving to various areas of the screen.

• **Special Effects.** Want to take a part of an image and move it somewhere else on the screen? Want to reproduce it 10 or 20 times or enlarge or reduce it? How about flipping it left to right, top to bottom, or rotating it only slightly? Using traditional media, all the above actions would be tedious and time-consuming. With computer graphics they're fun, and with the TrueVision system they're fast. Speed and flexibility in these types of operations are significantly increased with the addition of an expanded-memory card because more or all of the image is stored in RAM.

• **Text Fonts.** TIPS comes with a variety of text fonts, both serif and sans serif. You can adjust the size of the font, the direction it prints on the screen (including backward and at odd angles), and the color. You can even print text so that it rotates either clockwise or counterclockwise, and it can be antialiased; that is, you can smooth out its "jaggies" with appropriate gradations in color along its edges (as you can with most other TrueVision images). Text can also appear with either solid or translucent shadows, making it appear to jump out from the screen.

The spread function and the airbrushing, blending, tinting, and antialiasing functions feature the TrueVision system's ability to automatically fill in subtle, incremental changes of color. Here the TARGA 16's 32,768 colors really shine. If you select the airbrushing function, for example, and apply a blue color, TIPS draws from its array of possible colors and adjusts every pixel under the "spray" to a color with a blue index slightly higher than the one it currently has. More blue is added to the pixels under the center of the brush than to those near the edges, giving the added tint a feathered-out appearance. Moving a blending brush over an edge between two colors directs TIPS to draw from its full palette and fill in a range of colors intermediate to the original two, and the edge becomes blurred.

It's inevitable that in this short review I can mention many of the more subtle features of such a complex system only briefly. The TrueVision system can mask areas of the screen from special effects (so that you can, for instance, airbrush around an object). It provides a grid to facilitate placing objects in precise locations and lets you pixelize any area of the screen with the block size you specify to give the image the mosaic appearance of a computer-generated image. The system can also perform quick loads and quick saves to hold copies of images temporarily in memory while you experiment with them.

Easy Operation

Disk operations are included within the TIPS menu hierarchy and are easy to carry out quickly. To save the image on the screen, you simply choose the disk icon, select Save from the submenu, type in a filename for the image, and press Return. If you are saving to an existing file, all you do is click on its listing in the menu. I timed both the Load and Save actions (the time the image spent going to and from disk, not counting time spent in the menu) for a full-screen image and found both to be about 9.3 seconds. This is very good, especially since I've used floppy disk-based systems that demanded 40 to 60 seconds for the same operations.

A typical 512- by 400-pixel full-screen image takes up about 400K bytes of disk space, limiting the size of an image you can store on a floppy disk. However, TIPS gives you the option of saving to a compressed file, which shrinks a 400K-byte image to as small as 100K, depending on the image. You can save not only full screens to disk, but also windows (you select the area with a rubber-band box), patterns, colors (to supplement the palette on the menu), masks, brushes, and text fonts.

I was interested in seeing how compatible the TARGA 16 board would be with other machines besides the AT&T PC 6300, so I tried plugging it into my no-name PC AT clone. The TARGA 16 is a single-slot full-length board and, with the Overscan option for video output, it's thick enough to require two slots (it has three levels). However, when I put it into the last slot in my machine, I discovered that the board's third deck is located so that it cleared my hard disk drive unit. My computer is a fairly typical configuration. Thus, even with its Overscan option, the TARGA can take up only one slot, depending on the host machine.

Since the TARGA board that I reviewed came already installed in the PC 6300, it was seated in an 8-bit IBM PC-style slot. However, when I pulled the board out, I saw immediately that it was configured with an extension to fit in and take full advantage of a 16-bit PC AT slot. That's where I installed it in my PC AT clone, and it worked just fine. I tested all the functions of the system including loading and saving and found no hang-ups. In fact, the major difference I noticed was that loading and saving operations averaged around 4.6 seconds in my PC AT clone, about half the time of the PC 6300.

More Colors, More Pixels

As an illustrator interested primarily in print media, I'd rate the AT&T TARGA 16 TrueVision system as fantastic for sketching and conceptualizing, but only fair for my style of finished artwork. The power to quickly create, change, and save multiple versions of a sketch makes this system an amazing creative tool. For finished artwork, I'd suggest only two improvements: more colors and more pixels.

Although 32,768 colors may seem like a lot, I discovered that the airbrushing and blending functions didn't supply enough levels from one color to another; if two adjacent colors were fairly close in appearance, blending had little effect. I'd also like to see considerably higher resolution (perhaps 2000 by 2000 pixels). Actually, AT&T has already obliged my first requirement, because the next board up in the series, the TARGA 24 ($3995), sports 16,777,216 simultaneous colors.

As far as video is concerned, TrueVision already has all the resolution it needs to do an amazing job of capturing and manipulating television-quality images. ■

Four Laser Printers

Arthur Little

The Canon LBP-8, the BDS Model 630/8-E, and the QMS Kiss are all built around the Canon laser engine. The Quadram QuadLaser is built around the Ricoh laser engine. The engine is the electromechanical black box responsible for putting an image onto paper. The selection of one graphics engine over another largely determines factors such as print quality, dot density, and printing speed. Other features, such as font availability and programmability (the intelligence of a printer), are external to the engine. These intelligence features distinguish one company's laser printer from another.

The key intelligence features of these laser printers are emulation modes and onboard memory. Emulation modes determine how likely it is that a printer will work with existing applications software—primarily word processors and graphics packages. Emulation modes enable a laser printer to respond almost exactly as the emulated printer would to a variety of formatting, type style, and other printer commands. The amount of on-board memory largely determines how large a graphic image a printer can handle. All these printers are capable of printing 300 dots per inch, but not all of them have enough memory to hold a full page of such data. Approximately 1.5 megabytes is needed for an 8½- by 11-inch page with no data compression. However, most graphics don't require anywhere near that much memory. Many images such as bar and pie charts do not require 300 dpi, nor do they take up a full page.

Other important features of laser printers are the availability of typefaces in a variety of sizes and the method for adding new typefaces, either via cartridges containing ROM-stored fonts or via down-

continued

loading from the host computer. In any case, it is desirable to have the fonts provided in disk or cartridge by the company because creating your own font is an extremely time-consuming and tedious process.

The Canon LBP-8

Canon offers two versions of the LBP-8, which are designated A1 and A2 and sell for $3000 and $4300, respectively. The A2 is an enhanced A1 and has more memory, a vector printing mode, and an extended area-fill, or paint, mode. I tested the A1 model for this review. Unless specifically noted otherwise, references in this review to the LBP-8 apply to both models.

The LBP-8 emulates the Diablo 630 daisy-wheel printer and accepts the full set of ISO printer commands, which are versatile but not commonly used in the United States. If your word processor does not support Diablo 630 printers or the ISO standard, you'll need to write your own printer driver or ask the word processor company for one. The other laser printers reviewed offer a wider variety of emulation modes, such as Epson FX-80 and Qume Sprint emulation.

The LBP-8 comes with four built-in character sets, or fonts, and it accepts ROM cartridges that provide additional fonts. I did not test the cartridges for this review.

Canon refers to the built-in character sets collectively as Courier Normal typeface ("normal" means a vertical page orientation; it is also called portrait mode). The four Courier fonts are 10-character-per-inch roman, 10-cpi bold; 10-cpi italic, and a reduced-size roman for use in footnotes, subscripts, and superscripts.

Eight additional font cartridges are available for $230 each: Courier 10 in normal and rotated, or horizontal "landscape," versions, Pica 10 in normal and rotated versions, Elite 12 in normal and rotated, Garland Proportional in normal and rotated, and a single-line printer cartridge containing some normal and rotated character sets.

Additionally, the LBP-8 will accept user-defined fonts downloaded from a host computer, subject to the memory limitations of the printer. The A1 comes with 128K bytes of memory; the A2 has 1.125 megabytes.

You can change fonts manually using the buttons on the front panel of the LBP-8 or via commands from the host computer. Unfortunately, Canon does not provide a utility program to simplify the process of font selection and mode control. The only help is some general instructions in the user's manual.

LBP-8 A1 and A2

Type
Laser printer

Company
Canon U.S.A. Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700

Size
18¾ by 11½ by 16½ inches without trays; 28½ inches deep with both trays in place; 70½ pounds

Features
Diablo 630 and ISO emulation; manual or cassette feed; multiple fonts; landscape or portrait orientation; combined drum/toner cartridge; 100-sheet tray; A1 prints graphics at 300 dpi for partial page only; A2 prints graphics at 300 dpi in full-page mode; A1 has 128K bytes of memory; A2 has 1.125 megabytes of memory.

Options
Additional font cartridges: $230 each

Documentation
User's manual, 206 pages

Price
A1 $3000; A2 $4300

Model 630/8-E

Type
Laser printer

Company
BDS Corp.
800 Maude Ave.
Mountain View, CA 94043
(415) 964-2115

Size
18¾ by 11½ by 16½ inches without trays; 28½ inches deep with both trays in place; 60 pounds

Features
Diablo 630 and HP LaserJet graphics commands and line-printer emulation; manual or cassette feed; multiple fonts; landscape or portrait orientation; combined drum/toner cartridge; text amplification and horizontal expansion; 100-sheet tray; prints 150-dpi full-page graphics and 300-dpi half-page graphics

Options
Additional font cartridge: $300

Documentation
140-page user's guide with pull-out reference card

Price
$3495

```
This is 10-pitch Courier on the QMS

This is 10-pitch Courier on the BDS

This is 10-pitch Courier on the Quadlaser

This is 10-pitch Courier on the Canon LBP-8
```

Letter-quality typeface as rendered by the four laser printers.

Canon's documentation is thorough but not well organized, and it is definitely not sufficient to allow a computer novice to select multiple fonts from within a word processing document.

The BDS 630/8-E

The BDS Model 630/8-E, as its name implies, emulates the Diablo 630 daisy-wheel printer. [Editor's note: *The Model 630/8-E is an enhanced replacement unit for the original 630/8, which I used for this review. The new model has greater memory (256K bytes as opposed to 64K) and two more emulation modes (Hewlett-Packard LaserJet graphics commands and a line-printer mode of 66 lines per page with preset margins). The price of the enhanced unit is the same as that of the original, discontinued model: $3495.*]

One interesting feature of the Model 630/8-E is graphics amplification, which permits graphic or text enlargements of up to 800 percent. A similar feature allows

QMS Kiss

Type
Laser printer

Company
QMS Inc.
One Magnum Pass
Mobile, AL 36618
(205) 633-4300

Size
18¾ by 11½ by 16½ inches without trays; 28½ inches deep with both trays in place; 60 pounds

Features
Diablo 630, Qume Sprint, and Epson FX-80 emulation; advanced printing-command set; manual or cassette feed; 9 to 12 resident fonts, depending on emulation; landscape or portrait orientation; combined drum/toner cartridge; 1.25 megabytes of memory; downloadable fonts; Epson, Diablo, Qume, and IBM PC screen graphics; keypad/LED display for manual mode-select and status; full-page graphics at Epson single-density; ¾-page graphics at Epson double-density or high-resolution; 100-sheet tray

Options
Downloadable font disks ($199 each); PopSet software printer utility ($59); software tutorial

Documentation
User's guide, 330 pages

Price
$1995

QuadLaser

Type
Laser printer

Company
Quadram
One Quad Way
Norcross, GA 30093
(404) 923-6666

Size
20¾ by 13 by 16½ inches without tray; 14½ inches high with collection tray and 23¼ inches deep with paper tray; 82 pounds

Features
Qume Sprint 5 and Epson FX-80 emulation; custom printer driver; downloadable emulation software for HP LaserJet; manual or cassette feed; eight landscape and portrait fonts; 2 megabytes of memory; two-component toner and belt; automatic paper collation; QLX printer-control software; QuadFont font-creation/-modification software; 250-sheet tray; prints 300-dpi full-page graphics; printing speed of 8 pages per minute; downloadable font disks with 72 fonts

Documentation
Operator's manual, 158 pages

Price
$4495

horizontal expansion or compression of text from 70 to 160 percent of the original.

The graphics amplification feature permits printing headlines and signs or other documents in which the amplification can serve as an approximation of larger fonts. However, because the amplification uses the original bit-mapped image of a character, the text tends to break up as it is enlarged, with "jaggies" appearing in the diagonal lines. The greater the enlargement, the worse the jaggies, putting a practical limit on the use of the amplification feature.

The Model 630/8-E comes with 16 fonts, including various styles of Courier in 10 and 12 cpi and the IBM extended graphics character set, also in 10 and 12 cpi. An optional $300 font cartridge adds 16.7-cpi Gothic in portrait and landscape modes, Prestige Elite in portrait and landscape, and a scientific 12-cpi portrait font. According to a BDS spokesman, the company plans to introduce additional font cartridges approximating the popular Roman and Helvetica typefaces in various sizes from 6 points up to 18 or 24 points.

You select fonts manually using a control panel on the printer or through commands sent from the host computer along with the text. The BDS user's guide provides step-by-step instructions for using the printer with WordStar. The instructions also include a way to program the IBM PC or PC-compatible function keys so you can use them to change print modes.

The documentation also includes a pull-out reference card that summarizes all the printer's features, functions, controls, and error codes; none of the other printers reviewed offers this handy reference. Overall, the user's guide was straightforward and useful, though fairly brief.

The QMS Kiss

At $1995, the QMS Kiss is the least expensive of the four printers. It is also the most versatile in terms of its emulation modes. You can set up the printer to emulate a Diablo 630, several Qume Sprint daisy-wheel printers, and the Epson FX-80. The printer also recognizes an elaborate set of advanced printing commands peculiar to the QMS line of laser printers. One especially useful command lets you redefine the printer's character-translation table. For instance, if your word processor cannot handle Escape characters but you need them as part of a printer command, you can tell the printer to interpret the tilde or some other character as an Escape character.

The QMS Kiss has nine resident fonts; at any given time one font may be active for portrait printing and another may be active for landscape printing. You can select these fonts and the other parameters (e.g., printer emulation, mode characteristics, paper size and source, and copy count) through software commands or via the printer's control panel.

The portrait (vertical page orientation) fonts that are resident in the QMS Kiss are Epson Compressed, Epson Elite, Epson Pica, 16-point Q-Format, 10-cpi Courier, 12-cpi Prestige Elite, and 12-cpi Prestige Elite Italic. Two landscape fonts are resident as well: 5-point Q-Format and 10-cpi Courier.

Unlike the other Canon-based machines, the QMS Kiss does not accept font cartridges. Instead, you must download fonts into the printer's 78.5K-byte download-font memory. Currently, 16 font disks ($199 each) are available; each includes at least 10 different fonts.

The QMS Kiss has 128K bytes of memory for holding commands, text, and graphics, and it has 8K bytes for an input buffer. QMS offers an optional memory-resident software program for IBM PCs and compatibles that simplifies the printer setup process immensely. The program, called PopSet, lets you set up the printer via pop-up menus activated by the Alt-PrtSc sequence. PopSet costs $59 and is highly recommended.

QMS recently introduced a couple of more advanced printers, the Big Kiss and the Big Kiss Model 2, which offer font-cartridge capability, expanded memory, and other features. Prices of these two are $2995 and $4495, respectively.

The Quadram QuadLaser

This printer differs from the other three on several counts. The $4495 unit is based on the Ricoh engine rather than the Canon engine. Instead of the single toner-plus-photo-drum cartridge used in the Canon-engine printers, the QuadLaser uses separate cartridges for its toner and photoconductive belt. As a result, you don't

continued

need to discard a functional photo drum just because your toner is expended, as with the Canon-engine printers. Instead, you simply replace the toner cartridge.

Another difference between the two types of systems is in the paper flow through the printer. Canon-engine printers output a stack of pages in reverse order. The output of the Ricoh-engine machines is sorted properly from the first to the last page because the paper emerges face-down into the holder.

The QuadLaser has several features that go beyond simple convenience. The unit has built-in emulation of the Qume Sprint 5 and the Epson FX-80, as well as its own internal set of codes. Finally, the QuadLaser comes with downloadable software that enables it to emulate the HP LaserJet; users with advanced programming experience can write their own software to emulate almost any other printer protocol, subject to memory limitations.

Two fonts are resident in the QuadLaser: 10-point Courier and 10-point Courier Bold. Disks containing 72 other fonts for downloading into the printer are included with the unit.

The QuadLaser comes with 2 megabytes of memory, which is broken up as follows: 1 megabyte for bit-map graphics, 512K bytes for font emulation; and 512K as an input buffer. The unit also comes with a printer utility called QLX (QuadLaser executive). The IBM PC-compatible program lets you select printer emulation, fonts, page orientation, and page margins and dimensions.

Quadram also provides a font-design program called QuadFont with the QuadLaser. With it you create your own bit-mapped font or modify one of the existing fonts to your liking.

Performance

I ran the standard BYTE benchmarks for dot-matrix and daisy-wheel printers and printed a large file to measure the machines' throughput (see table 1).

Like copiers, laser printers take some time to warm up when you first turn them on. The Canon-engine machines all took just over one minute to get ready for printing. (Note: The additional 20 seconds for the QMS Kiss includes the time it takes to print a power-on status page at the end of its warm-up.) The QuadLaser was just a bit faster with its 50-second start-up time, but the difference is not really noticeable in a work environment. In a typical office, a laser printer is turned on in the morning and left running all day.

For the single-page character-speed benchmark, I used a BASIC program to time how long each printer took to produce a page containing 50 lines of 80 capital *A*s. Although the times were all close, the Model 630/8-E proved to be the fastest at 19.74 seconds. It was followed by the QMS Kiss (20.31 seconds), the QuadLaser (21.02 seconds), and finally the Canon LBP-8 (23.15 seconds). For all the benchmarks, all the printers were emulating a Diablo printer except the QuadLaser, which was emulating the Qume Sprint printer.

It is not accurate or fair to benchmark a laser printer on just a single printed page, however. A considerable amount of time is required at the beginning of each print run due to font-initialization requirements. For that reason, I timed the printers on some multipage jobs.

I ran the standard BYTE Shannon test, but instead of printing just 573 characters, I copied the test characters repeatedly until I had a 40K-byte test file and printed it using WordStar version 3.3. This time the QMS Kiss was the fastest, taking 4 minutes and 20 seconds to print the file's 12 pages.

Finally, I put together a text file that yielded 62 pages of single-spaced copy. It was made up of Chapter V, Section 21 of Strunk and White's *The Elements of Style* (third edition), repeated 25 times and was about 200K bytes long. The QuadLaser won this contest at 8 minutes and 29 seconds. A close second was posted by the QMS Kiss, which took 8 minutes and 53 seconds. These minor differences in speed are not significant, depending on buffer size and the resulting interaction with the host computer's software.

The maximum page-printing rate of all four printers, based on the print engine used, is eight pages per minute. Printers do not actually achieve that speed because of the longer time it takes for printing the first page, as well as other software factors.

One final general note about performance. All four printers worked out of the box with no coddling. Over 1500 sheets of letter-size paper went through these printers during the course of this review without a single paper jam. I only wish that my own dot-matrix printer could claim as much reliability and functionality.

For sheer value, the QMS Kiss stands out as the obvious winner. It costs just $1995 and offers a good variety of emulations, ample memory, a wide selection of resident fonts, and the availability of downloaded fonts. However, a need for special applications could point you toward one of the other printers. For instance, your needs might find a perfect match in the text-amplification feature of the BDS Model 630/8-E, the ISO-command support of the Canon LBP-8, or the automatic paper sorting, large memory, and host computer software included with the Quadram QuadLaser. ■

Table 1: *Benchmark results. Single-page times are in seconds; all other times are in minutes:seconds.*

Warm-up time with room temperature about 75° Fahrenheit	
LBP-8	1:18
Model 630/8-E	1:17
QMS Kiss	1:38
QuadLaser	0:50

Single-page time	
LBP-8	23.15
Model 630/8-E	19.74
QMS Kiss	20.31
QuadLaser	21.02

40K-byte Shannon text time	
LBP-8	4:31
Model 630/8-E	6:25
QMS Kiss	4:20
QuadLaser	4:37

200K-byte text file time	62 pages	Pages per minute
LBP-8	11:30	5.4
Model 630/8-E	20:37	3.0
QMS Kiss	8:53	7.0
QuadLaser	8:29	7.3

Warm-up time measures how long each printer takes to get ready to begin printing after being off for an hour. Single-page time measures how long it takes each printer to print a single page made up of 50 lines, each containing 80 *A*s. The 40K-byte Shannon test measures how long it takes each printer to output a file composed of the standard Shannon text repeated multiple times, which approximates average English frequency of characters. The 200K-byte text-file test measures how fast each printer outputs a 62-page document. Pages per minute is an average based on the number of pages printed divided by the total time required. The QuadLaser unit used for this review had less built-in memory and fewer fonts than the now-standard configuration; the BDS printer used was a non-enhanced version with less memory and only Diablo 630 emulation plus ISO code support.

Arthur Little (2 Juniper Dr., Amherst, NH 03031) is a senior technical writer at Charles River Data Systems.

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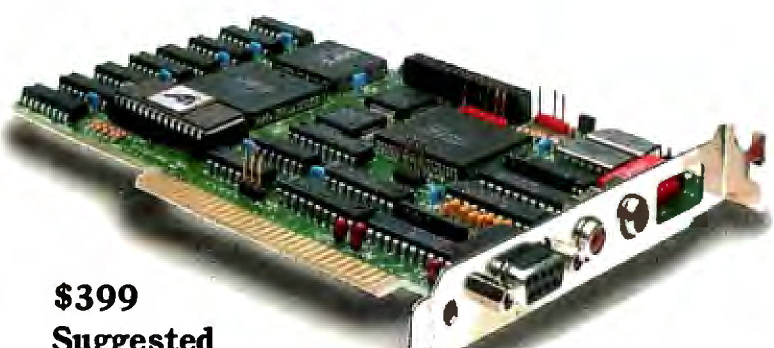

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William G. Wong

A powerful tool for learning programming style and semantics

PC Scheme version 2.0 from Texas Instruments is a low-cost ($95) implementation of Scheme that supports the DOS file system, windows, and graphics. It runs under PC-DOS and MS-DOS 2.0 or later and requires either dual disk drives or one floppy disk drive and a hard disk. The package is self-contained with an EMACS-style editor, EDWIN, which is customized for LISP, and a structure editor, EDIT. While PC Scheme requires a minimum of 320K bytes of memory, you must have 512K to use EDWIN. Three versions of PC Scheme are included with the system for running in conventional, expanded, or extended memory. The expanded and extended versions can address up to 2 megabytes of memory.

Scheme is a dialect of LISP developed by a team led by Gerald Jay Sussman and Guy Lewis Steele Jr. at MIT for experimentation with programming semantics and style. It is implemented as an incremental, optimizing p-code compiler suitable for developing applications for distribution, although not as stand-alone executable files.

A unique feature of Scheme is the lexically scoped variable definitions that give it a block structure similar to that found in C and Pascal. Traditionally, variables in LISP have had dynamic scope, meaning that their values are determined by the environment in force when the procedure requiring the variable is called. With lexical scoping, the value of a variable is determined by its definition environment. In Scheme, lexical scoping of variables is the default, but you can specify dynamic variable bindings. Another feature unique to Scheme is that every object is *first class*. This means that all objects can be passed as arguments and returned as results from procedures. PC Scheme also has a continuation-style execution environment, which I will describe later.

Tail Recursion

Scheme's lexical-scoping mechanism allows efficient compile-time optimization of tail-recursive functions. Tail recursion is used in listing 1. The function length returns the size of a LISP list. The let function defines find_length as a local variable that is a function. The find_length function call within the find_length definition is tail-recursive because the value it returns is also the value of the initial find_length function call. There is no need to consume stack space by making the inner find_length into a normal function call. Instead, this can be viewed as a GOTO that changes the parameters being used. This is similar to a loop statement in other languages but much more general.

This form of GOTO-like behavior is called a continuation-style environment. A continuation is a function that takes one argument and contains the information necessary to continue computation at a particular point. Each function can be viewed as taking a continuation as an implicit parameter. The continuation is called with the result of the last expression in a function definition. When evaluating a function's parameter, the continuation the function was called with is saved, and a new continuation is passed to each expression evaluation so that the parameter value can be obtained. For example, the (add1 size) function is passed as a continuation that uses the result as a parameter to the subsequent find_length call. The latter is performed not with a new continuation, but with one passed to the initial find_length call.

The use of continuations is useful in explaining how tail-recursion optimization works and how recursive function definitions can actually be compiled into interactive code. But PC Scheme actually makes the continuation accessible to the programmer via the call-with-current-continuation, or call/cc. The call/cc expression is a function of one argument, which in turn is also a function of one argument and looks like this:

```
(call/cc (lambda (x) exp))
```

The lambda expression is a function whose argument is bound to x. The exp expression is the code body for the lambda function. If the continuation, x, is encountered with some value during the evaluation of exp, then this value will be returned as the result of the entire call/cc function, and execution will continue at the point where the call/cc function was invoked. For example,

```
(call/cc (lambda (x) (+ (x 4) 5)))
```

The result of the call/cc function is 4, and the intervening + function is never performed because the x function invocation goes directly back to the point where call/cc was invoked.

This is essentially a LISP-style catch/throw function, where the catch function is similar to call/cc and throw is similar to the x parameter. However, the PC Scheme approach uses a named variable instead of a tag. The simplest use of continuations is as escape procedures in exception handlers, but you can also use them for implementing event simulation, nonblind backtracking, multiprocessing, and coroutines.

PC Scheme's use of lexical scoping provides fast access to function parameters and allows efficient implementation of closures. A closure is a function where all local variables are kept with respect to the function. For example,

```
(define (addx x) (lambda (y) (+ x y)))
```

continued

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PC Scheme (version 2.0)

Type
LISP compiler and development environment

Company
Texas Instruments
P.O. Box 655012
Mail Station 57
Dallas, TX 75265
(800) 527-3500

Format
Two 5¼-inch floppy disks

Computer
IBM PC, XT, AT, or compatible (320K-byte minimum); two floppy disk drives or one floppy disk drive and one hard disk drive

Software
PC-/MS-DOS 2.0 or higher

Documentation
113-page user's guide
265-page language reference manual

Price
$95

is a function that returns a function that has a local variable of x. The function takes one parameter, y. Each invocation of addx creates a new closure with a corresponding x value. The (addx 5) and (addx 10) statements produce closures where x has a value of 5 and 10, respectively.

The idea of a closure is extremely powerful, and PC Scheme uses this idea in a number of areas. Some typical uses include comparison functions with a specified accuracy, generator functions (random numbers), and streams.

Data Types

PC Scheme provides the data types found in most LISP implementations. This includes 15-bit signed integers, variable-precision integers with up to 9520 decimal digits, IEEE floating-point numbers, character strings of up to 16K bytes, vectors with up to 10,921 elements, and LISP-style lists.

PC Scheme supports numbers with a full complement of functions including trigonometric, exponential, and useful mathematical functions such as greatest common denominator (gcd) and least common denominator (lcd). You can manipulate strings using functions as complex as substring-move-left! and substring-move-right!, in addition to substring-find-previous-char-in-set. The functions are sufficient to allow implementation of an EMACS-style text editor in PC Scheme.

I/O Support

PC Scheme supports text files with sequential-file access. Binary-file access is available by reading a character at a time. One serious limitation is that the package does not provide random-file access.

PC Scheme supports multiple character-oriented windows. Scrolling is automatic, and you can use pop-up windows as an alternative to regular windows. The application must control overlapping windows. Graphic functions are cursor-oriented; for example, draw-line-to takes two parameters, x and y, where the line is drawn from the current graphics cursor to the new point. This new point is the new value of the graphics cursor. The graphic functions access the entire screen directly, independent of the windowing scheme.

System Interface

You can interface PC Scheme programs to DOS and other programs using the dos-call procedure or the sw-int facility. The dos-call procedure lets you call other programs with a .COM or .EXE extension. Procedures are also provided for deleting, renaming, or copying files and getting a directory or size of a file. You can call memory-resident assembly language or Lattice C functions from PC Scheme by installing them as an interrupt service routine and then invoking the interrupt with the sw-int function.

The two methods provided for interfacing PC Scheme to other languages are not the best. The dos-call procedure would be inappropriate for calling a function that you want to use repetitively because it is slow and takes a lot of memory. Using the sw-int function might be good for repetitive functions, but installing a function as memory-resident is complicated. It would be much better if PC Scheme could produce object files that could then be linked to object files compiled with other languages.

Object-oriented Programming

PC Scheme supports an object-oriented programming system similar to the LOOPS and Flavors system found on LISP machines. The PC Scheme system is called the Scheme Object-Oriented Programming System, or SCOOPS.

SCOOPS supports multiple and dynamic inheritance. This allows you to build an object-class definition from a set of other objects. For example, a boat object could be composed of a moveable object with a location, direction, speed, and weight plus an object that can carry other objects with attributes such as capacity and current contents. SCOOPS does not support a hierarchical class system, as the one in Smalltalk.

Objects are associated with a class, and each class may contain variables common to all objects of the class. The class is also the common repository for *methods*, or functions, that can be invoked through an object. Objects may contain variables that are distinct for each object. A method is invoked using the send function, as in

```
(send boat-object set-speed 100)
```

The actual process used by send to invoke the method corresponding to set-speed is hidden so that the compiler can make optimizations when possible.

Multitasking

PC Scheme supports multitasking through the use of engines and continuations. An engine is an object that can be set up to run for a specified number of ticks. In PC Scheme, the length of a tick depends on the system clock. An engine is created using the make-engine function, which takes a function with no parameters. The result is a function, or closure, that takes three parameters: the number of ticks, a success-continuation function, and a failure-continuation function.

You run an engine by calling the function with the three parameters. The engine

Listing 1: *This recursive implementation of a function to find the length of a list causes no net growth of the stack because the PC Scheme compiler optimizes the tail-recursive call to* find_length.

```
(define (length list)
        (let ((find_length
                  (lambda (list size)
                          (if (atom? list)
                              size
                              (find_length (cdr  list)
                                           (add1 size))))))
              (find_length list 0) ))
```

executes its internal function for the number of ticks specified or until the engine-return function is executed. You invoke the failure-continuation function with a single parameter, which is a new engine with the same internal function as the initial engine. You can use this again and again until the engine-return function is finally used. In this case, the success-continuation function is invoked.

The success-continuation function takes two parameters: the parameter to the engine-return function that caused the success-continuation function to be invoked and the number of ticks remaining. This setup allows a multitasking executive to service system requests from processes that are run as engines.

The continuation-passing approach to Scheme is important here because the stack does not continue to grow as each of the continuations is invoked. Instead, the execution process can be viewed as moving from a user process within an engine to the executive and then directly into another user process.

The approach allows you to build a time-slice multitasking system. In theory, real-time interrupts could be supported, but these have not been implemented. The actual details of the executive are left to the programmer. PC Scheme provides a number of support functions to assist in the implementation of such a system, but no examples are provided. Unfortunately, developing such a system may be beyond the interest or capability of many programmers unfamiliar with Scheme.

References to some good articles on the subject are in the documentation's bibliography, but many of them, such as ACM conference records, may be difficult to obtain. They also tend to be at a rather academic level. More suitable examples should have been provided with the package. Various examples would be appropriate because techniques to implement secure operating systems and various scheduling methods are difficult to work out from scratch. PC Scheme provides a great way to experiment with these techniques if you can figure out how to set them up.

Although it is a dialect of LISP, PC Scheme differs greatly from conventional LISP implementations. Using the system is the only good way to learn and appreciate all its facilities.

Editors and Debugger

PC Scheme comes with two editors: EDIT and EDWIN. EDIT is a command-driven structure editor that edits data structures in memory. It is useful for working with LISP lists directly, especially circular lists. Because this editor works on a tree comprised of pairs and atoms instead of strings or files of characters, it takes a bit of practice to become proficient with EDIT.

The EDWIN editor is a screen-based text editor patterned after EMACS with LISP-specific support. It uses some of the function keys and many control-key sequences. You can load and save text files as you can with conventional text editors. In addition, you can evaluate Scheme expressions directly from within the editor. EDWIN's response time is a bit slow on a PC XT. The editor could not display the characters as I typed them unless I typed very slowly. The response time is acceptable on a PC AT, however. Both editors are written in PC Scheme. However, their source code is not provided, so user modifications or enhancements are out of the question.

The debugging facilities give you flexibility in tracing procedures and setting both conditional and unconditional breakpoints. The debugger is invoked when a breakpoint or error is encountered. It allows single-character control-key functions that provide information about the current environment. You can examine and change variables and evaluation status.

A compiler debug flag is available that allows you to compile functions with enough information to let you view functions while debugging a program and determine what is going on. Setting the debug flag to true cancels some of the optimization; functions compiled using this mode operate three to four times slower. Also, because additional information is saved, the program may no longer fit in memory.

Documentation

PC Scheme comes with two manuals: a language reference manual and a user's guide. They are relatively complete and well organized with sufficient examples to allow you to use the system to a limited degree. Unfortunately, they are insufficient for learning about how to apply all the features found in PC Scheme.

The documentation includes tables organized by function, and the index and bibliography are invaluable. Function definitions are listed alphabetically. The documentation lists a number of system limits such as the maximum string size in bytes, but many other necessary pieces of information are left out. For example, there is no way to find out what the memory requirements are for lists or function invocations. These details are critical when applications become large in comparison to the amount of available memory.

The documentation recommends the book *Structure and Interpretation of Computer Programs* by Harold Abelson and Gerald Jay Sussman with Julie Sussman (MIT Press, 1985). This book should have been included as part of the package, as most people unfamiliar with Scheme will find PC Scheme confusing without it. This group includes most LISP programmers, except possibly those who have used full Common LISP or Scheme-like implementations.

Benchmarks

I tested PC Scheme using a number of simple benchmark procedures, each performed 5000 times (see table 1). The cons test takes a nil list and inserts nil as the first element. Integer addition and multiplication tests add and multiply 1 by 2. The floating-point addition and multiplication tests add and multiply 1.2 by

continued

Table 1: *A comparison of benchmarks performed on PC Scheme, Golden Common LISP, and Waltz LISP. Each test was run 5000 times. The Dummy NOP operation is simply a function call that returns a null value, which is used to calibrate the loop. All other times include the loop time as well. All times are in seconds.*

Test Name	PC Scheme 2.0	Golden Common LISP 1.01	Waltz LISP 5.01
Dummy NOP	7	15	16
cons test	11	18	18
Integer addition	11	18	19
Integer multiply	11	18	20
Floating-point addition	22	26	—
Floating-point multiplication	32	30	—
Global assignment	11	17	—
Local assignment	7	—	—
List indexing	234	26	[illegible]
Vector indexing	10	18	—
String indexing	10	18	[illegible]

234324.3. The global-assignment test assigns the list (1 2 3) to a variable. The local-assignment test, performed only for PC Scheme, defines a variable local to the function and assigns the list (1 2 3) to it. The list-, vector-, and string-indexing tests define a 128-element list, vector, and string, respectively, and access the 120th element.

I did not perform the file read and write functions because PC Scheme does not support a string-read function. For comparison, I also tested Golden Common LISP 1.01 and Waltz LISP 5.01. These two packages do not have lexical scoping, so the local-assignment test does not apply to them. Also, because they are interpreters, their tests should be expected to run slower than the compiled PC Scheme code. In most cases, however, the interpreters did not lag far behind PC Scheme, and in list-indexing they beat the compiler. Waltz LISP does not support floating-point numbers or vectors. (For more information on Waltz LISP, see my review of BYSO LISP and Waltz LISP in the July 1986 BYTE. [Editor's note: *Benchmark programs for PC Scheme, Waltz LISP, and Golden Common LISP are available on disk, in print, and on BIX. See the insert card following page 352 for details. Listings are also available on BYTEnet. See page 4.*]

Summary

PC Scheme is a good product with much potential and only a few deficiencies. The reading and compiling of programs was slow, as was the overall response of the screen editor, EDWIN. The latter might be improved with additional built-in functions or by optimizing some critical functions, but this is speculation since the source for EDWIN, which is supposed to be written with PC Scheme, is not provided. It would have proven to be a useful example of how to use PC Scheme.

The two areas that really need work are the file support and interfaces to other languages. File support needs to be enhanced, especially random-file access and binary-file support. The interface to other languages would be improved if PC Scheme could produce object files that could then be linked to object files compiled by other languages. Another much-needed addition is the generation of standalone executable files (.COM or .EXE).

PC Scheme is suitable as a learning tool and for a number of symbolic and graphic applications. However, it lacks major features such as random-file access, formatted output, record structures, and fixed-point arithmetic necessary for accounting or numeric processing. Sufficient enhancements could easily make it into a powerful general-purpose language. ■

Concurrent PC DOS

Wayne Rash Jr.

Digital Research first attempted to meet the needs of multitasking users with multiuser MP/M, and later with Concurrent CP/M. Now Concurrent PC DOS combines the capabilities of both these products in a system that runs multiple programs simultaneously and supports external terminals as well. Concurrent PC DOS runs software written for both MS-DOS and CP/M-86 in a menu-driven windowing operating environment that provides extensive on-line help.

Compatibility

Concurrent PC DOS version 5.0 ($395) runs on the IBM PC, PC AT, and close compatibles such as Compaq, AT&T, and Zenith computers. Digital Research provides a complete list of computers that Concurrent PC DOS supports.

Your system must have at least 256K bytes of memory (Digital Research recommends 512K bytes) and one double-sided floppy disk drive to run Concurrent PC DOS. (Two floppy disk drives or a floppy disk drive and a hard disk drive should be considered the practical minimum.) Concurrent PC DOS supports a color monitor if you have one.

Version 5.0 of Concurrent PC DOS also supports the Lotus/Intel/Microsoft Expanded Memory Specification (EMS) as well as the Enhanced Expanded Memory Specification supported by Ashton-Tate, Quadram, and AST Research. Concurrent PC DOS can use either of these memory-expansion systems to increase the amount of memory available to applications (both support 8 megabytes of RAM). This will allow you to run several large programs at the same time.

Because it is a large, flexible operating system that contains many utilities, Concurrent PC DOS takes up a lot of disk space (you will need a little more than 1 megabyte). Concurrent PC DOS comes on four 5¼-inch floppy disks and includes a Card File program, a text editor, a Printer Manager program, and the operating system support software.

Concurrent PC DOS supports all CP/M-86 software and most major MS-DOS software. There are some restrictions on the use of MS-DOS software, but most major programs including Lotus 1-2-3, WordStar, and dBASE III will run well. Digital Research provides a list of MS-DOS software that has been tested with Concurrent PC DOS, and it notes any special concerns involved with running it.

Installation

To install the software, floppy disk users need only press a key. The disk copying operations are handled via a single menu selection and use a program that identifies the disk format on the original disk and formats the target disk accordingly. Concurrent PC DOS handles MS-DOS– and CP/M-formatted disks with equal facility. The installation process requires only that you insert disks when directed.

Hard disk installation is also handled automatically. Digital Research makes things easy for the user by acknowledging the predominance of MS-DOS and finding ways to work within it. You can install Concurrent PC DOS in a subdirectory on your MS-DOS–formatted hard disk and run it from there. This allows you full access to all the MS-DOS directories and device drivers that do not exist for Concurrent PC DOS. For example, I was able to use the Xerox 6060 mouse with the Concurrent PC DOS File Manager.

During the installation process, Concurrent PC DOS creates a subdirectory called CON-DOS and then modifies your AUTOEXEC file so that you can run either MS-DOS or Concurrent PC DOS. You can also boot automatically from Concurrent PC DOS or create a disk partition devoted to Concurrent PC DOS. If you choose to use a CP/M-formatted disk, you are forced to use the CP/M user levels instead of the more flexible hierarchical directory structure of MS-DOS.

Using the CP/M-formatted disk has one significant advantage, however. You are no longer restricted by the MS-DOS 32-megabyte limit on disk size. The user's manual does not specify the maximum disk size that is supported, although earlier versions of the system were said to support any size disks available. Concurrent PC DOS had no trouble with 40-megabyte drives.

Running Concurrent PC DOS

If Concurrent PC DOS is on your hard disk subdirectory, you'll first become aware of it when MS-DOS starts running the AUTOEXEC file. You will be asked if you want to run Concurrent PC DOS. If you type Y, a message appears that says the system is loading. Next you see a sign-on screen that invites you to press F1 to see a menu or Esc to get the system prompt.

If you press Esc, the familiar C> prompt appears. Many of the commands from MS-DOS perform their familiar functions, as do most of the CP/M-86 commands. In many instances the commands overlap functions. You can copy files using either the MS-DOS COPY command or the PIP command from CP/M. In both cases the commands retain their normal syntax.

Concurrent PC DOS runs programs simultaneously by using virtual consoles. You can use each of these consoles just as you would a single-user console, and you can switch from one to another. To switch consoles, you press the Ctrl key followed by a number (1 through 4) on the keypad. You can, if you wish, create windows for one or more consoles that allow you to see more than one program running at a time.

Once you start a program, you can switch to another virtual console while that program runs. There are some restrictions on this; for instance, some MS-DOS programs, such as dBASE III and Lotus 1-2-3, ignore the operating system and write information directly on the screen. When this happens you can get screen output from a console that is switched out. Concurrent PC DOS allows you to suspend operation of an MS-DOS program unless its console is selected.

File Manager

If you prefer to use menus, the File Manager allows you to perform all system functions by selecting a command with a highlighted cursor and pressing Enter. (I used the optical mouse on the Xerox 6060.)

If you run a program from the File Manager, Concurrent PC DOS returns to it when the program finishes running. Any command that makes reference to a file allows you to indicate your file choice by moving a marker to the one you select and pressing Enter. If you want to type a text file, for example, you use the arrow keys or a mouse to move the cursor to the TYPE command, and press Enter. As soon as you do this, you will see an arrow pointing to directory entries on the screen. Again you move this arrow around with the arrow keys or the mouse until it points to the file you want, and press Enter. The file is printed on your screen, and then you are returned to the File Manager. You can also type in a command, if you wish.

Below the screen containing the directory information is a line that displays Help messages, and beneath that is a menu that shows the assignments of the function keys. You can reassign the function keys if you choose to do so.

Status Line

With an operating system that performs as many functions simultaneously as Concurrent PC DOS, it's very important that you know what is going on at any time. For this reason, Concurrent PC DOS includes a status line at the bottom of the screen that tells the name of any programs that are running, the printer assigned, any disk drives that are in use, and the time. The time does not make use of the clock/calendar installed in some computers. Concurrent PC DOS does not keep very good time in all cases. On the Xerox 6060, the clock gained about two minutes per hour, while on a Zenith Z-148, the time was accurate.

If you are running more than one program at a time with Concurrent PC DOS, you can watch the status line change as programs are loaded or when execution finishes. This alerts you when you need to change virtual consoles or perform other steps in a process. The status line also shows the progress of a program being executed automatically using a batch or submit file.

Running MS-DOS Programs

There are a number of restrictions on the use of MS-DOS programs in Concurrent PC DOS. Most of these restrictions revolve around screen use by the software.

Another consideration is the use of memory. Concurrent PC DOS allocates memory automatically for CP/M-86 programs, but MS-DOS programs react differently. Sometimes a program can grab all the available memory even if it is not going to use it. Therefore, Concurrent PC DOS allows you to designate a specific amount of memory for MS-DOS applications.

Most MS-DOS applications run well, but a number of programs, most of them system utilities, do not. These include FORMAT and CHKDSK. Sometimes nothing happens if you try to execute one of these programs, and at other times a program can lock up a console, requiring a reset of the computer before you can use that console again. Fortunately, the other consoles usually are not locked, so you can save other information before you perform the reset.

Multiuser Operation

Concurrent PC DOS's value really shows when you realize how easy and inexpensive it is to install multiuser operations. If your computer has a serial port, all you need to set up a multiuser system is either an ASCII terminal and a cable or another computer running a terminal emulation program.

A number of restrictions apply to using a serial terminal, since most single-user applications aren't written with this in mind. Nevertheless, many programs will run very nicely, including the MS-DOS and CP/M-86 versions of dBASE II and some versions of WordStar.

Although the multiuser mode works quite well, you may have a problem getting it started, especially if you're using a computer running in terminal emulation. The Concurrent PC DOS manual provides relatively little information on the multiuser mode or the proper hardware connections.

On the other hand, the software that sets the serial port parameters is well explained and easy to use. The Setport program sets up the communications details, and the Setup program configures the serial ports for multiuser terminals or printers. Both programs make use of menus and function keys.

Once everything is set up, using your terminal is like using the host computer. The only time you know that you're in a multiuser environment is when both users try to access the disk drive at the same time; there will be a brief delay for the user who tries last. Otherwise the system shows little effect from splitting itself between users. You should note, however, that I reviewed Concurrent PC DOS using an 8-MHz Xerox 6060 with a hard disk and an IBM PC AT. System response could vary with other machines.

continued

Concurrent PC DOS version 5.0

Type
Multiuser multitasking operating system

Company
Digital Research Inc.
60 Garden Court
P. O. Box DRI
Monterey, CA 94942
(408) 649-3896

Format
Four 5¼-inch floppy disks

Computer
IBM PC, XT, AT, and many close compatibles

Necessary Hardware
One double-sided, double-density floppy disk drive and 256K bytes of RAM (512K recommended)

Documentation
250-page user's manual
150-page reference manual

Price
$395

Once you have the operating system communicating with your terminal, you must take care of a few other details. Any programs that you anticipate might be used in more than one window or by multiple users have to be set to read-only status. In addition, you must be careful to choose terminal control codes that both your computer and your terminal will understand. This may take some trial and error. Unfortunately, Concurrent PC DOS does not use the ANSI.SYS device driver in the same manner as MS-DOS, so you must find an alternative device driver.

Utilities and Applications

Several useful programs come with the operating system. Concurrent PC DOS also includes versions of most of the utility programs supplied with both CP/M and MS-DOS.

The DR Edix text editor allows you to edit and display text in any of four windows. It works well for writing programs, memos, and the like, and while it's not designed to replace a full-fledged word processor, it does provide full-screen editing, unlike MS-DOS EDLIN and CP/M ED.

The Card File program is designed to perform as an electronic Rolodex. It is set up to handle the same type of information that you would have on a telephone file, and it has space for comments. You can search for information by field, look through all the cards, and use the program to print mailing labels and index cards.

The Printer Manager is a necessity for a system that may have three users and multiple printers. This program puts printing jobs into a queue, assigns them to the proper printer as requested, and formats the text where necessary. You can run the Printer Manager from a menu, or you can enter the necessary information from the command line, making it easier to load the print queue using a batch file.

Documentation

For the most part the user's manual is very clear, has excellent illustrations, and is well indexed. Still, there are areas that can be improved. The discussion on terminal installation is probably the weakest. Discussions of multiuser operations are scattered throughout the manual. This information needs to be presented completely, and it should be collected in a single place. Technically inclined users would benefit from expanded explanations of printer installation and from information about how to write programs that take advantage of the capabilities of Concurrent PC DOS.

The Bottom Line

Many small businesses need to be able to share information but don't want to pay for additional computers or for a local area network to connect them. Provided that the software they need will work with Concurrent PC DOS, this can be a very good approach.

Still, this is not the answer for everyone, since there is some MS-DOS software that will not run under Concurrent PC DOS, such as Framework 1.0, dBASE III 1.0 (later versions work fine), and a few of The Norton Utilities. Even more software will not run in a console that is switched out or that is in a window, and still more will not run with a terminal. However, the software that does run performs well. I found no degradation of performance in running MS-DOS software with Concurrent PC DOS. In fact, Concurrent PC DOS was much faster than MS-DOS for some operations.

I recommend this product, but with some reservations. Like any multiuser or multitasking operating system, it is more complex and requires more skill to set up and use than a single-user system. On the other hand, if you have an application that requires multitasking access with multiple users (such as a two-line bulletin board), or if you need to find a way to stop waiting for your computer to finish a task before starting another one, this is an inexpensive and effective way to do it. [Editor's note: *If you intend to buy Concurrent PC DOS 5.0, check with Digital Research to make sure that any applications you use will work with it and to learn what fixes might be required for software that will not run as is.*] ■

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Wendin's Operating System Toolbox

Jason Levitt

Wendin's Operating System Toolbox (OST) consists of about 300 files containing C source code (85 percent) and assembly code (15 percent) that you can compile and link to create the kernel of your own personal operating system. This resides on top of MS-DOS and accepts most MS-DOS system calls. With the OST you can create the operating system best suited to your needs by coding a user interface, or shell, and linking it with the kernel. The bulk of the operating system, the kernel, is completely supplied for you in object and source form on two disks.

Wendin's kernel has an accessible system-call interface and is robust enough to support a wide variety of operating system services such as multitasking and pipes. Application programs designed in your newly created operating system environment can take advantage of Wendin's enhanced system services, which include multitasking, paged memory management, and concurrent I/O. If you don't want to code your own user interface, you can purchase either PCVMS or PCNX (each for $99) from Wendin. These are two operating systems created with the OST. PCVMS has a user interface similar to the one supplied with VAX/VMS systems, while PCNX has a UNIX-like interface.

What You'll Need

The OST is designed to be used with MS-DOS 2.0 or higher and an IBM PC, XT, AT, or a 100 percent compatible system. PCNX did not run on my IBM RT PC with a PC AT coprocessor card installed. A hard disk is necessary because the source code for the kernel unpacks to a megabyte of disk space, and you will need room for your C compiler and object modules. Memory restrictions are modest, even though the operating system will end up wholly memory-resident. For instance, PCVMS requires less than 256K bytes to run, and PCNX requires less than 384K bytes.

Since the kernel is written in C, you'll need a C compiler. Using the Microsoft C compiler version 3.0 will greatly simplify compilation since the kernel is also supplied in Microsoft object form. If you don't have Microsoft C, then you'll have to compile the entire kernel by hand. The C compiler you choose must contain a number of features explained in the OST documentation. The three most important features are: It must generate reentrant code, it must support a large memory model, and the stack-segment register must be allowed to change after load time. The Lattice C compiler is mentioned in the OST documentation as a possible

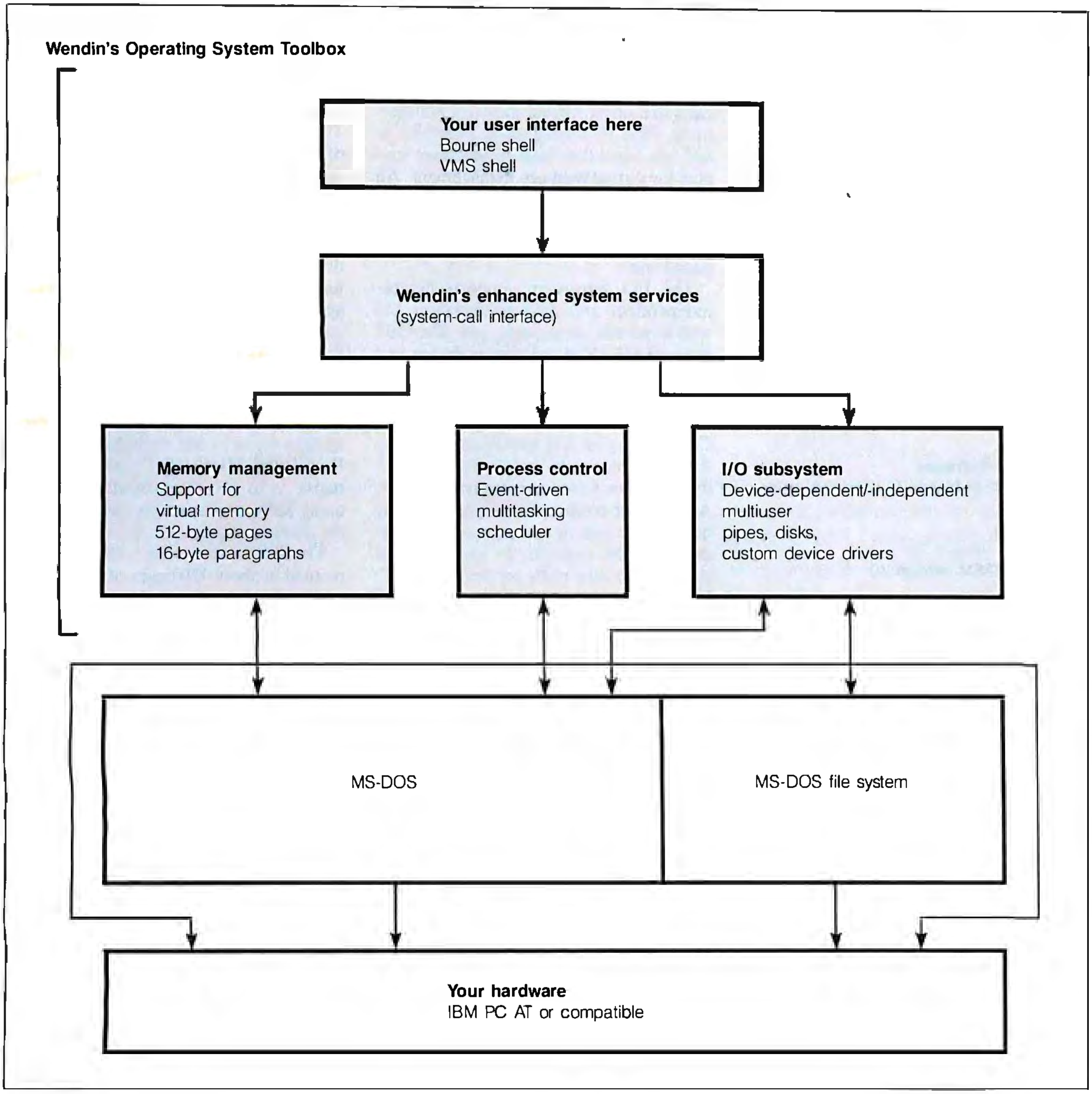

Figure 1: *An overview of a personal operating system built with Wendin's Operating System Toolbox. The Toolbox uses MS-DOS system calls to a great extent, but it also interacts directly with the hardware.*

alternative to Microsoft C 3.0.

You can code the user interface in any language. However, the language must somehow access the system calls provided by the kernel, and the object module will ultimately be linked with the kernel. If you want to avoid working with assembly code, the package comes with libraries for Turbo Pascal and Microsoft C. An advanced MS-DOS programmer could easily adapt other languages using the source code provided.

You'll also need an editor. The documentation suggests Wendin's XTC editor. For $99, this package gives you a thoroughly documented and reasonably fast text editor that supports multiple windows, a built-in macro language, and complete source code on disk. Being able to look at eight source files on the screen simultaneously in eight small windows is useful when you are dealing with the over 300 separate source files. I used it successfully without even opening the manual, since the on-line help was adequate. The editor lets you use a common subset of commands without having to deal with other features until you need them.

The Kernel

The OST is divided into three major components: process management, memory management, and the I/O subsystem. Each of these components is designed to add increased functionality to MS-DOS. Figure 1 illustrates the structure of an operating system built with the OST.

The OST process-management component allows the multitasking of processes by using a scheduler algorithm to queue processes that are attempting to run under DOS. The design of the event-driven

continued

Wendin's Operating System Toolbox version 1.08

Type
Operating system development package

Company
Wendin Inc.
P.O. Box 3888
Spokane, WA 99220
(509) 624-8088

Format
Two 5¼-inch disks; MS-/PC-DOS format

Computer
IBM PC, XT, AT, or 100 percent compatible with a hard disk (5 megabytes minimum)

Necessary Software
MS-DOS 2.0 or higher; C compiler; editor

Languages
Microsoft C version 3.0
Microsoft MASM version 3.0

Options

PCVMS operating system:	$99
PCNX operating system:	$99
XTC editor:	$99

Documentation
312-page user's manual

Price
$99

scheduler algorithm is based on the one used with the VAX/VMS operating system; each process in the queue has a current state assigned, and it waits until an appropriate system event modifies its status in the queue. Processes execute in one of four privilege modes, which are, in order of least to most privileged, User, Supervisor, Executive, and Kernel. Each mode has its own stack and, normally, processes executing in User mode do not have access to kernel data structures. However, without hardware protection this cannot be rigidly enforced. The multitasking works but, as might be expected on a system that isn't designed for multitasking applications, it is extremely slow. For instance, a small program running in the background causes a delay in echoing subsequently typed characters. In addition, the lack of hardware protection for memory on the 8086 makes it easy for a simple program to corrupt other processes waiting in the scheduler queue.

Memory management provides for the dynamic allocation and deletion of memory segments for individual processes in 512-byte or 16-byte blocks. Operating systems implemented on an IBM PC AT can take advantage of system calls that allow virtual memory management. IBM PCs swap entire processes in and out, since they have no hardware support for virtual memory management. All systems can lock pages into memory to support memory-mapped devices or other critical data that shouldn't be swapped or paged out.

The I/O subsystem supports device-independent and device-dependent I/O with terminals, disks, and pipes. The OST uses the MS-DOS disk device drivers and the MS-DOS file system for compatibility. Creating new device drivers is straightforward using Wendin's system calls. Concurrency of I/O operations by using software interrupts and queuing device requests allows processes to share devices. A multiuser configuration is achieved by hooking up one or two terminals, in addition to the console, to asynchronous communications ports on your IBM PC. I hooked two terminals up to my IBM PC XT running Wendin's PCNX, and I was pleased to see log-in prompts appear at both terminals and the console. I ran a different software package on each terminal simultaneously (a word processor, a database, and a game) without failure, although they ran rather slowly at both 4800 and 9600 (top speed) bits per second. The documentation cautions that certain programs that poll the communications ports directly (such as IBM's BASIC and BASICA interpreters) will crash the remote users. I, unfortunately, verified this behavior. The OST is indeed a multiuser operating system, but lack of hardware memory protection on the IBM PC makes each user vulnerable to the others.

The discussion above underscores the major drawback of the OST. The 8088 chip in the IBM PC does not support the virtual memory, multitasking, multiuser capabilities that Wendin provides in its software. The IBM PC AT supports these enhancements, but the OST does not take advantage of much of the 80286's functionality. Also, multitasking under DOS is a well-known kludge. Several software packages that I have seen allow multitasking, but DOS is a steadfastly single-threaded operating system, so multitasking is always achieved by handing processes to DOS one at a time and controlling how long DOS can execute each process.

The VAX/VMS operating system has influenced many of the minor design choices of the OST. In addition to the access modes and scheduler mentioned above, VMS users will recognize the authorized privileges that users may be granted, such as GROUP, BYPASS, ALLSPOOL, DETACH, WORLD, and the use of logical names for devices, like SYS$INPUT and SYS$ERROR.

The Enhanced System Services

The enhanced system services are the set of system calls provided by the OST. It is an appropriate name because many of the system calls are just filtered MS-DOS system calls in disguise. The enhanced version of the system call is well documented and allows access to the extra features in the OST. Both the operating system and application programs use enhanced system service calls. For instance, when you log onto PCNX, the Getty program creates a shell process for you using system service calls. As mentioned earlier, libraries containing these system services are included for Turbo Pascal and Microsoft C. Another alternative is to call the procedures directly using software interrupts (which is what the library routines do anyway).

The 80 or so system calls are documented in about 120 pages of the 312-page user's manual. About 30 of the system calls are for process control management, with the rest being almost evenly divided among device, memory, and file management, and a few additional calls for event-flag, logical-name, and time-conversion services. Each system-call description includes the calling format in high-level language and macro assembler format with argument description and return status.

Applications

Wendin suggests three uses for the OST. You can code your own user interface with Wendin's enhanced system services and link it to the kernel supplied on the release disks. Wendin provides a sample user interface coded in C that you can use as the starting point for development. The sample interface simply displays a prompt and allows you to execute DOS programs with the added feature of a PS command to obtain the process status list from the kernel. The user interface development philosophy is to be careful and to add features to the example a little bit at a time because you can't trust a debugger running from a defective user interface.

Most MS-DOS programs (Multiplan, for instance) will execute properly under the OST. However, the OST discourages the use of MS-DOS calls that don't belong in a multiuser multitasking operating system. The documentation claims that all well-behaved DOS programs will run; programs that don't directly address the hardware should be fine.

The second application of the OST is as a back end for applications that require

continued

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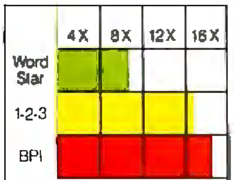

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sophisticated process, memory, or I/O services. A typical example would be a file server on a network or a database management system. Developing in this manner means that the application must provide system start-up and shutdown procedures just as if it were a shell. Of course, these procedures might be transparent to the user.

A third use of the OST is as an educational resource. The user's manual is packed with details about OST internals in addition to a good helping of MS-DOS information. The manual also has plenty of code fragments illustrating key points and lots of examples explaining how and why to use the enhanced system service calls that the OST provides. The section on writing device drivers is especially well written and contains an excellent discussion of the tty drivers. The manual is not introductory in nature, however. If you don't already know what a scheduler does in an operating system or what an asynchronous system trap is, the manual won't teach you. The text is aimed squarely at experienced DOS programmers and knowledgeable systems people.

Wendin should be congratulated for providing complete source code that is reasonably well documented and logically arranged. Everything from the assembly interrupt routines to the system header files is coded in a consistent fashion, with indentation and explanatory headers making the developer's job considerably easier.

Congratulations also go to the telephone support. It may not be toll-free, but the people on the other end understood my questions and seemed genuinely interested in what I was doing, as well as how I was doing it (I didn't mention that I was writing this article).

The best news is that anything created with the OST is royalty-free. You cannot distribute Wendin's source code with your application, however. That makes me want to write my own PCVMS operating system for people who want the feel of an IBM mainframe on their IBM PCs.

Conclusion

For users with sophisticated software ideas, the OST package is a steal at $99. Provided you have a Microsoft C compiler version 3.0 and a good editor, you can be immediately productive. Using another C compiler shouldn't be any big deal, but with so many variations of C on the market and with a complex piece of software like an operating system kernel, it wouldn't be any fun.

I heartily recommend the OST as an educational tool for experienced programmers of all types. The user's manual, combined with all the source code for everything in the OST, is an invaluable resource. If you don't want to build your own user interface or if you'd rather be able to look at the source code for a complete user interface, then PCNX and PCVMS are for you. They include the operating system (kernel and user interface), utilities (about 40 for PCVMS and 60 for PCNX), complete source code, and a user's manual. The user's manuals are geared toward explaining a particular implementation of the OST.

The Operating System Toolbox has its problems, mostly due to the deficiencies in MS-DOS and the 8088 microprocessor. A carefully planned application should benefit from the enhanced services and not fall prey to the shortcomings. You wouldn't, for instance, want three people doing software development at the same time; not only would the system load be oppressive, but the possibility of wiping out another user would be too risky in an environment where retention of data is critical. ■

Jason Levitt (P.O. Box 49860, Austin, TX 78765) is a UNIX consultant.

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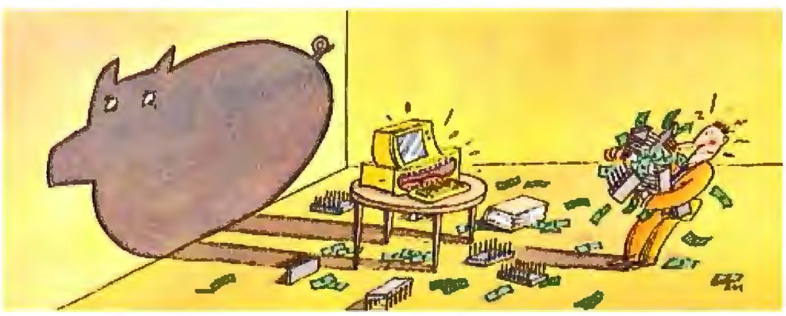

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PFS:First Choice

Larry D. Allen

Word processing, spreadsheets, file management, and more

PFS:First Choice, an integrated package for IBM PCs and compatibles, is designed for the first-time computer user. PFS:First Choice combines word processing, a spreadsheet, telecommunications, and file management in a package that is simple to learn and use. The first release, which costs $149 and requires at least 256K bytes of memory, needs several improvements, including a lot more speed. Some users may quickly find that they require more sophisticated features, but Software Publishing is right on track for its target customers.

PFS:First Choice is tightly integrated; each application is called from a common menu and employs the same user interface. You select functions and features via menus that are displayed when you press function keys. Alternatively, the most common commands have "speed keys" that you execute by pressing Alt in combination with a letter key. You can easily move data from one application to another via a clipboard. You can place up to six "bookmarks" within word processing, spreadsheet, or file-management data, which allows you to jump to and from specific places in each of the applications without going through the main menu. This is also helpful during cut-and-paste operations.

If you elect to bring up an existing document from the main menu, a directory is displayed with the files organized by application in sorted columns. Each type of file has its own extension name. Selecting a file opens the correct environment for that file automatically (e.g., word processor or spreadsheet). File size is limited by RAM; the program itself takes up approximately 187K bytes. An indicator showing the percentage of filled memory appears at the top of the screen.

Word Processor

The word processor is not designed for the user who cares about fancy formatting, jazzy cursor movements, or alternate-side page numbering. It is for those who want to put out decent-looking letters and memos with minimal learning time.

Some things about PFS:First Choice took some getting used to. For instance, pressing Tab does not insert a Tab character, even in Insert mode; it simply moves the cursor to the next tab stop. For word wrap, the cursor stays on top of the last character at the right margin instead of moving one character past the margin. This is fine unless a word ends right at the margin and you try to add characters to the word later (to make it plural, for example). Since you can't place the cursor to the space past the word, the only option is to delete the word and retype the longer word, which then properly wraps to the next line.

Text styles, including bold, italic, underlined, superscript, subscript, and centering are supported, but you must first enter the text and then select and define it with the desired style. You cannot simply turn on Bold mode and turn it off again when you've finished typing bold text. All styled text is displayed on the screen in reverse video, or as yellow text on a color monitor. To know what style a particular piece of text is in, you place the cursor on the text and press the Style function key. The Style window then pops up with a menu of available styles and displays a dot beside each style currently defined for the highlighted text.

The word processor's merge capability is easy to use and can access records stored in the file manager. For addressing labels, only single columns of labels are supported. Headers and footers are also supported, up to two lines for each. PFS:First Choice has no Undo key. However, you can restore marked text that has been cut to the clipboard.

The word processor and other applications have a Print menu with options that let you define the page length, page width, compressed or normal print, and draft or correspondence quality. The word processor provides a JOIN command that permits you to append multiple documents together at print time. When printing on a Hewlett-Packard LaserJet, I had to define my page length as 60 lines instead of 66. Software Publishing says this is because the LaserJet does not print on the top or bottom half-inch of the page.

PFS:First Choice comes with a 75,000-word dictionary for its spelling checker. The spelling checker employs a root-word algorithm. It also warns of numbers with misplaced commas, improper capitalization, and repeated words (e.g., *the the*). A word count is not provided.

Complex writing tasks may require features that you won't find in PFS:First Choice. You cannot exit temporarily to DOS, change fonts in a document (although printer codes can be embedded in a document), use proportional fonts, manipulate columns, rename a file, use 1½-line spacing, erase to the end of a line, perform a timed backup, automatically create a backup file, employ continuous underlining, move the cursor a page at a time or to a particular page, or perform a find-and-delete operation.

PFS:First Choice does not require you to enter the name for a newly created word processing or spreadsheet document until you save it. Curiously, the file manager requires a filename first, and the file is created immediately, even if you change your mind and exit that application.

PFS:First Choice is not upward-compatible to PFS:Write or PFS:Professional Write. Also, PFS:First Choice's user inter-

continued

Larry D. Allen is a senior electronics engineer for Advanced Technology Inc. (242 South Main St., Dumfries, VA 22026), where he works on office automation and signal processing projects.

PFS:First Choice version 1.0

Type
Integrated word processing, spreadsheet, telecommunications, and file-management program

Company
Software Publishing Corp.
1901 Landings Dr.
Mountain View, CA 94043
(415) 962-8910

Format
Two 5¼-inch disks; not copy-protected; also available on 3½-inch disks at no additional charge

Computer
IBM PC, XT, AT, or compatible with at least 256K bytes of memory (384K bytes if using MS-DOS 3.2); one double-sided 5¼-inch floppy disk drive; color or monochrome monitor; telecommunications function requires a modem (25 models supported); supports 8087 and 80287 math coprocessors

Language
C, assembly language

Documentation
User's manual, 220 pages

Price
$149

face is dissimilar enough from PFS:Professional Write that if it becomes necessary to upgrade to a product with more powerful features, PFS:First Choice users might as well consider other brands.

Spreadsheet

The package's spreadsheet has a few interesting twists. A column and row outside of the regular cells is reserved for headings. As you enter text into a heading cell, the column automatically expands to hold the text. Certain headings are especially easy to enter by using the program's Quick Entry mode. While in this mode, moving to the next heading cell automatically enters *Tuesday* if the previous heading was *Monday*. Similarly, *Feb* follows *Jan*, and *Week 2* follows *Week 1*.

Quick Entry mode also serves as a semireplicate key. Moving from cell to cell automatically copies the previous cell's formula into the next cell, adjusting the formula in the process. The program does not have a one-to-many replicate function. It is possible to select a group of cells and copy or move them to a new location, where the formulas automatically adjust. You cannot selectively adjust individual formulas during a copy operation; that is, you cannot adjust one cell reference and not another (unless you use named cells).

Cells are referenced by row and column number (e.g., R12C14), which requires more keystrokes than SuperCalc's "L14," for example. Alternatively, you can name a cell and refer to it in other cell formulas by that name. Common trigonometric, statistical, and financial functions are built into the spreadsheet. Conditional IF... THEN...ELSE logic for formulas is provided, as well as a Lookup function. You must be careful when entering text in cells because overflow text actually overwrites data in adjacent cells.

A global format change, such as displaying numbers to four decimal places, affects only new data. Existing data keeps whatever format it had when it was entered unless the cells are blocked and a new format (or style, as PFS:First Choice calls it) is defined. When you're copying cells, the program gives no feedback while you're waiting for the copy operation to finish and recalculation to begin. PFS:First Choice is extremely slow, and long waits with no user feedback are possible.

You do not define a formula in a cell by simply typing it in, as with SuperCalc version 4; instead, you select a menu option to define or edit a formula, and a window pops up with a space for you to define the formula. While this window is displayed, you can move the cursor from cell to cell, and the formula (and its name, if any) for each cell will be displayed. Unfortunately, the formula window always pops up in the same place, which may be covering the cell you're looking at. Also, you can move along only a single row. To move up or down to a new row, you must first exit the formula window, move to the new row, and then redisplay the formula window.

According to Software Publishing, PFS:First Choice's maximum spreadsheet size with 640K bytes of RAM is 1024 rows by 768 columns. Using MS-DOS 3.1 with 640K, however, I reached the memory limit with a standard spreadsheet measuring 173 rows by 25 columns. The standard spreadsheet simply multiplies the previous cell by 1.001. With the spreadsheet at the memory limit there is no clipboard room. PFS:First Choice does not have a spreadsheet-consolidation function.

File Management and Reports

The file manager is of the genre usually referred to as card-file managers. You define a database by simply typing the desired field names where you want them to appear on the screen. Field names end with a colon. You cannot define a length or type for each field; the field will expand as necessary to hold whatever data you type in. You can define up to 1000 fields, and each record can have a maximum of 21,000 characters. On a hard disk, you can have up to 16,000 records.

The program's database is not sorted or indexed. When perusing the database, you can choose to find records by exact match, partial match, relative match, or negative match. A partial match request searches for records with fields that end in, begin with, or contain the desired string. A relative match request searches for entries that are less than, greater than, or equal to a given number. Software Publishing opted to use the symbol /< to mean less than or equal to instead of the more common <=. The Search field can contain other characters, such as a dollar sign ($); everything except numbers is ignored. A negative match request lets you search for everything but a particular partial or relative string.

When entering or editing information in a folder, you can use the word processing functions. However, there is no "blank field" command; you must use the space bar to blank out unwanted text. You can easily redesign a folder by changing field names, relocating them on the screen, or adding names without losing existing data (unless a field is deleted). I can't imagine the process being easier than it is with PFS:First Choice.

Reports

The file manager's report capability is limited. You define which fields you want to appear on the report and the order they are to appear in, along with any search criteria. The report is then printed in the conventional one-record-per-line format with a column for each field. A report can have up to 20 columns, but you are warned before printing if there are too many columns to fit on the paper.

If you wish, the report will be sorted in ascending or descending order from the first field. You can perform calculations, including total, average, and count, on columns. You can also request subtotals, subaverages, and subcounts for each time the information in the first column changes. You can specify a numeric code for a column, which means all information in that column is treated numerically; text is ignored, decimal points are aligned, and trailing zeros are added to make each entry the same length. You can define an invisible column and use the data in it for calculations; this column is not printed. A report definition can be saved for later use.

Since there is no need for a field-length definition, the report generator scans the database prior to printing the report and sets the column widths to fit the largest entry in each column. For fields with long data strings, such as comment fields, the report generator wraps excess text to the next line within its column. For getting sorted information out of a semi-free-form database, PFS:First Choice has made the process exceedingly simple.

Telecommunications

When you select "Connect to another computer" from the main menu, another menu appears in which you can define up to eight communication services, such as The Source, CompuServe, or BIX. A ninth menu selection is for answering incoming calls. You define a service by filling in an information form with the name to appear on the menu, the phone number, communication parameters, and whether or not to create an automatic sign-on sequence.

If you opt to create an automatic sign-on, the program remembers each step you take the first time you sign on to the communication service until you tell it to stop remembering. I was able to get PFS:First Choice to consistently sign on to BIX and other single-data-rate bulletin boards; however, it could not handle services that answer the phone and do not output text immediately (multiple-data-rate bulletin boards are in this category because they wait for a keystroke or two from you to determine your data rate). PFS:First Choice must see something it recognizes before sending the next sequence of text to the remote computer. Unlike with Crosstalk, you cannot tell PFS:First Choice to wait a given period and then do something. Otherwise, the automatic sign-on is exceptionally easy to use. You cannot edit the automatic sign-on sequence; to change it, you must recreate it.

A nice feature of PFS:First Choice's telecommunications application is that the program automatically places you into the word processor when you are connected to a remote service. You don't have to bother with turning a Capture feature on, as with Crosstalk. At any point while online, you can scroll back through the session and edit it as desired, saving the session if you wish.

A Noble First Try

I appreciated the error trapping in PFS:First Choice. The program does not hang up if you try to print and the printer is not ready. Instead, the program displays a polite "The printer is not ready" message. Similarly, if a disk is not in the requested drive, the program displays a "Drive not ready" message. When I tried to exceed the 100 percent full indication, a "Not enough memory" error message was displayed.

PFS:First Choice is a noble attempt to bring the most commonly needed applications to the first-time computer user or to the user who doesn't wish to spend the time to become proficient with more powerful products. However, I would like to see some improvements such as column support, font changes, and an Undo feature. Such improvements would make it less likely that a user would quickly outgrow the software. Also, while it may not be as important to a first-time computer user, PFS:First Choice should be made to run faster, especially for those who do many find-and-replace tasks or work with large spreadsheets. ■

WriteNow for the Macintosh

Mick O'Neil

WriteNow for the Macintosh version 1.00 by T/Maker is a word processing program that runs on the 128K-byte and 512K-byte Macintosh and the Macintosh Plus. It requires a minimum of 128K bytes of memory.

The first thing that struck me about WriteNow is that its authors must have taken a hard look at the shortcomings of MacWrite and set out to rectify them. Once that was done, they added a few of their own features to make this software a serious contender in the Macintosh word processing market.

The most impressive aspect of WriteNow is its overall performance. It does about everything you would want a word processor to do and does it very well. In addition, its full range of features is accessible directly from pull-down menus.

The program also handles long documents as smoothly as two-page letters. In fact, when I received an early copy of the software, I also received a disk with the 175-page manual in the form of a WriteNow document that I could access and scroll through easily.

Special Features

WriteNow incorporates a variety of advanced features, including the following:

• **Backups**. Suppose that you delete 20 pages from a document and then change your mind? WriteNow includes a Revert

continued

Table 1: *The results of performing various functions with WriteNow using a 4000-word text file converted to proper format. All tests were done on a Macintosh Plus with the system file loaded on a RAM disk with the program disk in the internal drive and the data disk in the external drive. "Run program" shows the time required to run the program directly from the Finder. "Load document" refers to the time required to load a document while the program was running, while "Load from Finder" results from double-clicking the document icon while in Finder mode. "Save document" refers to the first save of a formatted text file, and "Save revision" shows the time required to resave the same document after it has been revised. "Search document" indicates the time required for the program to find a unique word inserted at the end of the file, and "Scroll document" refers to a manual scroll from the beginning of the document to the end. Times are in seconds.*

	WriteNow 1.00	MacWrite 4.5	Microsoft Word 1.0	Laser Author 1.0
Run program	20.3	15.7	12.4	61.0
Load document	11.5	14.4	5.6	4.8
Load from Finder	17.9	26.6	15.7	52.0
Save document	10.6	12.4	23.2	16.5
Save revision	3.8	7.4	20.0	8.8
Search document	1.5	7.2	17.9	45.0
Scroll document	82.9	64.5	73.5	55.0

WriteNow for the Macintosh version 1.00

Type
Word processor

Company
T/Maker
2115 Landings Dr.
Mountain View, CA 94043
(415) 962-0195

Format
Two 3½-inch floppy disks

Language
Assembly language

Computer
128K-byte Macintosh; 512K-byte Macintosh; Macintosh Plus

Documentation
User's manual, 175 pages

Price
$175

to Saved command that simply ignores your latest revisions and a Revert to Backup command, whereby you can replace the last saved version of your document with the previously saved version.

• **Page Setup**. WriteNow includes a well-designed Page Setup function that automatically scales margins, tab settings, and indentations to maintain relative positions under various page widths. Other options give you control over automatic footnote numeration, binding margins, printer spacing, page wrap, and ruler reduction.

Perhaps the most dramatic formatting control concerns multiple columns. You can specify up to four columns, and WriteNow will divide the body and footnote regions of each page into that number of equal-width columns, with text flowing from one column to the next. The ruler starts at zero at the left edge of each column, and the ruler settings are scaled accordingly. The actual division of the page into individual formatting areas means that you can edit or change the format of text within a column without affecting the appearance of the adjacent columns.

Formatting text into columns has its trade-offs: Graphics larger than one column wide are automatically cropped to fit. These can be resized or you can include a larger-than-column-size graphic in the header or footer.

• **Full View**. To make exact formatting possible, WriteNow allows you to view a document in several different ways. You can examine the normal typing area by simply viewing the page, while headers, footers, and footnotes have their own window to illustrate their ruler setup and spacing. Particularly valuable options include the ability to view while showing markers, which graphically illustrate all headers, footers, time and date insertions, soft hyphens, and page numbers; and the ability to view while showing space, which provides a dotted outline around your text that depicts page margins and header and footer boundaries. It also shows all non-printing characters, such as return characters, spaces, tabs, and page breaks.

• **Spelling Checker**. WriteNow uses a menu-driven 50,000-word dictionary to check the spelling in a document. The spelling checker includes several helpful buttons. The Find button finds the next word not included in the dictionary. The Guess button lists alternative spellings for a questionable word. Learn adds a word to the dictionary, Forget removes a word from the dictionary, Ignore skips a word designated as misspelled, and Load Dictionary uses a dictionary of your choice.

• **Import/Export**. Included on the disk with WriteNow is a program called Translator, which can take a MacWrite or Microsoft Word document and translate it with much of its formatting into a WriteNow document. The program also translates files in standard text format into WriteNow's format and allows you to save a WriteNow document as ordinary text. The latter capacity allows WriteNow to import and export documents to database programs or spreadsheets.

Finishing Touches

WriteNow includes a number of finishing touches, that is, small logical jumps from MacWrite that allow you a little more control. For example, the Find and Replace command can use wild cards. The ruler includes a point-by-point spacing toggle, and the page-break symbol is a broad, shaded band (no isolated "=," as in Microsoft Word). You can change default ruler settings by including a piece of stationery in the same folder as WriteNow. You can increase or decrease font size with a key combination. You can insert soft hyphens for better formed text and set off paragraphs by indenting left and right from the Format menu. You can also alter the distance between letters (kerning) to optimize printing and add and insert a variety of headers and footers on different ranges of pages. This is not an all-inclusive list of WriteNow's features, but it does give you some insight into the program's sophistication.

The program comes with a well-written and nicely illustrated 175-page manual containing a user's guide and a reference section. T/Maker has joined the growing group of software developers issuing unprotected software, so there is no problem with backups or installing WriteNow on a hard disk. I found the program very solid, fast, and predictable.

Like Laser Author (which I reviewed in the January issue of BYTE), WriteNow is not the complete Macintosh word processor. The biggest reservations I have concern its inability to merge text to produce form letters and the lack of a glossary for easy entry of boilerplate phrases or blocks of text. If you have no need for these features, WriteNow for the Macintosh is well worth a look. [Editor's note: *See table 1 for complete benchmark results.*] ■

Mick O'Neil (Box 544, APO, NY 09378) is a computer coordinator for the U.S. Department of Defense dependent schools in the U.K. and a freelance writer for several international journals.

CAD-3D

Rusel DeMaria

CAD-3D from Antic Software is a three-dimensional modeling program for the Atari ST. Written by Tom Hudson, author of NEOchrome and DEGAS, CAD-3D offers sophisticated control of wire-frame or solid objects in up to four simultaneous views. The program allows you to control up to 20 objects, join or animate objects, and export color pictures to paint programs like NEOchrome and DEGAS.

When you first load the program, the screen displays four windows and a group of pull-down menus. Each window contains a different view of the objects you create. Three of the windows offer a choice of views. For instance, one window offers a view either from the right or the left side. The others offer top and bottom or front and back views. You can select or change the settings in these view windows at any time. By pressing the button in the upper left corner that normally closes a GEM window, you toggle the size

continued

CAD-3D version 1.0

Type
Three-dimensional modeling system with animation capabilities

Company
Antic Software
524 Second St.
San Francisco, CA 94107
(415) 957-0886

Format
One 3½-inch disk; not copy-protected

Computer
Atari 520ST or 1040ST with at least 512K bytes of memory; one disk drive (second drive recommended)

Language
C, assembly language

Documentation
User's manual, 30 pages

Price
$49.95

and rotation controls for each window. Scroll bars at the bottom and right side of each window control these functions.

The fourth window is the Camera window. It allows you to view objects as if from a camera. You can change the amount of perspective, zoom in and out, and rotate the camera relative to the three-dimensional images. You can also take a Super View, or color snapshot, of the image in the Camera window. On monochrome systems, you can get a high-resolution image of the Camera view.

You can zoom any window to full-screen size and activate or deactivate any window you choose. With more complex objects and shading it can take quite some time to redraw the screen in each window, so closing nonessential windows speeds up the performance of the program.

All commands are available using GEM-like pull-down menus, and most of the commands have keyboard equivalents as well.

Creating a CAD-3D Object

Several standard objects are available under the Generate menu. You can create a cube, three increasingly complex spherical objects, a wedge, or a torus (doughnut) shape. If one of these shapes is not what you want, you can use the Spin and Extrude tools to create more complex objects.

Spin is essentially a lathe tool. You work on the right side of a special connect-the-dots–type screen and define a figure one point at a time for up to 32 points. Any figure you outline is mirrored on the other side of the dividing line. When you are satisfied, you use the Do Spin command, creating a three-dimensional object that follows the outline you have created. This is an excellent tool for creating radially symmetrical objects like goblets, light bulbs, vases, or bowls.

Optional features include Rubberband, which shows the connecting line from the last point created; Connect, which automatically closes a figure; Grid, which shows an even grid; and Snap, which automatically moves points onto grid lines for more precise control. Also, you can remove erroneous points or use the Undo key to back out of an error.

Extrude is another tool for creating a new object. It is similar to Spin, but you can use it to create asymmetrical objects. It works on a similar screen, but in this case you use both sides of the center line. You must draw clockwise and avoid crossing or intersecting lines, but otherwise you can draw virtually any outline you wish (up to 50 points). You can also use the Grid, Snap, Rubberband, Remove, and Undo options. Extrude automatically closes all figures, so Connect is unnecessary here.

With both Spin and Extrude, you can select the number of segments—up to 50 with Extrude and up to 48 with Spin—that the figure will contain. This is especially useful with round figures, since increasing the number of segments increases the smoothness of the object. It also increases the time it takes to draw and redraw the object.

After you have created objects, you may want to join them. Joining objects allows you to create complex three-dimensional models and allows you to exceed the 20-object limit effectively. You can achieve several effects with the Join command. Besides simply adding two objects to make a third, you can subtract the overlapping area of one object from another, create an object that consists of only the overlapping part, or stamp one object onto another, creating a two-dimensional image of one object on the surface of another. Most Joins go quickly, but with very complex objects the process can take quite a long time—up to several hours. In some cases, two planes on the joining objects may exactly match. If this is the case, you must move or rotate one of the objects at least one degree to allow the Join.

Manipulating Objects

After you are satisfied with the objects you have created, you manipulate them. You can select wire frame (the default), hidden lines, solids, or outlined shapes. Selecting Edges Only with the Outline mode shows a clean solid shape with all facets visible. This is my favorite way to view objects. Whatever display you prefer, you can select and deselect objects on the screen, drag them to new positions, or use the scroll bars to resize or rotate them.

With solid models you can use up to four different light sources to achieve different shading effects. Although objects display on the screen in monochrome, in Super View each object can display in one of two different colors, and you can have up to seven different shadings of those colors. You set your light sources for one of seven intensity levels and for direction. For three light sources, you can choose any combination of top/bottom/center, right/left/center, and front/back/center. The fourth light source is ambient light, for which you choose the intensity. You can also display Super View objects in 14 shades. This mode creates pastel effects but allows only one color at a time.

To select an object, you simply double-click on it; other objects then disappear from the display. You can select any combination of objects from the Select option under the Objects menu and drag any object to a new position in any window except the Camera view. You can also set the program to drag only vertically or horizontally for more precise positioning.

You can scale objects from 50 percent to 500 percent. The Scale command works in all three dimensions, whereas sizing in the windows works on only one dimension at a time. You can also select Rotate from the Objects menu. This command causes the object to rotate in one dimension. With both Rotate and Scale you can use either the Universe or the Group mode. Universe mode rotates and scales relative to the center of the three-dimensional universe. Group mode rotates or scales relative to the center of the currently selected group of objects.

One use of the Group mode is to create an animated spinning object. Rotating a single object set for Group mode causes it to spin on its own axis. If the setting is for Universe mode, the object will rotate around the universal center instead of spinning.

Animation

Possibly the most impressive aspect of CAD-3D is its animation. Beta versions of the program allowed a slow, space-consuming type of animation, but the techniques are improving rapidly. Currently you can have animation moving at up to 60 frames per second; broadcast quality is only 25 to 30 fps. Also, compression techniques allow you to store much more data on a single floppy disk. At the time of this writing, the program allowed up to 20-to-1 compression, but Antic prom-

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Karl Koessel **PC World** December 1986

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A. Parallel port, 256K Video memory, runs color/ mono display, 16 colors, 640 x 350 resolution.
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D. Nonglare, 12" screen, 800 x 350 resolution.
E. 640 x 200 resolution, IBM quality.
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K. **Club 384** Serial port, parallel port, 0-384K memory, clock/calendar, game port and software.

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ises 100-to-1 compression or greater in the near future. Antic estimates that you will be able to contain an entire hour of real-time three-dimensional animation on a single double-sided floppy disk.

To animate, you must take a Super View picture of your scene, save it, modify the scene, change it, and take another picture. Each picture you save is a single frame in the animation. Thus, producing complex animation can be time-consuming and tedious; however, the results are excellent. By using CAD-3D's tricks, you can zoom in and out of scenes, change lighting effects, add and subtract figures, and produce complex movement of various kinds.

What Makes CAD-3D Special

Antic has already released into the public domain several disks of three-dimensional figures. Antic also promises a number of other related programs and image collections for early 1987. Liquid-crystal-shutter three-dimensional glasses developed by Tektronix will be available from Antic in early 1987 for use with CAD-3D. I've seen both still and animated scenes using the glasses, and the effect is amazing. In a darkened room, you would swear that objects float five or six inches in front of the monitor screen. [Editor's note: *At press time, Antic planned to release CAD-3D 2.0 in early 1987. The new version will include an icon interface, integer math for real-time processing, and dimensioning capabilities. It will be bundled with an animation language and will cost $89.95.*]

A Bargain

CAD-3D is an impressive program for creating, manipulating, and animating three-dimensional graphics. It lacks some of the abilities of other CAD programs, namely autodimensioning and labeling. Therefore, it is more appropriate as a design and animation tool than as a drafting tool. Also, you can't create the outline of an object in all three dimensions. To achieve complete control, you must use the Join command. Extrude allows you to create asymmetrical objects, but you can control only two dimensions. Finally, the manual is adequate but not as impressive as the program. Some additional tutorials might be useful to people new to three-dimensional modeling.

Whether you want to send pictures to two-dimensional paint programs like NEOchrome or DEGAS, print pictures out on a printer or plotter, or use the growing number of available animation tools, you should find CAD-3D an excellent program. At $49.95, it is a bargain. ■

Rusel DeMaria (109 Akea Place, Kula, HI 96790) is a freelance writer and computer consultant.

REVIEW FEEDBACK

Western AT

I was pleased to see the Western AT reviewed in "Four IBM PC AT Clones" by Wayne Rash Jr. in the December 1986 BYTE. However, I was disappointed that you could not accept our 8-/10-MHz machine for review, which we have been shipping since last summer. We no longer ship the 6-/8-MHz unit and have not increased the price for the faster machine. The review does not mention this, and we feel a bit like a David without his slingshot.

Mr. Rash states that the Zenith Z-248 is "the obvious front-runner" and that "this machine is significantly faster than the competition." Neither of these statements is supported by the charts on page 241. Our Western AT actually beat the Z-248 in the 40K File Copy test by 0.6 second and was faster in both the Write and Read tests for Disk Access in BASIC by 1 second. Mr. Rash also commented on the quality of our front-panel lock, yet it is the same lock used by IBM.

We did photocopy our user's manual back in January 1986 when we first sent the review machine. We perhaps should have sent the completed new manual. Yet Mr. Rash did not have any problem using the documentation.

Finally, Mr. Rash does not know us and apparently is quite familiar with Zenith. We have no service complaints from our customers anywhere in the world. His speculation about our service seems out of context.

Earl Perera
President, Western Computer
Irvine, CA

We regret that we were unable to evaluate Western's 8-/10-MHz computer along with the 6-/8-MHz model. However, when the 8-/10-MHz machine was delivered, a letter accompanying the computer said the unit "will be FCC Class A and B approved," which implied that the unit had not received FCC approval at the time and therefore was not yet being shipped. As a matter of policy, BYTE does not review products that are not shipping.

Regarding Western's service, a spokesman for the company told us that Western has no dealers in Washington, D.C., and only two dealers east of the Mississippi. Also, although Western pays shipping charges when returning a serviced computer, the customer must pay the charges for shipping the computer to Western. We think, therefore, that Mr. Rash was fair when he stated that Western's service is limited.

Cathryn Baskin
Senior Technical Editor, Reviews

23 Modems

The review entitled "23 Modems" by Stephen Satchell (December 1986 BYTE) contains several procedural errors. The primary fault is a misunderstanding of parameters that affect performance. The most troublesome impairment encountered by modems on a telephone circuit is nonlinearity of the channel-transfer function, yet this was not mentioned.

Frequency offset is another common impairment that was omitted. Frequency offset is a shift in the carrier frequency caused by frequency-shift multiplexing and is often found on common carriers.

The test parameters themselves are suspect. For example, engineers measure modem sensitivity in dBm—not in dB, which is merely a ratio. One must specify a basis for a ratio in order to convey information.

The White Noise measurements are similarly suspect. A good 300-bps modem can handle a 3-dB signal-to-noise ratio; at 1200 bps, about 11 dB; at 2400 bps, perhaps 15 dB, for an error rate of 1 bit in 10^5, assuming no other impairments.

The Phase Hit test must be a mistake. No 1200-bps modem can survive a 150-degree phase hit; a 45-degree phase hit will force an error using the 212 modulation scheme. A good 212 can take about 35 degrees of phase jitter, while a 2400-bps modem might accept 20 degrees (again, assuming no other impairments). The Gain Hit test is also suspect; I doubt that a 1200-bps modem could sustain a 20-dB gain hit without error; a 2400-bps modem certainly cannot. In practice, observed phase jitter is less than 7 degrees.

A good modem evaluation must be traceable and reproducible. Mr. Satchell mentions using three signal levels and "a great deal of filtering" at −5 dBm. What does this mean? The FCC standard for modem transmitter output is −9 dBm, so a modem evaluation based on a −5-dBm input signal would hardly reflect the signal levels seen on a real call (perhaps −20 to −40 dBm).

James Nichols
San Mateo, CA

The Bradley 2A/2B line simulator is capable of second- and third-order harmonic distortion up to 15 percent. Only the Kyocera KM1200S showed sensitivity, being able to withstand 15 percent of second, third, and combined distortion without error. On page 260 you will note that in the Error Count test, 2 percent of second and third harmonic distortion was set up on the 2A/2B.

The 2A/2B is also capable of generating a frequency offset of plus or minus 10 Hz. No modem was affected by a steady-state frequency offset. When I switched the shifter in and out, all the modems were affected, even with a frequency offset of zero. I used no frequency shift in the Error Count test.

All sensitivity figures are referenced to a level of −5 dBm. In the tables, a value of 30 indicates that the lowest level the modem responded to without error was −35 dBm; a value of 40 indicates −45 dBm.

The White Noise figures are absolute output levels in dBrn (1 dBrn is equivalent to −90 dBm) before attenuation. The signal output level is −5 dBm, or 85 dBrn.

The Bradley 2A/2B can also define a ramp for both phase- and amplitude-hit impairments. I ran two test series, one with a 20-millisecond ramp and another with a 2-ms ramp from 0 degrees to the test value and from the test value back to 0 degrees. The spread reflects this test setup. In the future, I will add a much steeper ramp for drop-out testing to reflect some real-world drop-out conditions I was not aware of at the time I performed the tests.

The three levels I used were −5 dBm, −15 dBm, and −25 dBm. Since I've run into problems with modems that could not take a "hot" signal such as you would get with a PABX, I wanted to "smoke out" those with insufficient headroom. According to the Bell connection study, a 20-dB or larger loss at 1004 Hz was reported in less than 10 percent of the long-distance connections, and a 10-dB or greater loss was reported for 95 percent of the long-distance connections. The worst modem of the bunch required a signal stronger than −37 dBm to function at 300 bps; the best required −47 dBm. I did a test run at −35 dBm and was plagued with disconnects, so I elected to run at higher levels.

Stephen Satchell ■

REVIEW FEEDBACK is a column of readers' letters. We welcome responses that support or challenge BYTE reviews. Send letters to Review Feedback, BYTE Publications, One Phoenix Mill Lane, Peterborough, NH 03458. Name and address must be on all letters.

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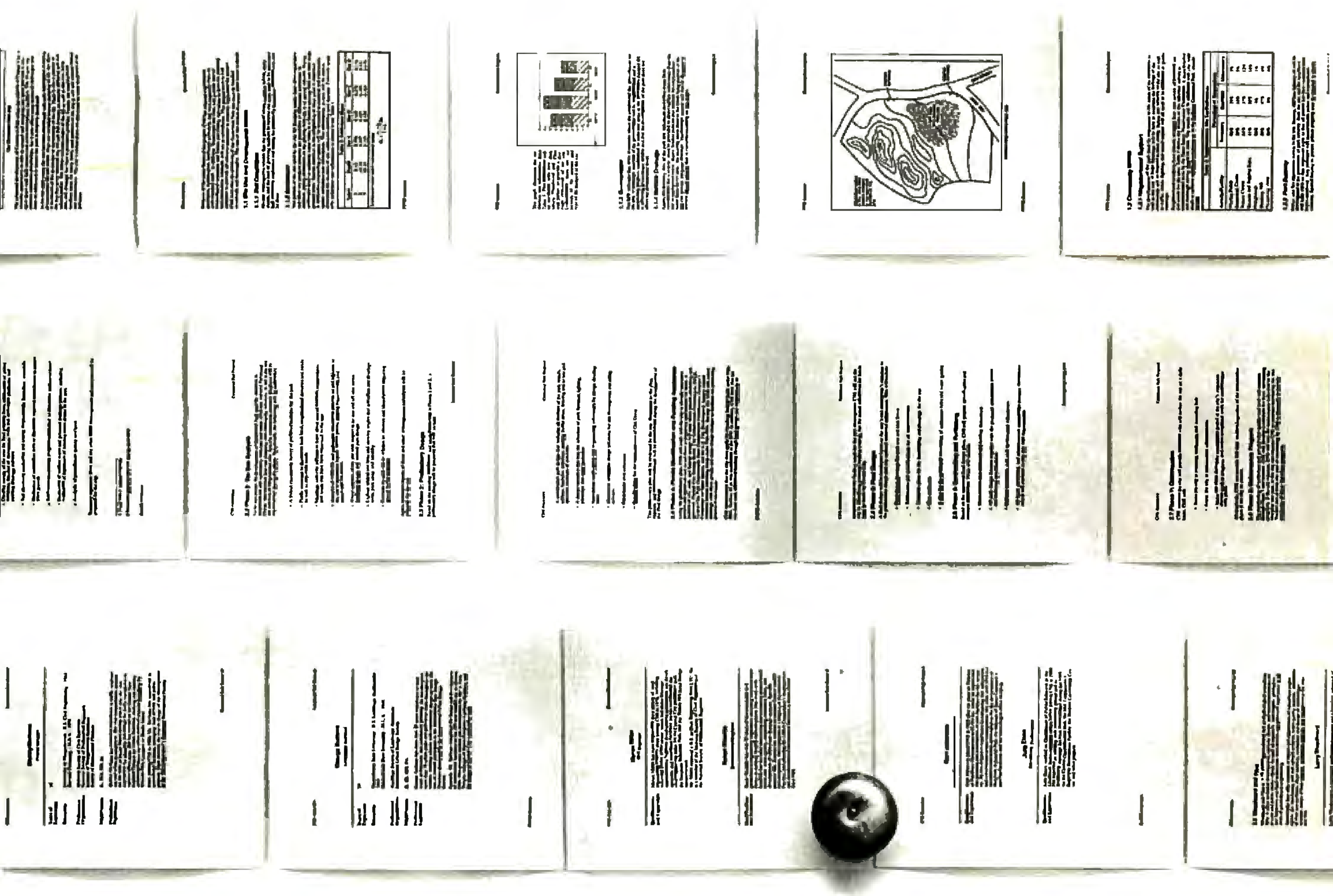

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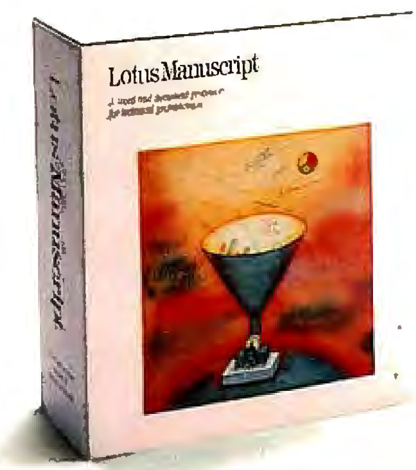

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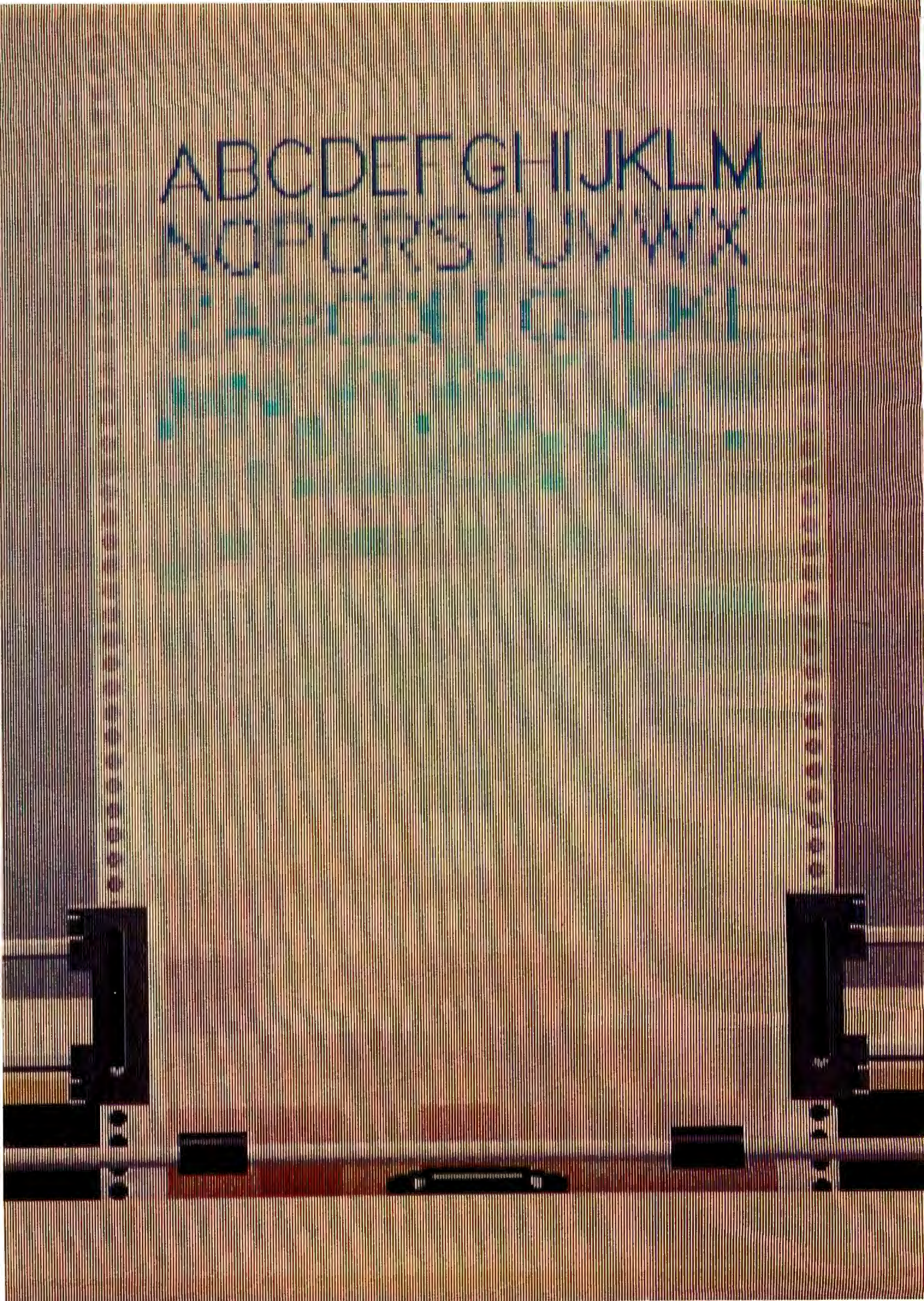
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Kernel

PROBLEMS WITH HIS COMPUTERS, a large number of deadlines to meet, and traveling to COMDEX and Europe caused Jerry Pournelle to have an especially chaotic month. Jerry, alas, didn't make all his deadlines. The basic reason for this is that his computers let him down. The Golem was away being fixed, Big Kat had a bad chip on the controller board, and Zebediah had communication problems. All this forced Jerry to be resourceful in finding ways to get his writing done. He did some of it working in the pressroom at COMDEX. Jerry describes this process, says more about WordPerfect, and mentions what he found of interest at COMDEX.

Ezra Shapiro's Applications Only column is slightly different this month. While he does look at a couple of new products—Ragtime and Write Now—Ezra also includes two sections of true confessions. Don't worry, this won't be anything like the *National Enquirer*. Ezra's confessions deal with the products, both software and hardware, he uses regularly. Since personal work habits affect program evaluations far more than writers usually care to admit, Ezra hopes that if readers know what he likes, they'll have a better chance of determining how his preferences match up with their own.

Abraham Lincoln once wrote, "I claim not to have controlled events, but confess plainly that events have controlled me." It seems that for most of us this often turns out to be true. Yet taking control is something we are constantly seeking to do. Dick Pountain considers the theme of control in another sense. He has recently been playing with three systems that let a microcomputer control events in the real world: the Scorpion controller from Micro-Robotics Ltd., a robot arm called RTX from Universal Machine Intelligence Ltd., and a FORTH development system called Martello from British Telecom. What's important to Dick as a software person is that all three use a high-level language to achieve their control.

As can be gleaned from the title of According to Webster, most of Bruce's column is devoted to the Amiga. While he was at the Developers Conference, Bruce met representatives of many companies that are developing products for the Amiga. He was able to take home and test two such products: the StarBoard II, a memory-expansion box from MicroBotics, and Marauder II, a disk backup program from Discovery Software International. Two other products Bruce saw at DevCon were ProWrite, an Amiga word processor, and DigiView, which lets you hook up a television camera to your Amiga and produce hold-and-modify images. Bruce also reviews four books for the Amiga and discusses his COMDEX trip.

The Curse of Chaos Manor

Jerry Pournelle

With Golem gone, Big Kat down, and Zeb not talking, what's a man to do?

This month has been hectic. It started with deadlines: I've got rather far behind on noncomputer works lately, and this month they all caught up with me. By month's end I was supposed to turn in an anthology; a novel; *Strategy of Technology*; this column and two others; an article for *Reason* magazine about the imbecilic decisions the United States Department of Commerce made in setting up a U.S.-sponsored cartel in computer memory chips; and the usual administrative stuff, including keeping up with my BIX conferences and going over the copy-edited manuscript for *The Legacy of Heorot*, which will come out next summer from Simon and Schuster.

If that weren't enough, COMDEX was on during the second week of the month, and I had to go to France and England the day after I got back from COMDEX.

I didn't make all my deadlines. I might have, if my computers hadn't let me down.

Golem Problems

Actually, only one machine failed; but three aren't working.

First there's the Golem, my big CompuPro 286/Z80. Last month we took him up to Viasyn's CompuPro headquarters in Hayward, where they did a full retrofit. When it came time to test it, the hard disk wasn't within spec.

CompuPro tests stuff thoroughly. I've been in their burn-in room: it's an insulated room full of components being exercised. I don't know the exact temperature in there, but it's above 100° Fahrenheit. They also test disk drives with voltages plus and minus 10 percent of rating (they guarantee plus or minus 5 percent), and mine had intermittent read errors under heat and high voltage, so Dr. Godbout decided to replace it with a drive system they're thinking of incorporating into the new CompuPro line. (One reason they're so nice to me is that I'm a guinea pig for new stuff: I *use* equipment here, and if it's going to break down, I'll probably manage to do it eventually.)

Meanwhile, I'd had to pay the bills. This is a big deal around Chaos Manor as my life is pretty complex. I've evolved a ritual. As bills come in, they go into an alphabetized folder. Come the end of the month, I make a big pitcher of vermouth cassis and seltzer, fire up the Golem, and bring up the accounting program I wrote back in 1978.

There's a story that goes with that.

I get a *lot* of computer programs. I don't suppose there is one major program out there that I don't have. Not one of them seems suitable for keeping track of my life. It isn't that the money manager programs can't balance my checkbook and watch out for my bank accounts: it's that they're so darned hard to get the data into. When I wrote my accounting system program, I set it up to take as large a chart of accounts as I would want (currently about 300 ledger pages); to know the difference between "family" expenditures that are not deductible and business expenditures that are; and to have the simplest possible entry interface. The result is a journal that looks a lot like the old accounting journals you see illustrated in textbooks. Each entry has a "To" showing where the money went; a ledger page entry representing the account (checking, savings, American Express, Bankamericard, etc.) from which the money was paid; a page number to show what kind of expense (entertainment, supplies, travel, family accounts, etc.); and an "explanation" intended largely to show a tax examiner why this was a legitimate expense (if it was a business expense).

Better than that, every month the program offers me the opportunity to write checks to everyone I ever write checks to. If I hit Return, it keeps the amount I paid last month; otherwise, I can fill in a new amount. When I'm done the program writes those checks with the current date, unless I've entered an amount of 0, in which case it skips that check. The whole thing saves no end of time, since I enter that data once and once only. While I'm at it, I go through the monthly credit card entries and put them in the journal. Then I list the deposits and the checks we wrote by hand during the month; and if I've been on trips or otherwise spent deductible cash, I get that in. The procedure takes about four hours, but when I'm done I'm finished with it, after which the computer makes up ledgers, balances the accounts, and in general digests the data; and I won't have to fool with it again until the end of the year when I do my taxes, and in fact I don't have to do much then.

I've never seen a commercial program that could do all that, so I stick with mine. (Incidentally, mine is available for CP/M or PC-DOS from Workman and Associates. The program works, but the documents aren't very good. I didn't write the program for other people, and I didn't put in enough examples when I tried to explain it.)

There was one problem with paying the bills: I normally use that program with the Golem, and the Golem was in Hayward.

Time to fall back on something else. The obvious course would be to use a PC version, but the problem there is I keep my accounts on 8-inch disks (I trust 8-inch disks a *lot* more than I trust 5¼-inch disks), and I have no PCompatible that knows how to read 8-inch disks. The only 8-inch drives are on the Golem and on Zeke, the ancient CompuPro Z80 I use to write most of my books.

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.

What the heck, I thought, when I wrote that program Zeke was the only computer I had. He'll run it fine.

He did, too. Of course, he's much slower than the Golem, but I ran everything off Zeke's CompuPro M-Drive/H (RAM disk cards: if you're trying to live with a CP/M system you'd *better* have a RAM disk; my CompuPro M-Drive/H cards have given trouble-free service for seven years now). Since the slowest part of my program is disk access, speed wasn't a real problem.

Memory was a problem: the CompuPro 286/Z80 system under Concurrent CP/M has much more available working memory than a normal CP/M system; and I had redimensioned the arrays in my accounting program to take advantage of that. Naturally I forgot that, put in too many entries, and got an "Out of memory" error. Fortunately I save early and often so I didn't lose much work, and all I had to do was break things into smaller chunks.

Came time to print the checks.

That presented a problem: the checks are on a tractor feed, and thus can be printed only with my NEC Spinwriter.

There was a time when my regular printer was the NEC Spinwriter 7710. That printer still works, but the HP LaserJet Plus is so much faster and nicer that it does all the upstairs printing work. (The downstairs printing is done with the BDS Model 630/8 laser printer, which has become permanently attached to Mrs. Pournelle's machines.) In particular, Zeke talks to the HP LaserJet at 9600 baud, and what he expects to see at the end of that line isn't really the HP: it's Applied Creative Technology's Printer Optimizer. The Optimizer can talk to the Spinwriter, of course; I've had it long enough that at one time that's exactly what it did. The Optimizer is a smart box full of memory that catches what the computer sends and feeds it off to the printer at the printer's speed. Sure it could talk to the NEC. Time to dig out the documents. Naturally I couldn't find them for a while.

About an hour later, though, the first crisis was over. My checks were printed, and my accounts were safely stored on two different 8-inch disks.

Next

The next problem was that the Golem arrived and had been damaged in shipping. He had to go back to Hayward. Sigh. That meant that anything I wrote this month to go out on a modem would have to be written on Big Kat, the Kaypro 286i PC AT work-alike; which means using WordPerfect.

That's no tragedy: I am not only getting used to WordPerfect, I have to confess I am beginning to *like* it. Many of the problems I had with the program turn out to be misunderstandings. I don't blame myself: WordPerfect's documents are confusing, or at least they are to me; but in fact I find the program relatively easy to use, which is to say some of the time it's nearly invisible. I still have trouble remembering how to do certain things, and I cannot find a command to cause the damn thing to jump to the *beginning* of a line (it does skip to end of line fine); but compared to Microsoft Word this is a wonderful program.

I suppose I'd better explain that.

My problem with Microsoft Word is that, being a touch-typist, I do not like to have to take my hands off the keyboard. Microsoft Word, on the other hand, assumes you'll use the mouse for nearly everything. Worse, it lacks a great many keystroke commands. For example, to delete something larger than a single character, you mark the word, line, or block you want to delete, then kill it. I hate that; WordPerfect has a way to delete words so that I can suck the rest of a line, or paragraph, down a black hole if I like.

continued

First new 1/4 inch cartridge since 1971

Cartrex introduces the first, brand-new, 1/4-inch tape cartridge technology in over 15 years for some fundamental technical reasons. . .

. . .and today's tape drive need for 400% increase in tape speed, 500% increase in track density, 1000% increase in bit densities, and 3000% increase in bits/second, are just a few. Read on to get the complete story.

Why a new cartridge

With the significant increases in tape drive capacity, system reliability demands a tighter tolerance cartridge. Most tape drive users aren't aware that all of the tensioning, tolerance, and data reliability issues are virtually all a function of the tape cartridge.

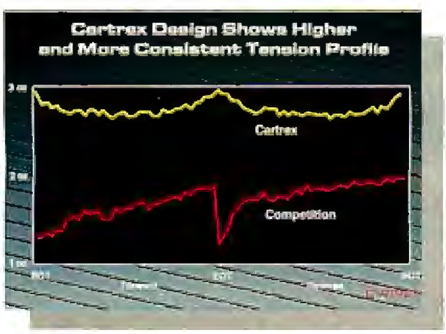
When 3M announced its cartridge in 1971, it was designed for a low capacity tape drive with less than 3 megabytes—2.88 to be exact. The tape was low in density—1600 bits per inch with only 4 tracks and 300 feet of tape.

The tolerances required for the tape drives of the early 1970's were fine for then, but today's tape drives require much tighter tolerance. Today's tape cartridges must work with drives that have 9 or more tracks and bit densities as high as 12,000 bits per inch on 600 feet of tape. That means capacity increases of 2,000 percent packed into the same cartridge.

The reasons that yesterday's cartridge technology simply won't work properly in today's high capacity drives is inherent in the cartridge design. The three culprits that make cartridge tolerances so important are fluctuating tape tension, redeposit nodules, and instantaneous speed variations (or ISV).

Tape Tension

Tape tension at the read-write head is important because the tape drive's electronics expect data to arrive at a constant rate. Consistent tape tension is a function of the cartridge tensioning mechanism. The new Cartrex cartridge tensioning design, based on a mechanical differential between two stiff belts, provides very predictable results. The historic 3M design—used by 3M and DEI—uses an elastic belt coupled with drag friction at the rear pulley to create tension. The accompanying graph shows the significant improvement the Cartrex cartridge design offers over the conventional design.



The Cartrex cartridge provides predictable and stable tension. Compare it to the tension variation of the conventional cartridge design. The consistent Cartrex tension virtually eliminates data errors and data loss from head-to-tape separation and redeposit nodules that can occur with fluctuating, low-to-high tension performance.

The new Cartrex 1/4-inch tape cartridge is the first new tape cartridge design in almost a decade and a half. Tape drive manufacturers now have a new cartridge technology which allows them to advance today's and tomorrow's drive performance.

Redeposit Nodules

Redeposit nodules are the insidious flakes of tape media that break off from the edges of the tape and get dragged to the edge of the read-write head. If the tension is low, or becomes low when the tape starts or reverses, the flakes slide past the edge, get smeared across the head, and reduce its ability to read data.

The free play in the two tape reels combined with the tape guides are the primary culprits in creating these redeposit nodules. As the tape enters the guide from the tape pack, the tape guide aligns the tape by balancing the tension at the edges of the tape. Uneven edge tension not only causes media to flake off causing redeposit nodules, but data is lost due to the "coining" or "scalloping" effect.

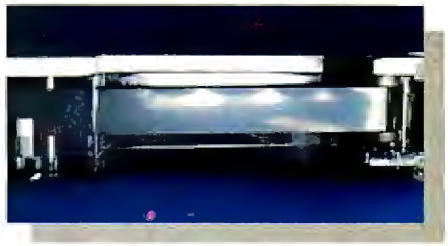
Cartrex eliminated the cause of the tape coining or scalloping with a barrel-shaped roller placed in front of the tape guide. The roller positions the tape and drops the edge tension to zero. By using this roller, the possibility of media flaking off and creating redeposit nodules is virtually eliminated.

Instantaneous Speed Variation (ISV)

Instantaneous speed variation is exactly what it sounds like—small, instantaneous changes in tape speed as it crosses the tape head. At slow tape speeds and low bit densities—like the 1971 standard of 30 inches per second and 1,600 bits per inch—ISV wasn't as big a problem. At that time, the bits were crossing the head at 48,000 bits per second.

Today, however, the story has changed. Ninety inches per second and 8,000 bits per inch mean that 720,000 bits cross the head every second. A 1,500% increase. As you may have guessed, 1971 speed fluctuations in the 48,000 bits per second range made reading data difficult for tape drive electronics. But today, when the electronics have to guess whether or not the bit rate of 720,000 bits per second is accurate, the electronics can become overwhelmed.

The Cartrex tensioning mechanism relieves the overload placed on the electronics with respect to ISV. The longitudinally stiff belts ensure tension at all times. The stiff belt overpowers variations that exist with the 3M elastic belt cartridges. The barrel roller guides, in addition to reducing the edge pressure to zero, tend to dampen out any residual ISV effects.



High speed tape seldom enters tape guides parallel to the top and bottom, even with improvements to the tape reel hub designs. The edge pressures which result create "scalloping" or "coining" on the tape. The effect is data loss due to head-to-tape separation, flaking media that smears across the head, and "redeposit nodules" that create hard errors.

Never a Single Issue

Your tape drive seldom has the luxury of dealing with an isolated problem. It's usually a combination of ISV, redeposit nodules, and tension problems all together. Now you understand why Cartrex developed a modern cartridge alternative.

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That alone is worth using WordPerfect rather than Microsoft Word, because when I write I fuss with the words a *lot*. I put up sentences, fool with them, erase them, stuff in more words, kill them, and generally scribble all over the screen until it reads the way I want it to; which means I want real simple ways of killing chunks of text. WordPerfect isn't as good as WRITE that way, but it's darned good.

Rating text editors is an impossible task anyway. One person's love is another's hate. The important thing is to find one you like and learn it well. I know people who still write whole books on WordStar—not even NewWord—and I find that incredible. Ah, well.

Anyway, without the Golem I cannot transfer anything from Zeke to Big Kat, and Big Kat has the communications systems.

At that point Big Kat died.

Well, not really: what happened is that suddenly he got an "unexpected interrupt" and on reset he was unable to find his floppy disks. When I try to access a floppy, the head loads, the light comes on, the disk spins—and nothing at all happens, until eventually the system times out. Clearly there's a bad chip on the controller board. It's also clear that I can probably *replace* that board for less than it will cost me to have someone repair it. Alas, I've been sufficiently harried that I haven't had a chance to do that yet. Real Soon Now. Meanwhile, Big Kat's hard disk works fine. Of course, the only way I can back anything up is to send it out the modem and store it on BIX.

And the Next Problem...

Of course, without floppy disks I wasn't going to test much software this month; but that's all right, because in addition to all those deadlines, due to all those trips I wasn't even *here* for most of the month.

First came COMDEX. It was fun, but there was one problem. I had a deadline that fell in the middle of COMDEX. Not only that, I'd have to send the material to the publisher by modem.

I could have done my writing on the NEC PC-8201. I have a nice 300/1200 modem for it, the TravelComm 1200, and I've been able to use it to connect to BIX and MCI Mail. Unfortunately, it's a little tricky to use—the PC-8201 apparently wants to hear that carrier *very* quickly after it has dialed the number, and sometimes I have problems with that. I could manage, but I wasn't sure I'd be able to get to a phone with a modular connector jack (the one in my hotel didn't have one), and even if I did, I wasn't sure I could manage the tricky protocols the publisher's communications system wanted.

What I'd intended to do was take Zebediah the Zenith Z-181 portable to Las Vegas, do my writing on that, and use Crosstalk to send it in. That's the way I do it here; I'd just take the Crosstalk script with me, and there'd be no problem.

Alas, Zenith is shipping Z-181 portables as fast as they can make them. I got a very early one—and it came with no modem in it. Zenith wasn't able to get me a modem in time. Scratch that idea.

On the other hand, the pressroom was full of Zenith computers, Z-141s I believe, and most of them had modems. By now I was sort of determined to work with a full-screen editor anyway. The PC-8201 is very nice, and with Traveling Software's Ultimate ROM II it can show me 60-character lines; but while eight lines of 60 characters is fine for notes and first drafts, it's a bit small for serious work.

A Matter of Protocol

I confess I had another motive for writing in the pressroom. I wanted to see if I could

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I've heard that WordStar 4.0 will be NewWord with some additional features.

do it. My friend Harlan Ellison often writes short stories in bookstore windows and other public places; some say he needs the additional motivation, but I think that's a cruel canard. Anyway, he does that.

I don't work that way. Generally when I'm writing, I jump halfway to the ceiling when someone comes into the room; there aren't many people I let stand within 30 feet of me while I work. However, years ago—back in the Dark Ages when I had to use a typewriter—I was sometimes able to write short pieces from the pressroom at meetings of the American Association for the Advancement of Science. Anyway, it seemed an amusing experiment.

It worked, too. There were drawbacks. The main one was WordStar. For reasons I don't recall, the only editor that would work on the machine I had to use was WordStar. I had forgotten just how much I dislike that program. The last time I used something like WordStar, I was really using NewWord.

Incidentally, I ran into Charlie Stevenson, chief programmer for MicroPro, and asked him if they were going to replace WordStar with NewWord now that MicroPro has bought out NewWord. Charlie said, "I'm not allowed to talk about NewWord." I've heard from other sources, though, that WordStar 4.0 will be NewWord with some additional features.

Moreover, I found after an hour that I don't really *hate* WordStar. It's old-fashioned, lacks features we now expect, and it's too slow; but it does get the job done. Beats heck out of a typewriter, the help screens are there when you need them (and can be suppressed when you don't want them), and despite the frustrations I can turn out text with the program.

Oddly enough that happened to me once before: about 1980 when I was part of a NASA study group out in the middle of nowhere, and when it came time to write I had a choice of WordStar on a Zenith, a Selectric typewriter, or a ballpoint pen. I chose WordStar happily enough and got more written than the next two people in the study.

All of which confirms one of Pournelle's rules: WordStar is almost no one's favorite program, but it's nearly everyone's second choice. You have to know it for self-defense, because if you're in a strange situation, chances are the text editor you'll be offered will be WordStar.

Modern Communications

Anyway, I got my writing done. Next problem was to send it to the publisher. *That* turned out to be the real bear for the day.

First, credit where credit is due: I would still be there in that pressroom trying to send my material if not for David E. Coursey, who writes for *Texas Computer Market* and *MISWeek*. There was some kind of communications software on the machines furnished us in the pressroom, but no documents, and I wasn't able to make heads or tails of it. My first attempts to send the material ended in utter failure.

I then found a copy of Crosstalk and tried that; but I clearly did something wrong, because that didn't work either. I've no notion why.

Dave Coursey, bless him, had been watching from the next machine and rather bemusedly offered to help.

He had brought his own communications program, called Relay, which is published by VM Personal Computing. It worked, and it looks easy enough to use.

Looks it, but the fact is that even with Dave's help it took about an hour to send in my material. First we had to set up all the parameters. Then we sent it, and I called to have the publisher look at it. They had garbage.

"Of course," Dave Coursey and I realized at the same time. "We sent a WordStar file." WordStar does nasty things to text, including setting high bits and putting lots of control characters into the text stream. Clearly we needed to change that.

There followed about 10 minutes of trying to figure out how to make WordStar read in a document in WordStar format, then write it back out in nondocument format. That was futile. WordStar, as it happens, can't *do* that.

"Print to disk," someone suggested. "Make it print out to disk. That will strip out all the weird characters."

That sounded like a good idea, and we tried it. I forget whether it wrote garbage or didn't work at all, but in any event we weren't able to make it work.

"At home I have a filter program," I said. "Hmm." We looked at the disk directory. There was a program called CONVERT.COM. In desperation we tried that, and it worked fine, converting my WordStar file to an ASCII file. After that Dave was able to get Relay to send my material in. It had taken only about 15 minutes longer to send it than it did to write it. Oh, well.

I know one thing. In future I'm going to take a full system: computer, text editor,

continued

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modem, and communications software; and for a backup I'll take my own copies of editing and communications software I've *used* and *tested*.

The Curse Continues

The simplest solution to that problem would be to set up the Z-181. After all, I'm writing *this* column with WordPerfect, and the Z-181 has a highly visible screen with 25 lines of 80 characters; there shouldn't be any problems. Unlike WordStar, WordPerfect has a very simple way to save your files in ASCII format, ready for sending out over any reasonable modem.

I'm sure, too, that's what I'll eventually do; but just now I can't.

Now that COMDEX is over, I have the modem for the Zenith Z-181. It's made by OmniTel. I have been using an OmniTel internal modem in the Kaypro 286i for nearly two years now with no problems; indeed, with few exceptions every column I've filed in the last year has gone out over the OmniTel. Meanwhile, my son Alex has an OmniTel external modem; it had some kind of glitch, but it was under warranty and they fixed it within a couple of days. He runs his bulletin board from it. In other words, we're very happy with OmniTel communications hardware, so that's no problem.

Alas, I got the modem directly from OmniTel, and somehow the hardware, documents, and software got separated. Installing the modem is no problem: you remove three screws from the Z-181, and the little cover plate comes off. The OmniTel modem will only go in one way and slides in fine. It's held in by two small machine screws. Put the Zenith cover plate back on, and all is fine.

Unfortunately, I can't test the modem since I have no software.

At this point someone is sure to remember that the Z-181 is fully PCompatible and ask, "Why not transfer some software from one of the IBM PC machines to the Zenith? Surely there is a way?"

And indeed there is. The Zenith came with two copies of a program called PCXFER, one copy on 3½-inch disks for the Z-181, and one copy on 5¼-inch disks for the PC. All it takes is a "null modem" cable, and I have those.

What I haven't done is put the doggone PCXFER program onto the Kaypro 286i, and, you'll recall, Big Kat is just now without floppy disks. As for other PCompatible systems, Zenith is supposed to have got me the Z-248 AT clone, which I was going to use to supplement—possibly eventually replace—Big Kat, and Tandy has promised a Tandy 3000 ma-

continued

chine for the same purpose; but both of those are coming Real Soon Now. The AT&T PC 6300 Plus sits out there with a single floppy disk drive and a hard disk so full of UNIX stuff there's no room for any PC software. So I'm stuck with Big Kat and no floppies.

I suppose I could use the AT&T machine, or even go downstairs and fire up Lucy Van Pelt, our absolutely genuine very early issue fussbudget IBM PC, and use PCXFER on one of those; but frankly I'm disgusted. Besides, tomorrow I'm supposed to go hole up where no one can find me to finish the third volume of the *Janissaries* series (this one will be entitled *Storms of Victory*), and if I take a working modem system with me, I'll be tempted to log on to BIX, which will defeat a good part of the reason for hiding.

I make no doubt all will resolve itself. Meanwhile, I keep feeling as if I were sailing under a curse.

WordPerfect Isn't

If that weren't enough problems, I discover that WordPerfect is designed to drive me nuts after all. The search-and-replace function doesn't quite work.

When you italicize a word in WordPerfect, you push the F8 function key. The word changes color on a color screen and presumably does something else on a monochrome monitor. When you're done with what you want to italicize, you push F8 again. So far, so good. Since WordPerfect is a "what you see is what you get" editor, you do not see any control codes or anything inserted in the text. However, WordPerfect (WP in future) has a "reveal codes" command that will let you see what it has done, and it shows that it has apparently inserted the text string [U] just before the italicized words and [u] after them. Great. But if you search for [U] with the search command, it says there are none.

This is a problem because if you save your WP file as ASCII text—and you have to if you want to send it over a modem—then it strips out all those codes, which means that all my carefully inserted italicized words come out just like any others. I had wanted to replace the [U] business with the underbar character (which is what WRITE does). The people at BYTE have always been able to interpret that properly.

But if WP can't *find* its own control characters, then what in the world am I to do? I'll have to go through and change every one of those by hand; not something I'm particularly fond of doing. Time to putter around . . .

Later. Indeed, it's worse than I thought. If you punch the F8 key when you go to do a search and replace, it will indeed find the italics marker—but it replaces *only* the *leading* [U] nonsense with the underbar and throws the trailing [u] away. And apparently there is no way to do anything about that, meaning that I will indeed have to replace all the control characters by hand. Wonderful.

For all that, WP is still the editor I'm using and will probably keep on using; but I confess it would be nice to find one that was a little more straightforward.

Flash: you can do it with macros. More next month, but I do like WordPerfect.

COMDEX and the 386

COMDEX was interesting. I liked the mood: the computer industry seems to have got out of the doldrums. On the other hand, there wasn't much very new there. Most were announcements of things that will be out Real Soon Now.

There were a mess of 80386 machines, but again most were prototypes. Until IBM tells the world what the 386 operating system is going to be, 386 machines aren't a lot more than fast single-user PCs anyway.

continued

The most interesting 386s were the new Zenith and a new machine from PC's Limited. Both these machines have something in common, a resident monitor in ROM.

Now all computers have a subprogram called a monitor. What that does is look at all the input and output and decide what to do with it. For most machines this program is totally invisible. However, back in the early days of small computers, it was common to have an accessible monitor that could take control of the machine and allow you to conduct various system tests, look at and change memory locations, send data out ports, and generally do by hand anything a program can do. The original Zeke I, my friend who happened to be a Z80, had a program called XMON that was the envy of all my other friends, because whenever my system crashed—and in those days systems crashed a *lot*—I could get in there and fix things, or at least see what was going on.

As micros got more reliable, and aimed more at the general public than at people willing to spend time understanding their equipment, the monitor program got buried deeper and deeper into the operating system, and in most machines it vanished from the user's view. Zenith, however, has always retained the monitor program, and while it's usually invisible, you can still get access to it if you think you need to. I've described in a previous column how I managed to fix a temporary glitch in the Z-181 by using the monitor program to boot the machine off the B drive.

Small machines also used to have what was called a "front panel," which was a hardware look into what the machine was doing. In the movies all computers have front panels, because front panels have, among other things, flashing lights.

PC's Limited has brought back not only the user-accessible monitor, but also flashing lights: they have a small LED display that tells things about the status of the machine, and which can be used as an aid to diagnostics.

Their machines are also *fast*. I was much impressed with PC's Limited at the Atlanta COMDEX; I was more so this time. As it happens I met the company's president at the "real" Pournelle/Dvorak party (which was hidden so well I almost didn't find it; and still more than 150 people showed up!). They've arranged for me to get one of their systems. I don't write much about stuff that's not running here in Chaos Manor, but I confess some anticipation.

In addition to their computers, they have a complete line of PC add-on products. Again, I've not tested any of their stuff; but I was highly impressed with what I saw at COMDEX, and I keep hearing good things about the company.

Virtual?

One of the most interesting interviews I managed at COMDEX was with Ken Williams, vice president of R&D for Softguard.

Softguard is a weird company. They make most of their revenue from copy-protection software. Since I hate copy protection, and they know it, I wondered if I were walking into the lion's den when I went up to their suite in the Bally Grand Hotel; but when I got there I found that all their programmers, including Williams, hate copy protection about as much as I do. "It's going to be done," Williams said, "and our schemes are more harmless than most, and it makes us enough money that we can work on things we like to work on."

What they like working on is VM386, which is a virtual operating system for the 386 chip.

When I first heard about VM386, I didn't quite understand. That, as it turns

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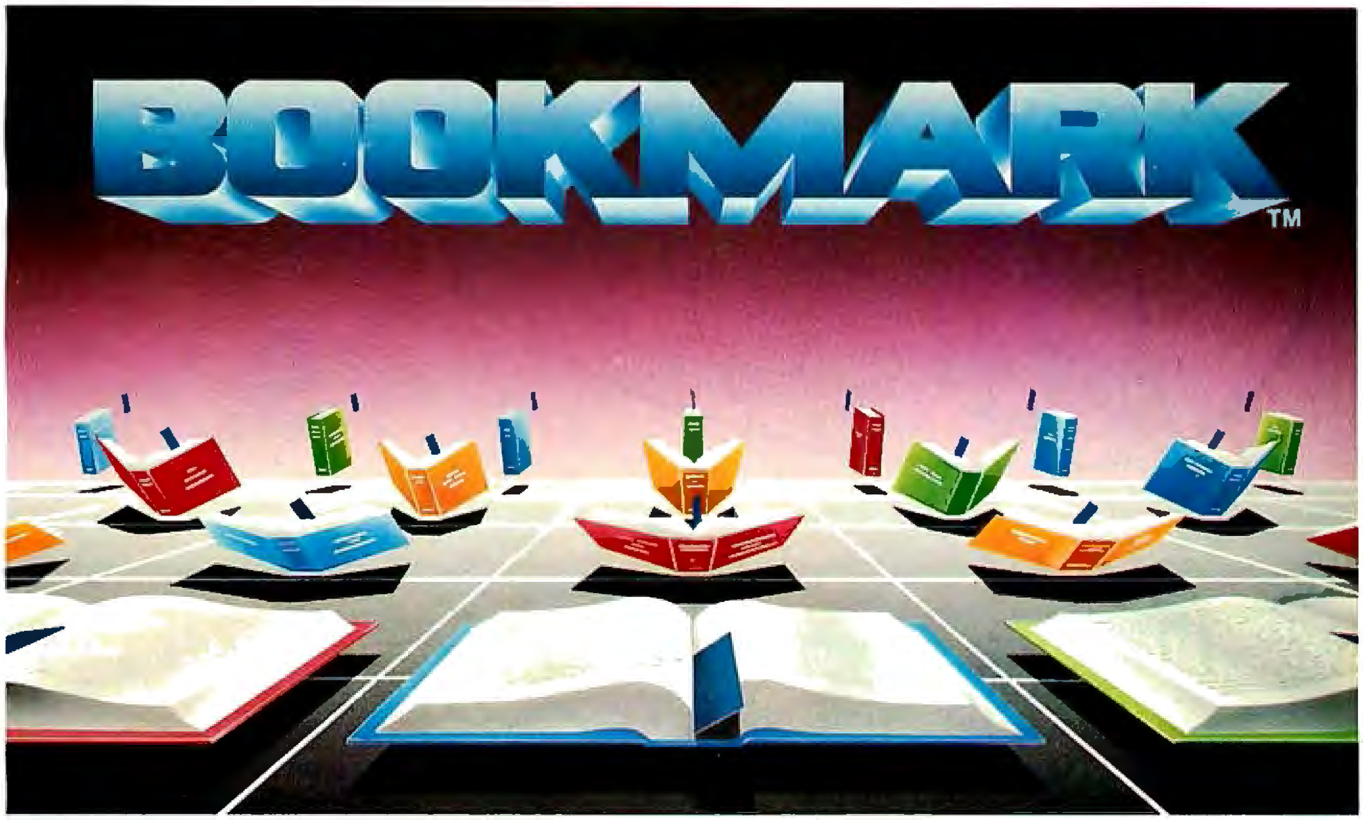

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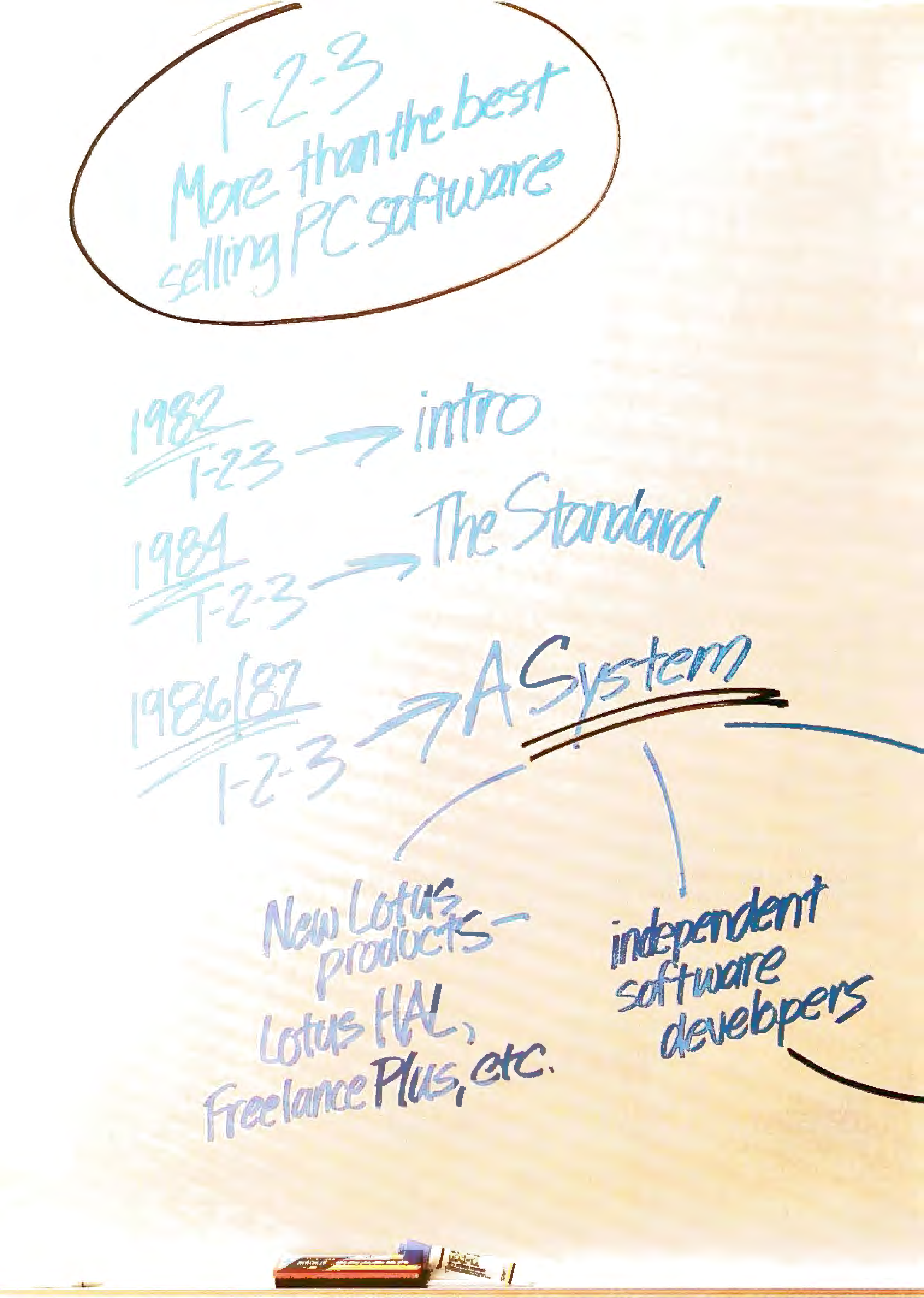
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out, isn't unusual, since not many others did either. After two hours with Ken Williams, I still don't know all I should, but I know more than I did.

First, not all PC-compatible programs can run under a virtual operating system (VOS). Many can. The advantage of a VOS is that it not only allows your 386 to run just about all the commercial software available for PCs and ATs, but it will run several of those programs at the same time, which is to say allow them to be truly concurrent.

We don't have that now. We have terminate-and-stay-resident (TSR) programs like SideKick and SuperKey and Ready!, which sit up in high memory. A sort of primitive monitor program (the kind of program we used to call a demon) watches for a special keystroke such as Alt-/ every time you strike a key. (This slows your machine down a bit, but not enough that anyone will ever notice.) When the demon sees that special keystroke, it takes over your machine. The demon saves off all registers and the stack and anything else he needs in order to put the machine exactly back the way it was when you pressed that key, then calls for his big brother the TSR program. This happens so fast you hardly notice. You then use SideKick or Ready!, and when you're done you exit; the TSR program calls the little demon, and he puts the machine back the way it was when you started.

Note, though, that you haven't really run two programs at once. If you had a fast enough machine, you could have accomplished the same result by saving whatever you were working on and loading in a new program.

Truly concurrent systems work differently. You could, for example, have a big spreadsheet that takes 10 minutes to recalculate (given the speed of a 386 that's going to be a *big* program, but what the heck). You can leave that running, go out to the virtual operating system, and call up a brand-new DOS; and under that you can load in another Lotus 1-2-3, or a word processor, or even Flight Simulator.

More than that: you could, under the VOS, call in an entirely different *kind* of operating system, such as Pick, or UNIX, or even the kind of thing Niklaus Wirth designed for Lilith, assuming that anyone can get the Modula operating system going on an 80386. You could even have all of them running at once, and each would have the full resources of the entire system. Actually, of course, each OS only *thinks* it has the system's full resources; but through the magic of swapping things in and out of both hard and RAM disk, the program never knows that it's sharing resources with something else.

That's the good news.

The bad news is that not all existing programs are "virtualizable," and existing virtual operating systems can't do much about the dreaded 640K-byte memory boundary that plagues us. Serious copy-protection schemes (Softguard says "We

continued

have some knowledge of that phenomenon") can drive a VOS mad. There are other limits.

The bottom line, though, is that a good VOS can make a multitasking system out of any PC retrofitted with a 386 board; Orchid, Paradise, Intel, and a bunch of others are already selling 386 boards for ATs and compatibles.

Softguard expects to be shipping developer kits well before you read this. Hackers should find them interesting. The Softguard people mostly come from a mainframe tradition. They see a lot of "truly heroic code" out in the mainframe world that almost no one in the micro world is even aware of; and they're trying to bring some of that to the 386.

Me, I wish them well.

Winding Down

I'm about out of space and I haven't even mentioned the trip to France, where I spoke to executives of Sperry Networking and their guests. Sperry has recently merged with Burroughs into a company called Unisys, but it was still Sperry when I was there.

One of my fellow speakers was David Brunnen of Britain's Network Nine. This is a new venture from the denationalized British Telecom. They're doing some really spectacular things combining office rentals and communications systems.

Brunnen recalled that in the late 1960s he pulled the plug on one of the last manual switchboards in England. It was replaced by an automatic system. As he stood there behind the operator waiting for zero hour, a call came in. The operator listened for a moment and said, "Oh, it's no use ringing the vicarage, love, I'll put you through to the butcher shop." She'd just seen the vicar walk past. A few minutes later Brunnen pulled the plugs. Now, he said, 20 years later, the technology is just beginning to be able to deliver that level of service.

The book of the month is by Seymour J. Deitchman, *Military Power and the Advance of Technology* (Westview Press, 1983). A sound analysis, and I'm folding some of it into my revised *Strategy of Technology.*

The game of the month has to be Starglider for the Atari ST. Incidentally, the Atari ST was the real hit of COMDEX; their booth was jammed from the first day to the last, and some of the new software for the ST is really impressive.

I'll have more about COMDEX next time. I'm still looking for a good 15-inch color monitor that can take both EGA and CGA output. Now that both Sony and NEC have 13-inch systems that can do that (the Multiscan and MultiSynch, respectively), I don't think a big-screen multiple synchronous monitor will be too long in coming. Incidentally, RIX Softworks' EGA Paint program will knock your eyes out on the new Sony monitor.

Meanwhile, the refurbished Golem has arrived, and Tony Pietsch is coming over to install it. My anthology went out today, and this column is done. I have the Omni-Tel modem for the Z-181, and it can't be long before I have documents and software for it. The Zenith AT is coming, and for that matter I should have a new controller for Big Kat by the end of the week, and before then I should have Volume III of *Janissaries* done.

With luck the curse is ended. ■

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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Status Report

Ezra Shapiro

Confession time finds Ezra telling which products he uses regularly

When I began writing Applications Only a year ago, I promised to be honest about my prejudices. I think it's important for a reader to know what software a reviewer uses on a day-to-day basis; personal work habits affect program evaluations far more than writers usually care to admit. I'm hoping that if you know what I like, you'll have a better chance of determining how my preferences match up with yours. So I've stuck two sections of true confessions to the end of this column.

But first, a couple of new products.

Rags or Riches?

I have mixed feelings about **Ragtime** (Orange Micro, $395) for the Mac, a novel blend of spreadsheet, word processor, and page layout program. I like the program a lot, but it has some holes I find disturbing. Because it allows you to combine active spreadsheet and text sections anywhere on a page, Ragtime is extremely good at forms design. But like most other integrated software packages I've tried, Ragtime's parts start looking shabby when you compare them to equivalent standalones. I don't mean to suggest that Ragtime isn't pretty amazing—it is—but it lacks a few features that would make it much better at what it's supposed to do, which is a shame.

The central element of the package is the page layout module, and it's here that Ragtime really shines. You create "frames" on a page by dragging the mouse, as you would to construct a hollow rectangle with a graphics program. Any frame can contain text, a spreadsheet, or imported MacPaint or PICT artwork. What's more, frames can be nested, so, for example, spreadsheets can live within text frames. If you're working with text, you can construct a "pipeline" between the two frames by simply drawing a connecting line. This is all very easy, and the program provides an informative status box anytime you're creating, resizing, or moving frames. Ragtime automatically numbers frames in order of creation, and you can choose to display or hide the number tags with one menu selection. Spreadsheets can reference cells in other frames using these tags.

The word processor in Ragtime is page-oriented; if you want to write something that's longer than a single page, you have to stop and create a new frame for the continuation. However, once you've linked pages, changes flow magically through the pipeline and the text reforms to fit. When you resize a frame, the speed with which Ragtime processes the change is impressive. The spreadsheet is a solid basic engine with a large selection of built-in functions (but no macros), and graphics import allows cropping and quick rescaling of images.

The components work well together, and creating business forms is easier than it has ever been. While you can't quite have spreadsheet data floating within a text paragraph—frames remain fixed until you move them—you can shrink a spreadsheet frame down to a single, naked cell. The program's potential is amazing. You can even save any document as a blank form, ready for reuse, without having to manually delete its contents.

So what's wrong?

Well, I can live without a spelling checker, and I can also live without automatic hyphenation. But how can a program that prides itself on fast text reformatting exist without any sort of soft hyphens? Any time you change the width of a frame, you've got to go in and painstakingly hyphenate, rehyphenate, or unhyphenate your text.

As to the spreadsheet, I can survive without macros and user-defined functions. But why are there no graphics? I find this omission truly bizarre; in order to construct a bar graph or pie chart, you've got to dump out your worksheet as delimited text, suck the data into another program, build the chart, save it on the clipboard, go back to Ragtime, and so on. Very strange, especially for a program that's supposed to be the business person's answer to desktop publishing. I also would have expected the spreadsheet to be capable of importing either Excel or 1-2-3 worksheets; Ragtime reads only delimited text, so you lose your formulas.

I realize the program is pushing the Mac's CPU, but scrolling is choppy and not particularly fast. You could endure it, but it's on the outside limits of acceptability. There are also some minor bugs repainting the screen, but nothing that doesn't correct itself with the next command.

The reduced view, which displays a full page in miniature, is completely live. That's great for repositioning and resizing elements, but if you happen to click the mouse inside a frame rather than along its border, you're suddenly editing the frame's contents (which you can't see)—a big mistake that can happen easily.

The documentation is thorough but not outstanding, and the on-disk tutorial shows you how to produce yet another three-column newsletter. (Are other Mac owners getting as sick of these as I am? Seems like they come with every new program.) The press kit contains a full IRS tax form, complete with boxes and teeny type. "Wow," I thought. "I bet they'll show me how I can construct a self-calculating tax package." Wrong. The only sample you get is the newsletter.

Ragtime doesn't quite make up its mind what it's trying to be. Is it an all-purpose

continued

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integrated package, a page layout program with some extra features, or a forms design product? I just can't shake the feeling that Ragtime's authors lost track of their purpose along the way.

Spelling Demon

Write Now (Airus, $150) is a great little word processor for MS-DOS machines. It isn't the world's biggest or fanciest product, but I like it. If you don't need much more power than PFS:Write, Write Now is entirely adequate and packs some nifty unusual features to boot.

First of all, you don't get multiple-column formats, footnotes and tables of contents, sophisticated typesetting, outlining, or any of the features associated with industrial-strength word processing. You do get a solid editor that can handle a simple mail merge, basic layout (like headers, footers, and page numbers), cut and paste, a choice between function key menus and WordStar-like command sequences, and all the usual editing tools.

The neat stuff is in the area of spelling. If you ask it to do so, Write Now will check words as you type, beep at you, suggest correct spellings, and even complete words for you as soon as it identifies a unique entry in its dictionary. Or you can shut off any or all of the above and simply check an entire document anytime you want. In several weeks of testing, I noticed no degradation in speed as a result of the real-time comparisons.

My only quibbles are in the area of personal taste. I'd like a bigger dictionary, and I'd like to be able to shut off the status lines that clutter the top and bottom edges of the screen, and I'd prefer a larger file size than Write Now's limit of 64K bytes. But I found the program easy to learn and use, well designed, effectively documented, and all-around nice.

Once you accept that you're not getting MultiMate or Microsoft Word, you'll love this product. It's certainly a good choice as a basic editor, a first word processor, or a convenience if you're a rotten speller. Airus, the company that produces Write Now, listens to users and provides good support. I have no qualms recommending it to anyone.

Confession Time

The question I'm asked most frequently goes something like this: "Okay, Shapiro, I read what you had to say in your column, but what do you *really* use?" It deserves an answer. Bear in mind that I'm a freelance writer, editor, and graphic designer by trade; I'm not an engineer, accountant, or programmer (though I do dabble). That means I'm a heavy user of word processors and related tools, and I use spreadsheets and databases to run a very small personal business. Like most people, I'm also a creature of habit, and I'm lazier than I like to admit.

For the past year, my primary editor under MS-DOS has been Framework, chiefly because I love the spreadsheet and the windowing interface. When I have a complex project that requires fancy formatting, I confess I haul out good old WordStar 3.3, though heaven help me if I need footnotes. I've never been able to crash WordStar, and I learned to use it before anybody told me that it's difficult to master. I maintain that when the going gets tough, the tough use WordStar. I have tried, and failed, to shift my writing over to XyWrite, WordPerfect, Volkswriter 3, Microsoft Word, and PC-Write. Of the five, I'm most attracted to XyWrite; it's fast, powerful, and programmable, but I haven't had the energy to completely redefine the keyboard, which I'd want to do before making the switch. Walter Feigenson (formerly of NewStar, now of MicroPro) tells me that the new version of WordStar will ease my embarrassment over my old standby; I sure hope so.

continued

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Item #9501 $24.95 New
Composite Video Monitors
12" Monitor (Controls front panel mounted)
12", green phosphor, high resolution (12 lines center) and bandwidth (from 10Hz to 30Hz ± 3dB. Op. volt.: 120/240VAC, 50/60Hz., 65VA max. Controls front panel mtd. Mfr – Motorola – Alpha Series
Item #10043 $29.95 New
15" Monitor
15" screen. Same specs as above.
Item #10044 $34.95 New
PUMPS – COMPRESSORS – BLOWERS – MOTORS – POTENTIOMETERS – COUNTERS TIMERS – RELAYS – VOLTAGE REGULATORS – POWER SUPPLIES
3¼" DISK DRIVE EXPANSION MODULES...
IBM PC Jr.
Side-by-side mounting (PC Jr. mounts on top). With floppy disk drive controller board. Contains: 2 Tabor TC-500 3¼" disk drives. Total capacity 360K. Item #8825
~~$199.00~~ $99.00 New
APPLE
Side-by-side mtg. with disk storage space in front. Floppy disk controller board capable of handling 4 disk drives. Contains: 2 Tabor TC-500 3¼" disk drives. Total cap. 360K. Item #8826
~~$199.00~~ $99.00 New
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Stacked mounting, replaces old-fashioned 5¼" disk drives. Contains: 2 Tabor TC-500 3¼" disk drives. Total capacity 360K. Plugs right into your controller. Item #8827
~~$169.00~~ $99.00 New
Each unit supplied with two 3¼" flexible diskettes.
IBM® COMPATIBLE 3¼" DISK DRIVE
Tabor TC-500 drivette. Single-sided, quad density. Capacity: 164K bytes. Will work with any 5¼" disk controller.
Item #8824 ~~$79.95~~ $49.95 New
*Total cap. 500K bytes with special software.
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For all phone orders, call TOLL-FREE 800-524-0809. In New Jersey, 201-939-2710.

I use Instant Recall (the pop-up free-form text database) constantly; it has replaced Borland's Reflex as my database of choice, though I still use Reflex when I have to accomplish structured analytical tasks. I load Ready! every time I need to generate an outline, and I run SideKick only when I need an ASCII table. I've become addicted to Cruise Control for precision cursor control; every time I remove it to test another terminate-and-stay-resident program, I find myself missing it. For telecommunications, I use Mirror because it can transfer in the background and because I'm familiar with the Crosstalk interface. If I had to construct heavy-duty spreadsheets and databases, I'd use VP-Planner and Paradox.

Over on the Macintosh, I began using Microsoft's Works as an interim solution while waiting for final copies of Word 3.0 and Excel 1.03, and I've been surprised at how much time I'm spending with it. I gnash my teeth at its many limitations (for example, who ever heard of a database without a "logical flag" field type?); but I use it for just about everything, though I expect to move my writing to Word 3.0 when it gets here. I use More when I'm developing anything for which outlining is appropriate. For telecommunications, I find Works barely adequate (no macros, but I can upload a document without having to convert it to ASCII text). When I'm downloading binary material, I use two simple but effective shareware packages, MockTerminal and BackDown. Both are desk accessories; MockTerminal dials and establishes contact, and BackDown is an XMODEM downloader that operates in the background, so I can keep working during the transfer. I use both SuperPaint and GraphicWorks, and my current love is Fontographer, a typeface design program from Altsys.

I'm not yet as firmly entrenched on the Mac as I'd like to be, so I'm still not ready to vote in several categories. Reflex for the Macintosh and Omnis 3 are battling it out in the database management arena, and PageMaker and Ready,Set,Go! 3 are running neck and neck for layout. I've also been toying with building my invoicing system into Ragtime.

Please note that I'm not endorsing any of this stuff; it's merely what I use. Choosing software is a very personal process; what's right for me may not be right for you. And there are scads of excellent programs out there.

Hardware

The second most popular question I'm asked is, "What equipment do you recommend?" That one's a toughie because I'm a consumer with a limited budget just like anybody else. So I can't make any official comparisons, but here's a rundown of what I own.

I've got an "ancient" Compaq portable equipped with a loaded AST Six-Pak Plus, an NEC V20 CPU, an 8087-2, and a Fast88. (I've received a lot of mail since I mentioned the Fast88 in my column last October. It's a miniboard that gives me a clock speed of 4.77 or 8 megahertz, switch- or software-selectable. I'm hoping it will delay the inevitable purchase of a 286 or 386 machine by a few more months. Great product.)

My hard disk is a grubby external 30-megabyte box, with a grinding drive from Tandon (sold to me as a 35-millisecond unit, but it's never run faster than 50 to 60 milliseconds). I use a Logitech C7 serial mouse. My Macintosh is a Mac Plus with a DataFrame 20 SCSI external hard drive; no problems there. My Tandy TRS-80 Model 100 has 32K bytes of RAM and an Ultimate ROM II from Traveling Software.

I own three modems, all external: a Hayes 300, a Prometheus 1200, and a U.S. Robotics Courier 2400. All have per-

continued

Items Discussed

BackDown $30
Ron Risley
P.O. Box 1724
Orange, CA 92668

Cruise Control $29.95
Revolution Software Inc.
715 Route 10 East
Randolph, NJ 07869
(201) 366-4445

Excel 1.03 .... $395
Word 3.0 (Mac) $395
Works $295
Microsoft Corporation
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
(206) 882-8080

Fast88 .... $149
MicroSpeed Inc.
5307 Randall Place
Fremont, CA 94538
(415) 490-1403

Fontographer $395
Altsys Corporation
720 Ave. F, Suite 108
Plano, TX 75074
(214) 424-4888

Framework II $695
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000

Instant Recall $69
Precept
3790 El Camino Real, Suite 173
Palo Alto, CA 94306
(415) 327-6885

Mirror $69.95
SoftKlone Distributing Corporation
1210 East Park Ave.
Tallahassee, FL 32301
(904) 878-8564

MockPackage $35
(includes MockTerminal, MockWrite, MockPrinter, MockChart, and EZ-Menu)
CE Software
801 73rd St.
Des Moines, IA 50312
(515) 224-1995

More $295
Ready! $99
Living Videotext Inc.
2432 Charleston Rd.
Mountain View, CA 94043
(415) 964-6300

Omnis 3 Plus $495
Blyth Software Inc.
3655 Campus Dr.
San Mateo, CA 94403
(415) 571-0222

PageMaker $495
Aldus Corporation
411 First Ave. South, Suite 200
Seattle, WA 98104
(206) 622-5500

Paradox $695
Ansa Software
1301 Shoreway Rd., Suite 221
Belmont, CA 94002
(415) 595-4469

QMS PS-800 .... $5895
QMS Inc.
1 Magnum Pass
Mobile, AL 36618
(205) 633-4300

Ragtime $395
Orange Micro Inc.
1400 North Lakeview Ave.
Anaheim, CA 92807
(714) 779-2772

Ready,Set,Go! 3 .... $195
Manhattan Graphics
401 Columbus Ave.
Valhalla, NY 10595
(914) 769-2800

Reflex $149.95
Reflex for the Macintosh $99.95
SideKick (MS-DOS) $84.95
Borland International
4585 Scotts Valley Dr.
Scotts Valley, CA 95066
(408) 438-8400

Ultimate ROM II $229.85
Traveling Software
11050 5th Ave. NE
Seattle, WA 98125
(206) 367-8090

VP-Planner $99.95
Paperback Software International
2830 Ninth St.
Berkeley, CA 94710
(415) 644-2116

WordStar 3.31 .... $350
WordStar Professional $495
MicroPro International Corporation
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200

Write Now $150
Airus Inc.
10200 Southwest Nimbus Ave., Suite G-5
Portland, OR 97223
(503) 620-7000

XyWrite III $395
XyQuest Inc.
3 Loomis St.
Bedford, MA 01730
(617) 275-4439

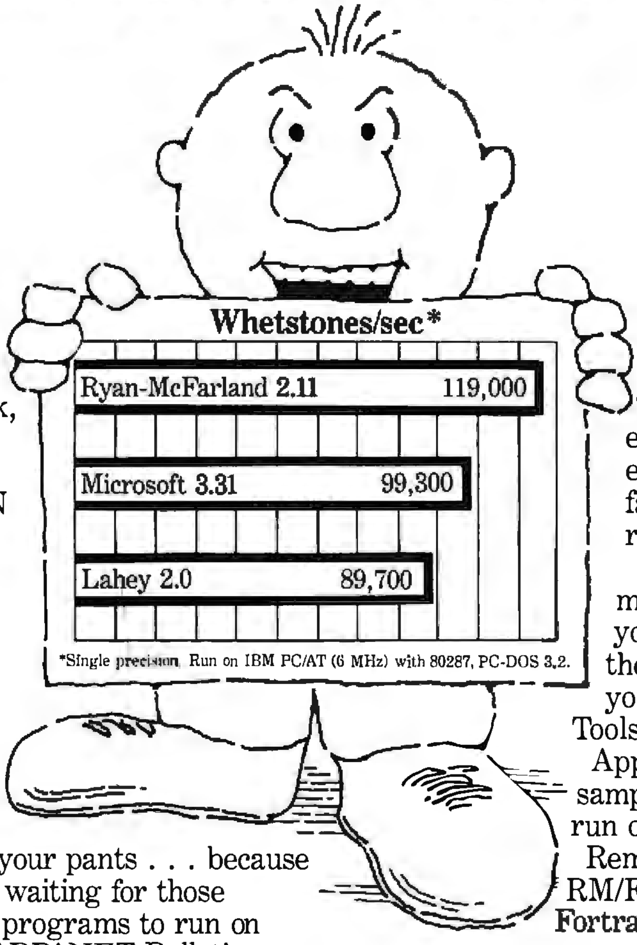
formed flawlessly. Checking my records, I realized that I paid almost exactly the same amount (about $400) for each of them, with a two-year gap between each purchase.

For printers I have an Okidata 192P with a cut-sheet feeder and a PS-800 from QMS (the PostScript laser printer). The Okidata has been a reliable little workhorse since it replaced a Mannesmann Tally a year ago. The PS-800 is wonderful. I've never had another laser printer, so I can't say how it stacks up against the competition, but I've had no trouble, and the laser output is spectacular. If you're looking for a hardware object of lust, I cheerfully nominate laser printers, and the QMS is a fine choice.

I own more cables than the average small public utility company.

That's about it. ■

KILLER FORTRAN.



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Inquiry 203

Taking Control

Dick Pountain

The theme of this month's column is control. I've recently been playing with three different systems that allow a microcomputer to control events in the real world. What they have in common is their use of a high-level language to achieve this control. That's significant to me because I'm basically a software person. If the high-level language is also interactive, you can build applications by *rapid prototyping*, the industry's jargon for "try it and see."

These systems let a microcomputer control events in the real world

Scorpion

The first system is the Scorpion controller from Micro-Robotics Ltd. This is a standalone single-board computer to which you need add only a terminal to talk to it and any mass storage you may want. My "terminal" was a Macintosh running a simple VT100 emulation program and connected to the Scorpion's serial port. This port conforms to the S5/8 standard that employs TTL voltage levels; the IBM PC does not work with this standard, so Micro-Robotics also offers an adapter card to raise the port to full RS-232C compatibility.

The Scorpion is contained on a small card, measuring only 4 by 6 inches, on which a CMOS Hitachi HD6303 microprocessor is mounted. This 8-bit processor is a descendant of—and code-compatible with—the old 6800 and has become popular as a slave processor and for applications that require low power consumption. It is packaged in a tiny surface-mounted flat pack and looks quite lost among the other chips. In addition to the CPU, the Scorpion has sockets for a system ROM, a user ROM or EPROM, 24K bytes of RAM in three chips, a clock/calendar, and lots of interfaces. The whole system draws only 80 milliamperes, and you can easily power it with a 12-volt battery, although I used the optional adapter. The RAM is nonvolatile and is maintained by a rechargeable lithium cell fitted on the card. When the Scorpion is switched off, programs are retained in memory, and you can have them start automatically when you turn it back on, if you wish. The Scorpion also has a ROM socket from which you can auto-boot a program.

The card contains 21 assorted I/O connectors and 16 sets of servo output pins in addition to an edge connector that brings out the system bus—although it seems unlikely that you would want to expand the I/O capabilities much further. Three of the connectors are for a serial terminal, an optional LCD, and an optional 20-key keypad. The rest are all concerned with controlling various devices.

Eight analog-sense inputs read either voltage or frequency from external sensors; two shaft-encoder inputs receive feedback from the rotating drive shafts of motors; four digital outputs can drive 500-mA peak loads or 100-mA continuous loads; the servo outputs can drive Futaba servo motors that have automatic feedback position control; and you can configure a user port for pulse-counting TTL signals at up to 0.5 megahertz or for digitizing waveforms and generating frequencies. Finally, there is a network connector for the Philips I^2C network, a new standard for connecting the application-specific peripheral chips used in video, teletext, and speech-synthesis systems. The network can handle 64 digital I/O lines, 32 analog inputs, 8 analog outputs, a color video display, a speech-synthesis ouput, and an infrared handset decoder.

This splendid array of I/O channels would be useless to me except for the high-level language that makes them extremely easy to use. The Scorpion language, devised by Micro-Robotics, is loosely based on BASIC or Logo, depending upon whom you talk to. It has a simple, clean syntax superior to either one and resembles a simplified Pascal. It's fully interactive like Logo: You can execute statements directly from the keyboard or define named procedures and functions. It's also a multitasking language—essential for control applications. For more details, see the text box "The Scorpion Language" on page 280.

You can include machine code in Scorpion's programs, for example, to handle interrupts, but performance considerations seldom require this. The Scorpion language is about as fast as interpreted BASIC on computation-intensive jobs; however, typical control programs are not computation-bound. They tend to be loops that read the various interfaces and spend much of their time waiting; the interfacing primitives are quite fast enough to read a device thousands of times a second. You may need a little practice to design multitasking programs in which the individual tasks are small enough and fast enough not to degrade each other's performance.

I received an assortment of gadgets to plug into the Scorpion, such as a thermocouple, an optical sensor, a one-line LCD, and a stepper motor. Combining these into simple systems was extremely easy with the Scorpion language. Micro-Robotics also offers more complex devices, such as a tiny vision system that plugs into the Scorpion's user port and can capture and process an image at a resolution of 128 by 256 pixels in 100 milliseconds; it uses a lens from the miniature Pentax 110 camera. The nicest thing of all about the Scorpion system, though, is the price: A basic Scorpion with power supply is £249; the vision system is an extra £130.

RTX Robot Arm

The second system is a serious robot arm

continued

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called RTX from Universal Machine Intelligence Ltd. A *serious* robot arm is one that's big enough to knock you down if it gets angry, as opposed to a toy for picking up matchboxes at parties. RTX stands 4 feet, 3 inches tall, and I wouldn't pick a fight with it. Although it's primarily aimed at educational users, it has sufficient power and precision for light industrial jobs.

RTX doesn't look like the typical industrial robot; it has a vertical *z* axis that makes it look rather like a photographic enlarger. The actual arm, which operates in the horizontal plane, slides up and down a vertical column, or linear slideway, to add the third dimension. The vertical motor, which does all the lifting against gravity, is installed in the base unit, so it can be bigger and more powerful (20 watts); it can lift 4 kilograms.

RTX has five movable joints controlled by seven motors. The arm has shoulder, elbow, wrist, and gripper joints—the wrist has two. The wrist unit is a box with its

continued

The Scorpion Language

When the Scorpion starts up, it asks if you want to clear memory. If you answer no, the system keeps the program currently in memory and may automatically run it. If you answer yes, you get an arrow prompt, and the system is ready to program. The Scorpion language, complete with a simple full-screen editor, resides in the system ROM; it uses TO, as in Logo, to define procedures, for example, TO greet PRINT "Hello world!" END. You invoke this procedure by typing its name, greet.

Procedures can contain parameters and local variables defined with LOCAL. Scorpion supports the control structures IF. . . ELSE, WHILE, REPEAT, and FOREVER and imposes block structure by using brackets. For example:

```
IF test > 200
[ WAIT 100 TURNOFF 2 WAIT 100
  TURNOFF 1 ]
ELSE [ TURNON 1 TURNON 2 ]
```

Many procedures can coexist in memory; you can selectively LIST them, or you can EDIT them with the built-in editor. There is no mass storage on the Scorpion card, so you save programs on your terminal's disks by typing LIST ALL and capturing the output via your communications package's ASCII file-transfer facility—like downloading from BIX.

The Scorpion supports 24-bit signed-integer arithmetic, Booleans, bit-wise logical operators, pointers, and pointer arithmetic. You can input hexadecimal numbers if you use the $ prefix. As in BASIC, you can use scalar variables without previously declaring them, and you use DIM to declare arrays. The Scorpion also supports tables of constants. These have an advantage over arrays: You can embed them in a procedure without first initializing them.

Multitasking is straightforward; to run a procedure as a task, you type START *procedurename*; to terminate a task, you type STOP. LIST TASKS tells you what tasks are running. (Task 1 is the system task, and it is always running.) You can even run tasks that haven't been defined as procedures. For example, START [FOREVER WAIT 1000 PRINT "Hello world!"] will generate "Hello world!" every second. START is a function that returns the task's identification number, so if you want to have tasks starting and stopping under program control, you could enter *tasknumber* := START [FOREVER WAIT 1000 PRINT "Hello world!"] and later STOP *tasknumber*. In addition to WAIT, which gives a pause measured in milliseconds, AWAIT pauses until a Boolean expression becomes true, for example, AWAIT *test* > 200.

The core of the Scorpion language, however, lies in the built-in keywords that access the various I/O channels. Each type of interface has its own dedicated keywords. The analog sensors are SENSE 1 through SENSE 8; the shaft encoders, SHAFT 1 and SHAFT 2. The servo ports are controlled by ANGLE, SETANGLE, and MOTOR. The digital outputs are switched on and off with TURNON and TURNOFF, respectively, and read or set by OUTPUT. A simple configuration composed of an infrared sensor connected to analog port 1 and a motor connected to servo port 3 could, for example, advance the motor whenever the sensor is illuminated:

```
FOREVER
IF SENSE 1 > 200
[ temp := ANGLE 1
  ANGLE 1 := temp + 10 ]
```

The real beauty of an interactive language like this one is that you can always find out instantly, from the keyboard, what is happening to the devices. For example, typing PRINT SENSE 1 gives you the value at the sensor input.

own three degrees of freedom: The whole box can swivel horizontally in "yaw," and the gripper unit that emerges from it can "pitch" through a vertical quadrant and "roll" about its own axis. This allows complex motions and enables the simple pincer-type gripper to approach most points in its space from any direction. RTX doesn't have any sophisticated senses (e.g., sight), but each motor has feedback control via shaft encoders so that it is aware of its own position. For example, the gripper's feedback control stops it from closing further when it has applied a chosen force. The motors drive the joints through toothed belts and precision reduction gears, and the whole robot arm is solidly constructed from stout alloy castings and vacuum-formed plastics.

RTX is controlled from an IBM PC via an RS-232C connection. The robot itself contains intelligence in the shape of twin Intel 8031 microcontrollers that each have 128 bytes of on-chip RAM and 256 bytes of RAM for external workspace. Each 8031 is capable of controlling five motors, leaving some spare capacity for custom applications. The low-level driver programs for the 8031s reside in ROM and were written in a mixture of assembly language and PL/M. They operate asynchronously as slaves to the IBM PC's 8088, which communicates with them by message passing using a 3-byte message format over the serial link.

The driver program that runs on the IBM PC was written in Turbo Pascal, the few time-critical routines being compiled either as INLINE code or EXTERNAL procedures. The driver becomes memory-resident when it's loaded with the START command. You can control RTX in three main ways: by writing relatively permanent programs in Turbo Pascal using a supplied library of procedures; by manually leading the robot through a sequence of moves (via the LEARN mode in an interactive FORTH system) and then compiling them into a FORTH word; or by controlling RTX manually from the IBM keyboard using either FORTH or a program called Test.

Test is invoked from the DOS prompt and is a menu-driven program that lets you set up numerous parameters, such as motor speeds and accelerations, and the maximum force and error limits for each joint. It also permits soak testing of each motor, absolute numeric control of the joints, and initialization to the start position, which is frequently necessary during your first programming attempts after you've messed up the arm positions.

Programming RTX was an education for me. I had never really thought much about just how complex articulated mo-

continued

tion is, and the experience has given me a new respect both for robot system programmers and for the human brain, which handles it all the time unconsciously. One thing I learned is that controlling a robot is an inherently concurrent exercise; although you could in principle program a complex movement as a strict sequence of different joint movements, the result would be awkward and slow. In practice, you need all the joints to be moving at the same time, which brings in considerations of synchronization and communication. On RTX, the driver software can handle this for you.

Other complications arise as well. Suppose you want the gripper to follow a smoothly curved path. You might approximate the path with a lot of tiny linear moves, but this would be tedious and slow as the arm would stop before each move. If you tell RTX to move the arm to a new position, the software will drive it there by the most efficient route it can find. RTX software also has an "interpolation" mode in which you create a series of seven element arrays of distance increments (one for each motor) that describe the curve; the arm then smoothly follows the curve.

The Turbo Pascal library contains 14 procedures that can be used to control the arm. They are implemented via a software interrupt so that you can in fact use them from C or other languages by putting the command code in AX, putting a pointer to an eight-word table of parameters in BX, and calling the interrupt.

I did most of my RTX programming from FRTX, the FORTH system. This is a multitasking FORTH-83 system with a special teach-and-replay vocabulary added. To teach RTX a new movement, you can type LEARN NEWMOVE and then start to manually make the required movements using the cursor and function keys to control each axis. When you press the End key to finish, the sequence of moves is compiled into the dictionary as a FORTH word called NEWMOVE, which you can execute by typing its name or use in the definition of other words. You can compile the current location of the arm as a constant, using PLACE *name*, so that you can refer to this location by name. RTX worked well, as long as I entered the moves slowly and deliberately. The cursor keys start an arm movement and the space bar stops it; it's hard to avoid instinctively holding down the cursor key and causing an overshoot.

As with the Scorpion, the interactive nature of FORTH makes programming RTX a cinch. If something happens that you don't understand, it takes just seconds to write a test word to read a port or inspect a memory location so you can see

continued

what's going on. RTX costs £5000, which is cheap for a robot of this capability. The people at Universal Machine Intelligence tell me they already have orders from customers in light industry, including one who is using RTX to manipulate cloth under sewing machines.

Martello

The third control system is a FORTH development system called Martello from British Telecom, the U.K.'s equivalent of AT&T and one of our largest corporations. British Telecom made a small foray into microcomputing about a year ago with a range of business desktop computers that were "badge-engineered" from Rair and ICL. Martello is a product from British Telecom Research Laboratories, a different division of the huge company, and it's intended for scientists and engineers interested in instrumentation and control. The significance for me, as a FORTH enthusiast, is that it represents another big step in the acceptance of FORTH. Another large U.K. utility, British Rail, is presently evaluating FORTH as a possible replacement for assembly language programming in its critical train safety systems. Despite its lack of academic "respectability," FORTH seems to be increasingly accepted by those who have to get things done.

Martello is based on the relatively new STE bus (also known as the IEEE P1000). The basic system contains a 19-inch rack with 16 slots for single Eurocards, a CPU card, a disk controller, and twin 800K-byte 3½-inch floppy disk drives that occupy two slots. A 55-W switching power supply is hidden in the shallow base of the unit. It is a conventional FORTH system from the hardware point of view, relying on conventional microprocessors rather than on dedicated FORTH engines like the Novix chip. The system I tested had an 8-bit 8085 CPU; Motorola 68000 and Hitachi 64180 CPU cards should be available soon. Other available boards include a color graphics subsystem using an NEC 7220 graphics processor. You can include more than one CPU board for multiprocessing systems, and STE permits multiple bus masters. The 8085 card can address up to 1 megabyte of bus memory, 128K bytes of which can be local.

My chief interest in Martello was the software, Martelforth, which contains a FORTH-83 standard kernel in ROM plus some significant enhancements. It was partly developed by Microprocessor Engineering Ltd., a veteran firm on the U.K. FORTH circuit. The most obvious enhancement is that Martelforth includes a "proper" disk filing system rather than the orthodox single-blocks file; FORTH source programs are kept in named files that are organized into a hierarchical directory system, as in PC-DOS or UNIX. For serious applications I find such a filing system essential, and I can't understand the FORTH purists' resistance to it. Code inside the files is still organized into numbered blocks, so you can easily port code from conventional systems. The built-in full-screen editor is extremely powerful, featuring search and replace, on-line help, and full-block, rather than the usual single-line, moves.

Other tools and utilities supplied on disk include an interactive debugging and tracing environment that "animates" the source code as it executes in single-step fashion, while showing the contents of stacks and other vital system parameters. A floating-point package, ROM-code generator, EPROM programmer, and an 8085 macro assembler are standard with Martelforth. Its ROM includes an interrupt handler, and multitasking uses interrupts rather than the simpler but less powerful round-robin scheduling normally used in FORTH. Thus, you can synchronize tasks to external events in real time. Finally, there is a professional-quality floppy disk test program that can exhaustively test the physical performance and integrity of both drives and disks.

All in all, Martello is a good example of what a modern interactive development system can look like and would, I'm sure, come as a pleasant surprise to anyone who thinks that machine code and swearing are the only way to develop control systems. The Martello system I tested costs £1975, including the license for the software.

Don't Be Scared

Control systems have always frightened me. They smell of solder, oscilloscopes, and assembly language programming, but using a high-level language takes a lot of the fear out of them. More important, it also saves development time. ■

Companies Mentioned

British Telecom Research Laboratories
Martlesham Heath
Ipswich, Suffolk
IP5 7RE, U.K.
(0473)-642933

Micro-Robotics Ltd.
264 Newmarket Rd.
Cambridge CB5 8JR, U.K.
(0223)-323100

Universal Machine Intelligence Ltd.
The Royal Victoria Patriotic Building
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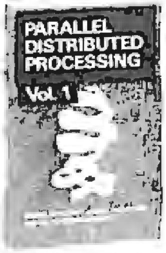

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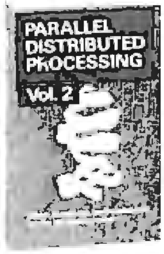

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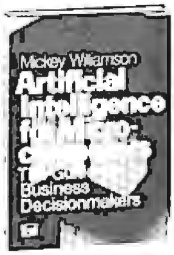

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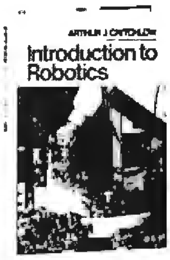

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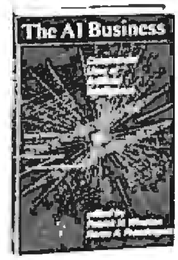

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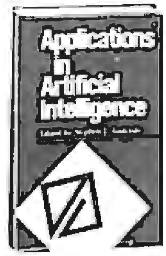

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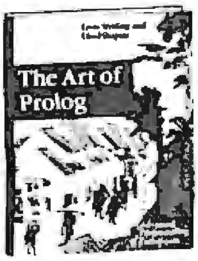

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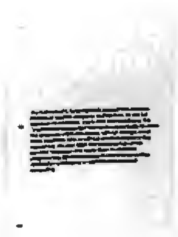

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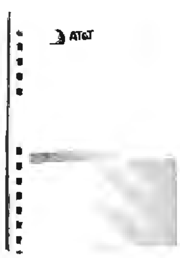

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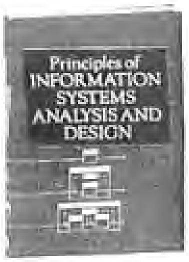

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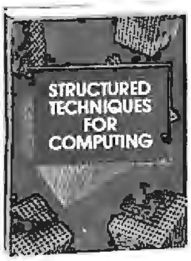

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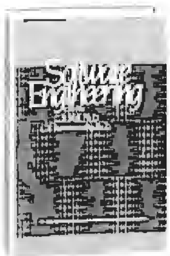

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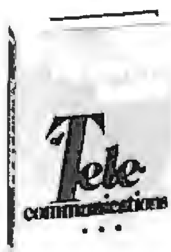

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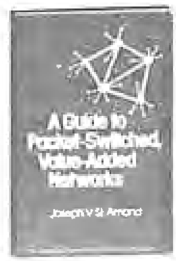

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Inquiry 337

Amiga Developers Conference

Bruce Webster

Bruce learns more about the Amiga and products to be used with it

Commodore put on another Developers Conference, some 18 months after its first one. Like the first one, it was held at the Doubletree Hotel in Monterey, California. Unlike the first one, it was not a resounding success. Much of the information presented was recycled from the first conference; many of the handouts were the same and were even dated May 1985. A lot of developers were unhappy with the conference itself, feeling they had spent a lot of money and had not learned anything new. Many expressed unhappiness with Commodore's struggles in marketing the Amiga. One developer (while at the conference) drafted a letter to Commodore reminding the folks there that the developers' survival was closely tied to the success of the Amiga and asking if Commodore could please do a better job of selling the thing. Forty-two of the developers attending signed the letter.

The Commodore representatives, to their credit, were for the most part honest about past mistakes and current problems, a candor that most found reassuring. Also reassuring was confirmation of a second straight quarterly profit (with hints of strong profits in the third quarter) as well as a steady climb in Amiga sales. Most interesting were the sales figures released. They're probably covered by the nondisclosure agreement I signed, so I won't repeat them here. However, if they are accurate, they would indicate that Amiga dealers are selling far more systems per store than Macintosh dealers sold during its first year.

Did Commodore announce any new machines, new hardware, new software, and so on? Sorry, no comment.

I almost didn't go to the conference dinner Friday night, but I'm awfully glad I did. The food was better than most mass banquets, the company was great, the awards presentation didn't drag on, but best of all were the videos. Yes, there were videos, just as there were at the Apple IIGS Developers Conference. However, these videos weren't slick, weren't professional, and weren't aimed at making you run out and be baptized by John Sculley. They were done by the crazies at the Amiga development group in Los Gatos, had no rock songs or heartwarming images, and were aimed mostly at having a good time. Several "commercials" poked fun at Commodore ("The Amiga 999! Totally incompatible with any previous product!"), the Amiga folks (RJ Mical and Dale Luck doing their Bartles-and-Jaymes imitation), and even Apple (Terry Ishida doing a wickedly good imitation of the Pathological Liar as an Apple spokesman).

The best videos, though, were two done by Allan Hastings. One was a space-combat video, along the lines of *The Last Starfighter*. The other had a "worlds within worlds" theme, taking you through the screen of a computer sitting on a table inside a house, through space to a planet, down to the surface, cross-country to a house, completely around the outside of the house, then through a window to a room where a computer sat on a table. Both of these were done with frame-by-frame computer animation on an Amiga, Allan using an 8mm video camera with single-frame advance to photograph each image after it was processed. The result was truly amazing. Allan hopes to show the films at the next SIGGRAPH conference, and I think many of the attendees—used to equipment costing tens or hundreds of thousands of dollars—are going to be surprised at what can be done with equipment totaling less than $3000.

As a developer, I would have probably decided that the conference was not worth my time and money. As a reviewer of Amiga hardware and software, I found it very worthwhile, especially since there was a minishow on the last day with different companies exhibiting their wares. It gave me a chance to see some products that were just being released or still under development, and it let me line up a number of products for review. Speaking of which . . .

StarBoard II

One of the firms represented at the conference was MicroBotics, maker of the MAS-20 hard disk that I discussed in my December 1986 column. MicroBotics has released its next product: StarBoard II, a memory-expansion box for the Amiga. Redmond Simonsen (yes, wargamers, *that* Redmond Simonsen) is the marketing director at MicroBotics, and he was kind enough to let me take a StarBoard II home.

The StarBoard II is slightly longer and about twice as wide (1.5 inches versus 0.75 inch) as the Alegra memory unit. Like the Alegra, it attaches to the expansion bus on the right side of the Amiga with two screws. As with the Alegra, I recommend standing the Amiga on its left side (after unplugging it, etc.) for maximum ease in connecting the StarBoard II.

The StarBoard II differs from the Alegra box in several important respects. First, it passes the expansion bus through, so that you can attach other expansion devices (like another StarBoard II). Second, you can put 1 megabyte of RAM in it with 256K-bit chips. Third, it can be upgraded to 2 megabytes without using 1-megabit chips; instead, an optional daughterboard (known as the Upper Deck) lets you double the number of 256K-bit chips in the box. Fourth, it has an optional MultiFunction Module

continued

Bruce Webster, a consulting editor for BYTE, can be reached c/o BYTE, P.O. Box 1910, Orem, UT 85057, or on BIX as bwebster.

that contains goodies like battery-backed clocks, a socket for a 68881 floating-point coprocessor, and a switch that turns the StarBoard II into a RAM disk that can survive a system crash and reset.

It took me only a minute or so to remove the Alegra and another few minutes to attach the StarBoard II. I powered up the Amiga and found myself with 2.5 megabytes of RAM—nice! The StarBoard II I've got doesn't have the Multi-Function Module, so I couldn't test that out, but the RAM itself seemed to behave perfectly.

I was going to put the Alegra away in the StarBoard's box but then realized that the StarBoard had the expansion bus coming out the side. So I just plugged the Alegra into the StarBoard. I had no way of securing the Alegra since I didn't have jackscrews long enough to reach through the StarBoard to the Amiga, but the Alegra bus connector seemed to hold snugly onto the StarBoard's expansion bus, and I placed the external disk drive so that it would press the Alegra against the StarBoard. I powered up again, rebooted, and now had a system with 3 megabytes of RAM.

The StarBoard II (with 512K bytes) is only $495, about $120 more than the Alegra unit (with 512K bytes). If you can afford the extra bucks, you probably should get the StarBoard II.

Marauder II

Discovery Software International was also at DevCon II (not to be confused with DefCon IV), showing off Marauder II, the latest version of its disk backup program for the Amiga. They were kind enough to give me a beta copy (it should be out in final release by now). I've tried it out, and it has copied every copy-protected program I've tried it on with absolutely no problem. I must confess that I breathe easier knowing that I can safely file away my master copies of Deluxe Paint, Instant Music, and other such programs. Every Amiga owner should have a copy for just that reason.

In a note of irony, Rick Ross of Discovery Software told me of their dismay over what has happened with another utility they've developed and released. Said utility is not copy-protected and has been heavily pirated. Ross is also getting tired of the constant escalation between software manufacturers, who want to protect their programs, and firms like his, who offer programs to help users make backup copies. Ross would like to see more firms go to the "random word" or "key wheel" form of protection. In these methods, the disk itself is not protected in any way. The owner is encouraged to make a working copy and to put the master away safely. Each time the owner runs the program, it requests a random word from a random page in the manual or asks the user to look up and enter a given value from a table or calculating wheel. This limits casual distribution of the program since each user has to have a copy of the manual or calculating wheel. Ross promises that his company will make absolutely no effort to unlock or crack this type of protection, that their concern is that the user be able to safely put master disks away, and that they do not condone piracy in any form.

I, for one, believe him. As a software developer, I am not thrilled by piracy; there's nothing like having a program you've worked on for a year and a half appear on a nationally known pirate bulletin board three weeks after its release. As an end user, I am not thrilled by protected disks that can (and do) get clobbered. I've been happy to see a number of firms drop copy protection; I just hope our community can reward that trust with some honesty and consideration.

Other Items

A number of products were shown in various stages of development. James Bayless of New Horizons Software showed ProWrite, an Amiga word processor with many Mac-like features. It is due out by the time you read this—but we all know how that goes. The beta version I have is far from complete and looks promising but for one problem: It uses interlace mode, which has an intolerable flicker. Adjusting the colors with the Preferences utility doesn't help since ProWrite sets its own colors. You probably want to wait until Commodore releases an Amiga that doesn't need interlace mode for high-resolution text processing . . . assuming that ever happens.

NewTek was also present. NewTek puts out DigiView, which lets you hook up a TV camera to your Amiga and produce hold-and-modify images. HAM pictures can have up to 4096 different colors on the screen simultaneously. They were showing a beta version of DigiPaint, which—as you might guess—is a paint program that works on HAM images.

Some of you might not realize what a difficult feat a program like that is, so let me describe how HAM images are set up on the Amiga. A HAM image uses six bit planes, which means that each pixel—each colored dot on the screen—uses 6 bits to determine its color. If the first 2 bits are "00," the remaining 4 bits (yielding a value from 0 to 15) are used to look up the pixel's color in the color table (16 values chosen from the total palette of

continued

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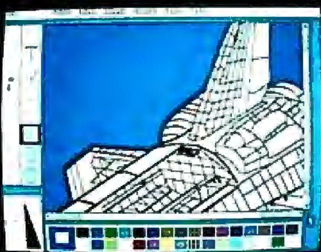

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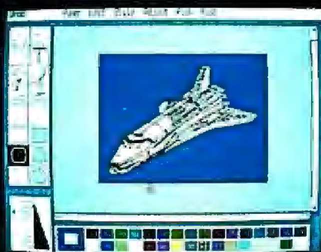

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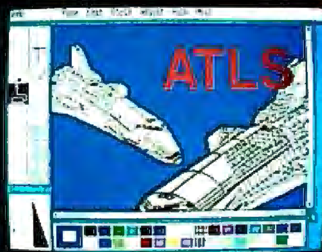

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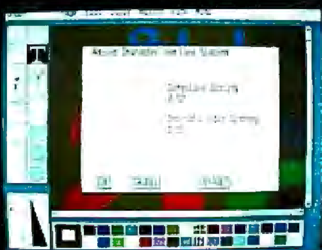

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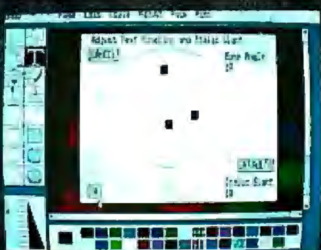

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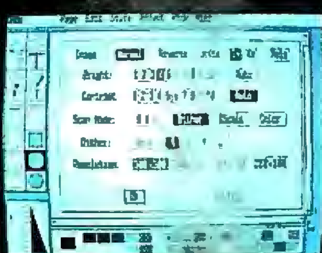

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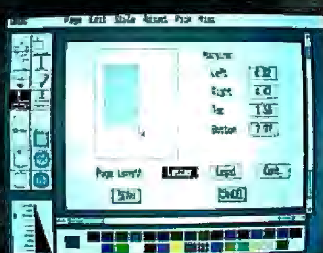

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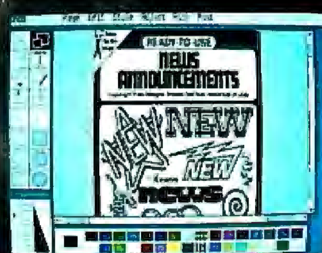

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4096 colors). Each color has 4 bits' worth of red, green, and blue; that is, the color is described by combining one of 16 values of red, one of 16 values of green, and one of 16 values of blue. So far, not too impressive.

Now, if the first 2 bits are "01," the pixel has the same color as the one to its left, except the last 4 bits replace the red value in that color. If the first 2 bits are "10," the last 4 bits replace the green value in that color, and if the bits are "11," the last 4 bits replace the blue value in that color. This allows for subtle shading from left to right, which lets DigiView produce the sharp, colorful images that it does.

It's amazing enough that DigiView can produce a HAM image using a black-and-white video camera and red, green, and blue filters—then chooses the best palette of 16 colors and fills in with derived shades. To then be able to manipulate that image by drawing, cutting, pasting, repainting, and so on is remarkable. I have neither DigiView nor DigiPaint, so my comments are based on what I saw at DevCon. If you want more information, contact NewTek.

Four Books for the Amiga

I collect books, and I am always on the lookout for books that can teach me what I am too lazy to dig out on my own. For that reason, I have been collecting Amiga books lately, seeing what I can gain from them. I've picked up four so far; here are brief reviews of each.

The Amiga Programmer's Handbook by Eugene P. Mortimore (Sybex, 1986, $24.95) is meant to be a companion to (or interim substitute for) the Amiga ROM kernel and Intuition technical manuals. It contains a function-by-function listing of all the major libraries. For each function, the book lists the syntax of the function call, the function's purpose, its input parameters, and what the function is supposed to do. The book groups functions according to task: Exec, graphics, animation, text, layers, Intuition, and workbench.

My biggest complaint with this book is that it contains absolutely no code examples. Consequently, the book is insufficient to stand on its own; it needs other documentation to support it. Even so, it might make a good second text if you're getting stumped figuring out just what your program is supposed to be doing.

Inside Amiga Graphics by Sheldon Leemon (Compute! Publications, 1986, $16.95) aims at helping experienced programmers quickly get their hands dirty with graphics programming on the Amiga. It assumes a certain familiarity with C and/or BASIC, using examples in both languages to show you how to carry out tasks involving graphics.

This book isn't usable as a stand-alone text, but it obviously wasn't designed to be. It fills its niche well, introducing graphics but not going so far as to lose you. The C examples are not for the novice.

Inside the Amiga by John Thomas Berry (Howard W. Sams, 1986, $22.95) appears to be the best all-around text I've seen for the Amiga programmer. While neither perfect nor comprehensive, it does explore the major areas of the Amiga—Intuition, Exec, graphics, etc.—with lots of diagrams, example code, and other aids.

Unfortunately, the book has a number of quirks, and a fair amount of the information in it is outdated or wrong. I'm not sure the MAP and XREF listings of a sample link—occupying almost 40 pages—serve any useful function. Some of the C source examples take far more statements to accomplish their task than they should. At least one acquaintance of mine, involved with technical support for the Amiga, was very unhappy with the book. However, I'm not sure what else to recommend for now.

The Amiga by Michael Boom (Microsoft Press, 1986, $19.95) is subtitled "Images, Sounds, and Animation on the Commodore Amiga." Unlike the other three books, this aims squarely at the novice user who has bought the machine and is now wondering what to do with it. It is reminiscent of some early Macintosh books, with ties to specific software. *The Amiga* uses Amiga BASIC for its programming examples (all rather simple) and refers to Deluxe Paint, Deluxe Music, and Deluxe Video for its sections on art, music, and animation. (Not surprisingly, Trip Hawkins of Electronic Arts wrote the introduction.)

This is a good book for novice Amiga owners. It introduces many concepts well, has code samples and other helpful information, and just does a good job of introducing the Amiga without getting you lost in the maze of libraries and ROM calls.

COMDEX

A few days after getting back from the Amiga conference, I flew down to Las Vegas and COMDEX/Fall. This is the big trade show in the microcomputer industry, designed for dealers, corporations, and manufacturers more than for end users. And "big" is the operative word here; even at a brisk pace, I had to walk several hours to cover all the exhibits (located in the Las Vegas Convention Center and four hotels).

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A few trends were obvious. IBM PC clones keep getting cheaper. Several booths were advertising AT clones—not PC, but AT—for much less than $1000. A number of firms, including most of the major clone makers, were showing 80386-based systems. Unfortunately, it looks as though said manufacturers can't agree upon a 32-bit bus standard, which will probably leave them all at the mercy of IBM. They appear to be too concerned about short-term gain to worry about long-term survival.

Another buzzword appearing in just about every microcomputer manufacturer's booth was "desktop publishing." Most people seemed to think that desktop publishing meant word processing on a high-resolution, reverse-video, monochrome monitor (in unconscious emulation of the Macintosh). Unfortunately, the state of the art in desktop publishing on MS-DOS machines isn't very impressive, at least compared to that found on the Mac. Why? Because the basic concepts of clipboard, scrapbook, and resource type are inherent in the Mac operating system and ROM routines, making it easy for applications developed by different firms to pass text and graphics back and forth. An item in the Microbytes conference on BIX reported that two different IBM PC users groups were now using Macs to do their newsletters, one of the groups doing so after having tried "desktop publishing" on an IBM PC and having found it wanting.

And speaking of the Mac . . . Apple pulled out of COMDEX, so they weren't there to push their vision of desktop publishing. Bad move, since it means that at-

continued

endees who haven't used the Mac (and who missed the Aldus/PageMaker booth) didn't have a chance to see just what the Mac can do. Commodore wasn't there (again), and Atari was (again). Rumor has it that Commodore didn't have a booth because the Interface Group refused to allow them to let third-party developers exhibit in their booth. If that's true, it might also explain Apple's pullout, since Apple pioneered that concept. Then again, Atari did it anyway; but there were rumors of a heated exchange on the floor between the Interface Group and Atari officials. If all this is true, it shows a lot of shortsightedness on the part of the Interface Group. After all, the Atari booth was one of the most crowded in the show—even on the last day—when many other booths looked deserted.

I stopped by the Western Automation booth. This firm makes the DASCH external RAM disk for the Macintosh, which I reviewed in the June 1986 BYTE. When I wrote that review, the prices for the 500K-, 1000K-, and 2000K-byte versions were $495, $795, and $995, respectively; they have now come down to $395, $450, and $545. Since the DASCH has an external power supply, you can power your Mac down (or have it crash) and not lose anything. At $545, a 2-megabyte RAM disk could do wonders for development speed.

A number of firms were claiming to have the "world's fastest personal computer." Several companies with 80386-based systems were bestowing that crown upon themselves. The folks at Levco ran some benchmarks on their Prodigy 4 (16.67-megahertz 68020 Mac upgrade) and on a Compaq 386 and documented themselves as being faster. But the winner (though not yet shipping) was probably the Datavue Advanced Personal Computer System. The computer—an IBM PC compatible—uses a discrete logic implementation of an 8086 processor, which they call their 86150 CPU. This CPU consists of two large (about 12 by 15 inches) boards in a box that sits under a regular AT-like system. Datavue claims that the processor executes instructions at a speed equivalent to a 150-MHz 8086—about 15 times faster than an IBM PC AT. Anticipated cost is in the $10,000+ range, but hey, you know how these power users are.

In the Queue

Two hardware reviews are coming up next month: the PAL expansion chassis for the Amiga and the Magic Sac (Macintosh emulator) for the Atari ST. I'll also have a few software reviews and other bits and pieces. Until then, see you on the bit stream. ■


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CHAOS MANOR MAIL

Conducted by Jerry Pournelle

Amiga Defense

Dear Jerry,

In your December 1986 column you commented about Activision's Little Computer People and said ". . . I don't think the current version of Amiga's operating system has the answer."

The problem is that the Amiga's operating system is getting blamed for faults in applications programs. Allow me to use the example of Little Computer People.

The program was translated from 8-bit versions and 8-bit operating systems. In most of those operating systems, what happens if a file is not found or if the disk is write-protected? The program either gives a message (the preferred result) or crashes. Either way, the programmer is responsible for what goes on.

In the case of the Amiga, a requester pops up and asks for the correct disk, or to remove write-protection, or whatever. This removes the programmer's responsibility of protecting the user from such problems. The programmer can take control of such things or, if the programmer is lazy, he can just leave it to the OS.

The sad part is that the system calls make it so easy for the programmer. In other words, what you thought was caused by the OS was really the fault of a lazy (or careless) applications programmer. If you don't have them already, get the Addison-Wesley Amiga manuals and the AmigaDOS manual from Bantam. Take a half-hour sometime and scan the Intuition manual and you'll see some examples of what I'm trying to say: The stuff is there, but some of the early programs we're seeing don't use it!

I have enclosed a disk with select choices of programs from the public domain. Just put it in instead of Workbench. (Since I don't yet have version 1.2 of the OS, use the 1.1 version with this disk.)

Warren Block
Chadron, NE

I'd love to agree with you. People seem to have the notion that I've got it in for the Amiga and nothing could be further from the truth. I wish it well.

However, the software is suitable for hackers and hobbyists, but not for the rest of us.

I have several versions of the Amiga Kickstart program. Each works only with the corresponding Workbench. Although many Amiga programs will run with the newest Kickstart 1.2, not all will. You have to figure out which to use.

You blame the programmers and, of course, you're right. The fact is, though, that programs ported over to the Atari tend to work; those ported over to the Amiga tend to have problems. It may well be that the Amiga attracted a disproportionate share of bad programmers, but another explanation is that the Amiga is just harder to program for.

It may be worth the extra effort and skill required, of course. It can be spectacular. But it's not easy.

For example, I went in and fired up the Amiga with Kickstart 1.1, and inserted the disk you sent me. After the machine trundled awhile, I got

```
Can't Cancel DF1
Assign failed returncode 20
```

I don't know what that means, and I suspect most of us don't want to find out.

The Amiga will be a wonderful machine for the rest of us when it gets an operating system for the rest of us. Until then, I recommend it for people who like to find out what returncode 20 *means.*—Jerry

Flash: I later found out you'd done a no-no on that disk; also that AmigaDOS 1.2 is a bit more stable. It's still harder to port to Amiga than Atari.

Turbo Denmark?

Dear Jerry,

For several years now, many people here in Denmark have been puzzled by the mysterious similarity between computer programs marketed by Borland International and programs marketed here by Poly Data some time in advance. Turbo Pascal, for instance, was somewhat disappointing to me when first marketed, as it was clearly an outdated version of Compas Pascal (now Poly Pascal), an old friend of mine.

The differences between the two products have diminished over time, although Poly Pascal is still a somewhat more polished product. The likeness is not superficial. A close inspection of the inner workings of the two compilers show them to be different only in minor details.

Now a similar situation seems to have

continued

arisen concerning Turbo Prolog and PC Prolog from Poly Data. What is going on?

There is no doubt in my mind that at least several of the Borland products are developed over here, but what is more interesting is this question: Is Borland International in reality a Danish company? And how about the mysterious Frank Borland? If he exists, maybe he isn't American after all!

Sven Korsgaard
Odense, Denmark

Fascinating. In fact, there has never been any such person as Frank Borland. When I first asked Philippe Kahn about the origin of the company name, he said "It's an Irish company and Borland is an ancient name for Ireland." This was before any but a handful of people had ever heard of the company.

He also told me some tales of the origin of Turbo Pascal. These stories tend to be, uh, fanciful, particularly the parts about Philippe's contributions to the code itself.

I later found out where SideKick and SuperKey came from: not internal development at Borland, as is usually thought. For that matter, some of the connections between Borland, Kahn, and ETH (Swiss Federal Institute of Technology) in Zurich are better remembered by Philippe than by the professors and staff at ETH.

In other words, Philippe Kahn is a master of marketing and will go down in history as such. The products are reliable, and he does in fact write a good part of the documentation himself. He sells good stuff at good prices. However, I tend to buy salt by the kilo when listening to stories about the origins of the products.

I've heard before that Turbo Pascal was originally a Danish product. I know for a fact that SideKick and SuperKey were not. I do know I use all three and I still say Philippe Kahn and Borland have done a great deal of good for this industry. —Jerry

BASICally, What I Said . . .

Dear Jerry,

You said in your December 1986 column that you throw out anything written in BASIC. (Well, you didn't state it that firmly, but the implication was strong.)

We have developed a business records program in BASICA (compatible with GW-BASIC) for the IBM PC. This was done for internal use and provided ledger record keeping and invoicing. Like many small in-house projects, the program was ultimately coveted by other small businesses. We improved it, and now it is distributed by Dynacomp Inc. It is not a great, multifunctioned, stand-alone accounting system for all businesses; on the other hand, we have reduced the direct price from $59.95 to $9.95. It is a good, graceful program for the record-keeping needs of many small businesses. I would like to send you a copy, but if it is just going to be thrown away, I won't waste your time or mine . . . .

Paul Horvick
Minneapolis, MN

No, no. What I said was that I throw out disks that arrive without documents and prove to be games with BASIC choose-a-number player interfaces. Incidentally, most of that stuff is on such cheap media that I won't even put them in my machine for fear it will mar the disk heads.

Some very good programs are written in BASIC. Even better ones are written in QuickBASIC or other compiled BASIC. I wrote my *accounting system in CBASIC.*

Accounting programs had better have decent documents, though; I don't see how you can afford to sell it at that price. But, by all means, send a copy.—Jerry

Computer Shopping War Stories

Dear Jerry,

I recently moved from Jacksonville, Florida, to the Philadelphia area. One of my first activities was locating all the local computer stores as groundwork for purchasing a computer for software development and general office use, as part of a consulting deal I won up here.

Your advice, "If you don't know what you're doing, buy from those who do," needs the addition, "if you can find someone who knows and cares!"

I settled on three criteria for my new office computer: It must be able to handle at least two users, run good versions of UNIX, and have acceptable Pascal, FORTRAN, and C compilers available. Figuring that since I had been allocated a mean figure of $6000 to spend, I might as well go for service and support, I went to ComputerLand. Huge mistake number one.

Upon entering the store, I was ignored for five minutes. Then I touched a computer and had instant attention.

Now, I may be a lone stranger in a different state, but I do not consider it polite for a salesperson to open with the question "Hello. How much money do you want to spend?" But I considered the different cultures and manfully set the perceived slight aside and answered "Oh, I don't know. It depends on what you have, I suppose."

Talk about getting off on the wrong foot. I finally convinced this person that I was serious only after I named $5000 as the figure and was asked what kind of system I wanted. I named my three speci-

continued

fications. "I don't know anything about UNIX or Pascal, but I know the computer you need," came the reply. I was quickly whisked off, set in front of an IBM PC AT, and told "This is it."

Unfortunately, the AT would not boot off the hard disk. After about 15 minutes of trying to boot the thing, and ignoring my suggestion that there was probably no system on the hard disk, the salesperson went off to ask her boss. She promptly and cheerfully returned with a disk that was "just what I needed." It was a "get to know the PC" disk, one of those programs that start off drawing the keyboard on the screen. I had reached my limit and asked to see someone who knew a little bit more about the machine. Her boss came out. Putting my temper firmly on hold, I again asked about the machine's capabilities. After being assured that the machine would do everything I wanted it to (even though he could not answer questions about extended versus expanded memory), I asked about price.

The boss quoted a figure about $500 above what I had said I wanted to spend, but he gave me a 15 percent discount that brought it down. That was just for the hardware! The software (even though they didn't know anything about UNIX—or, more accurately, though I didn't have the heart to tell them, XENIX) was extra, as was the memory configuration I requested, and everything else. They would not even bother to give me a quote on the total system price!

Just about at the end of my tether, I finally said that I would have to think about it, but I would definitely have to see the stuff all together and operating before I plunked down the cash.

"Oh. We don't do that. You have to buy it first," they said. Needless to say, I thanked them and deposited their business cards in the first trashcan I passed after I left the store. I tried three more ComputerLand stores; only two people knew what UNIX was—and *they* didn't know where to get it!

Episode number two was even worse.

My wife and I use our little CP/M computer for just about everything. We want to upgrade to a 68000-based system just because they are new, exciting, cheap, and fun to play with. However, the Mac meets only two of those criteria, so we decided to take a look at the Atari 1040ST. A computer store in our neighborhood sells them, so off I went.

Admittedly, I was in jeans and my hair was a bit windblown, but I wasn't grungy or anything. I walked into the store, sat down in front of a machine, and moved the mouse around. Zoom! Right over my shoulder appeared a pair of polite salespeople. When I asked for a word processor and the system disk, saying I'd like to just "play around for a little while," one of them said "We don't let people touch our disks. Just show me what you want to do and I will do it for you." Now, I don't let strange people touch my disks either (especially if it's not write-protected), but I very politely explained that I wanted to do it myself. I offered to buy any software or disks I damaged in the process and promised not to touch or examine any data disks.

No good. I was not supposed to touch the disks. After ComputerLand, this was too much. I got up, thanked them, and headed for the door. They said some rude things to me on my way out, and I was rude right back.

The only places where I have been treated with courtesy and respect are Radio Shack and a small mall-oriented computer shop called the Electronic Boutique. Unfailing politeness and a willingness to dig out the answers have been the rule there. (Unbelievable, isn't it?)

Well, the whole point of this is, how about writing a column on computer-shopping etiquette? I mean, it seems that the normal rules of politeness do not apply here. There was a time when anyone shopping for a computer was almost always welcome to at least try out the stuff he was shopping for! I don't feel very confident about buying anything from someone so rude. If they are going to be so (the only word I can think of is terrifically impolite), then why should I do business with them? But then I am left with just mail-order suppliers, who are generally very polite and helpful, thank goodness!

Paul Raulerson
Norristown, PA

Stories like yours need telling often. Unfortunately, many (most?) computer store managers don't seem to read BYTE anymore.

Of course, I agree with your stipulation about Pournelle's rule and that finding a good dealer is often as difficult as deciding what computer to buy; indeed, in some cases I'd choose the better dealer, even if he didn't handle the particular machine I wanted.

By the way, from the criteria description in your letter, the machine you want is the AT&T PC 6300 Plus, only make sure you get the largest possible hard disk.—Jerry

Copyrighting Software

Dear Jerry,

In October's Chaos Manor Mail, a reader questioned why the simple copyright notice that appears in books is inadequate protection for software. In

continued

essence, copyright protection prohibits software users from doing three things: copying, distributing copies, and adding enhancements or making new versions. If these were the only three issues with which a software publisher had to be concerned, then I agree that the copyright notice would be sufficient.

However, copyright protection does not prevent a software purchaser from selling, lending, licensing, or leasing his copy to anyone else. It does not prohibit copying the program for backup purposes or using the software at as many locations as the user wishes or with an entire network of machines, and it may not prohibit the user from reverse-engineering the software.

Further, copyright protection does not prohibit a user from bringing a lawsuit for damages he believes resulted from use of the software. Lotus Development Corp. has been sued in Florida by a construction company, which alleges that a latent defect in Lotus's Symphony program caused it to lose $250,000 in a construction bid. Other potential examples include liability of software developers for errors in computerized medical diagnostic techniques, architectural programs, elevator control programs, tax preparation programs, and securities investment advice programs, to name but a few.

It is only through software licenses that software developers can address these issues. If these licenses are invalidated, it is the users who will ultimately bear the price if software developers have to insure against damages resulting from use of their software. Software costs would rise and the small software developer responsible for much of the industry's innovation might find it difficult to survive.

It will take the legislatures and courts many years to define the rights of software users and the extent of software developers' liability. An awareness of the issues by both software developers and users is essential to help shape resolutions.

Lawrence B. Levy
Palo Alto, CA

Well, the Lotus suit was withdrawn. And the one thing that I am certain of is that when all the controversy is over, the lawyers will have made lots of money. But, then, they always do.—Jerry

Drippy Disks

Dear Jerry,

Here is a summary of an article I thought would interest you. It's from "Hanging Your Software Up to Dry" by Nancy B. Olson, published in *College and Research Library News*, November 1986:

> A complete run of the software serial SoftDisk was soaked when a waterpipe somewhere overhead broke in the early-morning hours of June 19, 1986, in the Mankato (Minnesota) State University Library. Water not only stood in the envelopes but also got inside the plastic jackets and into the disks and liners themselves.
>
> Disks that were only slightly wet (water didn't spurt out when they were squeezed) were dried with a hair dryer (no heat—blow only) and copied successfully onto new disks.
>
> Dripping disks were peeled out of their jackets when possible and cut out with a paper cutter when necessary. The extracted disks were then wiped off with a rag (thermal underwear!) and hung up to dry. A temporary jacket was made by cutting 1/16 inch off the write-protect edge of a new floppy and removing the blank disk. One at a time, the dried inner disks were inserted and successfully copied to fresh ones.

Joseph E. Ryus
Richmond, CA

Thanks for that story! The picture of the little round disks hanging up to dry (suspended by lines through the center holes) is hilarious. Glad to know it can be done, but I'd sure hate to have to do it.
—Jerry

Not So Easy

Dear Jerry,

I noted your dislike of copy-protected software again, which is why I am writing.

Why isn't it possible to write a transfer program that will bypass all copy-protection schemes? Suppose you transfer one sector at a time?

Read Sector 0000, track 0000, disk 1, and write to memory locations abc&–xyz&

Read memory locations abc&–xyz& and write to sector 0000, track 0000, disk 2

With the use of incrementing, one could read and write the entire disk, and by using the same memory locations, only one sector is in memory at a time, so the copy-protection scheme never gets a chance to act.

Cecil H. Royce
Chattanooga, TN

Alas, copy-protection schemes do things like mislabel disk sectors, reformat the disk by putting data in places it's not supposed to be, and many other odd schemes. One detection method is to burn a hole in the disk, then write to that sector; if it can read back what it wrote, the copy is illegal.—Jerry ■

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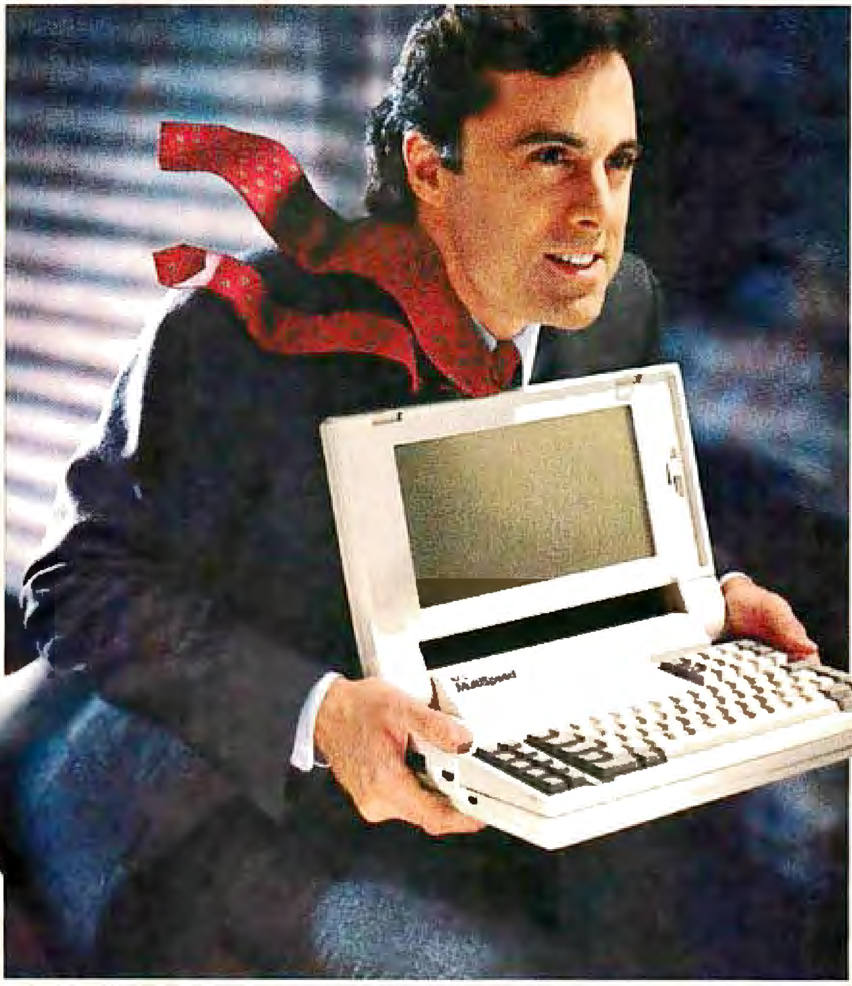

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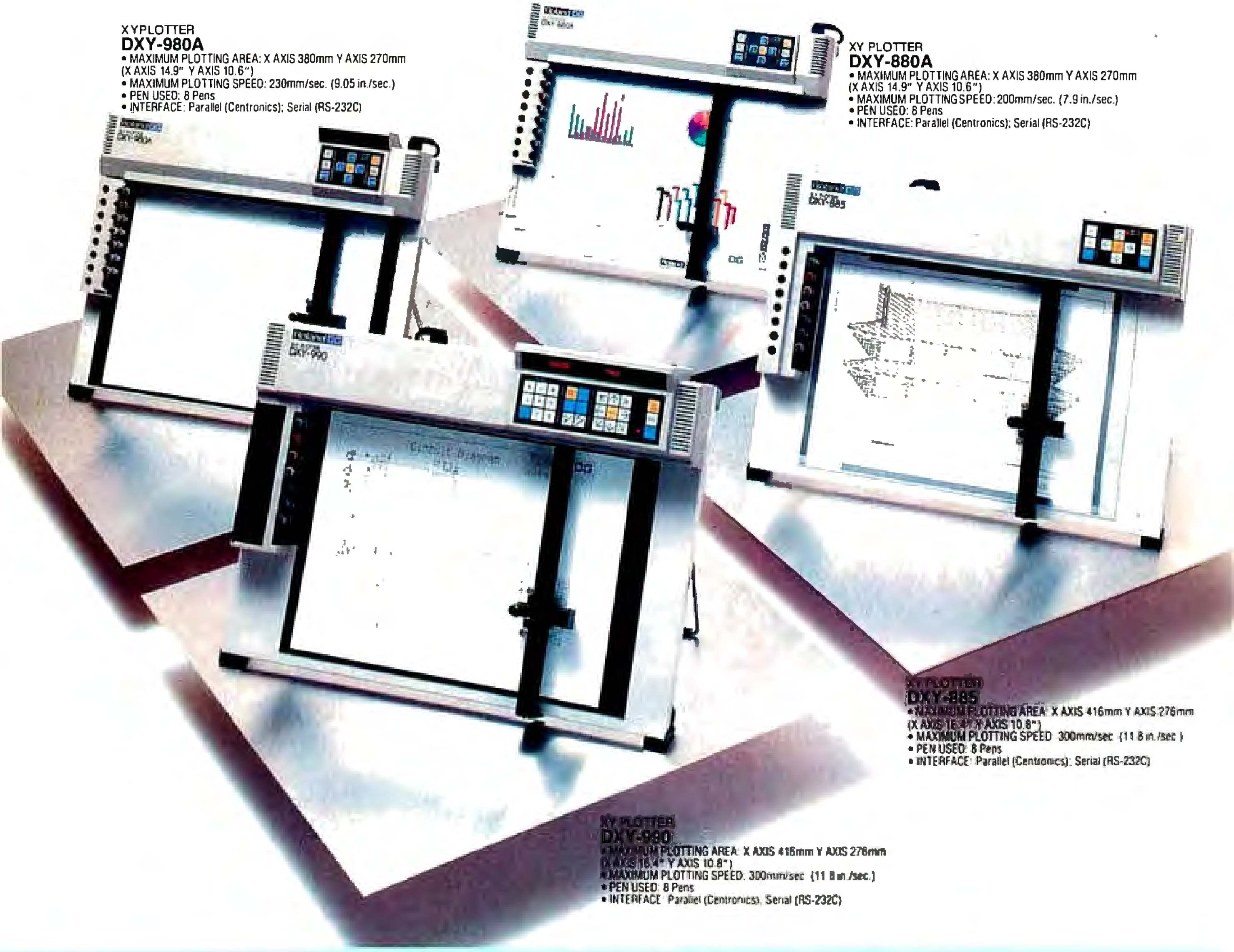

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■ If the above doesn't cover your inquiries, please contact Roland DG Corporation, Japan.

Inquiry 261

The Best of BIX is a look at a few of the thousands of messages posted on BIX each month. Excerpts this month are taken from the Amiga, Atari ST, IBM PC, Apple II, Macintosh, BASIC, and Pascal conferences. For more information on joining BIX, turn to the advertisement on page 354.

AMIGA

The Amiga window this month begins with the problems faced by someone writing a printer driver. From unknown references to stack allocation problems and type mismatches, the concerns are voiced, met, and dealt with through the efforts of other BIXen. The window closes with a look at circle and ellipse drawing in C.

PRINTER DRIVER PROBLEMS

---

amiga/hardware #705, from tweiss (Todd Weiss), Tue Dec 9 13:04:06 1986.

This message is to anybody who has (or knows how to write) a printer driver. I have all the code written, assembled, and compiled. I cannot seem to link it correctly, however.

Here's the scoop. I have written and assembled/compiled the following segments:

```
printertag.asm
init.asm
data.c
dospecial.c
render.c
wait.asm
```

as per the documentation (what there is of it) in the RKM and through other sources. If I link them together without the astartup.obj module, I can get it to link with 2 unresolved references: __base and __cxovf (I think). When I do this, the command table is active (I can use escape codes that don't require a dospecial or render code), but anything that requires the code doesn't work. When I use astartup.obj or c.o, I get all sorts of crazy errors. Looking through the RKM, it seems impossible that Commodore's code would have linked either (too many duplicate and missing declarations).

---

amiga/hardware #706, from afinkel (Andy Finkel, Commodore Business Machines), Tue Dec 9 13:14:10 1986. A comment to message 705.

Actually, we put that in the manual right from our printed source, so I'm almost certain that it links (as long as you add the missing wait.asm module). The __base and __cxovf sound like Lattice constructs. Have you tried supplying 2 ULONGs with the proper names to make it happy? The printer drivers use NO startup, and the printertag.obj file MUST be first. Perhaps we can get someone more familiar with Lattice to comment on _base and _cxovf? Do you have a listing of lstartup.asm?

---

amiga/hardware #707, from tweiss, Tue Dec 9 13:24:46 1986. A comment to message 706.

Thanks for the reply, Andy. (That was fast!) Yes, I did include the wait.asm. I'll try to add 2 ULONGS and I'll let you know what happens. By the way, the documentation is extremely confusing on this issue as one version shows astartup.obj as the first link file and another shows printertag.obj as the first. Is there any chance of getting "authoritative" documentation on the procedure?

---

amiga/hardware #708, from cmcmanis (Charles McManis, Intel), Tue Dec 9 14:01:03 1986. A comment to message 706.

The -v option to LC2 will disable stack checking and the references to __base and _cxovf.

---

amiga/hardware #709, from afinkel, Tue Dec 9 14:51:06 1986. A comment to message 707.

Actually, you need to use the -v option on the LC2 pass to disable stack checking. You also need to do this when you spawn "child" tasks. Otherwise, Lattice gets confused. The link order I use (and I'm one of the authors) is:

```
printertag.obj
init.obj
wait.obj
data.obj
dospecial.obj
render.obj
```

This may be viewed as definitive. However, the only thing that really matters is no startup file, and printertag.obj must come first.

(BTW, if you think you've found duplicate symbols in the printer listing, tell me which ones...)

---

amiga/hardware #710, from tweiss, Tue Dec 9 15:05:41 1986. A comment to message 709.

Declaring the 2 ULONGs didn't do the job. I'll try this. The duplicate symbols are not in the printer listings (at least none that I found). The problem was that when I used astartup.obj (as shown in the RKM), a few symbols (like _sysbase) are defined in both places. Without using the startup, there's no problem with that. Thanks for the info on the -v option. Unfortunately, it's been quite a while since I've done any programming like this (and then it was very little). I'm mostly used to PL/I and Assembler on a VAX, so I figured I'd run into plenty of silly problems on my part.

---

amiga/hardware #712, from jmeissen (John Meissen, Lattice), Tue Dec 9 17:22:58 1986. A comment to message 709.

That's correct. The compiler generates stack-checking code at the entry point of a function unless you use the -v option of phase-2. The only reasonable way this could be done was to check the contents of A7 against a static data location, and branch to an overflow handler. The static location is in the startup routine, and the handler is in lc.lib. And, BTW, if you forget to use -v when spawning part of your code as a separate task, Lattice doesn't get confused, but your program sure will. The location containing the bottom of the stack is filled in by the startup code. The new task is created some time later and is given a separate stack. However, the stack-checking code still refers to the original static location with the original bottom-of-stack value. IMHO, the best way to handle stack overflow detection is in hardware. I've worked on systems that have stack instructions with overflow detection and the approach seems to be much cleaner. Too bad Motorola didn't think so.

---

amiga/hardware #713, from afinkel, Tue Dec 9 17:25:50 1986. A comment to message 712.

>And, BTW, if you forget to use -v when spawning part
>of your code as a separate task, Lattice doesn't get
>confused, but your program sure will.

Yes, this is a better way of saying it. I tend to think of (compiler-added) options such as stack-checking as being part of the compiler rather than part of my program. Fuzzy, I know.

---

amiga/hardware #715, from tweiss, Thu Dec 11 11:50:23 1986. A comment to message 710.

Using the -v switch and no startup module, the driver compiles and links fine. At this point, I don't have

continued

the manual for my printer (on back order) and have figured out the control codes based on a higher revision of the manual. This works fine, except I can't figure out the codes for graphics dumps.

Having said all of this, I've gotten the command table filled in and the dospecial() routine written. The command table works properly, but the dospecial() routine never seems to be called. I'm stumped! I seem to be doing everything correctly, and all I'm using dospecial for is to modify OutputBuffer and *vline. Still, I can't set tabs or do a printer initialization for this reason.

Any idea of why dospecial might not be called? I'm not so worried about dospecial as I am with render(). If dospecial isn't being accessed, that makes me worry a little bit about render() (when I get it written).

Does anyone have any knowledge as to when, where, and how dospecial is called? Thanks.

---

amiga/hardware #716, from afinkel, Thu Dec 11 12:32:56 1986. A comment to message 715.

Dospecial is called whenever an escape command of the proper form is detected by the printer driver (i.e., someone sends ESC[1m). Dospecial will then either return 0 (to indicate that the command can be found in the data table), a positive number (indicating the number of characters that the ESC sequence translated to), or a negative number (to indicate no characters are to be inserted).

---

amiga/hardware #718, from tweiss, Fri Dec 12 03:33:04 1986. A comment to message 716.

Thanks, Andy. That explains it, as I am automatically returning a 0 from dospecial. One more question: I have since found out that my printer supports 3 densities. Looking through the documentation on the setdensity() function, I have a very hard time figuring out 2 things:

1) Where does the user get to select the density of the print, and
2) How is setdensity() called? It isn't in the ptog for the H-P Plus, and the only mention I see of it is a very vague one in render.c. Unfortunately, my C isn't great, so I'm having a difficult time deciphering the H-P Plus density section.

I'll get this thing together come hell or high water.

By the way, I forgot to ask, but has any documentation been released by C-A regarding drivers in addition to the RKM?

---

amiga/hardware #719, from afinkel, Fri Dec 12 10:10:07 1986. A comment to message 718.

Setdensity is called first thing. You get the parameter (1-4) of density picked from the x parameter of the render call when SPECIAL_DENSITY is set, if the user wants to give a setdensity call via his/her dumprport call. Otherwise, on our printers we pick a default and let the user select another density via the printquality item of Preferences (limit of 2 densities this way).

---

amiga/hardware #720, from tweiss, Fri Dec 12 11:46:45 1986. A comment to message 719.

Thanks, Andy. I have one more (hopefully the last) question. I've gotten the escape codes for graphics dumps and am finishing up render.c. I have also gotten copies of drivers that have been modified by other people. Since they have done it, I know it can be done, but I can't seem to compile it for the following reason: When the compiler gets to something like

```
if (err=(*(PD->PWrite)("x",1))),
```

continued

I get an error stating that this is a void (error #91 of Lattice V3.03C). I can't see a switch that would allow this, but I know it's been done. What's the secret? (By the way, dospecial is working fine now and I am using the -v switch.)

---

amiga/hardware #721, from afinkel, Fri Dec 12 17:01:37 1986. A comment to message 720.

Check out the typing of PWrite; make sure it is defined as a LONG. Then change the size of err to LONG. I suspect that's it. Also, make sure that render isn't defined as a VOID anywhere.

Green Hills doesn't bother us with these kinds of errors, since it seems to be able to handle them without any problem. I have to lint my code to find these out.

---

amiga/hardware #722, from cscheppner (Carolyn Schneppner, Commodore Business Machines), Fri Dec 12 19:49:48 1986. A comment to message 720.

If you are using 1.1 and 1.1 headers, some of the structures in prtbase.h contain variables declared as pointers to functions such as PWrite, dospecial, and render. They are declared as pointers to VOID functions and this is wrong. Green Hills seems to be really unconcerned about type mismatches, but Lattice is much more picky (I think this is good, BTW). Solution is to change the prtbase.h header so it calls them int or LONG functions. I think this is fixed in the 1.2 headers.

The other type of mismatch problem is caused by the fact that render.c is typed as int on its entry line, but the variable err that it often return()'s is a BYTE. I change "int render(...)" to "LONG render(...)" and "BYTE err" to "LONG err". Seems to work fine. The code receiving the return value (cdumprport in the printer.device) is expecting a 32-bit int, anyway.

SLOW CIRCLES

---

amiga/softw.devlpmt #3063, from mthant (Myo Thant), Sun Nov 16 23:26:15 1986.

Does anyone know why the circle/ellipse routine is so slow? (I'm using Aztec C.) Not only does it draw slowly, but it pauses before it even starts to draw. Does anyone have a fix, or know of a 68000 routine to do the same?

Also, I'm having trouble with the Amiga constantly sending mouse movements to my program. I thought I had all the report flags off. I don't understand it, but whenever I move the mouse my program slows down considerably. Any ideas? Or patches?

And lastly, the Mac has a function to clip both rectangles and ellipses from bitmaps; the Amiga only has rectangles. Any quick-and-dirty ways to do this? (I think I have an idea: Use draw/ellipse into a bitmap and use that bitmap as a mask.) I dunno...... Thanks in advance. J.K.

---

amiga/softw.devlpmt #3064, from rjesup (Randell Jesup), Sun Nov 16 23:38:17 1986. A comment to message 3063.

Ellipses are slow because they take lots of calculation to draw. Recheck your flags. Sounds like REPORTMOUSE or some such is on. Are you using a console device and telling it to report to you? Your idea to draw an ellipse and then use it as a mask is good. Remember, in 1.1 and before there WERE no ellipse routines.

---

amiga/softw.devlpmt #3065, from jdow (Joanne Dow), Sun Nov 16 23:40:23 1986. A comment to message 3064.

The circle draw uses the more general ellipse routine. And the ellipse routine is set up very general. For many specific applications you can do better with custom code. <^_^>

---

amiga/softw.devlpmt #3142, from jim_kent (Jim Kent), Sat Nov 29 18:39:13 1986. A comment to message 3064.

Actually there are ways to draw ellipses with a "stepping" algorithm so that the per-pixel overhead is only slightly more than a line's overhead. You can even do ellipses with axis not along x or y, using stepping algorithms. The end conditions get hairy, though. But anything you do a pixel at a time on a bit-plane machine is going to be fairly slow, even if there's NO calculation involved.

---

amiga/softw.devlpmt #3067, from cheath (Charlie Heath), Mon Nov 17 00:45:45 1986. A comment to message 3063.

What is your program doing? Do you need "real time" control of the mouse, can you sacrifice multitasking compatability during the time when you want very high-speed response?

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amiga/softw.devlpmt #3074, from w.volkoegis (William Volk, Aegis Development, Inc.), Mon Nov 17 16:31:25 1986. A comment to message 3063.

Creating a mask is the more efficient way to do a ClipRegion a la the Mac. The Mac, I gather, has a rather high-powered multipolygon clipper, hence the region stuff.

---

amiga/softw.devlpmt #3079, from dhubbord (David Hubbord), Tue Nov 18 21:46:16 1986. A comment to message 3063.

Regarding circle generation, there is a good discussion in "Fundamentals of Interactive Computer Graphics" by Foley and Van Dam (Addison-Wesley). Also, check out "Microcomputer Displays, Graphics, and Animation" by Bruce Artwick (of Flight Simulator fame) (Prentice-Hall). A custom routine sounds like best bet.
Dave H.

---

amiga/softw.devlpmt #3085, from mthant, Wed Nov 19 19:26:51 1986. A comment to message 3063.

I talked to Carolyn at Commodore, and she said the reason everything was so slow was because I had a high-res 4-bitplane screen opened, and that was slowing down Intuition. (Beat that!) Anyway, I got things going at a reasonable rate and I could always close the Workbench screen to speed things up. (Oh boy, here come the cries from those who desire multitasking....) But the fact is I can't spare any bitplanes, so.... By the way cheath, I'm writing a game on the Amiga, a surgery game, and I was displaying an EKG pattern on the screen, which is supposed to be "real time," but as I moved the mouse (to cut into the patient for instance) the EKG slowed down. Too much actually, but now it's a little better. Ideally, I'd like it to be in a separate task, and timed, but I haven't figured that out yet! Oh well. As for the masking with the ellipses, that's what I'll do. Right now I'm having sprite troubles. (I can only get one sprite on screen at a time; as soon as I put a second one up, the first one disappears!) I'll fix it.... Thanks. J.K.

---

amiga/softw.devlpmt #3087, from cheath, Wed Nov 19 19:50:14 1986. A comment to message 3085.

That's tough with 4 bitplanes HIRES. It's okay to close down the Workbench screen if it's done through the Intuition calls and it is reopened when you exit. You can't guarantee it will be closable, though, because there must be no windows open in it except for the WBench windows, else it can't close. However, that's not likely to improve your speed, because the WBench screen doesn't use any extra cycles unless it is being displayed. The only way I can think of to improve speed is to install yourself ahead of Intuition in the input.device, and snarf up the MOUSEMOVE events. You'd need to think through a lot of possibilities to make sure this works safely. For an example, check out how "Grabbit" works. For implementation, the closest thing to an example I know of is popcli, and the chapter on input.device in the RKM.

ATARI ST

The Atari ST section begins with a long thread discussing the disk format used by the ST. Access speed, FATs, and similarities to the IBM PC format are mentioned. The second thread concerns itself with reading Shift/Control/Alt keys in conjunction with other keystrokes from within a C program.

ST DISK FORMAT

atari.st/tech #1216, from dmichael (Michael DeCorte), Thu Nov 13 23:51:55 1986.

First, does anyone have some suggestions as to where I can find some accurate information on the disk format for the ST from the software point of view (where and how are the directories and stuff like that - not what are the sector gaps)? I understand the STs have the same format as the IBM; is this right? Second, can the first 2K of the ST be modified? I want to change the BIOS calls. In other words, is the first 2K in ROM? I am going to try a program (might be an accessory) that will change the disk I/O routines so that they do disk buffering. Should speed things up about 5 times so that sequential disk access is on par with the IBM, Amiga, and Mac.

P.S. The name of a book would be just fine for disk format info.

atari.st/tech #1217, from sprung (Ron Sprunger), Fri Nov 14 01:27:38 1986. A comment to message 1216.

The directories start on track 1, sector 3 for single-sided, and track 0, sector 3 for double-sided (side 1). Format is the same as IBM, but I don't have the details at hand as to how the offsets are referenced, etc.

As for the first 2K of memory - it's not in ROM, but it IS protected. The details are in the Hitchhiker's Guide (DevPak); the Abacus books probably have it as well. David Small had an excellent article about the controller in the last issue of STart, along with a raw sector-read program. I'm told you can speed it up considerably if you turn off error checking. The drives are not slow, but in sequential reads, they turn off while you process - you might want to just leave them on to speed things up.

atari.st/tech #1218, from dmichael, Sun Nov 16 01:40:46 1986. A comment to message 1217.

Thanks for the info. I will look in Hitchhikers. As for the drives not being slow - I did a few tests a while back. I used program loads, a file copy, and data loads as tests. The conclusion that I came to was that the ST reads 1 sector/revolution. That's 512 bytes/sector * 1 sector-read/rev * 5 rev/second = 2560 bytes/second. Not good. On the other hand, assuming 9 sectors/track, you could read 512 * 9 * 5 = 23040 bytes/second. This is the best possible time and is optimistic, but people have increased sequential I/O fivefold using a simple track buffer. It kills almost 5K, but I have a meg here, so 5K won't kill me.

atari.st/tech #1221, from sprung, Sun Nov 16 13:10:05 1986. A comment to message 1218.

>1 sector per revolution...

I hope that's on a badly churned disk; that is, where the sectors have been really spread around. For track reads, the XBIOS routine FloppyRead is easy, but make sure you have the updated version from listings and, of course, you'll have to figure from the directory just what it is you want to read. I use it for disk copies, and they go fast enough. If you really want to change the BIOS, I wonder if Dave Small's approach would serve. In The Amazing MouseTrap, he installs and stays resident, but changes the trap-14 vector to himself, so

continued

that he can intercept and act on right button clicks, but pass all else through to TOS. (Hope I didn't mangle that too badly.)

---

atari.st/tech #1273, from dmichael, Sat Nov 22 01:47:57 1986. A comment to message 1221.

1 sector per rev. That's the timing I got for file transfers and program loads. About changing the trap - you read my mind.

---

atari.st/tech #1222, from dsmall (David Small), Sun Nov 16 15:44:44 1986. A comment to message 1218.

The problem with track buffering is going track to track. Atari uses a seek-with-verify that manages to miss the first sector of the next track on chained reads; hence, you always lose one rotation. TOS adds a fierce amount of overhead.

---

atari.st/tech #1303, from lanl (Ian Lapore), Thu Nov 27 02:43:07 1986. A comment to message 1222.

I hope everyone is familiar with the formatting utilities that correct this seek-with-verify timing problem. I first ran across it in Analog, in the form of a program called FORMAT PLUS. This BASIC program requires TOS in RAM. It changes the BIOS format routine such that subsequent disk formatting results in a different track layout.

I started analyzing the track format it creates, in hopes of writing a C program to do the format... primarily to eliminate the need for a RAM TOS. Several beat me to it (QFORMAT.PRG, et al.). What I did determine was that the number of slack bytes between sectors was reduced slightly, and the resulting extra room was used to add a "dummy" sector or two to the end of the track. This (apparently) provides time for a seek-with-verify to happen without the start of track marker flying by, and the resulting 1-rev wait for it to come around again.

Using disks in this format, and turning off the write-verify switch, truly DOUBLES floppy I/O rates. (As long as track-sized reads/writes are being done.) The track format is still 9 sectors per, with no interleaving. As far as the BIOS/XBIOS/GEMDOS routines are concerned, it is a standard format disk. If need be, I can upload a couple of the programs that do this formatting. I swear by this. I couldn't go back to the standard format disks and still get any work done.

---

atari.st/tech #1219, from jtittsler (Jim Tittsler, Atari Corp.), Sun Nov 16 12:42:38 1986. A comment to message 1216.

The best source of information about the ST disk format is to use the Hitchhiker's Guide to the BIOS in conjunction with your favorite MS-DOS document (I might suggest one of Peter Norton's books like "Inside the IBM PC," but I won't). The Guide will explain the layout of the boot sector, including the prototype BPB. The MS-DOS reference should fill you in on how to interpret that in terms of FATs and directory space.

---

atari.st/tech #1272, from dmichael, Sat Nov 22 01:45:33 1986. A comment to message 1219.

Thanks for the book name. It should contain the info that I am looking for. Hitchhiker's is fine if you know how the FATs and directory are interpeted, but not very good if you don't.

---

atari.st/tech #1274, from sprung, Sat Nov 22 01:50:45 1986. A comment to message 1272.

Yes, I had to do some FAT stuff today, and found the Norton book ideal for the purpose. It doesn't necessarily tell you exactly where everything is, but it gets you close enough that you can find it with a sector dump. It's the first time I ever understood how FATs work; now I can actually find a file or directory reliably with sector dumps.

---

atari.st/tech #1220, from jtittsler, Sun Nov 16 12:44:57 1986. A comment to message 1216.

No, the first 2K of the ST are only accessible when the 68000 is in supervisor mode. (The physical reset vector comes from the first 8 bytes of ROM.) Software can enter supervisor mode and modify the "system RAM."

---

atari.st/tech #1302, from lanl, Thu Nov 27 02:41:17 1986. A comment to message 1216.

About disk buffering...I did a _little_ work on this a while back. I'll toss out what I learned.

You want to hook into the hdv_rw vector (at $476). Even though it's not documented as such, it seems that ALL sector-oriented reads/writes go through here, even the floppies. Resist the temptation to hook the TRAP 13/14 handler to catch floprd/flopwr calls. It's a pain in the neck.

The application I was working on was write-through caching for either floppy or hard drives. I was working it such that the writes went into cache, then were passed along to the regular handler (the old value in the vector). A read would be checked against the cache map. If I could return ALL the sectors requested, I handled it, and the regular handler never saw the call. Otherwise, I would count the accesses to the sector(s), and when the counter got to a certain value, that sector would be cached. Unfortunately, this never got finished, due to problems sensing and dealing with media changes on the floppies. (Actually, I can SENSE a media change okay, I just can't seem to clear it afterwards. The work proceeds...slowly).
Anyway, I hope this helps.

STATUS OF SHIFT/CONTROL/ALT KEYS

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atari.st/tech #1254, from dbetz (David Betz, Senior Editor, BIX), Fri Nov 21 10:21:25 1986.

How do I determine if one of the Shift/Control/Alt keys was pressed along with a keystroke fetched with bconin()? The getshift() function tells me the current state of the modifier keys, but since the ST buffers keystrokes, it is possible that the current state does not correspond to the state at the time of the actual keystroke.

---

atari.st/tech #1255, from sprung, Fri Nov 21 11:21:58 1986. A comment to message 1254.

According to Hitchhiker's Guide, "If bit 3 in the system variable 'conterm' is set, then the high byte of the upper word will contain the value of the system variable 'kbshift' for that keystroke. [The default state for 'conterm' is OFF.]" Conterm is at $484.

---

atari.st/tech #1260, from dbetz, Fri Nov 21 11:41:24 1986. A comment to message 1255.

Thanks! That's just what I needed to hear.

---

atari.st/tech #1261, from jim_kent (Jim Kent), Fri Nov 21 14:45:56 1986. A comment to message 1260.

Try looking at the high word that cconin() returns normally. Don't think you need to check the system variable. It will be 0 if nothing fancy is pressed, otherwise the high word will tell you about arrow keys, Alt keys, and other good non-ASCII stuff.

---

atari.st/tech #1291, from mpack (Don Milne), Wed Nov 26 12:51:40 1986. A comment to message 1261.

Jim, I don't think that conin returns when only the Alt key is pressed, and if you press any other key, the high word contains only the scan code (not modified by Alt). So if you want to interpret the key differently when Alt is active, you are still left with the problem

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City/State/Zip ______ Accredited by the National Home Study Council 170-037 of detecting Alt at the time the key is pressed. Ron's solution should handle this easily.

---

atari.st/tech #1295, from neilharris (Neil Harris, Atari Corp.), Wed Nov 26 13:13:15 1986. A comment to message 1291.

You can use the BIOS function 11 (kbshift) to read only the shift status. This function returns the following codes:

Bit	Meaning
0	Right shift key
1	Left shift key
2	Control key
3	Alternate key
4	Caps Lock on
5	Right mouse button
6	Left mouse button
7	unused

---

atari.st/tech #1298, from hisoft (Andy Pennell, HiSoft), Wed Nov 26 13:42:55 1986. A comment to message 1295.

Kbshift (BIOS call 11) will *not* return the mouse buttons as documented, though the keyboard bits do work. The BIOS routine reads a system variable at $e1b, but, sadly, this has nothing to do with the mouse. Another "feature" of Hitchhiker's I guess.

---

atari.st/tech #1306, from jtittsler, Fri Nov 28 12:31:44 1986. A comment to message 1298.

Actually, what the kbshift BIOS call is documented as doing in the Hitchhiker's Guide IS correct, but open to misinterpretation, admittedly. It says

```
0  Right shift key
1  Left shift key
2  Control key
3  Alt key
4  Caps Lock
5  Right mouse button (CLR HOME)
6  Left mouse button (INSERT)
7  (reserved)
```

What bits 5 and 6 are used for is returning the state of the keyboard mouse button equivalents, Alt/Clr Home and Alt/Insert, not the physical mouse button states. The other thing that might need clarification is that the Caps Lock bit indicates the current state of Caps Lock as if it were implemented with a locking push-button; rather than indicating the switch is closed, it will toggle with each Caps Lock keypress.

---

atari.st/tech #1289, from mpock, Wed Nov 26 12:50:16 1986. A comment to message 1255.

>bit 3 in "conterm" forces return of kbshift states...

Thanks, Ron. I have a use for that information myself. I wonder why it defaults to off? Is there some disadvantage to having it returned all the time?

---

atari.st/tech #1309, from sprung, Sun Nov 30 00:15:04 1986. A comment to message 1289.

I don't know, but it seems a pain to have to go supervisor just to tell the machine you want all the keyboard info, doesn't it?

---

atari.st/tech #1312, from dbetz, Sun Nov 30 09:14:30 1986. A comment to message 1309.

I have run into problems with some programs if I leave bit 3 on. They seem to think that they are going to get a value from 0 to 255 from the high word of bconin() and crash when they try to use the full value with the shift bits as an index into a table.

continued

Inquiry 98

IBM PC and Compatibles

The IBM PC section begins with a question of how to prevent a format. Specifically, someone wants to make it more difficult to accidentally format the hard drive. A number of suggestions making use of .BAT files are given. The section ends with a look at the uses and interrupt codes for a variety of COM ports, whether standard or not.

TO CATCH A FORMAT

ibm.pc/software #1839, from dnicol (David Nicol), Tue Dec 2 15:38:22 1986.

I am having trouble with DOS 3.2. I started to write a program, FORMAT.BAT, to catch any attempt to reformat the hard disk (Okay - I have since heard that DOS 3.2 warns you). But I keep getting error messages about intermediate file error. If you are really unlucky, the keyboard can seize up entirely - all you can do is switch off. The .BAT file was something like

```
REM  hard disk saver
if X%1 == XA goto |ok
echo silly trying to format hard disk
goto exit
:ok format %1 %2 %3 %4 %5
:exit
```

Now, trying to trace down the error I find that without any TSRs loaded or anything (DOS is not happy about secondary command processors), COMMAND on its own will enter a new process - but COMMAND DIR to run DIR at the next level falls over with SPECIFIED COMMAND search directory not loaded. This is not what the DOS book says. What am I doing that's silly? It's a standard AT with a PGC card. I had CED loaded, but even without that, and with no other TSRs, I am still running into trouble.

ibm.pc/software #1840, from jrobie (Jonathan Robie), Tue Dec 2 16:29:15 1986. A comment to message 1839.

I'm not sure what your problem is, but I wrote a program to do the same thing months ago and left it in ms.dos/batch as message #108. It works on my computer under DOS 3.2. Hope it does the job for you!

ms.dos/batch #108, from jrobie, Mon Aug 4 23:12:01 1986.

I have a good friend who just formatted his hard disk. Since I'm the person who has to bail him out when he does these things, I thought I'd write a batch file to protect him.

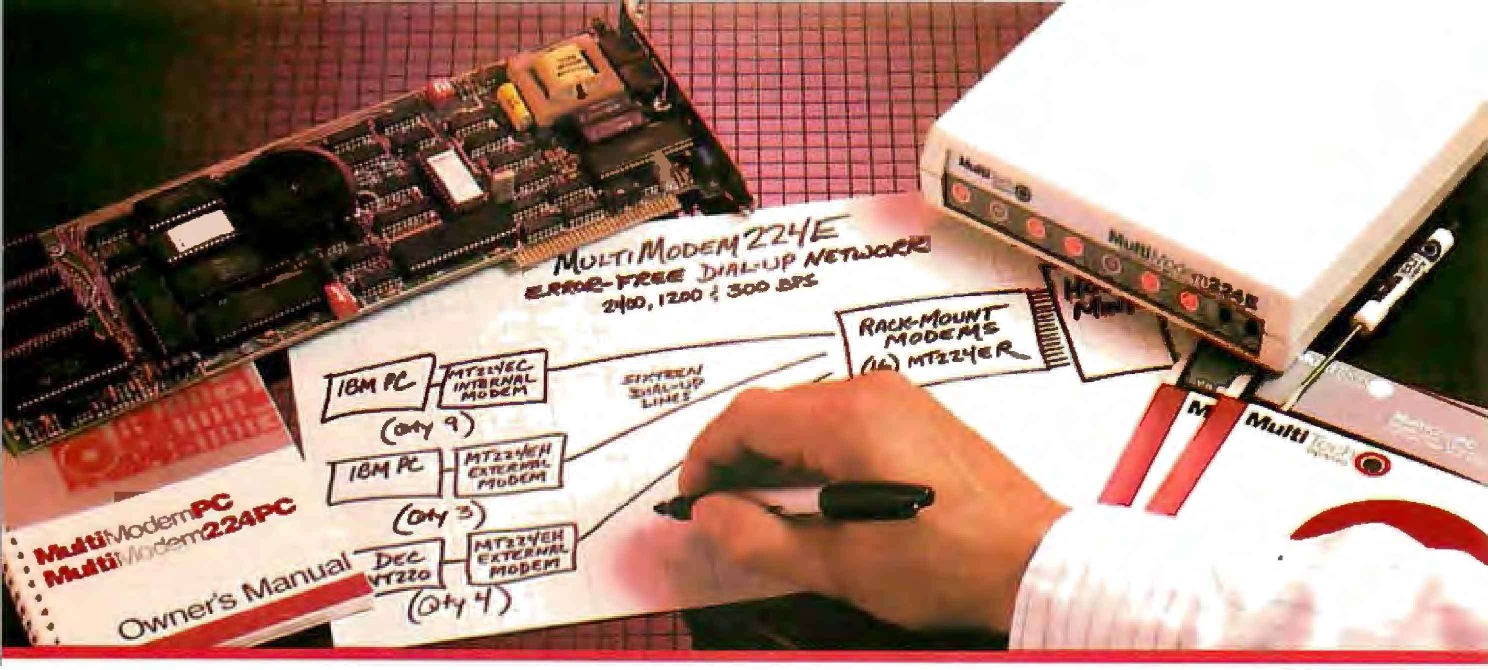
This batch file expects a format statement in the formt a: /s/v

That is, the first argument is the drive identifier, and the second is the list of parameters to be used when formatting the disk.

If the drive identifier refers to a floppy drive, then it simply calls the standard format program (conveniently renamed FORMATX.COM). If a hard-disk identifier or an invalid identifier is given then it displays an error message.

```
echo off
if %1 == a: goto :a
if %1 == A: goto :a
if %1 == b: goto :b
if %1 == B: goto :b
echo  You may only format a disk in drive A or drive B!
echo  Please place a disk in drive A or B, then try
      again.
echo  Use the form:
echo         format a: /s/v
echo  where the first argument is the drive and the
      second is the list of parameters for the format
echo  command.
```

continued



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```
goto :bye
:a
:b formatx %1 %2
:bye
echo off
```

---

ibm.pc/software #1841, from skluger (Sigi Kluger, Definicon Systems), Tue Dec 2 16:35:03 1986. A comment to message 1839.

I am currently running 3.2 and I haven't gotten any error messages from your .BAT file, yet it doesn't work anyway. You cannot follow a label with a command, like

```
:ok format a:
```

because whatever follows the label on the same line is ignored. Also, you are not testing for lowercase "a:"...

Changing that line to two lines as in

```
:ok
format %1 %2 %3 %4 %5
```

worked for me. Also, this, of course, assumes you only want to format A:; how about B:? I even tried running it from a secondary COMMAND.COM, and it, too, worked!

---

ibm.pc/software #1842, from geary (Michael Geary), Tue Dec 2 20:48:48 1986. A comment to message 1839.

If you want to execute a secondary command processor and give it a command like DIR, do it like this:

```
command /c dir
```

You need the "/c". If you put anything before the /c, COMMAND thinks that is the directory you want to put into the COMSPEC setting. That's why it complained about the "COMMAND search directory."

As Sigi mentioned, you can't put a command on the same line as a label. Put it on the next line instead. Also, if you are writing a batch file to override a program like FORMAT, you should rename the .EXE or .COM file to a different name. If you're in the same directory as the program, it will go ahead and run the program, not the batch file. (The search order is .COM, .EXE, then .BAT.)

And, as you noted, DOS 3.2 has enough warnings in FORMAT.COM that batch files like this aren't really necessary any more. I just tried to format my hard disk:

```
C:\WINDOWS >
format c:
Enter current Volume Label for drive C: fixed disk

WARNING, ALL DATA ON NON-REMOVABLE DISK DRIVE C: WILL
BE LOST! Proceed with Format (Y/N)?n

C:\WINDOWS >
```

---

ibm.pc/software #1843, from skluger, Tue Dec 2 21:34:57 1986. A comment to message 1842.

That is, if your hard disk has a volume label. If it doesn't, you will only get the WARNING message. I haven't formatted a hard disk in about 2 weeks so I don't quite remember, but I think it asks you AGAIN if you say yes the first time.

continued

OVERFLOWED ENVIRONMENT TABLE

ibm.pc/software #1846, from anon (John Masters), Thu Dec 4 13:36:31 1986.

I had an overflowed environment table and I added the line

```
SHELL=C:\bin\command.com /p/e:320
```

in my CONFIG.SYS. (By the way, I'm using DOS 3.2.) It's working fine in terms of the environment variable table size. However, one problem I am having is that COMMAND.COM doesn't execute AUTOEXEC.BAT automatically. I tried to add "/C autoexec" option to the line. Then it executes AUTOEXEC.BAT, but the control doesn't return to the terminal. It freezes the computer after it finishes executing AUTOEXEC.BAT. Anybody know how to expand the environment table size while having COMMAND.COM execute AUTOEXEC.BAT automatically?

---

ibm.pc/software #1847, from dondumitru (Donald Dumitru), Thu Dec 4 18:15:05 1986. A comment to message 1846.

I use

```
SHELL=C:\path\command.com c:\path /e:nn /p
```

where "path" is the path to the command processor, and "nn" is the environment size. This is under DOS 3.1, though I have the same thing on another system with DOS 3.2 - maybe there is a requirement on the order of the switches. (By the way - the c:\path thingy tells COMMAND.COM where to reload itself from.)

---

ibm.pc/software #1851, from geary, Fri Dec 5 01:03:33 1986. A comment to message 1846.

I have

```
SHELL=C:\bin\command.com /e:512 /p
```

and it works fine. AUTOEXEC.BAT is in the root directory; it's DOS 3.2. It also worked if I swapped the /p and /e:512.

---

ibm.pc/software #1858, from gstrahl (George Strahl), Sun Dec 7 20:32:37 1986. A comment to message 1851.

I thought the /p option indicated that the AUTOEXEC.BAT should be executed next. My XT clone works nicely with

```
SHELL=C:\command.com c:\ /p,
```

although I have not used the /e:xxx option. Am I wrong about the /p usage?

---

ibm.pc/software #1859, from dmick (Dan Mick), Sun Dec 7 20:37:58 1986. A comment to message 1858.

/p means that a copy of COMMAND is permanent and should not be removed upon receipt of an EXIT command. I don't know whether it affects AUTOEXEC execution or not.

---

ibm.pc/software #1861, from geary, Mon Dec 8 04:03:36 1986. A comment to message 1859.

Yes, /p means both those things: Make COMMAND.COM permanent, and execute AUTOEXEC.BAT.

COM PORTS

ibm.pc/hardware #1655, from dmick, Wed Nov 19 13:25:14 1986.

All this talk about COMn has me confused. On the PC XT-class machines, COM1 is the 3xx addresses, COM2 is the 2xx addresses, and each have their own IRQ (3 and 4, I think, but whatever). What are COM3-whatever? Qmodem lets me do all a way up to COM16, but what good does that do unless there's a reasonably standard port/IRQ mapping for them?

---

ibm.pc/hardware #1656, from skluger, Wed Nov 19 13:52:14 1986. A comment to message 1655.

According to my ProYAM manual, here are COMn ports/IRQs:

COM3	3E8	IRQ4
COM4	2E8	IRQ3
COM5	2B8	IRQ3
COM6	2B8	IRQ2
COM7	2F8	IRQ2
OM8	278	IRQ2

(The last three are marked "alternate for IBM" and COM5 is marked "Columbia".)

---

ibm.pc/hardware #1658, from geary, Wed Nov 19 19:03:43 1986. A comment to message 1655.

COM1 and COM2 are the only "standard" ports, and they're as you describe. Serial card vendors can, of course, build nonstandard cards using whatever port addresses and interrupt vectors they choose. Or even different serial chips. How they're addressed (COM3, FOOBAR4, etc.) is entirely up to the software used with them.

---

ibm.pc/hardware #1682, from rlatham (Richard Latham), Thu Nov 20 22:12:27 1986. A comment to message 1656.

The guys who originally wrote the BIOS obviously expected to run up to four serial ports. They left room in the equipment list area for four UART addresses.

---

ibm.pc/hardware #1692, from geary, Fri Nov 21 02:28:56 1986. A comment to message 1682.

That's right, and there is also room for four parallel printer port addresses in that same area. It's interesting to look over the BIOS and hardware design - the PC architecture was obviously thrown together in a big hurry. (I get a kick out of seeing the light pen connector on the monochrome display adapter, which is not usable because of the long-persistence phosphor on the monochrome display.)

---

ibm.pc/hardware #1708, from dmick, Sat Nov 22 00:44:08 1986. A comment to message 1692.

Depends on the monitor. We can use the pen with a Paradise board, anyway. But you've gotta really crank the contrast, and the FTG does a worse job than the Micrografx. But it works...sorta....

---

ibm.pc/hardware #1827, from jmontl (Joe Miramontl), Sun Dec 7 02:35:40 1986. A comment to message 1656.

Based on my use of an Everex half-card modem, and the ProComm software, and some playing around with Debug, here is my understanding of the interactions between COM1, COM2, and additional ports. Here are the apparent addresses and hardware. Interrupt assignments for the four "supported" COMn: ports. as recognized for my system:

BASE	ADDR	IRQx	INTx
COM1:	3F8	4	0C
COM2:	2F8	3	0B
COM3:	6F8	4	0C
COM4:	7F8	3	0B

When DOS first loads, vectors 06, 07, 0B, and 0C all point to a dummy routine, since DOS supports only noninterrupt-driven serial I/O through the BIOS. The BIOS has support for 4 serial ports and maintains a four-entry table (called RS232_BASE in the BIOS listings) to store the I/O port addresses. BIOS I/O is performed through software INT 14h with a code of 0-3 in DX, which acts as an index into the port addresses in RS232_BASE. The BIOS then performs wait-mode I/O, without benefit of interrupts.

ProComm gets around this restriction by taking over the hardware interrupt vector 0B if COM2: or COM4: has

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Inquiry 151

been selected, or hardware vector 0C if COM1: or COM3: was selected. It does this on the fly as you change the "parameter" settings (Alt-p). This can be seen easily by changing the COMn: settings, opening a "DOS-Gateway" (alt-F4), and running either of the excellent memory-mapping utilities (PMAP or MAPMEM), which, among other things, will show which resident programs stole which vectors.

The problem with all this is that even and odd ports share the same hardware interrupt vectors. On a machine with a well-designed I/O channel (BUS), like the DEC 11/XX series computers, this would be no problem, since the multiple interrupts would be "either'ed" or "or'ed" electrically or "chained" and the processor could then go out and read status ports to find out which COMn: interrupted (POLLING). IBM, however, curiously put tri-state drivers on the IRQx (interrupt request) lines. (Tri-state means positive, negative, or open circuit). These types of drivers short out if more than one is enabled for a given interrupt line. These drivers are enabled whenever hardware ints are enabled (bit 3 in port ?FCh - modem line control - is set).

The point of all this is that you can have beaucoup ports connected to IRQ3 (or IRQ4), but only one can have interrupts enabled. You can't, for example, have your mouse hooked up to COM1:/COM2: and expect to use COM3:/COM4: for ProComm. Both ports get ints enabled and you end up with tri-state drivers shorting each other out (almost as bad as it sounds, but the boards won't be harmed). This causes you to lock up your mouse, and while ProComm will dial any number you like, you won't see anything on the screen. You CAN, however, put a noninterrupt-driven device like a serial plotter on COM1: and your interrupt-driven mouse on COM2: and use COM3: for mostly-interrupt-driven ProComm.

The upshot of all this for software writers is that if you're going to use COM3:/COM4: with interrupts, then you must first check for interrupts enabled on COM1:/COM2:, and vice versa. (And, if so, remedy the situation.) ProComm does not do this; an easy oversight to make.

If any of this is incorrect, please let me know. Skip the next message if you've already read more than you wanted to.

ibm.pc/hardware #1828, from jmonti, Sun Dec 7 02:38:29 1986. A comment to message 1827.

As a diversion, I was curious what would happen if I were to modify the bus drivers on my serial card and my modem card, making them open-emitter drivers, so that the bus or'ed the multiple interrupt requests. (The actual implementation was 1N914 diodes terminating into about a 1K resister to ground. This gave about 0.0/2.5 volt levels. Pretty bad, but better than the 0.5 volt I was seeing with the drivers battling each other.

Sadly, while the hardware could now support multiple interrupts with polling, the software was not up to the mark. I mention it, however, as a viable solution if anyone needed to design a custom system with more than two interrupt-driven serial ports. And for those who are curious about such things, as I am, the interrupt latency on an 8088, at 4.77 MHz, is 60 microseconds (worst case 200), and on an 8086 at 9.54 MHz is 20 microseconds (worst case 50). If anyone knows the figures for an AT, please let me know. (Times were from the rise of IRQ3 till it fell back -- time till serial port read.)

ibm.pc/hardware #1829, from barryn (Barry Nance), Sun Dec 7 10:44:38 1986. A comment to message 1828.

Interesting, Joe. Do you want some configurable/modifiable communications software to try out with the "new" hardware? Take a look at "telecomm.tech/example.code," and watch (shortly) for a buffered, interrupt-driven int 14 replacement that I'll be posting.

ibm.pc/hardware #1832, from geary, Mon Dec 8 04:06:18 1986. A comment to message 1827.

Keep in mind that these port assignments apply only to the Everex modem. If another manufacturer's modem or serial card allows selection of COM3 or COM4, they may or may not follow the same port and interrupt assignments.

APPLE II/MACINTOSH

The Macintosh thread is based on a long message on truncating Macintosh interface files for faster program compilation times. The first Apple II thread deals with whether it is possible to BLOAD a text file in DOS 3.3. The next thread looks at accessing a clock through ProDOS on the IIGS, and leads to a general discussion on slots and devices. The final thread looks at what is required to boot from the RAM disk on the IIGS.

TRUNCATING INTERFACE FILES

macIntosh/softw.devlpmt #685, from ccrawfor (Chris Crawford), Mon Dec 1 21:43:13 1986.

Some of you may recall that awhile back I posted results of a direct comparison of compilation times for the same program in Lisa Pascal and MPW Pascal. You will recall that the timings were 7 minutes for Lisa Pascal, 8 minutes for MPW Pascal on a 512K Mac, and 6 minutes on a Mac Plus. I made an experiment today that has striking implications. What I did was to carry over my truncated OSIntf, ToolIntf, and PackIntf files from Lisa Pascal to MPW.

An explanation is in order at this point.

Every Mac Pascal program that makes use of the Toolbox and OS must use these interface files to tell the Pascal compiler where all the Toolbox and OS routines are. Of course, with a Toolbox as big as the Mac's, that adds up to a bunch of interface stuff. As it happens, any given program will likely use only a fraction of the stuff in the interface files. What I did was to go through the interface files, ripping out all references to stuff I knew I wouldn't use. This created my truncated OSIntf, ToolIntf, and PackIntf files.

Now, my earlier comparison was unfair to MPW, because I used the truncated files for Lisa Pascal but not for MPW. I didn't think there'd be much difference. Boy, was I wrong! When I ported over the truncated files and ran the test, I got a time of 5 minutes, 15 seconds on a 512K Mac. That's only about 65% of the time that the compilation with regular files takes!

The conclusion I draw from this is that those interface files really cost lots of compilation time. My truncation was not heavy-handed; I could probably go through my truncated files and remove as much material from them as I have already removed.

And it is here that I finally come to the debatable point I would like to present. How far should I go in this effort? The temptation is to rip and slash out anything that I do recognize. My fear, though, is three-fold: 1) How do I know that minor routines that I don't recognize aren't called by higher-level routines that I *do* use? Might this somehow confuse the compiler? 2) How do I know that the routine I am NOT using today may become necessary tomorrow? 3) Is there some chance that such radical surgery might not cause weird bugs further down the road? Or that the truncated material might contain information necessary for my program to run on machines with other configurations than mine?

Some of these concerns may seem paranoid to you, but my first line of defense against bugs has always been hysterical paranoia.

macintosh/softw.devlpmt #693, from scotty (Barry Wilson), Wed Dec 3 20:21:25 1986. A comment to message 685.

I've been using a {$LOAD} compiler directive in my uses statements. The syntax is {$LOAD filename}. This dumps the symbol table the first time it is encountered and then loads it on consecutive compiles. Only problem is that if the heap is fragmented enough, you end up with some weird errors. This is apparently because the {$LOAD} expects the symbol tables to get loaded into the heap contiguously. Other than that, it speeds compiles up tremendously. Now, if only something could be done about Links...

DOS 3.3 POKE FOR BLOAD

apple/software #444, from bill.p (Bill A. Pugh), Thu Dec 18 19:04:23 1986.

Any DOS 3.3 experts out there? If so, I need help from

continued

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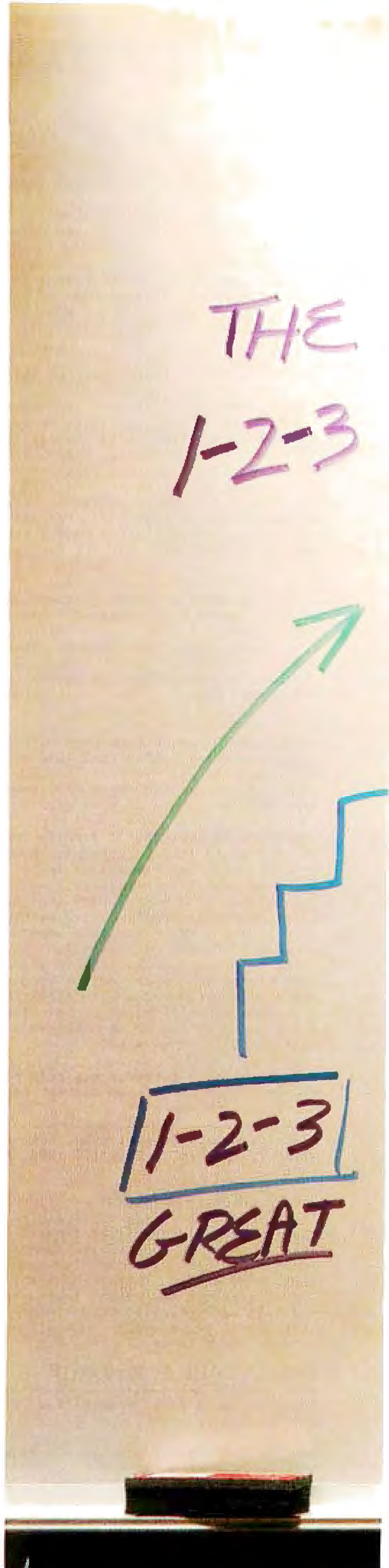
Lotus HAL resides in memory with 1-2-3 and operates with it; a minimum system configuration of 512K is required.
*Lotus HAL does not operate with 1-2-3 for the IBM PCjr (ROM version), IBM PC Convertible or Release 1A for the IBM 3270 PC.



you. Is it possible to directly BLOAD a text file into memory? I'm thinking of making a very small patch or poke(s) to DOS 3.3 in memory to get it to ignore the type of file that is specified so that it will load the data in the text file straight into memory as if it were a binary file. Anyone know how?
bill.p

---

apple/software #445, from jerryh (Jerry Hewett), Fri Dec 19 12:36:58 1986. A comment to message 444-

Yes, it is possible to BLOAD text files from Sloth 3.3 -- I just wish I could remember what I changed and where to make it possible (we're talking a *long* time ago...). Why would you want to modify Sloth 3.3 when ProDOS does that (and a whole lot more!) already? You can load *anything* into memory -- even a directory or subdirectory! The feature is built into ProDOS. In your case, the command would be:

```
BLOAD <filename>,TTXT,A$<address>
```

Is there a really good reason why you haven't dropped Sloth 3.3 like a hot rock and moved over to ProDOS?

---

apple/software #446, from mdavis (Morgan Davis), Fri Dec 19 13:17:47 1986. A comment to message 444.

I have the answer for you (it's on a disk I have in a program listing). So when I get off BIX, I'll list it out and report the answer here. (Not that I actually use DOS 3.3, mind you. I had to [he says, with this sour look on his face] when a client wanted a ProDOS and DOS 3.3 version of a utility I wrote. ProDOS is so much simpler with its "T" parameter...)

---

apple/software #447, from mdavis, Fri Dec 19 13:43:56 1986.

Assuming you have "normal" DOS in memory (not relocated to the language card or anything) the following POKEs will allow you to BLOAD any file.

```
POKE -23706, TYPE        POKE -23699, TYPE

where TYPE is one of the following values:

        00      Text file
        01      Integer BASIC program
        02      Applesoft BASIC program
        04      Binary file
        08      Special "S" file
        10      Relocatable "R" file
        20      Special "A" file
        40      Special "B" file
```

--Morgan

---

apple/software #448, from bill.p, Fri Dec 19 15:33:24 1986. A comment to message 447.

Okay, thanks for the info. I really appreciate it. Why do I need to know this for DOS 3.3, you ask? Because I am used to ProDOS and am unfamiliar with DOS 3.3, but a situation came up where I needed to make a program compatible with DOS 3.3 programs.
Don't worry, I am slowly but surely converting over to ProDOS....I just wish that more people would do the same so I would not have to remember so much stuff for BOTH DOS types; I just learn and become expert with one... bill.p

---

apple/software #449, from bill.p, Fri Dec 19 15:34:52 1986. A comment to message 447.

The DOS 3.3 type I have loads itself into the language card area of RAM (Pronto DOS), so which memory locations do I poke now?

bill.p

---

apple/software #452, from mdavis, Sat Dec 20 14:07:19 1986. A comment to message 449.

continued

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Well, I would suggest, then, that you use normal DOS, make the pokes, and then use DDMOVER (or something similar that moves DOS to the language card) followed by a Master Create of your disk. That will at least allow you to make the changes and make them permanent on that one disk. Of course, that means whatever file type you poke for BLOADing will be the only one allowed.

It might be better to poke the following, if you don't care about any file type error handling:

```
POKE -23587,96      (RTS)
POKE -23586,234     (NOP)
POKE -23585,234     (NOP)
```

This will bypass the file type checking routine. This might be best if you're going to Master Create the disk (at least you can BLOAD any file that way).

I hate DOS 3.3.

THE CLOCK THROUGH PRODOS

[Message 377 picks up on a thread dealing with klutch's problems with his IIGS.]

---

apple/gs.other #377, from klutch (Bruce Klutchko), Tue Dec 2 20:39:07 1986. A comment to message 367.

... As it is, I am having trouble accessing the clock from ProDOS 1.1.1, and suspect that ProDOS-8 will be a help.

I do find the machine a tremendous improvement over my IIe's, as I love the keyboard and the ability to set the options on the control panel. My greatest problems are *not* Apple's doing, such as not being able to use my DOS 3.3 RAM disk software (on which I was totally dependent) for my AE Ramworks card. I may have to rewrite the software to ProDOS now. Also, I was very much dependent upon using an enhanced AppleWorks with the AE desktop expansion. I did buy V2.0, but as of yet, of course, this software isn't compatible. Therefore, I will still have to run my business on the IIe's in the office. But I suspect I will be spending much of my free time on the IIGS.

---

apple/gs.other #380, from robmoore (Rob Moore, Apple Computer Inc.), Wed Dec 3 04:47:32 1986. A comment to message 377.

ProDOS-8 will handle the clock for you. If your dealer calls his Apple distribution center, he should be able to get system disks. If he can't, then go to any other Apple dealer and make a copy if you want. I believe that AppleWorks 2.0 does expand the desktop in the GS. I'm not positive, though, because I don't use AppleWorks much. In any case, I hope this helps. Let me know if you have other questions.

---

apple/gs.other #385, from gs.softteam (Apple Computer Inc.), Wed Dec 3 13:43:45 1986. A comment to message 380.

The clock is implemented as a function under one of the tool sets (namely, the miscellaneous tool set). It does not appear in a slot, like the ThunderClock did. Nor does it place the time in page 2 locations as the ThunderClock did. Under ProDOS-8, the "get time" call will access the IIGS clock via the miscellaneous tools. APDA will be the earliest source of technical documentation and development software.
Ray Montagne (IIGS Software Team)

---

apple/gs.other #388, from mdavis (Morgan Davis), Wed Dec 3 19:27:50 1986. A comment to message 385.

ProDOS Tech Note #1 stated that the clock under ProDOS will deposit the ASCII time string into page 2. Now, under ProDOS-8, this won't happen. What was the rationale behind NOT making ProDOS-8 compatible? P16 is fine, but I would think that in order to avoid undue problems, Apple should have kept things compatible. We can't always trust tech notes now.

---

apple/gs.other #393, from gs.softteam, Thu Dec 4 12:38:51 1986. A comment to message 388.

The main compatability issue here is that the original clock (usually a ThunderClock) was implemented as a peripheral card. There were no additional slots available to do this.

Second, your statement asking the rationale of ProDOS-8 not being compatable with P16 is in error. ProDOS-8 has been modified to recognize when it is running in the IIGS and, thus, will use the IIGS clock when possible. ProDOS-8 running in an Apple IIe will still run with a ThunderClock.

ProDOS-16 actually has no call to read time. Since new (P16) applications will likely be running in the full native environment (16-bit), the application will have to make calls directly to the miscellaneous tool set and avoid the additional performance hit if the

continued


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call were to be made through P16. If P16 had implemented the time calls, then P16 would have ended up making the tool call. It's just faster to let the application do it itself.
Ray Montagne (IIGS Software Team)

---

apple/gs.other #394, from delton (Don Elton), Thu Dec 4 17:55:04 1986. A comment to message 393.

I think Morgan's point was that the ProDOS-8 GS clock driver doesn't put the date/time string at $200 like the ProDOS driver does on a IIe with a ThunderClock. Software that depends on the Apple-documented policy that all user clock drivers put the time date string in ASCII at $200 would thus fail on the IIGS because of the difference between the Apple software specs and the apparent performance of the Apple driver.

---

apple/gs.other #395, from mdavis, Thu Dec 4 18:41:42 1986. A comment to message 393.

You misread my message. What I said was, since ProDOS-16 cannot run on an Apple IIe, Apple IIc, or Apple II+, I felt as though the clock incompatibility was not an issue. However, since Apple made it clear in Tech Note #1 that you'll get an ASCII string of time data into page 2 whenever you use the "get time" call, I would have at least expected the 8-bit (ProDOS-8) to adhere to this in order to avoid problems for existing Apple II software being used on the GS in emulation mode. As it is, I now have to rewrite the clock routines in a few of my programs so that it will work correctly on the GS in emulation mode. It was nice having most of the work done for you; but now I'll have to unpack those damn date bytes (which isn't anything new to me) and write an algorithm to calculate the day of the week from that information, and so forth. My "time" routine will probably quadruple in size.

---

apple/gs.other #397, from gs.softteam, Thu Dec 4 20:06:32 1986. A comment to message 395.

ProDOS-8 supports the IIGS clock as the ProDOS "get time" ($82) mli call has always been documented. Applications executing "get time" receive the time in a hex format in the BF-hundred page ($BF90-$BF92). I don't have Tech Note #1 right now, but I think it describes installing a clock driver into ProDOS, and not how ProDOS returns the time. I will get a copy of the tech note and try to clear up any discrepancies. Stay tuned....
Ray Montagne (IIGS Software Team)

---

apple/gs.other #400, from mdavis, Fri Dec 5 03:58:47 1986. A comment to message 397.

You're partially correct. Tech Note #1 details the global page date bytes, but also discusses how you will get a string of ASCII characters into the input buffer whenever "get time" is executed.

Have I ever lied to you, Ray? :-)

BOOTING THE /RAM5 DISK

---

apple/gs.other #405, from mdavis, Sun Dec 7 03:58:12 1986.

Is there a set of commands that will let you "boot" /RAM5 as if it were a real disk-storage appendage on the GS? Since it's mapped to slot 5, drive 2 (or wherever, drive 2), can this be done? If not, is that just a limitation of ProDOS-8, or is it also true with ProDOS-16 (or with the hardware itself)?

---

apple/gs.other #406, from delton, Sun Dec 7 07:07:02 1986. A comment to message 405.

You can boot from the RAM disk, slot 5. Go to the "slots" section of the control panel and keep hitting --> until "RAM disk" comes up. /RAM5 is still mapped to slot 5, drive 2, but it boots from there instead of the 3.5-inch disk in slot 5. You have to copy ProDOS onto the drive and a system program as you might expect and you probably have to use FILER first to format the disk (so boot code gets written). I haven't tried it without this latter step, since the Apple Memory Expansion card (slinky card) has this same requirement and it probably applies to the IIGS as well.

apple/gs.other #407, from delton, Sun Dec 7 07:07:46

There's also an option to boot from ROM disk but I don't know where that one tries to boot from.

apple/gs.other #408, from gs.softteam, Sun Dec 7 13:00:48 1986. A comment to message 406.

Close, but not quite. When you set the boot device to RAM Disk at reset, the RAM disk is assigned unit 1. The 3.5-inch drive that was unit 1 will be unit 2. The Apple IIGS works like all other Apple II products in that you can only boot from unit 1 in any given slot containing a block device.

In order to accomplish booting from various devices in slot 5, the assignment of unit numbers to devices is based on the control panel setting for the boot device. When set to boot off "Slot5" or "SCAN," booting will occur off the 3.5-inch drive closest to the computer (unit 1). When set to boot off the RAM Disk or the ROM disk, whichever of these devices is selected and installed will be assigned unit 1. A detailed explanation of device-mapping on slot 5 has already been offered on this forum, but I don't remember what message number. You may want to search for it.
Ray Montagne (IIGS Software Team)

apple/gs.other #409, from gs.softteam, Sun Dec 7 13:17:23 1986. A comment to message 408.

I found my previous explanation. See apple/gs.flames #287 for more information on SmartPort device mapping.
Ray Montagne (IIGS Software Team)

apple/gs.flames #287, from gs.softteam, Sun Nov 2 14:15:24 1986. A comment to message 284.

I have been waiting for this one to show up and was sure it would. If you count the number of devices supported on the IIGS and the number of internal slots, you see that there are more devices than slots.

[1] Serial port 1
[2] Serial port 2
[3] 80 column card
[4] Mouse
[5] SmartPort
[6] Disk][
[7] AppleTalk
[8] RAM disk
[9] ROM disk

This being the case, the only way we could support the RAM disk and ROM disk was to logically insert these devices into the SmartPort device chain. Boot devices can only boot off the first device in any given port. When dealing with SmartPort, we have 3 bootable devices (Slot5, RAM Disk, and ROM Disk). In order to support booting off of any of the 3 different types of devices on SmartPort, the logical arrangement of devices has to change, depending on the boot configuration set in the control panel, so that the boot device is moved to the first device in the chain. SmartPort does this at boot time by assigning unit numbers to SmartPort devices in a two-stage process. First, unit numbers are assigned

continued

in ascending order, starting with the RAM disk, ROM disk, and then the SmartPort devices such as AppleDisk 3.5 & UniDisk3.5. Once all devices have had their unit numbers assigned, the second-stage assignment takes place. During the second stage, the boot device is moved to unit 1 (the first device on the chain) and all devices that were ahead of the boot device in the first-stage assignment are moved behind that device in the second-stage assignment. This is how your device list in ProDOS can appear different for various boot configurations. ProDOS 1.1.1 only supports two devices per slot. When using a RAM Disk and two 3.5-inch disk drives with slot 5 set as the boot device (or scan, for that matter), the first physically connected 3.5-inch drive will be unit 1, the RAM Disk will be unit 2, and the second physically connected 3.5-inch disk drive will be unit 3. Since ProDOS 1.1.1 only supports 2 devices per slot, one of the devices will be lost. But, alas, we anticipated your frustration and mapped the second two SmartPort devices into slot 2 when using ProDOS-8. This means that with ProDOS-8 your second 3.5-inch drive would appear in slot 2, drive 1 of the ProDOS device list. You can recover lost devices on ProDOS 1.1.1 applications by copying ProDOS-8 onto that disk. ProDOS-16 will recognize SmartPort devices and will list all SmartPort devices as slot 5 with the appropriate unit number.

I hope this explains the missing device problem. It has been pretty confusing to most everyone at Apple, too.
Ray Montagne (IIGS Software Team)

---

apple/gs.other #410, from mdavis, Mon Dec 8 01:26:03 1986. A comment to message 406.

> Go to the "slots" section...and keep hitting -->
>until "RAM disk" comes up.

Yeah, yeah, yeah....and then what? (I don't have a GS in front of me, so I can't visualize the rest of the procedure.)

While at Jerry's place a few days ago, we used UniCopy to move an entire 3.5-inch disk to /RAM5 for booting and using from there. Much faster, of course, than the AppleDisk 3.5. Rather than 44 seconds to boot P16, it takes less than half that time.

---

apple/gs.other #412, from delton, Mon Dec 8 19:18:52 1986. A comment to message 410.

Okay, after "RAM disk" comes up as the startup slot, you hit return to accept and then move to the quit bar to get out of the control panel. Next time you boot, the system will boot from /RAM5 instead of whatever was previously set up.

BASIC

Topics in this excerpt include the degree of support for windows and mouse devices in QuickBASIC 2.0 and Turbo BASIC, and solutions to a variety of programming problems.

WINDOWS AND MICE IN BASIC

---

basic/newbasics #406, from shalom (Sholom Hamada), Sat Dec 27 21:19:56 1986.

I have a question about Microsoft's QuickBASIC and Borland's upcoming Turbo BASIC. Why won't they implement some windowing and mouse commands in BASIC proper? Microsoft BASIC for the Mac contains such commands as MENU (to create and interface with pull-down menus), mouse functions (to get mouse coordinates and values), DIALOG (to create and interact with dialog boxes), WINDOW (to open actual windows, not just to redefine x,y coordinates), EDIT FIELD, etc, etc. If it can be done for the Mac, why not for the PC?

I assume, of course, that these commands need interfacing to some windowing system. Well then, why can't QuickBASIC interface to Microsoft's own Windows? And if Borland could create such a sophisticated user interface for *developing* TurboBASIC programs, then why can't they allow BASIC programs to utilize those facilities?

Is there some difficulty in implementing this that I'm not aware of? Is there some company that sells QuickBASIC code for doing these things? Is there some way of interfacing these BASICs to Windows, GEM, etc?

---

basic/newbasics #407, from btonkin (Bruce Tonkin), Sat Dec 27 22:00:32 1986. A comment to message 406.

I can only offer my suspicions concerning these questions, but I think they're probably reasonably close.

1. Windowing techniques are pretty difficult to write without making some assumptions about the hardware. So, if you want a general-purpose access to windowing environments, it's going to mean a fairly hefty library. Now: QB sells for $99, and TB will sell for $99.95. I'll bet those libraries could be sold for more than the $99, all by themselves. Certainly, the MS C package with links to Windows sells for about $400.

2. MS and Borland are both assuming (probably incorrectly - certainly incorrectly in my case) that developers aren't going to use BASIC, but C or Pascal. So, windows is offered on those languages and not on BASIC.

3. Windows support under BASIC would mean a different calling convention than for C. The parameters are passed in a different order. That would mean either changing BASIC or having a different version of windows for BASIC developers, with twice the support requirements as for the current package.

4. How much of a market is there for windowing environments? Is there enough of one to go beyond the support furnished in C? MS may hope that Windows catches on in the MS-DOS market, but I see no signs that it has, or will ever do so. If it does, fine; you can bet MS will support it on all their products, one way or another. If it doesn't, or until it does, why commit resources to it beyond what is currently in place?

You may guess from my comments that I don't think much of windowing environments. You'd be right. My impression is that they demand a great deal of overhead, a faster processor than is present in most current micros, and a lot of work to get going correctly. My personal opinion is that they offer nothing to the user and should be avoided whenever and wherever possible, but that's just my PERSONAL opinion. My impressions (as opposed to my opinions) are fairly widely held in the industry.

There are, of course, a few misguided souls who disagree with my opinions. :-)

---

basic/newbasics #408, from lkraft (Larry Kraft, Borland International), Sun Dec 28 02:11:22 1986. A comment to message 407.

As we did with Turbo Pascal, Turbo BASIC will have a wide range of source-code Toolboxes that will give you additional program capabilities. There are add-on products for BASIC. One company is Crescent Software in Connecticut. Ethan Winer has a BIX account, so you might get ahold of him.

EGA SCREEN DUMPS

---

basic/programming #305, from jhuguenard (John Huguenard), Tue Dec 9 00:50:20 1986.

continued

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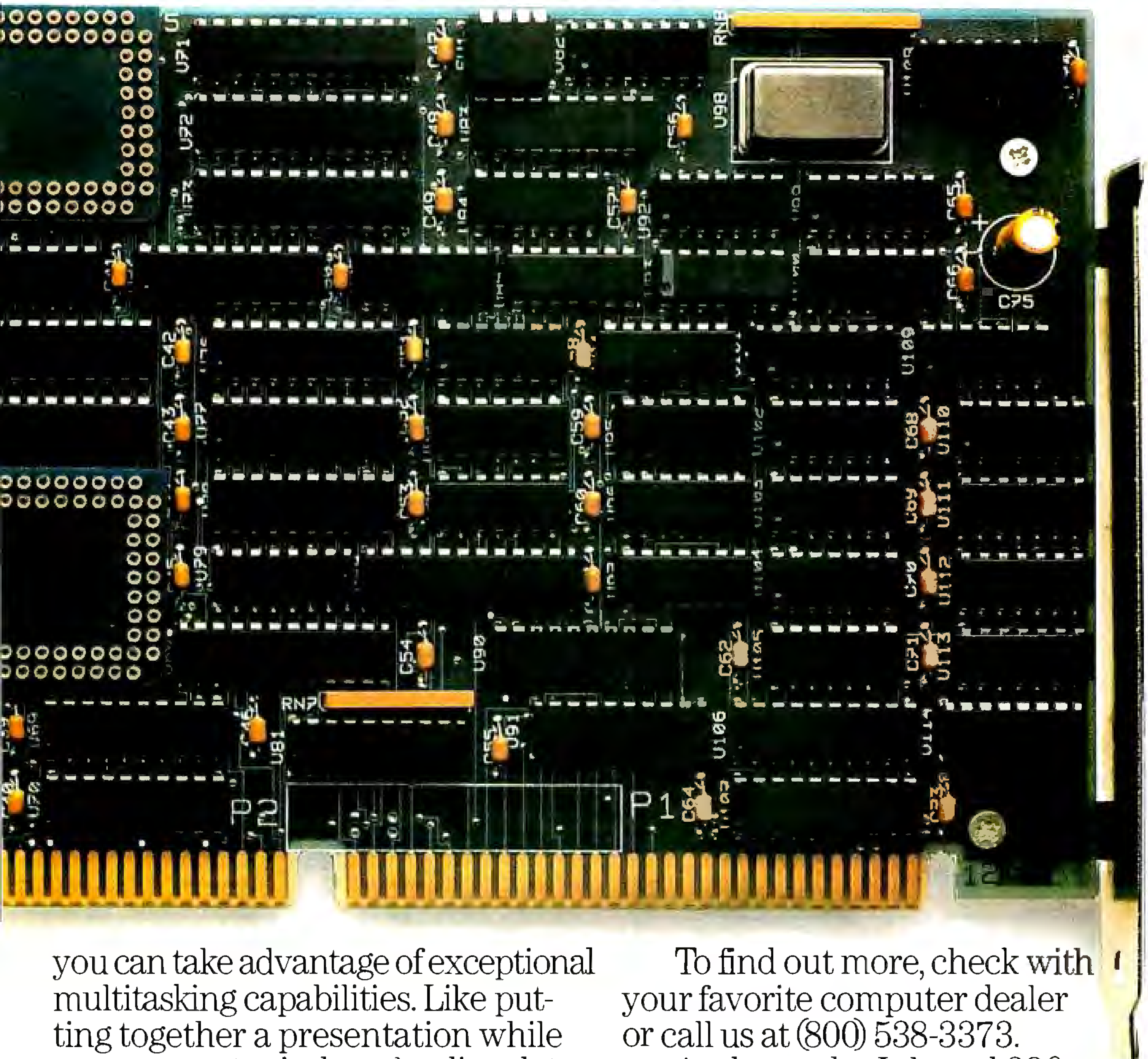

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I need help again on my current program. Two problems: 1) Is there a public domain program (utility) that will allow EGA graphics screen dump to an IBM graphics printer or equivalent? 2) Is there a way to chain to a nonBASIC (QuickBASIC in this case) .EXE or .COM file (e.g., a Turbo Pascal program)?

---

basic/programming #306, from dmick (Don Mick), Tue Dec 9 01:04:45 1986. A comment to message 305.

You can't *chain* to a non-BASIC program, but you can "RUN" or "SHELL" it. No help on the first one, though.

---

basic/programming #307, from barryn (Barry Nance), Tue Dec 9 01:11:49 1986. A comment to message 305.

There's a public domain "Print Screen" program in the Listings conference. It's in the ibm.lib area, and it's called "prtsc.lqr". It contains source code, .doc, and .com files for a print-screen TSR program that is designed for Okidata 92/93 printers *without* the IBM-compatible Plug-'N-Play kit.

I'm sure you can modify it to do EGA graphics on an IBM printer, if you know a little assembler.

FINANCIAL CALCULATIONS

basic/programming #201, from alf (Eric Klein), Wed Dec 3 10:22:18 1986

I need to find the annual percentage gain based on the initial price, the final price, and the amount of time that has passed by. For example, something that was worth $100 two years ago and is worth $121 today would have an annual percentage gain of 10 percent. $100 * 1.1 * 1.1 = $121. Does anyone know the correct formula? Eric Klien

Note: The answer lies in a BASIC finance program that is provided with Apple II computers. (Or, at least, used to be.) Unfortunately, I no longer have this program.

---

basic/programming #302, from btonkin, Wed Dec 3 23:21:34 1986. A comment to message 301.

It all depends on how often you're compounding. The answer to your question would come from a little subroutine that looked like this:

```
X=FINAL/INITIAL RATE=100*((X(1/PERIODS))-1) RETURN
```

where "final" is the final valuation, "initial" is the initial valuation, "periods" is the time period over which interest is to be calculated, and "rate" is the interest rate per period (normally, per year). This calculation implicitly assumes that interest is continuously compounded and would have to be altered if the interest would be compounded at fixed intervals (quarterly, monthly, semi-annually, or annually). In that case, the formula would be more complex.

If accuracy is important, I suggest all variables be made double-precision.

PASCAL

This month's excerpts include questions about data file integrity and security using Turbo Pascal, and a discussion of writing to the lower right corner of the screen without scrolling.

continued

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Inquiry 322

FILE SECURITY TECHNIQUES

pascal/turbo #2283, from prez (Pres Tuesley), Sat Dec 13 12:48:11 1986.

I have an application written in TP that calls up a remote database, transmits some information to it (one "record" at a time), and gets back updated information. I am having problems with line noise and other glitches confusing the program and causing it to lock up or crash. Until I make this program bulletproof, how can I insure the integrity of the disk file I am saving this info to? I find that if the program crashes without closing the file, the directory doesn't get updated and ALL of my information is lost. I understand that I can close the file after every entry is added, but this is also VERY slow (I have been told). Since I am using Concurrent DOS (nee Concurrent CP/M), I don't have the ability to duplicate my file handle and close that, like MS-DOS can. Has anyone out there solved this problem before?

pascal/turbo #2284, from bbrown (Bob Brown), Sat Dec 13 13:00:50 1986. A comment to message 2283.

Pres, what's the load like on the database end? And how long does it take to send a record? If you're the only user, or if the machine is lightly loaded, and if you can overlap (buffer) your communications, then it might not make any difference that closing and reopening a file is a time-consuming operation. If closing/opening takes less time than sending the next record, it's invisible to the remote (sending) end. You probably also want to put a checksum on each record and reject those where the checksum doesn't match when the record gets to the other end. There's a telecommunications conference on BIX where a lot of this kind of stuff is discussed, but I'm not a member, so I can't point you to the right area. You might want to just wander over there and ask your question again.

pascal/turbo #2289, from jimkeo (Jim Keohane), Sat Dec 13 13:34:41 1986. A comment to message 2284.

Pres, the receiving program should be able to detect loss-of-carrier, or garbage-on-line, or time-out, and then close the file at that point. The garbage-on-line condition can be detected by some simple protocol, like a checksum, appended to each transmission. If the checksum does not match what was received, you *might* want to have the recieving program request that the transmission be repeated. After a number of unsuccessful retries, assume it's hopeless and close the file. - Jim

pascal/turbo #2290, from barryn, Sat Dec 13 13:59:42 1986. A comment to message 2283.

I think a good, fast, CRC-based protocol is what you need. Want one already coded in Turbo? Join the pc.bix conference, look at the read.me topic to see which message in the source.code topic is the BIXMODEM.INC file (I forget which it is), and then capture that message from the source.code topic.

[Editor's note—*BIXMODEM.INC, copyrighted by Barry Nance, is almost 10K bytes long, too long to print here. Barry has, however, granted permission for us to include it on BYTEnet Listings (see page 4) and on this issue's listings disk (see insert card following page 352).*]

WRITING TO THE LOWER RIGHT CORNER

pascal/turbo #2291, from bbrown, Sat Dec 13 22:50:23 1986.

If you (read I!) use WRITE (not WriteLn) to put a character in the bottom right corner of the screen, or a window set with the Window procedure, the screen or window rolls up. Is there a way to avoid that?

continued

pascal/turbo #2292, from dondumitru (Donald Dumitru), Sat Dec 13 23:18:42 1986. A comment to message 2291.

What is happening is this: The Turbo Write and WriteLn procs use the BIOS TTY-Write function for their output. The problem is in the BIOS routine. The only way around it involves using a different system for screen writes. You could create your own user-written I/O driver for ConOut. See page 209 in the TP manual. You would need to do your own handling for the cursor. (Does all this make sense, or do I need to go into more detail?)

P.S. It is certainly possible to handle the bottom right corner as a special case - hmmm.

pascal/turbo #2293, from barryn, Sat Dec 13 23:23:52 1986. A comment to message 2292.

I think you're on to something, Don. If only a certain message from a program can ever appear on line 25 (and cause the scroll when it "touches" column 80), then maybe something besides Write() should be used to put that message on the screen in that location. Use Write() for everything else, but do something special for the bottom right corner.

pascal/turbo #2294, from dondumitru, Sun Dec 14 09:56:08 1986. A comment to message 2293.

Actually, I was thinking that you install a new ConOut, in which you look at where the character will be printed. If it is in the bottom right corner, then use the BIOS Write-Character/Attribute-at-Cursor-Position routine; otherwise, use the TTY-Write routine. Now that I think about it, I'm not so sure that Turbo *does* use the TTY-Write routine. TTY-Write doesn't let you give it an attribute; it uses the attribute that is already in that cursor position. Ack. Anybody brave enough to go trace through it? I guess I am...

But yes - if possible, the best choice is to use some other screen-writing technique for the last line only. (Assuming it is reasonable....) Could we have some more info on the application?

pascal/turbo #2297, from dondumitru, Sun Dec 14 10:32:52 1986. A comment to message 2294.

Well, I *was* wrong when I said Turbo used TTY-Write. It uses BIOS call INT 10h, AH=09h (Write Attribute/Character at Cursor Position). Turbo does all the cursor positioning itself. What happens is this: It writes a character, then positions the cursor to the position after the written character. Then, if the cursor is beyond column 80 (or whatever the installed width is), it increments the cursor row. Then, if the row is beyond row 25, it scrolls the screen. Using the normal Turbo Write routines, there is no way to avoid the scroll. You need to use something else to write to that last character position. (Probably a simple BIOS Write-Attribute/Character-at-Cursor-Position thingy, but don't scroll the video. And make sure you put the cursor back somewhere believable, or Turbo may get lost. And if you are using windows, you need to be even more careful...)

pascal/turbo #2298, from bbrown, Sun Dec 14 10:37:38 1986. A comment to message 2297.

Don, thanks for the detective work! I'm still in the design-the-external-interface stage of this project; I think I'll just try to avoid the last byte in each window. Since I know now that it's necessary, I can pro'ly do it.

pascal/turbo #2299, from dondumitru, Sun Dec 14 11:15:27 1986. A comment to message 2298.

Now just a minute! Before you go avoiding the last byte in the display, take a look at this little gem. It solves the problem...

continued

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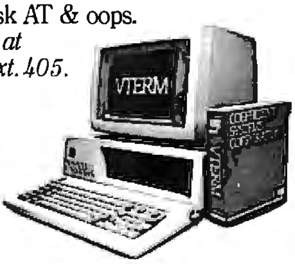

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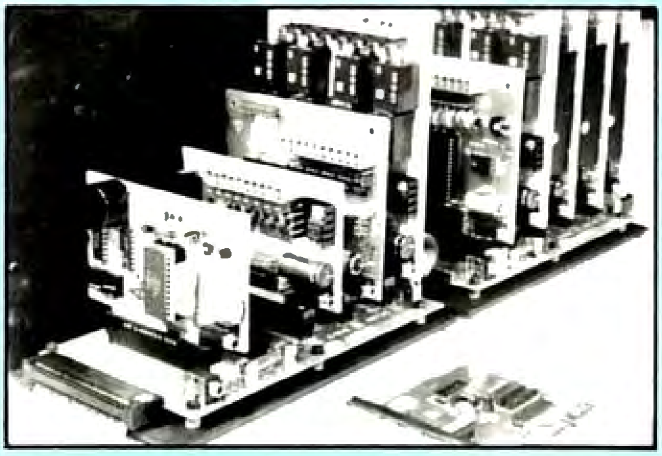

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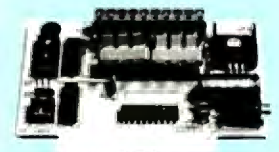
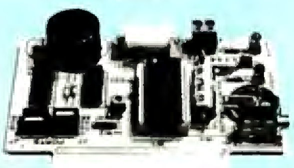
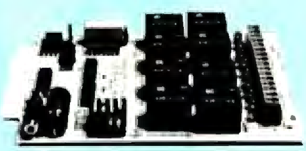


ST-143



CL-144



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```
PROGRAM NewWrite;

  TYPE
    MaxString = STRING[255];

  PROCEDURE BIOSWriteStr(PosX, PosY : BYTE; s :
                         MaxString; f, b : BYTE);
    (* Write 's' at 'PosX', 'PosY', using foreground
                         color 'f' and background color 'b'.
                         This routine does *not* handle
                         Turbo's windows. The cursor is left
                         where it was on entry. *)
    CONST
     MinX = 1;
     MaxX = 80;
     MinY = 1;
     MaxY = 25;
    VAR
     r     : RECORD
              ax, bx, cx, dx, bp, si, di, ds, es, flags :
                         INTEGER;
             END;
     OldX,
     OldY : BYTE;
     i     : INTEGER;
    BEGIN
     PosX := PosX - 1;
     r.ax := $0f00;
     INTR($10,r);
     r.ax := $0300;
     INTR($10,r);
     OldX := LO(r.dx);
     OldY := HI(r.dx);
     FOR i := 1 TO ORD(s[0]) DO BEGIN
       PosX := PosX + 1;
       IF PosX > MaxX THEN BEGIN
        PosY := PosY + 1;
        PosX := MinX;
       END;
       IF PosY > MaxY THEN BEGIN
        PosY := MaxY;
        (* possibly scroll - beware that IBM PC/XT BIOS
                         scroll routines destroy BP! (Other
                         BIOS' may also.) *)
       END;
       r.ax := $0200;
       r.dx := (PosY-1) * 256 + (PosX-1);
       INTR($10,r);
       r.ax := $0900 + ORD(s[i]);
       r.bx := HI(r.bx) * 256 + 16 * b + f;
       r.cx := $0001;
       INTR($10,r);
     END;
     r.ax := $0200;
     r.dx := OldY * 256 + OldX;
     INTR($10,r);
    END; (* BiosWriteStr *)


  BEGIN

     ClrScr;
     BIOSWriteStr(70,25,'Hello there - this is just a
                       test.',YELLOW,BLACK);
     WRITELN('Testing...');
  END. (* NewWrite *)
```

---

pascal/turbo #2300, from barryn, Sun Dec 14 12:13:33 1986. A comment to message 2299.

Looks good to me.

---

pascal/turbo #2301, from bbrown, Sun Dec 14 13:14:27 1986. A comment to message 2299.

Neat stuff! Thank you very much! ■

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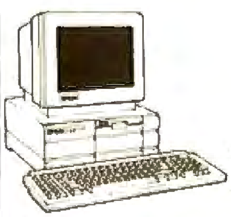

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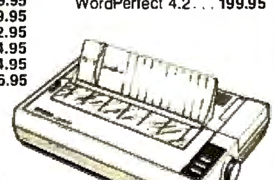

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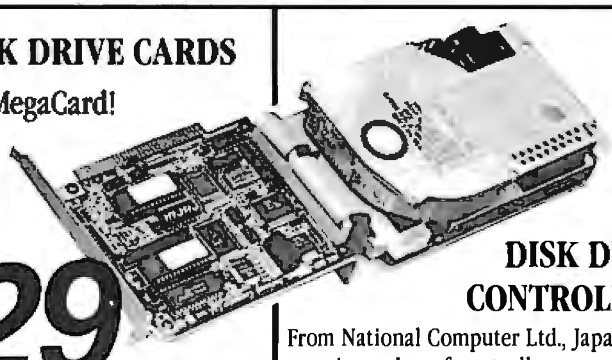

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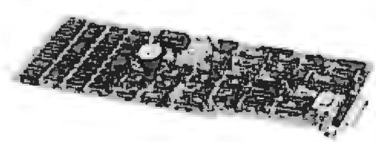

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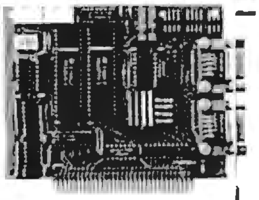

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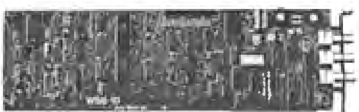

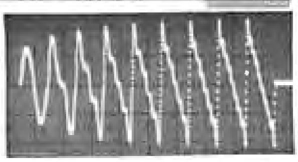

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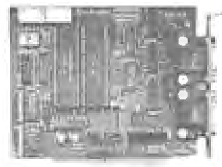

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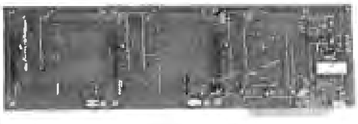

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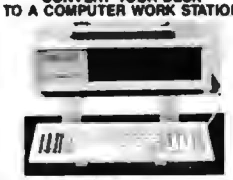

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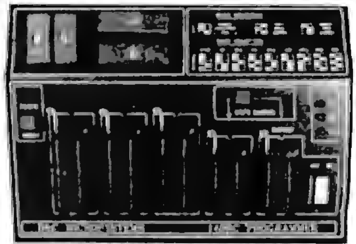

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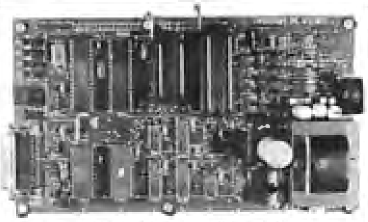

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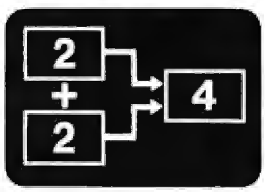

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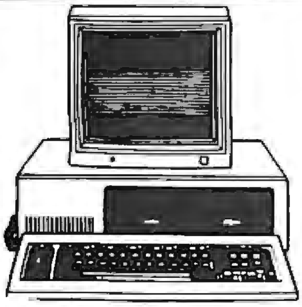

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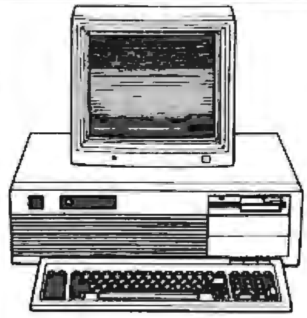

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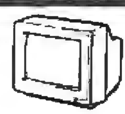

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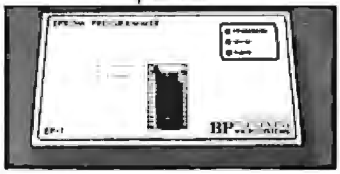

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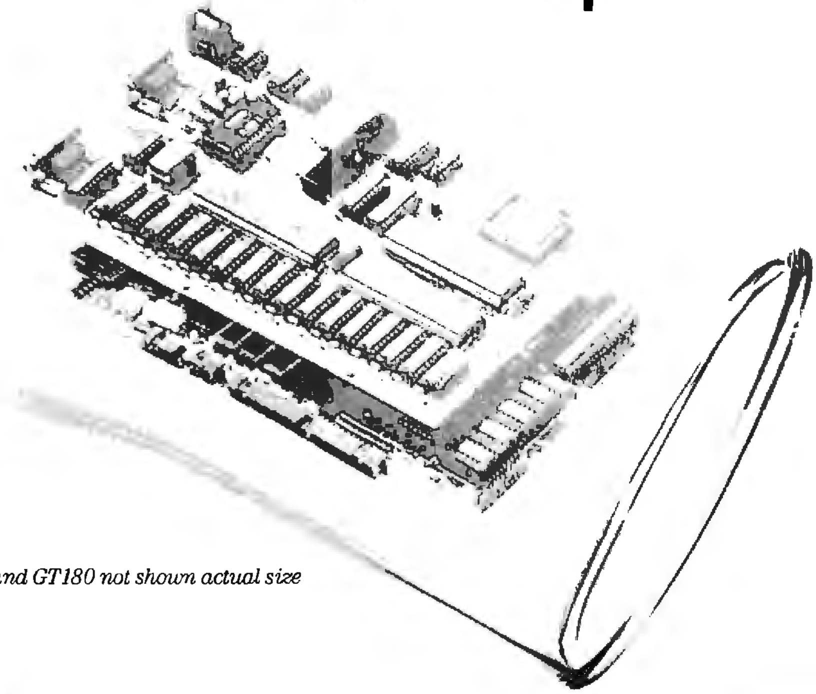

SB180FX and GT180 not shown actual size

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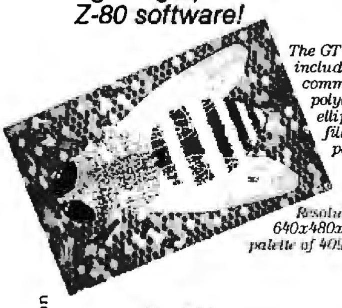

The GT180 has 38 commands including 23 graphics drawing commands: line, rectangle, polyline, polygon, circle, ellipse, arc, ellipse arc, filled rectangle, paint, pattern and copy.

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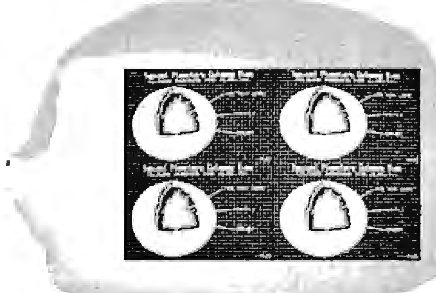

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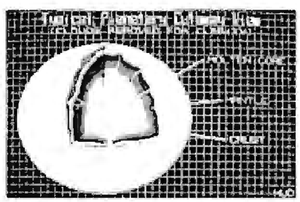

Software: Modula 2 by Borland International including SB180/GT180 Grafix Toolbox.

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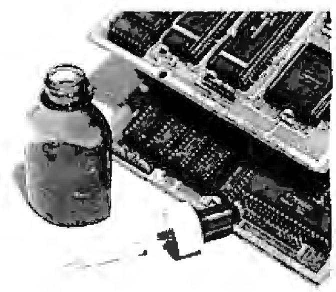

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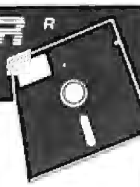

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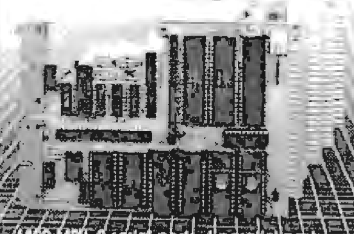

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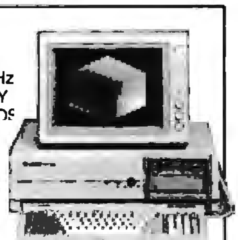

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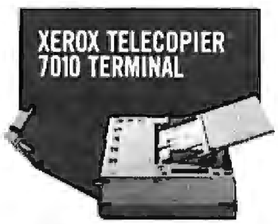

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MITSUBISHI MF-501 48TPI. $95 / MF-504 96TPI. $ 129
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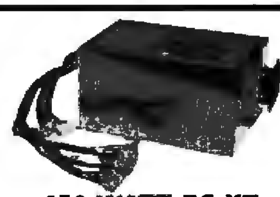

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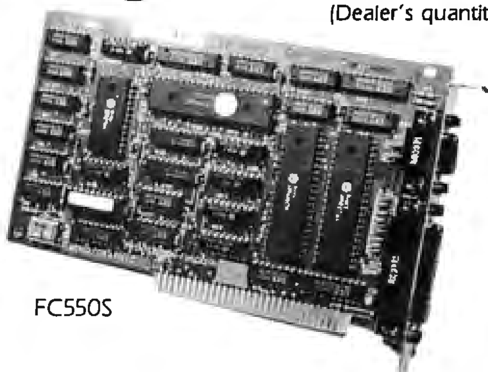

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California Digital

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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 of plotter.

OTHER PLOTTERS AVAILABLE:
Hewlett Packard ● HoustonInstruments ● Roland
SweetP ● CalComp... please call for prices.

Qume 142 PC Compatible

$65

Quantity Two

These Qume double sided PC **compatible** drives bear the IBM logo. The drive was manufactured for IBM for use in the recently discontinued PC Junior computer. We have purchased a large quantity of these drives and are currently offering them in sets of two for only $65 each.

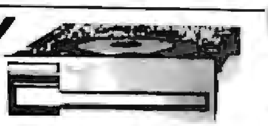
Panasonic AT Compatible

$115

The Panasonic 475 is jumper selectable between 96 TPI format and 1.2 Megabyte as used in the IBM/AT computer.
Suggested price of this drive is $189 but because of unusual buying opportunity, California Digital is able to offer these drives at only $115 each, quantity two.

	One	Two	Ten
QUME 142 half height	69	65	call
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 475 1.2 Meg./96	119	115	109
MITSUBISHI new 501 half ht.	129	119	109
MITSUBISHI 504A AT comp.	169	159	155
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

SONY $139



The Sony 53W is a 3½ inch double sided double density disk drive. The drive can be connected to your existing floppy controller but will require MS/DOS 3.2 to properly operate in the PC and compatibles. The 53W is similar to the drive being used in the PC portable.

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 Typewritter Company for CosmoWorld 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, and Centronics parallel interface make the Adeus CP/2000 an exceptional buy at only $159. **Original price $595.** RS232 serial interface $30.00 additional.

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 possility 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.

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20+20 Meg.	**A2220H**	4540	2095
Bootable Controller		255	189
10 Meg. Cartridge		79	49
20 Meg. Cartridge		99	65

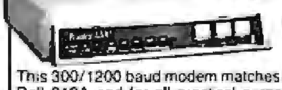
Smarteam 2400 Baud

$289

The Smarteam 2400 offers all the features of the Hayes Smart Modem 2400 for a fraction of the price. Now is your opportunity to purchase a 2400 baud modem for only $289.
Also available: The Smarteam 1200 at only $159

U.S. Robotics 2400 Internal $189

The US Robotics 2400 modem is one hundred percent Hayes compatible, auto dial, auto answer, auto everything. A super value at only $189.



$99

This 300/1200 baud modem matches design specs of Bell 212A and for all practical purpose those of the Hayes Smart Modem. The Avatex brings you reliable data transmission for only $99.

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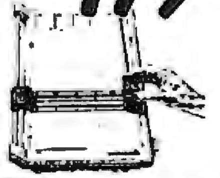

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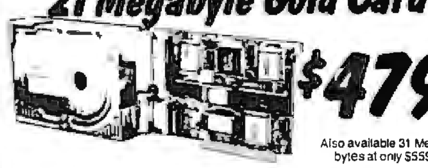
Uses a standard RS-232 serial port hookup to interface easily with your computer.

$59.95 IBM Thermal Printer

Manufactured by IBM for use with the PC series printers. This 80 column "super quiet" thermal printer is ideal for fast low cost drafts. The printer is capable of interfacing to any computer with an 1200 baud RS-232 serial port. Accepts either fan fold or 8½" roll fed thermal paper. Will "NOT" accept writing paper. Nine pin head allow the IBM thermal printer to output extended foreign character set, math symbols and bit image graphics. At $59.95 we expect quick sell out.

21 Megabyte Gold Card



$479

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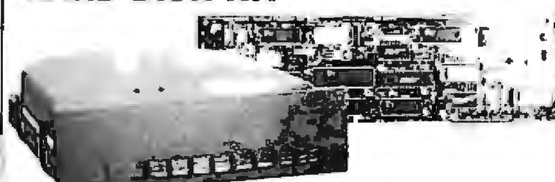

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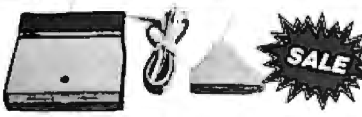

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• Connects directly to User Port • Manual Answer/Dial • Function keys defined for convenience • Includes Midwest Micro Associates communication software.
CM-1 (For VIC-20 and C-64) ~~$34.95~~ $24.95

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Singly or in any combination!
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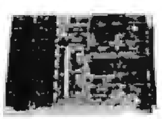

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Expand the memory of your Tandy 1000 (128K Version) to as much as 640K. Also includes DMA controller chip.
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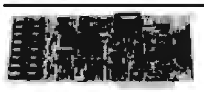

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Expand the memory on your Tandy 1000 (128K Version) to as much as 640K. Complete with an RS232 port, clock/calendar, RAM Disk Printer Spooler and on-board DMA controller chip.
MTAN-256K Includes 256K RAM $179.95
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Erases all EPROMs. Erases up to 8 chips within 21 minutes (1 chip in 15 minutes). Maintains constant exposure distance of 1". Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact - 9.00"L x 3.70"W x 2.60"H. Complete with holding tray for 8 chips.
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NOW YOU CAN BUILD AN IBM PC/XT COMPATIBLE!

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Regular List $574.50

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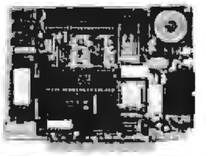

For IBM PC, XT, AT & Compatibles
• Auto-answer/Auto-dial • Extensive diagnostics • Built-in speaker/vol. control • Auto redial on busy • Ability to access Com-port 3 • Hayes compatible • 2 yr. warranty
PM1200B-2 without software $129.95
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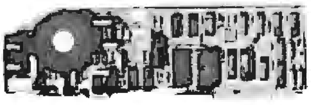
2 yr. warranty! **ZOOM 300 Baud Modem**
for Apple II, II+ and *IIe*



• Auto-dial/Auto-answer • Hayes compatible • Includes call progress monitor, speaker, Zoom Communications software and manual • Made in U.S.A.
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Fully Compatible with the NEW APPLE II GS!

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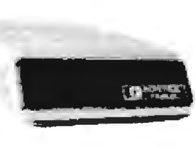
PM1200A-2 . . . . . $199.95

ProModem 2400/1200/300 Baud Modems
For Any Computer w/RS232 Serial Port



• Hayes command compatible • Call progress tone detection • Auto redial on busy • Internal power supply • Voice/data switching • Second phone jack for voice handset • Auto-answer/Auto-dial • Touch tone and pulse dialing • Speaker with volume control • 8 LED status lights • 1-year warranty
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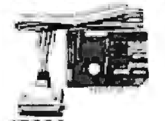
Jameco ELECTRONICS **Parallel Printer Card for Apple II, II+ and *IIe***



• Intelligent interface to most dot matrix graphics printers
• Centronics standard
• Advanced text printing

JE880 Parallel Printer Card $49.95
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Universal 64K/256K Printer Buffer
JOHNATHON FREEMAN DESIGNS

• Four possible combinations: 1) Serial to Serial, 2) Serial to Parallel, 3) Parallel to Parallel, 4) Parallel to Serial • Cut sheet feeding • Software selectable output • Modem support • Selectable baud rates • Manual included
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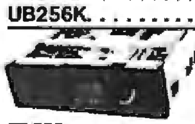

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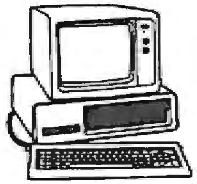
JADE TURBO or 286



- 640K of RAM
- 7 MHz turbo mode
- 360K disk drive
- 5151 or AT style
- 8 expansion slots

$568

- 640K of RAM
- 8 MHz 80286
- 1.2 MB disk drive
- AT-style keyboard/case
- 8 expansion slots

$1198

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Parallel printer port
Monochrome monitor

TURBO $698 | 286 $1398

OPTION #2
20 MB hard disk
Parallel printer port
Monochrome monitor

TURBO $1098 | 286 $1698

OPTION #3
20 MB hard disk
Color graphics card
Parallel printer port
Hitachi hi-res color monitor

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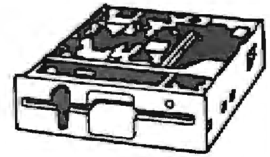
360K DISK DRIVE

Built by Alpine Electronics to IBM specifications, same as Qume 142



- 360K
- 48 TPI
- Double-sided
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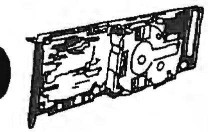
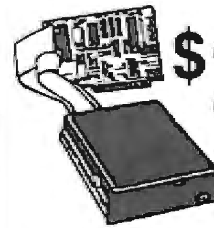


- 21.3 MB Formatted
- Lowpower.
- Head Park Zone
- Plated Media
- Light 2.4 lbs.

HARD DISK DRIVE



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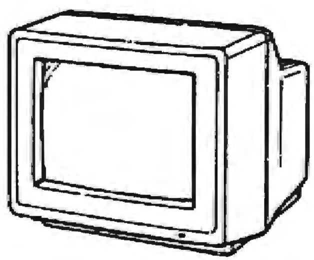
List Price $699



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Includes drive, mounting rails and cable

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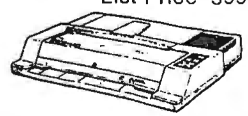

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- Repetition .3 mm
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- 2K Buffer
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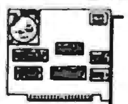

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Hayes 1200B internal card w/Smartcom II	$359
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Hayes Smartmodem 2400	$589

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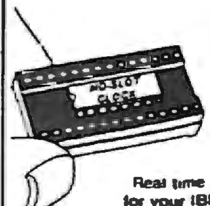
For Your Apple, PC-XT or Clone



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8 PEN PLOTTER
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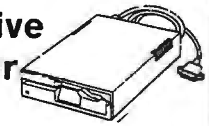

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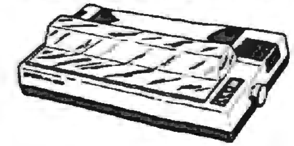

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LP=Low power

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4164-150	65536x1	(150ns)(5v)	1.29
4164-120	65536x1	(120ns)(5v)	1.95
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5v=Single 5 Volt Supply REFRESH=Pin 1 Refresh

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2764	8192x8	(450ns)(5V)	3.49
2764-250	8192x8	(250ns)(5V)	3.95
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27256	32768x8	(250ns)(5V)	7.49

5V=Single 5 Volt Supply 21V PGM=Program at 21 Volts

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8237	4.95
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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
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74LS85	.49	74LS293	.89
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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
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74HC86	.69	74HC299	4.99
74HC93	1.19	74HC368	.99
74HC107	.79	74HC373	2.29
74HC109	.79	74HC374	2.29
74HC112	.79	74HC390	1.39
74HC125	1.19	74HC393	1.39
74HC132	1.19	74HC4017	1.99
74HC133	.69	74HC4020	1.39
74HC138	.99	74HC4049	.89
74HC139	.99	74HC4050	.89

74HCT00

74HCT: Direct, drop-in replacements for LS TTL and can be intermixed with 74LS in the same circuit.

74HCT00	.69	74HCT166	3.05
74HCT02	.69	74HCT174	1.09
74HCT04	.69	74HCT193	1.39
74HCT08	.69	74HCT194	1.19
74HCT10	.69	74HCT240	2.19
74HCT11	.69	74HCT241	2.19
74HCT27	.69	74HCT244	2.19
74HCT30	.69	74HCT245	2.19
74HCT32	.79	74HCT257	.99
74HCT74	.85	74HCT259	1.59
74HCT75	.95	74HCT273	2.09
74HCT138	1.15	74HCT367	1.09
74HCT139	1.15	74HCT373	2.49
74HCT154	2.99	74HCT374	2.49
74HCT157	.99	74HCT393	1.59
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
74F64	.89	74F244	3.29	74F374	4.29

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 Inquiry 152

2400 BAUD MODEM FOR IBM WITH PC TALK III SOFTWARE $259!

CMOS

4001	.19	14419	4.95
4011	.19	14433	14.95
4012	.25	4503	.49
4013	.35	4511	.69
4015	.29	4516	.79
4016	.29	4518	.85
4017	.49	4522	.79
4018	.69	4526	.79
4020	.59	4527	1.95
4021	.69	4528	.79
4024	.49	4529	2.95
4025	.25	4532	1.95
4027	.39	4538	.95
4028	.65	4541	1.29
4035	.69	4553	5.79
4040	.69	4585	.75
4041	.75	4702	12.95
4042	.59	74C00	.29
4043	.85	74C14	.59
4044	.69	74C74	.59
4045	1.98	74C83	1.95
4046	.69	74C85	1.49
4047	.69	74C95	.99
4049	.29	74C150	5.75
4050	.29	74C151	2.25
4051	.69	74C161	.99
4052	.69	74C163	.99
4053	.69	74C164	1.39
4056	2.19	74C192	1.49
4060	.69	74C193	1.49
4066	.29	74C221	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
74S02	.29	74S168	3.95
74S03	.29	74S174	.79
74S04	.29	74S175	.79
74S05	.29	74S188	1.95
74S08	.35	74S189	1.95
74S10	.29	74S195	1.49
74S15	.49	74S196	2.49
74S30	.29	74S197	2.95
74S32	.35	74S226	3.99
74S37	.69	74S240	1.49
74S38	.69	74S241	1.49
74S74	.49	74S244	1.49
74S85	.95	74S257	.79
74S86	.35	74S253	.79
74S112	.50	74S258	.95
74S124	2.75	74S280	1.95
74S138	.79	74S287	1.69
74S140	.55	74S288	1.69
74S151	.79	74S299	2.95
74S153	.79	74S373	1.69
74S157	.79	74S374	1.69
74S158	.95	74S471	4.95
74S161	1.29	74S571	2.95

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

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

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)

LINEAR

TL066	.99	LM733	.98
TL071	.69	LM741	.29
TL072	1.09	LM747	.69
TL074	1.95	LM748	.59
TL081	.59	MC1330	1.69
TL082	.99	MC1350	1.19
TL084	1.49	MC1372	6.95
LM301	.34	LM1414	1.59
LM309K	1.25	LM1458	.49
LM311	.59	LM1488	.49
LM311H	.89	LM1489	.49
LM317K	3.49	LM1496	.85
LM317T	.95	LM1812	8.25
LM318	1.49	LM1889	1.95
LM319	1.25	ULN2003	.79
LM320	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
LM380	.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

EDGECARD CONNECTORS

100 PIN ST	S-100	.125	3.95
100 PIN WW	S-100	.125	4.95
62 PIN ST	IBM PC	.100	1.95
50 PIN ST	APPLE	.100	2.95
44 PIN ST	STD	.156	1.95
44 PIN WW	STD	.156	4.95

36 PIN CENTRONICS

MALE

IDCEN36	RIBBON CABLE	6.95
CEN36	SOLDER CUP	4.95

FEMALE

IDCEN36/F	RIBBON CABLE	7.95
CEN36PC	RT ANGLE PC MOUNT	4.95

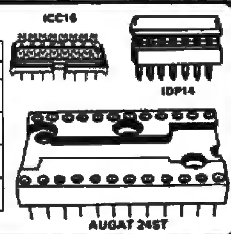
INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	4.95
ICM7207A	5.95
ICM7208	15.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	—	.95	.95	—	—	—	1.75	—	2.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE BELOW



DIODES/OPTO/TRANSISTORS

1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
1N5402	.25	4N37	1.19
KBP02	.55	MCT-2	.59
KBU8A	.95	MCT-6	1.29
MDA990-2	.35	TIL-111	.99
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

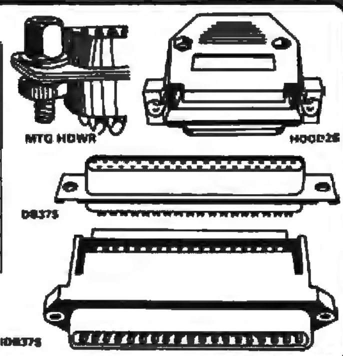
D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.82	.90	1.25	1.25	1.80	3.48
	FEMALE	DBxxS	.95	1.15	1.50	1.50	2.35	4.32
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.20	1.49	—	1.95	2.65	—
	FEMALE	DBxxSR	1.25	1.55	—	2.00	2.79	—
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	—	3.89	5.60	—
	FEMALE	DBxxSWW	2.76	4.27	—	6.84	9.95	—
IDC RIBBON CABLE	MALE	IDBxxP	2.70	2.95	—	3.98	5.70	—
	FEMALE	IDBxxS	2.92	3.20	—	4.33	6.76	—
HOODS	METAL	MHOODxx	1.25	1.25	1.30	1.3[illegible]	--	—
	GREY	HOODxx	.65	.65	—	.6[illegible]	.75	.95

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN TH.. 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
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
MAN-8940	COM CATHODE	.8"	1.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/LOGIC	.270"	9.95

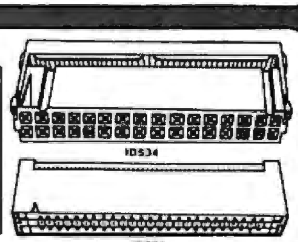
DIFFUSED LEDS

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	—	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE ABOVE



SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
BCD OUTPUT 10 POSITION 6 PIN DIP		1.95

DIP SWITCHES

4 POSITION	.85	7 POSITION	.95
5 POSITION	.90	8 POSITION	.95
6 POSITION	.90	10 POSITION	1.29

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.18	1.60	.30	2.75
16	.28	2.50	.48	4.40
20	.36	3.20	.60	5.50
25	.45	4.00	.75	6.85
26	.46	4.10	.78	7.15
34	.61	5.40	1.07	9.35
40	.72	6.40	1.20	11.00
50	.89	7.50	1.50	13.25

HARD TO FIND "SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE	1.49
2x40	STRAIGHT LEAD	2.49
2x40	RIGHT ANGLE	2.99

SHORTING BLOCKS

GOLD CONTACTS SPACED AT .1" CENTERS

5/$1.00

As a highly satisfied customer, I wish to praise the speedy and efficient ways in which my previous orders were handled. The quality of your merchandise is excellent and the prices are set to suit my budget. I have already reccomended your company to many of my colleagues and associates.

Lloyd Lynch

CALL FOR VOLUME QUOTES

Inquiry 152

2400 BAUD MODEM FOR IBM WITH PC TALK III SOFTWARE $259!
DISK DRIVES
FOR APPLE COMPUTERS
AP-150
$99.95
• ½ HT, DIRECT DRIVE
• 100% APPLE COMPATIBLE
• SIX MONTH WARRANTY
BAL-500
$129.95
• TEAC MECHANISM-DIRECT DRIVE
• 100% APPLE COMPATIBLE
• FULL ONE YEAR WARRANTY
AP-135
$129.95
• FULL HT SHUGART MECHANISM
• DIRECT REPLACEMENT FOR APPLE DISK II
• SIX MONTH WARRANTY
DOUBLE SIDED!
MAC535
$249.95
• 3.5" ADD-ON DISK DRIVE
• 100% MACINTOSH COMPATABLE
• DOUBLE SIDED 800K BYTE STORAGE
• HIGH RELIABILITY DRIVE HAS AUTO-EJECT MECHANISM
• FULL ONE YEAR WARRANTY
AD-3C
$139.95
• 100% APPLE IIc COMPATIBLE, READY TO PLUG IN, W/SHIELDED CABLE & MOLDED 19 PIN CONNECTOR
• FAST, RELIABLE SLIMLINE DIRECT DRIVE
• SIX MONTH WARRANTY
DISK DRIVE ACCESSORIES
FDD CONTROLLER CARD $49.95
IIc ADAPTOR CABLE $19.95
ADAPTS STANDARD APPLE DRIVES FOR USE WITH APPLE IIc
KB-1000 $79.95
CASE WITH KEYBOARD
FOR APPLE TYPE MOTHERBOARD
• USER DEFINED FUNCTION KEYS
• NUMERIC KEYPAD WITH CURSOR CONTROL
• CAPS LOCK • AUTO-REPEAT
KEYBOARD-AP $49.95
• REPLACEMENT FOR APPLE II KEYBOARD
• CAPS LOCK KEY, AUTO-REPEAT
• ONE KEY ENTRY OF BASIC OR CP/M COMMANDS
EXTENDER CARDS
IBM-PC $45.00
IBM-AT $68.00
APPLE II $45.00
APPLE IIe $45.00
MULTIBUS $86.00
APPLE COMPATIBLE INTERFACE CARDS
EPROM PROGRAMMER $59.95
MODEL RP525
• DUPLICATE OR BURN ANY STANDARD 27xx SERIES EPROM
• EASY TO USE MENU-DRIVEN SOFTWARE IS INCLUDED
• MENU SELECTION FOR 2716, 2732, 2732A, 2764 AND 27128
• HIGH SPEED WRITE ALGORITHM
• LED INDICATORS FOR ACTIVITY
• NO EXTERNAL POWER SUPPLY NEEDED
• ONE YEAR WARRANTY
16K RAMCARD $39.95
• FULL TWO YEAR WARRANTY
• EXPAND YOUR 48K APPLE TO 64K
• USE IN PLACE OF APPLE LANGUAGE CARD
BARE PC CARD W/INSTRUCTIONS $9.95
IC TEST CARD $99.95
• QUICKLY TESTS MANY COMMON ICs
• DISPLAYS PASS OR FAIL
• ONE YEAR WARRANTY
• TESTS: 4000 SERIES CMOS, 74HC SERIES CMOS, 7400,74LS,74L,74H & 74S
300B MODEM $49.95
FOR APPLE OR IBM
INCLUDES ASCII PRO-EZ SOFTWARE
• FCC APPROVED
• BELL SYSTEMS 103 COMPATIBLE
• INCLUDES AC ADAPTOR
• AUTO-DIAL
• DIRECT CONNECT
CABLE FOR APPLE IIc $14.95
JOYSTICK CR-401 $7.95
FOR ATARI 400, 800, 2600, VIC 20/64 AND APPLE IIe
DISKFILE
HOLDS 70 5¼" DISKETTES
$8.95
3.5" DISKFILE HOLDS 40 $9.95
POWER STRIP
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• 15A CIRCUIT BREAKER
$12.95
2 WAY SWITCH BOXES
• AVAILABLE IN SERIAL OR PARALLEL
• CONNECTS 2 PRINTERS TO ONE COMPUTER OR VICE VERSA
• ALL LINES SWITCHES
• PUSH-BUTTON SWITCHES MOUNTED ON PCB
• 3 FEMALE GOLD-PLATED CONNECTORS
AB-P CENTRONICS PARALLEL $39.95
AB-S RS232 SERIAL $39.95
MOLDED INTERFACE CABLES
6 FOOT, 100% SHIELDED, MEETS FCC
IBM PARALLEL PRINTER CABLE 9.95
CENTRONICS MALE TO FEMALE 15.95
CENTRONICS MALE TO MALE 14.95
MODEM CABLE FOR IBM 7.95
RS232 SERIAL MALE TO FEMALE 9.95
RS232 SERIAL MALE TO MALE 9.95
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C. ITOH RITEMAN II PRINTER
• 160 CPS DRAFT MODE, 32 CPS NLQ MODE
• 9 x 9 DOT MATRIX
• SUPPORTS EPSON/IBM GRAPHICS
• FRICTION AND PIN FEEDS
• VARIABLE LINE SPACING AND PITCH
$219.95
IBM PRINTER CABLE $9.95
REPLACEMENT RIBBON CARTRIDGE $7.95
NASHUA DISKETTES DEALS
5¼" SOFT SECTOR
DS/DD WITH HUB RINGS
$9.90 BOX OF 10
69¢ea BULK QTY 50
59¢ea BULK QTY 250
NASHUA DISKETTES WERE JUDGED TO HAVE THE HIGHEST POLISH AND RECORDED AMPLITUDE OF ANY DISKETTES TESTED ACCORDING TO "COMPARING FLOPPY DISKS", BYTE 9/84
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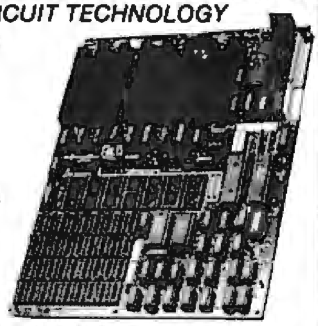

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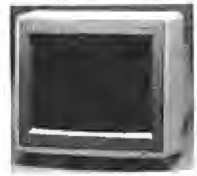

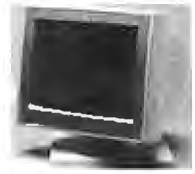

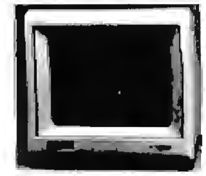

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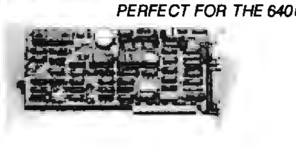

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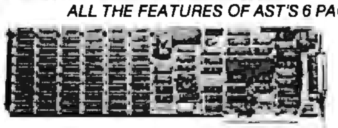

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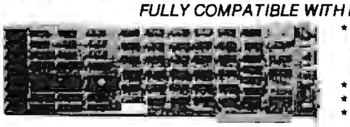

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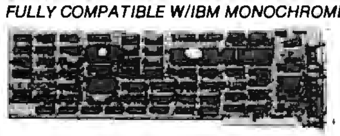

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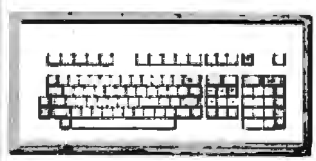

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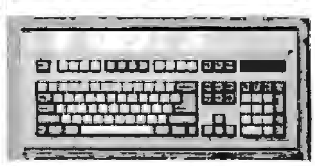

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BYTE's ongoing monitor box (BOMB) lets you rate each article you've read in BYTE as excellent, good, fair, or poor. Each month, you can mail in the BOMB card found at the back of the issue. We tally your votes, total the points, and award the two top-rated nonstaff authors $100 and $50, respectively. An additional $50 award for quality goes to the nonstaff author with the best average score (total points divided by the number of voters). If you prefer, you can use BIX as your method of voting. We welcome your participation.

ARTICLE#	PAGE	ARTICLE	AUTHOR(S)
1	9	**Microbytes**	staff
2	29	**What's New**	staff
3	52	**Ask BYTE/Circuit Cellar Feedback**	Ciarcia
4	67	**Book Reviews**	Hoenig
5	84	**Product Preview: The Commodore A2000**	Williams, Thompson, Grehan
6	101	**Product Preview: Turbo BASIC**	Stewart
7	113	**Ciarcia's Circuit Cellar: Build a Trainable Infrared Master Controller**	Ciarcia
8	127	**Programming Insight: Building a Random-Number Generator**	Wichmann, Hill
9	129	**Programming Project: Installing Memory-Resident Programs with C**	Edginton
10	143	**Probing Space by Camera**	Sheldon
11	151	**Digital Image Processing in Art Conservation**	Asmus
12	169	**Introduction to Image Processing Algorithms**	Dawson
13	191	**Low-Cost Image Processing**	McManis
14	197	**PreScript**	Sheldon
15	209	**A Trio of 8-MHz PC AT Compatibles**	Miastkowski
16	215	**AT&T's TrueVision Image Processing System**	Tinney
17	217	**Four Laser Printers**	Little
18	223	**PC Scheme: A Lexical LISP**	Wong
19	226	**Concurrent PC DOS**	Rash
20	228	**Wendin's Operating System Toolbox**	Levitt
21	235	**PFS: First Choice**	Allen
22	237	**WriteNow for the Macintosh**	O'Neil
23	238	**CAD-3D**	DeMaria
24	251	**Computing at Chaos Manor: The Curse of Chaos Manor**	Pournelle
25	271	**Applications Only: Status Report**	Shapiro
26	279	**BYTE U.K.: Taking Control**	Pountain
27	291	**According to Webster: Amiga Developers Conference**	Webster
28	311	**Best of BIX**	BIXen

BOMB RESULTS

Top mention for December's BYTE, which is based on the quantity of votes received, goes to Steve Ciarcia for his Circuit Cellar project entitled "Build the GT180 Color Graphics Board, Part 2: Hardware." In second place is Stephen Satchell's evaluation of "23 Modems," for which Mr. Satchell wins $100. Winner of $50 for placing third is Kenneth E. Perry for "Abstract Mathematical Art." Monetary awards are given only to top-ranking authors who are not part of the BYTE staff. First place in our tally for quality also goes to Steve Ciarcia, with Stephen Satchell receiving an additional $50 award. Congratulations to all.

COMING UP IN BYTE

Theme:
How do you make a computer blindingly fast? In terms of design, the choice has always come down to balancing the demands of silicon and software. Where do you put the simplicity? Where does the complexity go? In April's theme on instruction set strategies, we take an in-depth look at efficiency in terms of reduced instruction set computers (RISC) and their terminological offspring, CISC (complex instruction set computers) and WISC (writable instruction set computers).

Features:
Features due to appear soon include a construction piece on building a BERT (basic educational robot trainer). Another construction article being readied is one that shows you how to build an 80386 expansion board that will go into your present IBM PC and/or compatible computer.

Reviews:
We're up to our eyebrows in printers these days. Results of our testing will appear soon. As promised in our preview of the Apple IIGS, a comprehensive BYTE review is ready to roll.

Circuit Cellar:
A hardware builder's answer to the store-bought laser pistol.

Special 68000 Series:
Home-buildable projects for the Atari 520ST.

Programming Articles:
"Concurrent Programming in Turbo Pascal"; "A C Interface for ANSI.SYS."

EDITORIAL INDEX BY COMPANY

Page refers to the first page of an article or section in which products made by the company are discussed.

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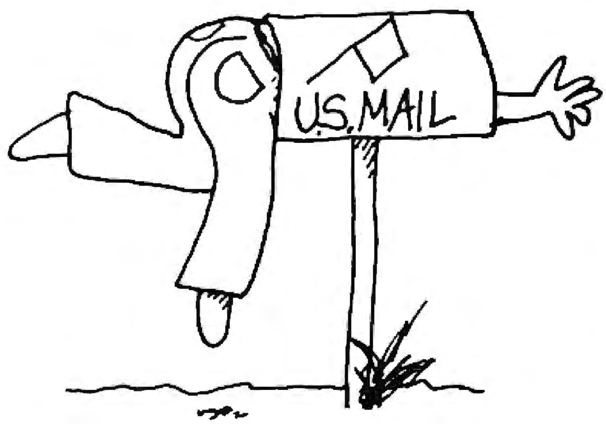

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