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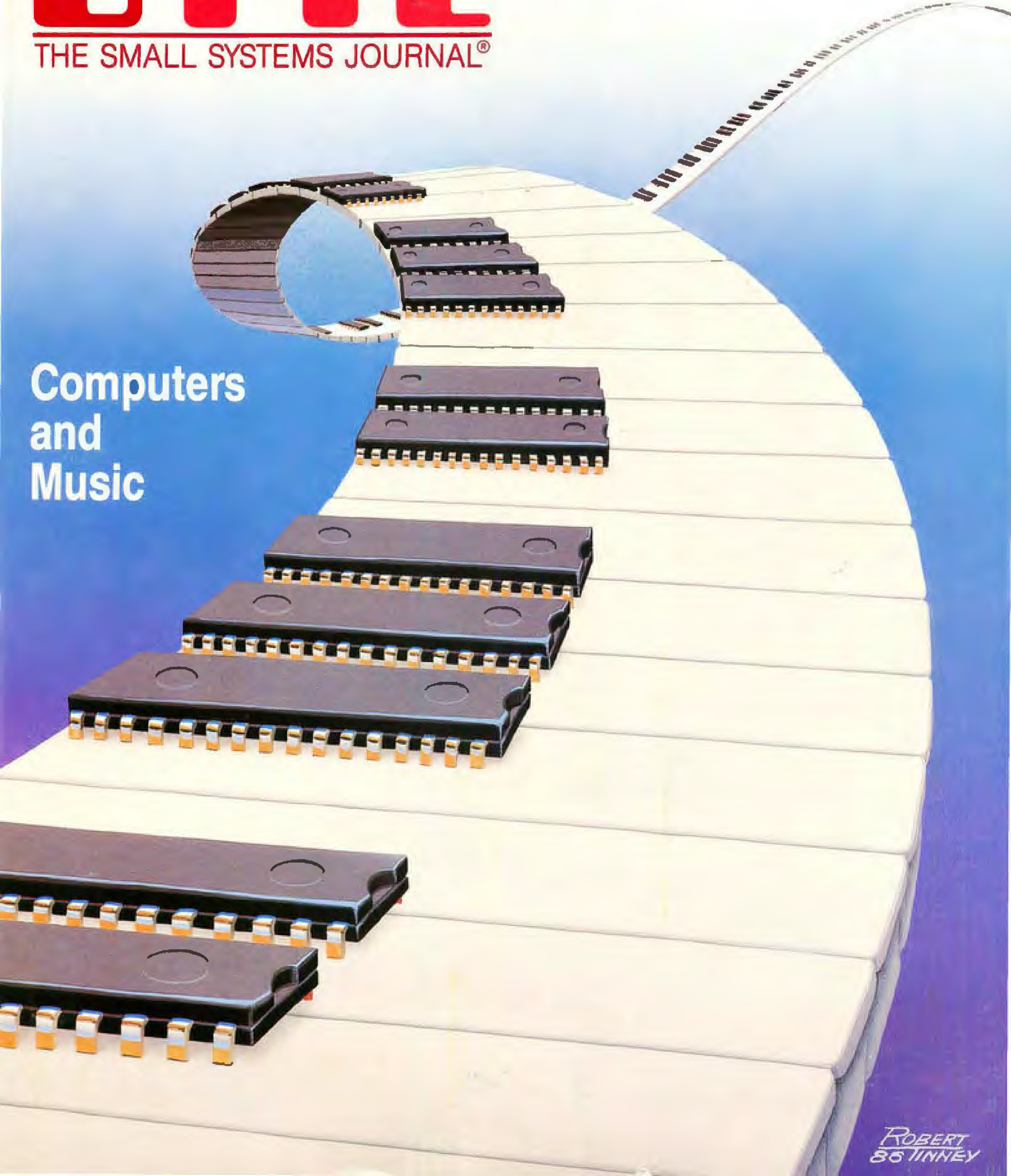
Computers and Music



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We broke new ground in 1986 with Turbo Lightning.™ It includes the Random House® dictionary and thesaurus. Turbo Lightning is the forerunner of a complete electronic reference library, newly joined by the Word Wizard,™ which solves the unsolvable twists, and boggles and challenges your mind. Word Wizard also includes Turbo Pascal source code so you can figure out how the Turbo Lightning access system works.

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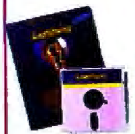

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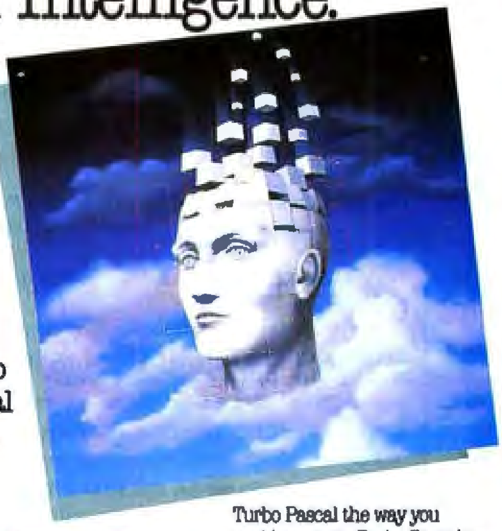

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Turbo Prolog 1.0 Technical Specifications

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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. At run-time, Turbo Prolog programs can call the editor, and view the running program's source code.

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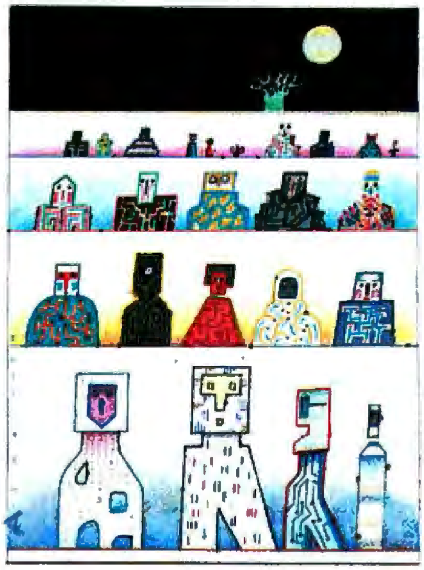

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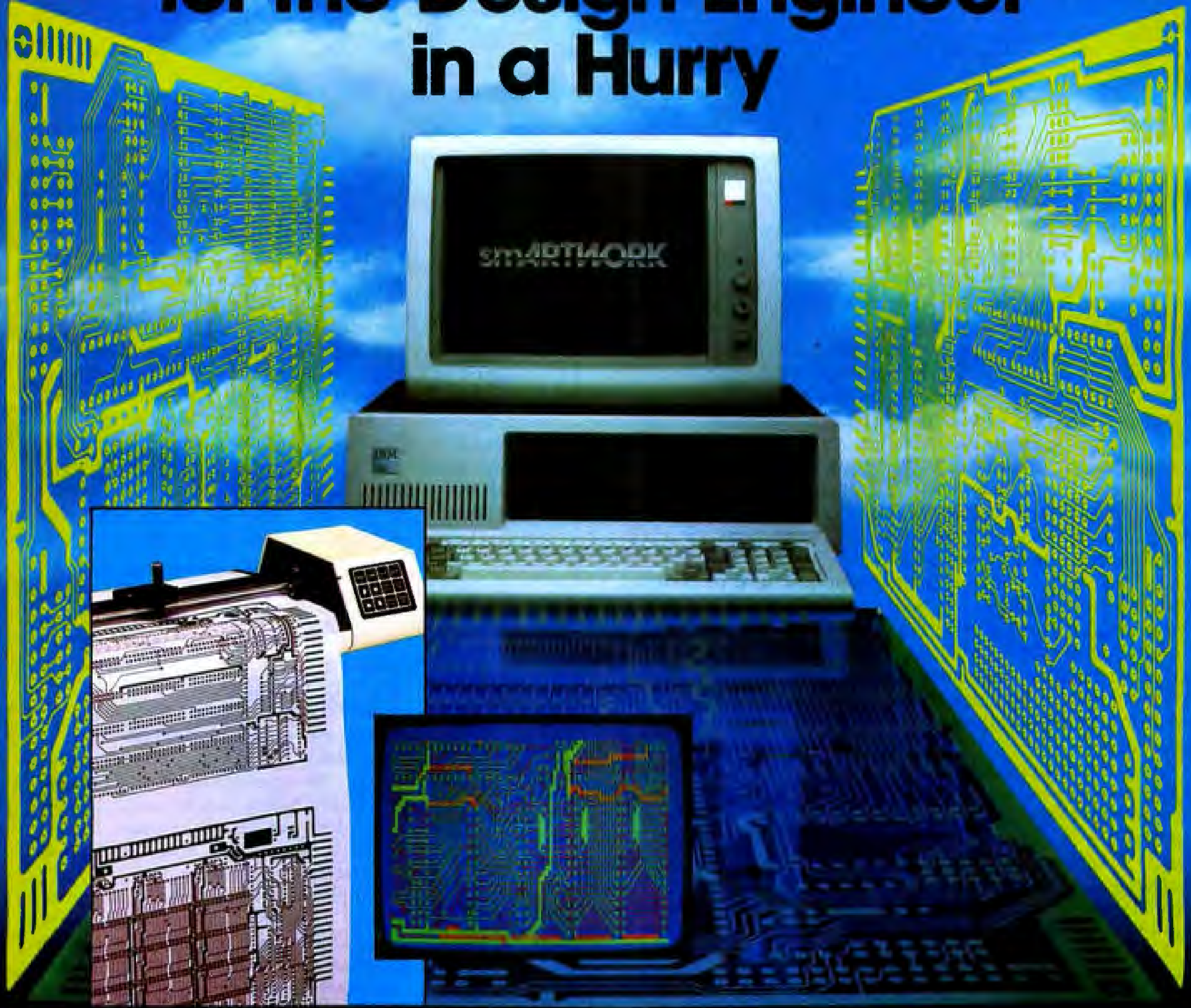

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Music and MIDI

Have you noticed the stir going on in the electronic music industry? Take keyboard synthesizers. A significant drop in price has been accompanied by a dramatic rise in capability and sound quality, opening the doors of musical exploration to multitudes of newcomers. We've also seen computer technology claim new territories in music through the advent of MIDI (musical instrument digital interface), a data-communications protocol that lets you join synthesizers and computers into small networks for composition or performance. MIDI has stimulated the entire music industry by providing a standard for hardware and software to be used for the production of music. Creativity, efficiency, and productivity are enhanced by the development of computer-based tools aimed at the mystical process of music generation.

The current specification for MIDI has been in existence for four years. It came about through the cooperation of music synthesizer manufacturers around the world, notably those from Japan and the United States. Essentially, a large group of manufacturers got together and decided to add serial data channels to all future electronic music instruments so that events generated on one instrument could be played on remote instruments connected via the MIDI cable. Layers of sound, for example, can be produced from a single keyboard controller by driving multiple sound modules equipped with MIDI inputs. By inserting a personal computer into the middle of all this sound-generating equipment, composers can record and manipulate scores much as word processors do text.

The Good News

So we now have a data-communications standard for moving music event data between a computer and sound-generating hardware. We can buy instruments from different manufacturers and interconnect them at once. Older versions of music synthesizers, having no compatibility to any other device you might be using, were doomed to eventual obsolescence as newer products were released to replace them. Now it's different—what you get tomorrow can be integrated with what you have today, and it's reasonable to consider building an elaborate system over a period of budget-controlled time. A variety of good MIDI software is now available. We find software that can act as a kind of digital tape recorder for music data; programs that edit, store, and retrieve libraries of synthesizer voice parameters; and software that can display, print, and edit scores rendered in traditional music notation. It's a heyday for musicians of all persuasions. Or is it?

The Bad News

While the MIDI specification goes a long way toward unifying the tasks necessary to the production of music, it does not suggest any format for the storage of MIDI data files. Thus, developers of music software are on their own to adopt a structure for disk files containing MIDI performance data created by the software. And that is precisely what has happened during the development of today's MIDI music software: Each program on each computer produces a data file that cannot be instantly read by any other combination of hardware or software. Furthermore, few, if any, file-converter utilities are available to assist transportation of data between environments. (Of course, there is always the issue of differences among the underlying DOS formats for individual computers.)

A Data File Standard

Utility programs that convert music files from one manufacturer's product to another must be seen as only an interim measure. A better approach would see all the important players get together (in a fashion similar to the one that led to the MIDI 1.0 specification) and hack out a target format for file interchange. If software developers could produce a musical equivalent of the DIF standard used for database files in the business world, users operating in different computer and synthesizer environments would benefit immensely from expanded access to the large body of music data now being stockpiled. This tactic would also let existing products "speak" to future programs designed to use the target file format.

A number of obstacles present themselves when attempting to derive a convenient, universal method of organizing music data files. That's not to say that no one is trying. Besides continuing development on the academic level at universities like Carnegie-Mellon, Stanford, and MIT, commercial concerns like Roland and Electronic Arts have worked hard in an effort to establish useful guidelines toward the goal of increased music data sharing. In its own way, each organization has faced hurdles, including:

- Some computers have a lot more memory, speed, and display resolution than others. How can a file produced on a more powerful computer be rendered on a less capable machine? What should a minimum configuration consist of?
- Should graphic data for displaying common music notation or some derivative be included with MIDI performance data? Since both types of data might exist independently, and, given that some software does not recognize both, should these two kinds of data be kept in separate, parallel files?
- Should we go further and attempt to design a full-blown operating system for music that could be ported to various computer architectures? This is ambitious but could produce long-term benefits.

Naturally, other important points need to be ironed out. At this time, we invite software and hardware developers to plug in their irons. The success of the MIDI standard offers hope for a standard for file interchange. At the moment, the consumer is getting shortchanged by the inability to move data between music-processing programs. The audience for computer music software is growing larger and more sophisticated, and it's up to the leaders in music technology development to provide software standards. We at BYTE want to encourage all concerned to investigate the work already done and then have a series of formal conferences involving a variety of sources. It's not going to be easy, but it has to happen (and soon, too, because I have a lot of music data on IMSAI-8080 cassettes waiting to be uploaded to my Amiga).

—*Roger Powell, Contributing Editor*


maxell

M·I·C·R·O·B·Y·T·E·S

Staff-written highlights of developments in the microcomputer industry.

New Geometry Could Have Implications for Telecommunications

Dr. Donald Kreher and Dr. Stanislaw Radziszowski, assistant professors at Rochester Institute of Technology's School of Computer Science and Technology, have discovered a non-Euclidean geometry that could enhance long-range satellite transmissions and telecommunications. The two professors used a new basis-reduction computer-search technique to find a simple 6-design, the smallest such design possible.

Researchers at the University of Nebraska discovered the first two 6-designs in 1984. According to Kreher, "We were able to find this third design because the computer-search technique that we created enabled us to search a larger space of possibilities than previously searched anywhere in the world." Kreher and Radziszowski solved complex 99-integer equations in 12 hours, a process that they estimate would take several million centuries of computer time if they used a "brute force" technique.

The new geometry could help in correcting transmission errors over long distances. According to Kreher and Radziszowski, scientists can use the geometry to construct code for error reduction. When errors are received, the geometry used to construct the code gets distorted. Distortion characteristics let the scientist find and correct the error.

"Teachable" Pattern-Recognition System on IBM PC AT

Nestor Inc., a small research and development firm in Providence, RI, said it has successfully moved its prototype self-adaptive pattern-recognition system from a minicomputer to an IBM PC AT. The Nestor System, developed by two Brown University physicists interested in animal neuronal networks, is significant in that it must be taught, not programmed, to recognize new patterns. The system inherently makes use of parallel processing and distributed memory but currently emulates these capabilities on today's serial-processing computers. Interestingly, a spokesperson from Nestor claimed that the system runs just as fast on an AT as it did on an Apollo minicomputer, primarily because of the Apollo's graphics-processing overhead.

Nestor is currently investigating using a bit pad with its system to analyze free-form handwriting and is in negotiation to procure funding to develop a large-vocabulary voice-recognition system.

SIMMs: Denser Memories Through Packaging

If you think that a circuit board jam-packed with 256K dynamic RAM chips is the ultimate in dense, solid-state memory, keep reading. The new generation of chip packages—leaded chip carriers (LCCs)—is making a splash in memory chips for microcomputers. Because these packages take up far less space than their predecessors, the venerable DIPs, computer designers can fit far more memory in the same space on a board. But the chip and system makers are going even further. They are mounting several LCCs on a long, narrow circuit card that has leads on one long side. That card, called a SIMM (single in-line memory module), can then be mounted vertically onto a standard circuit board.

The first well-known micro to use this form of memory is the Apple Macintosh Plus, which has a megabyte of RAM on four 256K-byte SIMMs. The SIMMs plug into special sockets and can be easily exchanged for 1-megabyte SIMMs to create a 4-megabyte Mac Plus.

One of the first semiconductor firms to announce SIMMs for the commercial market is NEC Electronics, Mountain View, CA. The NEC SIMMs come in five configurations: 256K by 4, by 5, by 8, or by 9 bits, and 1 megabyte by 1 bit. Both 120-ns and 150-ns access times are available. The SIMMs are standard epoxy-glass substrates with pins or edge connectors on one long side; they are based on 256K-bit dynamic RAMs in plastic LCCs.

(continued)

Hannover Fair: Atari Shows PC Box, German Firm Announces Supercomputer

At the opening of the Hannover Fair in West Germany, Atari exhibited its IBM PC compatibility box for its 520ST and 1040ST computers. The box had its own 8088, a socket for an 8087, and 512K bytes of RAM. It connects to the ST via the DMA port. With the product's introduction at least several months away, Atari representatives wouldn't discuss pricing except to reaffirm the company's policy of producing in "high volume at low cost."

IP Systems, of Karlsruhe, West Germany, announced but did not show the TX2 series of supercomputers. The result of work done by researchers at Karlsruhe University, the parallel-configuration machine is based on the 80286 and has at least 16 chips. It can perform 10 million to 30 million instructions per second. The TX2 uses neither arrays nor vectors. Its parallel architecture is based on an extended tree structure. The machine represents a new type of parallelism that could apply to functions beyond the typical uses in floating-point math, for example, in the types of calculations used in expert systems, optimization, and other non-numeric tasks.

Toshiba exhibited three optical disk products it said will be available to consumers late this year. Toshiba also showed two plasma-screen laptop computers, the T2100 and the T3100, compatible with the IBM PC XT and AT, respectively. Ing. C. Olivetti also brought PC compatibles to the Fair. Sanyo showed for the first time its SPX-840 LED printer, said to rival laser printers in print quality and performance. The unit's method of printing involves electronic photography using an LED-array head and a selenium-tellurium photosensitive drum. Resolution is 400 dots per inch, and print speed is rated at 20 pages per minute.

A Norwegian company, Ask LCD, has come up with a flat-screen display for the IBM PC. At Hannover, it was suspended from a desk-mounted support arm. The unit measures 330 mm by 230 mm and is 25 mm thick. The screen surface is 250 mm by 160 mm.

Prospero Software, a British firm exhibiting at Hannover, announced a FORTRAN compiler for the Amiga and the Atari ST. Called Pro Fortran-77, it could help open up the 68000-based machines to technical and scientific applications.

NANOBYTES

Intel Corp., Santa Clara, CA, introduced the 80287-10, a 10-MHz version of its numeric coprocessor. The device operates at up to twice the speed of older versions. . . . In other Intel news, the company has enlisted the support of four software developers to provide compilers for its 80386 32-bit chip. **Silicon Valley Software**, Cupertino, CA, and **Green Hills Software**, Glendale, CA, said they will develop FORTRAN, C, and Pascal compilers for the 80386. **Ryan-McFarland**, Rolling Hills Estates, CA, said it's porting its standard FORTRAN and COBOL compilers to run on the chip. And **Language Processors**, Waltham, MA, announced it would develop COBOL, FORTRAN, C, Pascal, PL/I, RPG II, and BASIC compilers for the 80386. . . . **Apricot Computers**, Fremont, CA, said it will offer Microsoft's MS-DOS 4.0 as part of its XEN Multiuser System. . . . **NEC Electronics**, Mountain View, CA, and **Oki Semiconductor**, Sunnyvale, CA, have developed a CMOS version of NEC's μPD7720 Digital Signal Processor. The new chip, called the NEC μPD77C2 or the Oki M77C20, is a pin-for-pin replacement for the 7720 and draws only 24 mA, 80 percent less than its predecessor. . . . **PicTel Corp.**, Peabody, MA, has a desktop videophone system that transmits color video images over dial-up digital lines. PicTel said calls cost just twice that of ordinary phone calls, but the videophone setup costs $150,000. . . . **SSI Software**, Orem, UT, unwrapped an operating shell for its WordPerfect and other SSI packages. WordPerfect Library is a RAM-resident program designed to enhance the performance of WordPerfect, MathPlan, and SSIData. . . . **Brown Wagh Publishing**, San Jose, CA, has released a word-processing program for the Amiga. Besides standard editing capabilities, Scribble provides four windows that can each hold a separate document. . . . **Personal Composer**, Honaunau, HI, has brought out version 2.0 of its Personal Composer music software. MIDI features include a 32-track recorder and a patch recorder. . . . Two United Kingdom companies have released products based on the Motorola 68020 32-bit CPU. **MicroAPL** of London launched a multiple-processor machine, the Aurora, that can handle as many as 64 users. Although it was designed to run the company's APL interpreter, it can be programmed in other languages. Another product using the VMEbus is the ET-68020 VME card from **Integrated Micro Products Ltd.**, County Durham. IMP said it has managed to make the 68020 run reliably at 25 MHz, at which speed it performs more than 10 MIPS in bursts. . . . **Apple Computer Inc.**, Cupertino, CA, is offering rebates to full-time teachers and college students who buy Apple hardware: $75 on a IIc, $150 on a IIe, $175 on a 512K Mac, and $200 on a Mac Plus. . . . **IBM's** PC Convertible is being built by robots at a plant in Austin, TX. The automated workers perform all assembly and test operations, and the assembly process reportedly takes 6 minutes.

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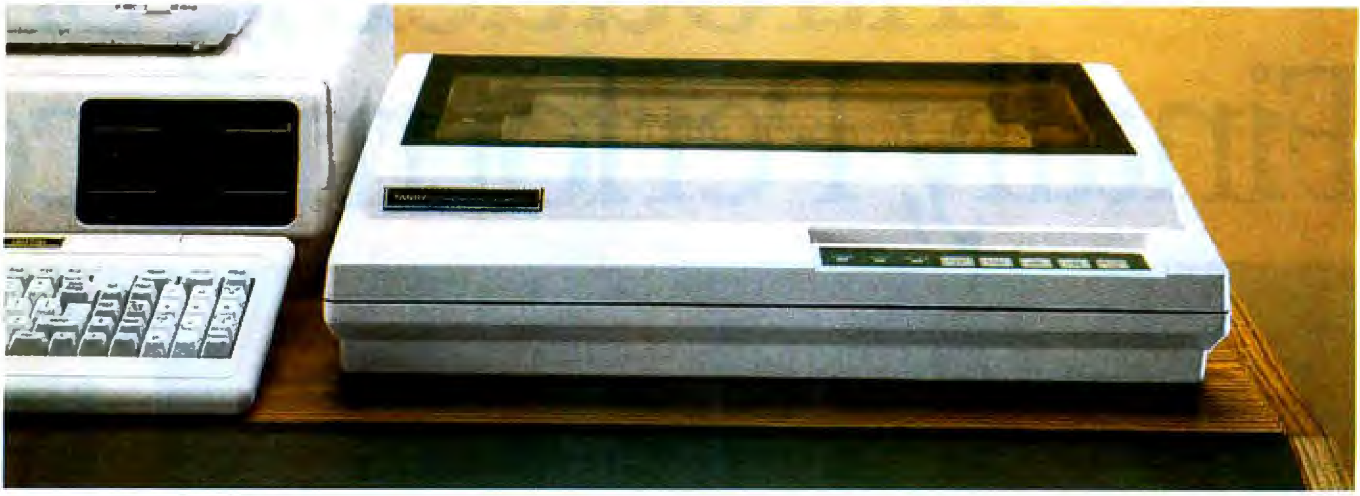

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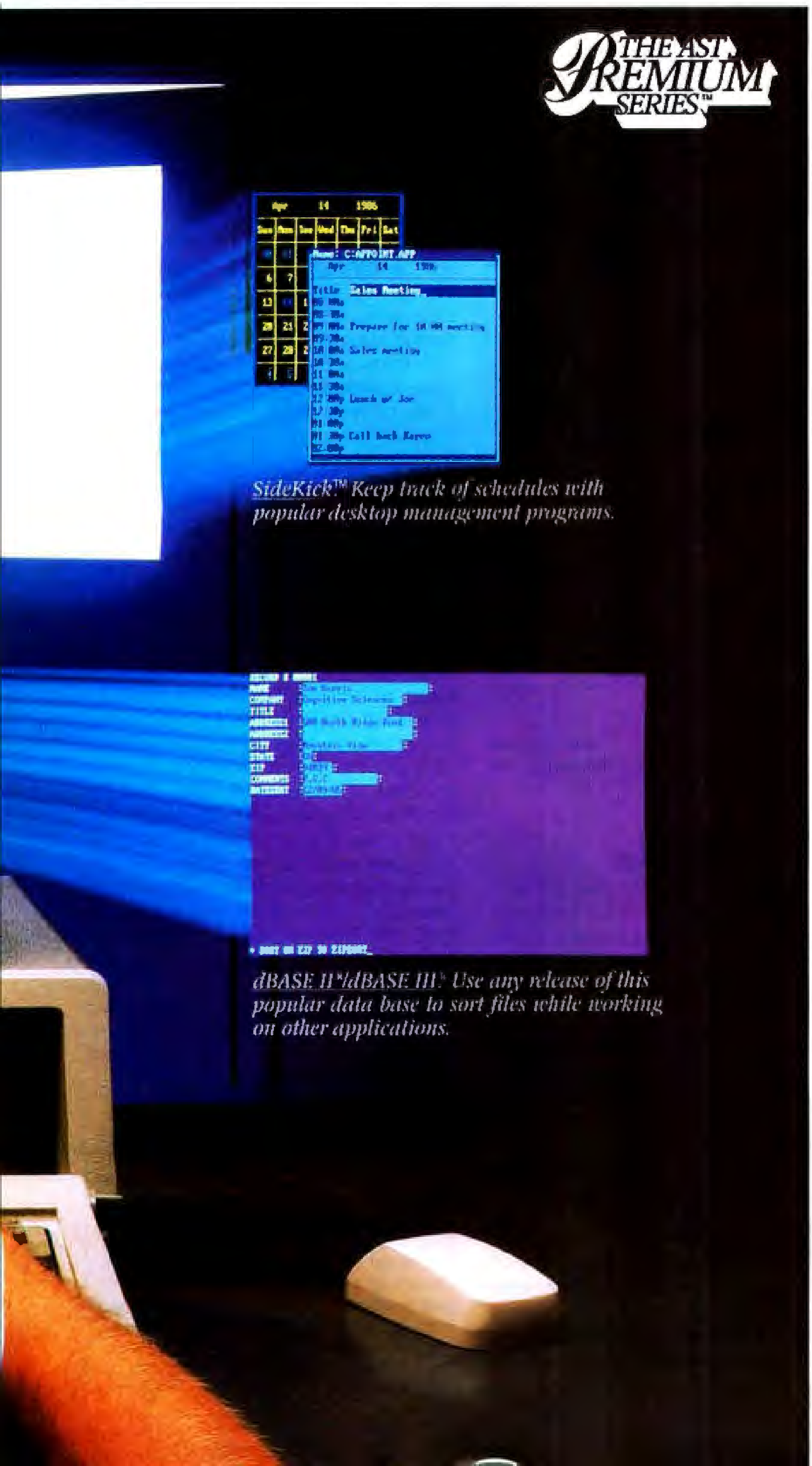

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Inquiry 2 for End-Users. Inquiry 3 for DEALERS ONLY.

ATARI 520ST MEMORY UPGRADE

I recently completed the Atari 520ST 1-megabyte memory upgrade modification as outlined by Gert Slavenberg on page 372 of the February BYTE. (*Editor's note: Also, refer to the Atari/tech.st conference on* BIX, *message #239, and to* ST.DOC *from* BYTE*net Listings.*) It wasn't as easy as expected, and I'd like to share my experience with those tempted to add 512K to their machine for $50 worth of dynamic RAM and a few hours of free time.

After piggybacking the new 120-nanosecond DRAMS, I quickly soldered them to the old ones using a 35-watt iron. The joints did not look that good, but I buzzed out the board with the ohmmeter and all connections passed. When I finally booted up, erratic operations resulted. Most common among these were

- Black balloons on screen with system keyboard dead
- Display filled with dots
- Double menu images

After taking some aspirin, I proceeded to troubleshoot the board. Could my problems be traced to those DRAMS, which get very hot, making a cold-solder joint "colder"? My suspicions were confirmed when I shorted the connections together, one by one, and rebooting or erratic symptoms were triggered. I was able to get the modification to work properly by resoldering every connection slowly and carefully with a 15-watt pencil iron, examining each joint with a magnifying glass.

Here now are some pointers I'd like to pass on to anyone attempting to complete this memory upgrade modification.

Note 1: The modification does not work with the 16 despiking caps unconnected.

Note 2: After turning on the power, try to copy the system disk in one pass instead of two. If this works, run the memory test program outlined below.

Note 3: If you have little experience in doing chip soldering and debugging, I strongly suggest not doing this modification yourself. While being a major improvement to the ST, it can easily destroy your computer.

A simple test of system memory from BASIC can be quite informative. Issuing the command x=fre(0):print x returned 529,492 bytes available on my system. This number may seem low, but without the added memory only small programs can be written.

The following is a diagnostic program to quickly test out memory, 1K at a time. This program writes zeros and ones from the end of 512K bank 1 past the end (FFFFF hexadecimal) of 512K bank 2.

```
5 rem memory test should run until
   address 1048574
6 rem test ability to write 0's and 1's to
   all blocks
10 for adr = 450000 to 2000000 step
   1024
20 bits = 0
30 GOSUB 200
40 bits = -32767
50 GOSUB 200
60 next
70 end
200 poke adr,bits
210 j=peek(adr)
220 print "address = ",adr, "data = ",j
230 if j<> bits then print "error ":stop
240 return
```

TOM DOLAN
Flushing, NY

SUPPORT NETWORK FOR THE HOMEBOUND

As someone who has been disabled since the age of five and who is currently telecomputing full time for a Fortune 500 insurance corporation, I would like to commend you for the excellent article "Working at Home with Computers" by Jane Morrill Tazelaar, which appeared in the March issue.

Disabled people are indeed creative, motivated, productive people. We have done excellent work in many fields over the years. We have been lawyers, doctors, teachers, and even a U.S. president. Now, thanks to the microcomputer and the modem, even the severely mobility-limited disabled person—the homebound person—is showing his or her potential.

Some of these men and women have expressed an interest in setting up a support network for homebound disabled workers. I think it is not only an excellent idea, but it could open up new worlds for many of us homebound workers who are bright and creative but also terribly isolated. Therefore, anyone interested in being a part of such a network can write to me at *Disability News Online*, 257 Center Lane, Levittown, NY 11756. They can also reach me via CompuServe at 76505,656, via The Source at BCG138, or via PeopleLink at IQR860. I'd like to hear anyone's ideas, comments, or feelings about setting up such a network.

By the way, *Disability News Online* is a national newsletter by and for the disabled. It can be read on The Source by typing the following at the command prompt:

BASICV SFILES>BCG138>DISABILITY-NEWS-ONLINE.

ROBERT MAURO
Levittown, NY

PUTTING THE AMIGA TO GOOD USE

What's an Amiga good for? I seriously asked an Amiga salesman that question at a local Amiga Fest and the following conversation ensued.

He told me that the Amiga is the best personal computer ever made, and he asked me what I wanted a computer for. I said I was a scientist and did a lot of numerical work that required speed and accuracy. He explained to me how much faster the 32-bit 68000 Amiga is over the 8088 IBM PC family. I said that that may be and asked if the Amiga is faster or more precise than the 8087 in the IBM PCs. He admitted that the 8087 is faster and more precise, and maybe the IBM PC

(continued)

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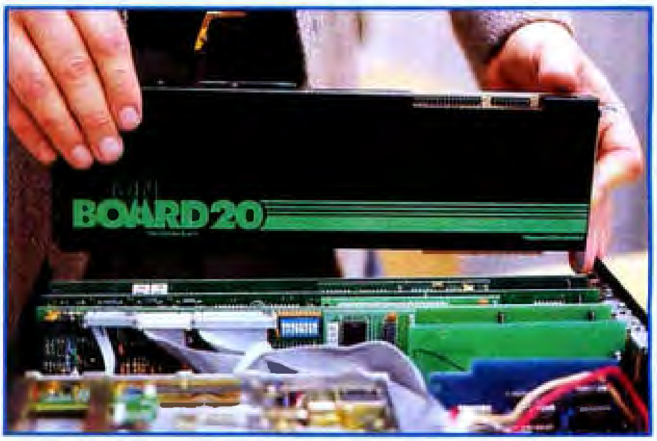

Single-Slot Installation.

Simply snap OnBoard into expansion slot 1 of your IBM PC* or XT, leaving all your other slots free for additional boards.

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Inquiry 208

is better for mathematical work.

I said that I run my own business and would like to use a computer for accounting. How would the Amiga be for business work? More than anything, I need the computer to be reliable and error-free. I can't have the computer altering my accounting data. The salesman said the Amiga would be great for business use. I asked about error detecting or correcting memory, and he said the Amiga doesn't even have parity checks on memory.

That meant that a memory bit change could eat a hole in my business databases and I might not discover the error for months, and even then I won't know what happened. I can live with a computer that dies, but I can't allow it to take me with it. Business computers must have some kind of memory error detection and all the business computers I use have error detection and correction. In my opinion, lack of memory error detection rules the Amiga out as a business computer, especially since I can buy computers that do have memory error detection. The salesman admitted that this was a valid point.

I said that I do a lot of writing and could use a good word processor. The salesman said the Amiga would be a fantastic word processor. After seeing good Amiga graphics, how about some good Amiga text? Wow! The Amiga has the worst 80-column text quality I have ever seen on any computer. I couldn't write or program that thing for more than two hours without developing a bad headache. I suspect anyone could get around that problem by writing a word-processing program that uses the Amiga graphics to do the text. However, the lack of a connection for a monochrome monitor would rule out the Amiga as a good word-processing machine anyway. The composite video output would not make as good a monochrome display as a real monochrome output signal. For those of us who spend a lot of time looking at the tube, this makes a big difference. Well, Mr. Salesman didn't know quite what to say except that the graphics are fantastic.

Amiga graphics may be fantastic for a personal computer, but they are very mediocre for real graphics work. Amiga graphics are not good enough for image-processing work, and most engineering workstations in industry today have 1024- by 1024-pixel displays with 256 gray shades or colors per pixel. They cost a lot more, but the applications require it and nothing less will be productive.

So, back to my original question: What's an Amiga good for? I am not trying to pick on the Amiga, but it looks like Com-

(continued)

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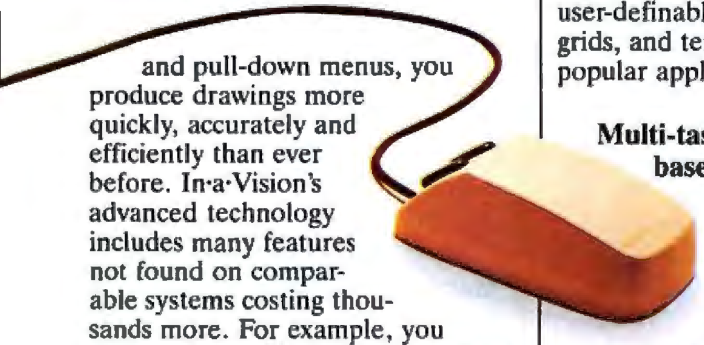

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Inquiry 225

modore is caught in a sandwich (poker term). A poker sandwich is a situation in which you don't have a good enough hand to win high and you don't have the right cards to win low, but you definitely are contributing money to the pot. Amiga is too expensive for the average home computer, and it's not quite up to the IBM PC AT clones for business or scientific use. The most interesting thing about the Amiga will be the reason for its survival, if it survives.

RONALD R. MILLER
Poway, CA

DVORAK VERSUS QWERTY

Your article about the Dvorak keyboard ("Keyboard Efficiency" by Donald W. Olson and Laurie E. Jasinski, February) failed to mention one major limitation: It is highly language-specific for the English language only. To be used for the German language, for example, it would have to be drastically rearranged. This rearrangement can be applied even to the "standard" QWERTY that became QWERTZ for the German typewriters, because Y is barely needed, but Z is used quite often.

This holds true, to a varying degree, for other languages as well, like Italian or some northern and eastern European languages. In addition, these languages need additional characters that are not considered in the QWERTY or Dvorak keyboards. These characters occur quite frequently in these languages. For example, ä, ö, and ü together make up about 3 to 5 percent of the characters of German or Swiss German writing. (My computer does have these characters, but they are well hidden in the graphic-shifted set.) And once we get into languages other than European, the Dvorak layout might have to be modified into a completely new system. The QWERTY and its modified/expanded variants seem to be much more usable and have found their way to the remote corners of the globe. The more effective something is for a certain task, the more limited its scope, no matter what it is. Even human beings are this way.

A. METTLER
Maluku, Indonesia

MACINTOSH WINDOWS

While I'm not certain that the Macintosh windowing environment is the ultimate, I am sure that Alex Funk's proposals ("Copyrighting Icons," March Letters, page 14) are less intuitive and less useful.

His first complaint is about scroll bars. I have no idea what he means about going right to go up, unless he is referring to positioning the mouse over the scroll

(continued)

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bar. Since this is the only way to indicate which window to scroll in multiwindow applications (like QUED), it's hard to see how this can be avoided. Although scroll bars do take up space (16 pixels of width), this is little more than 3 percent of the screen width (and you can often resize a window, so over half of this is off-screen).

I don't consider this a problem on the Macintosh, although it might be with graphics environments like GEM, which run on low-resolution screens. The little box gives an instant visual indication of what part of the document the window portrays. A major deficiency of the alternate to scroll bars in ThinkTank was that there was no way to tell if you were at the end of a document. Funk's proposal gives no feedback to this problem. Neither does it give the ability to go instantly to an end of the document. Finally, I can't see how holding down an arbitrary key while moving the mouse is intuitive. What happens when you run out of room? The scroll bars allow continuous scrolling.

When I resize a window, I want to be able to resize it precisely. Funk's proposal seems to be a way to get relative sizing (wave the mouse pointer around to make it bigger), rather than being able to position the window next to another. In any case, Apple's method gives visual feedback that a given window can be resized, rather than leaving the user wondering if he held down the wrong modifier key.

Funk's method for closing a window (waving the mouse pointer around with no keys held down) seems reminiscent of what I do when I want to make sure my mouse is clean and functional. Again, the close box for a window gives a visual cue that the window can indeed be closed, while if Funk's method failed, one would be left wondering if he hadn't "erased" the window vigorously enough.

What is a global zoom? That seems to imply zooming every window, which hardly makes sense. The new Macintosh ROMs do allow a window to have a zoom box, if Funk means a standard way of zooming.

I also wonder what a global abort is. Abort what? What kind of state should things be in after an abort? If Funk really wants to abort things, he can install the Programmer's Switch and press Reset.

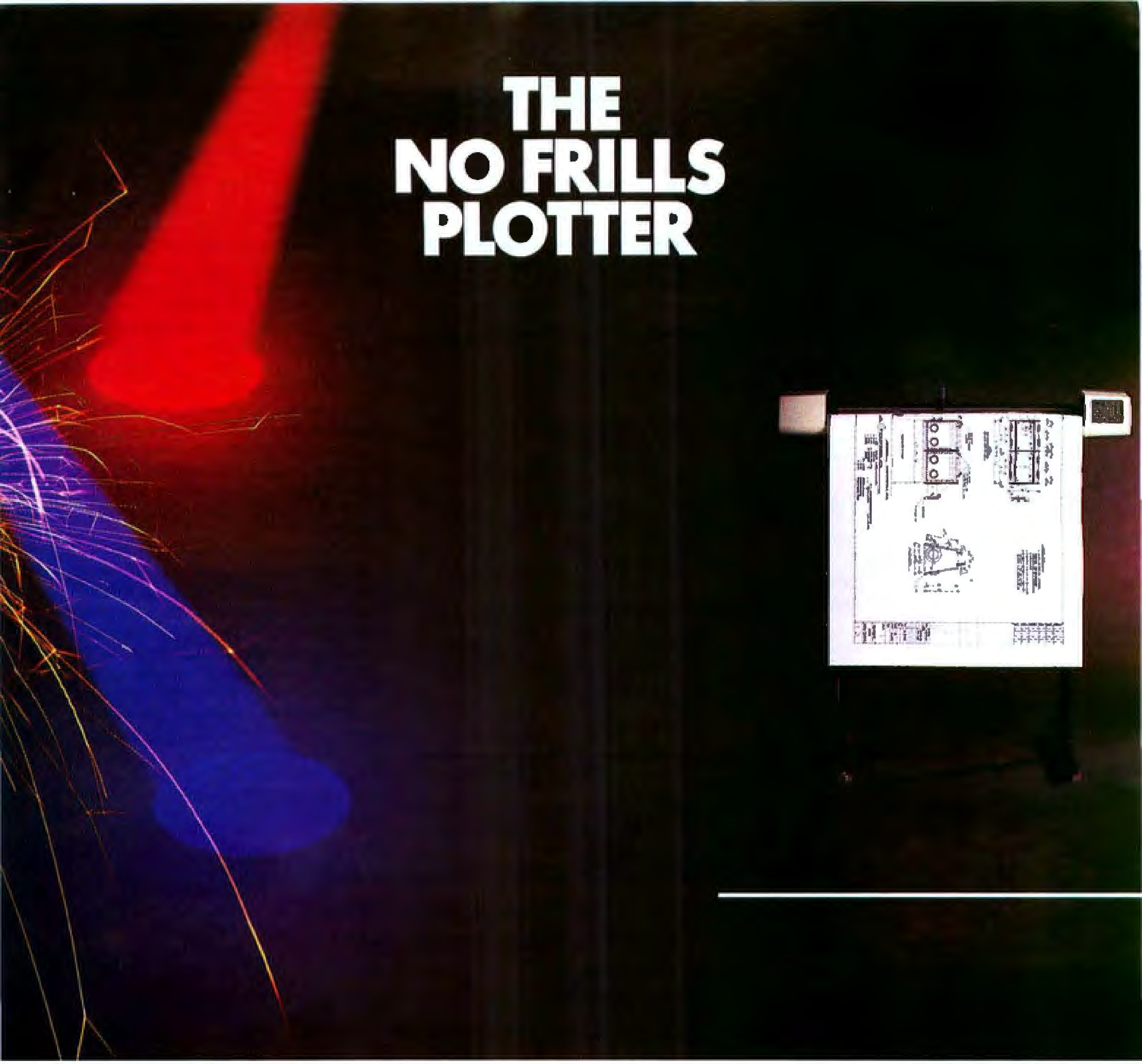
Since, in the real world, people will be switching between different machines, it makes sense for different windowing environments to work similarly. (Since I learned the Macintosh first, I get very annoyed at the differences in the way GEM and the Amiga handle things.) I still can't figure out why Digital Research caved in to Apple's ludicrous claims to own the look I first saw on a Xerox Star. Perhaps Apple is considering the fact that they spent a lot of time and money developing a good user interface (rather than just coming up with something that seems good, as I believe Funk has), and they don't want someone stealing it. But any new product is going to be copied—just look at VisiCalc. What Apple needs to do is make sure their implementation is the best, rather than trying to cripple all others by making sure they're nonstandard.

DAVID DUNHAM
Goleta, CA

LENGTHENING SHORT DELAYS

The notes in the February "Best of BIX" indicate that some users were having problems involving shortened delays of one type or another when the NEC V20 chip was installed in place of an 8088. Perhaps they can benefit from my experiences in solving a similar problem operating under MS-DOS 2.00 and 2.11.

(continued)



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For several months, I have used an NEC V20 in an NCR Decision Mate V, and recently the hardware clock rate was increased from the stock 5 MHz to 7.3728 MHz. The DMV uses a delay routine to allow time for the flex drive to get the motor started and to bring READY active. After installing the V20, this delay was too brief and caused a "Drive not ready" error when the drive was accessed with the motor off. If (R)etry was pressed immediately, the drive was accessed normally (as the motor was already on) and READY was active by that time. An increase in the hardware clock rate compounded the problem; however, a patch to the delay routine in IO.SYS increased the delay, after which it worked properly. This will not be a total solution for many users, because the DMV start-up routines are called from ROM using a Z80A, and the V20 has no control until after the operating system is loading. In most computers, the V20 always has control, so delay routines in ROM would be affected also.

Listing 1: *The results of unassembling* MOTORCK *using Debug.*

```
xxxx:2ED5 E413     IN    AL,13     ;get drive status
xxxx:2ED7 2401     AND   AL,01     ;test MOTOR ON bit
xxxx:2ED9 E614     OUT   14,AL     ;switch motor on
                                   ;if off
xxxx:2EDB 7501     JNZ   2EDE      ;delay if motor off
                                   ;(jump to2EDE)
xxxx:2EDD C3       RET             ;return if motor on
                                   ;—end MOTORCK—
xxxx:2EDE BBFFFF   MOV   BX,FFFF   ;# of passes to BX
xxxx:2EE1 D40A     AAM             ;8088 = 83 cycles
                                   ;V20 = 15 cycles
xxxx:2EE3 4B       DEC   BX        ;one less pass left
xxxx:2EE4 75FB     JNZ   2EE1      ;jump to 2EE1 if
                                   ;not last pass
xxxx:2EE6 C3       RET             ;end of last pass -
                                   ;return to 2EDD
```

MOTORCK is the routine in IO.SYS that starts the drive motor, along with similar routines in FORMAT.COM and a special DMV utility called RDCPM.COM (for reading CP/M disks). Unassembling MOTORCK using Debug yields the results shown in listing 1.

Method #1—Use if the hardware clock rate is unchanged. Replace the AAM command with IMUL AL. IMUL AL executes in 80 or more cycles on an 8088, and only 38 on the V20, but provided enough delay for my system even though the delay was much shorter. The advantage of this method over #2 is that 8088 compatibility is retained; so if it works on your system, use it.

(continued)

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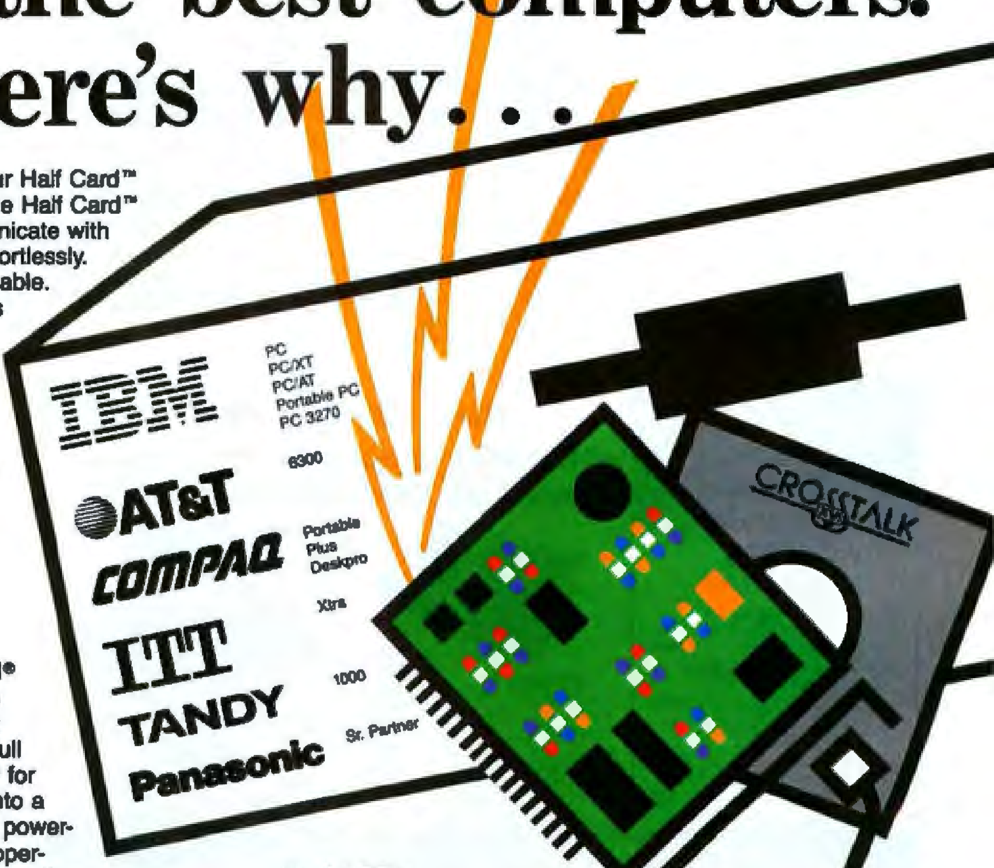

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Method #2—Use if the hardware clock rate is increased. Replace the AAM command with DB 60 61. The V20 recognizes 60 and 61 as PUSH R and POP R, respectively. While those commands are incompatible with 8088 use, the V20 takes 67 and 75 cycles to execute them, causing the duration of the delay to substantially increase. If the delay is too long, change the number of passes through the loop from FFFF to some smaller number (5FFF worked reliably at 7.3728 MHz, while 3FFF was marginal).

Incidentally, the 8087-3 is compatible with the V20 but couldn't keep up at 7.3728 MHz. Probably an 8087-2 would have worked at the higher clock rate, but the upcoming NEC 8087 replacement chip may be faster yet. Also, the DMV slowed down markedly when the hardware clock rate was increased to 8 MHz, which is why I settled on an odd rate. The crystals were purchased locally in 22.1184- and 24-MHz frequencies. The divide-by-three logic in the clock circuitry yields clock rates of 7.3728 and 8 MHz, respectively.

CHUCK STERLING
Las Cruces, NM

MISLEADING STATEMENTS

I'm writing this in protest of the JS&A ad that appeared in the March issue on page 403. The ad speaks of "the memory requirements of the monitor which in the Amiga can eat up (as) much as 70% of the unit's cycle time or speed." This just isn't true! The Amiga's memory runs at 14.2 MHz, and the 68000 and custom chips take turns accessing memory, as your past articles have explained. I think that you should read your ad copy a little more carefully.

Also, in the Atari 1040ST preview (March), you state that the Sieve of Eratosthenes runs in 85 seconds using Atari ST BASIC. My Amiga does the Sieve in 69 seconds with ABasiC and 57 seconds with AmigaBASIC. (I used your Atari version.) I'm not knocking the Atari. I wish that I could afford one, but when it is stated in the industry that the Atari is "faster" than the Amiga, I want to see proof. Actually, I expected much better results from the Atari on the Sieve.

I appreciate your coverage of the Atari and Amiga, and perhaps now the stagnation that has plagued the micro industry from the premature fixation on a standard will be overcome and we really will someday own "mainframes on a desk." (This stagnation happened in the TV industry, with the unfortunate result that we are stuck with 50-year-old technology.)

RICHARD L. SMITH
Tampa, FL

PROBLEMS WITH SMALLTALK

Is Smalltalk a "dead" system? As a Smalltalk fan, I would like to think not. Unfortunately, my recent experience with Smalltalk-80 on a Xerox 1108 convinced me that it has some serious failings. More important, the lack of progressive improvements gave me the strong impression that active development ceased some time ago; I was working with a "dead" system.

It was the strong visual aspects of a product that I was designing that led to my selection of Smalltalk for prototyping. While the prototype was completed in the expected three months, the number of concessions I had to make to the system along the way left me unhappy. At first I put these down to my lack of familiarity with Smalltalk, but as my knowledge increased and the problems continued, it became clear that the system was the main source of the problems.

(continued on page 357)

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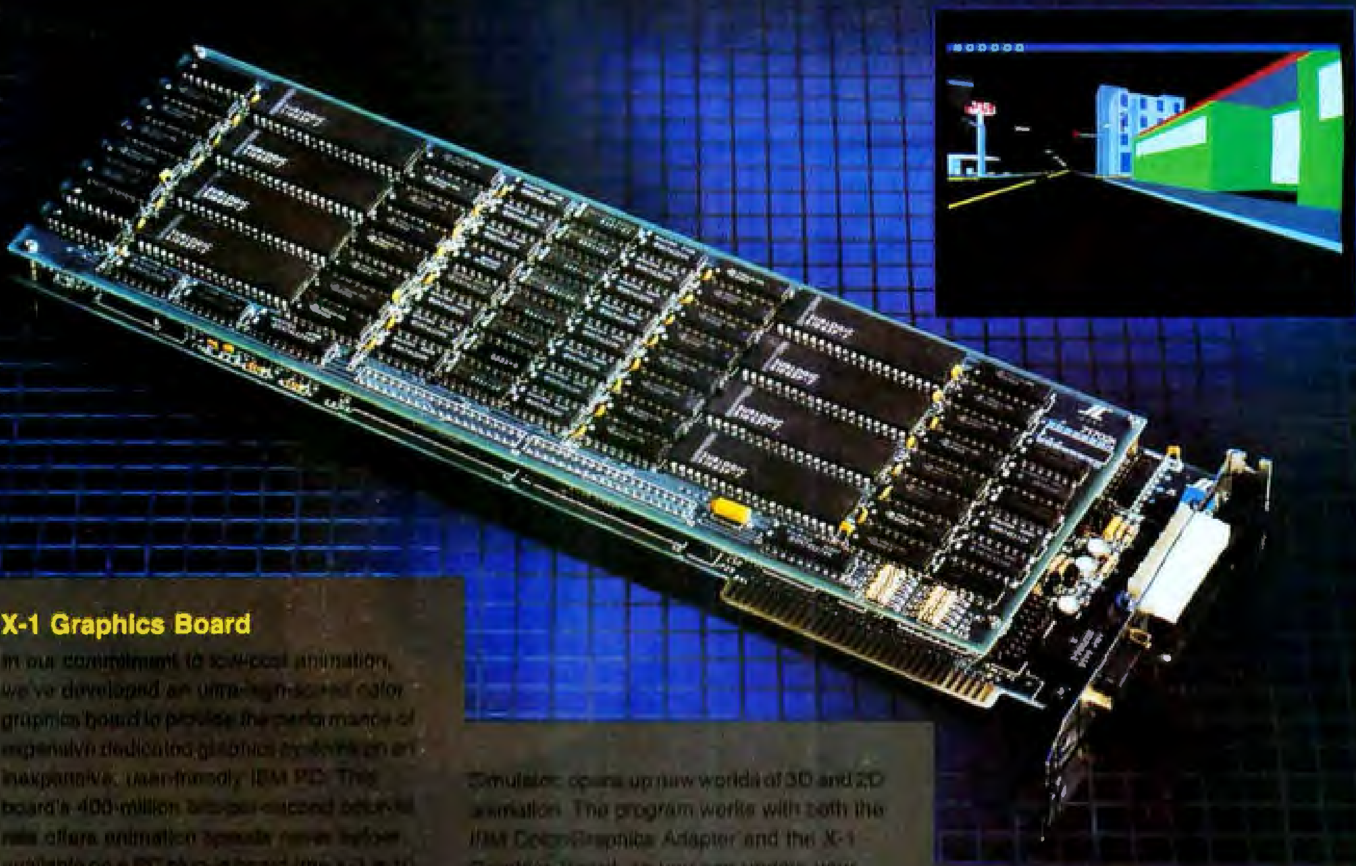

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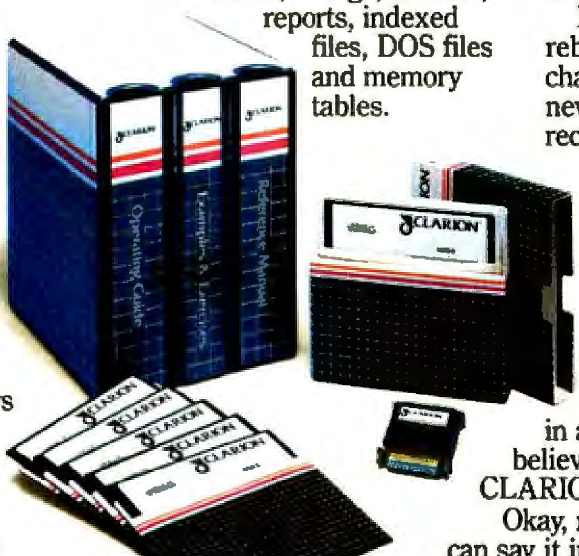

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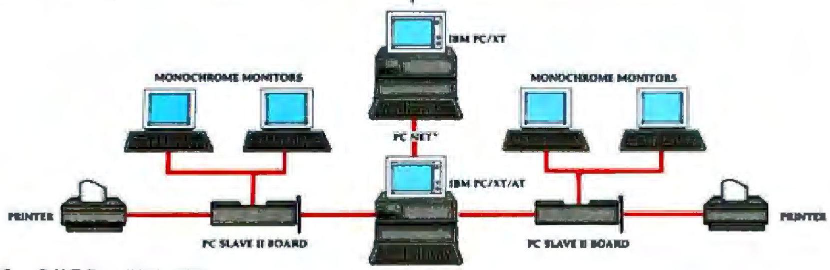

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IBM Introduces Laptop Computer

The PC *Convertible.* IBM's *laptop computer.*

The Bondwell 8, *an* IBM PC*-compatible laptop.*

IBM's laptop computer, the PC Convertible, features a fold-up, removable, 80-column by 25-line liquid crystal display; two 3½-inch, 720K-byte floppy disk drives; and a rechargeable battery that can power the unit for 6 to 10 hours. Internally, the computer has a CMOS 8088 processor and 256K bytes of static CMOS RAM that can be expanded to 512K bytes. Other standard features are a 78-key keyboard, an AC power adapter, and software that includes SystemApps, a package with a scheduler, notepad, phone list, and calculator. The computer requires the recently announced DOS version 3.2.

According to IBM, the Convertible's performance is similar to that of the IBM PC, and in some tasks the laptop may be faster because of its static RAM. Reportedly, the static RAM also allows you to turn on the system and return to the same point in a program at which you turned the computer off.

Without the AC adapter the Convertible weighs 12.2 pounds and measures 15 by 12 by 2.6 inches. You can remove the LCD screen and attach a video display adapter ($350) and either a 9-inch monochrome monitor ($180) with a resolution of up to 640 by 200 pixels or a 13-inch RGB monitor ($400) with 320 by 200 resolution. IBM says the computer's keyboard is compatible with other IBM PC keyboards. The laptop's keyboard includes an inverted-T cursor keypad and a function shift key that changes the cursor keys to Home, End, PgUp, and PgDn keys and sets up a slanted numeric keypad in the typewriter keys.

The back of the system contains a system bus connector to which you can daisy-chain a number of adapters. These include a parallel/serial adapter ($195), the video display adapter, and a thermal-transfer dot-matrix printer ($295) that can run off the computer's battery or with the AC adapter. The printer operates at the rate of 40 cps and can print on copier, thermal, or thermal-transfer paper.

Other options include an internal 1200-bps modem ($450) and battery charger ($25). To allow easy transfer of data between existing desktop computers and the new machine, IBM is offering external 3½-inch floppy drives ($395) for the IBM PC, XT, and AT and an internal 3½-inch floppy drive ($190) that can be connected to IBM's new version of the PC XT with a 20-megabyte hard drive.

Shortly after IBM unveiled the new computer, most major software firms announced the availability of their products in the same 3½-inch disk format that is used by the Convertible. Ashton-Tate, for example, announced 3½-inch versions of Framework II, dBASE III Plus, and MultiMate Professional Word Processor Series 3.3. Lotus Development Corp. announced 3½-inch versions of 1-2-3 and Symphony, scheduled to ship this summer and fall, respectively. Similarly, Microsoft Corp., which developed the MS-DOS 3.2 operating system for the Convertible, announced 3½-inch versions of Microsoft Word, Project, Chart, Access, and Multiplan as well as Windows and Microsoft programming languages.

A PC Convertible with 256K bytes of RAM is priced at $1995; each additional 128K bytes of RAM costs $195. A *Technical Reference Manual* sells for $75, and a *Hardware Maintenance and Service Manual* costs $150. Contact IBM Corp., Entry Systems Div., POB 1328, 5201 South Congress Ave., Boca Raton, FL 33432, (305) 982-3474.
Inquiry 550.

Bondwell's Laptop

The Bondwell 8, an 11-pound portable computer that's compatible with the IBM PC, runs on a 4.77-MHz 80C88 micropro-

(continued)

cessor. The computer comes with 512K bytes of RAM, a built-in 720K-byte 3½-inch floppy disk drive, and a 300-bps modem. The portable's 80-character by 25-line backlit LCD displays graphics with a 640- by 200-pixel resolution and can be switched on and off to conserve power.

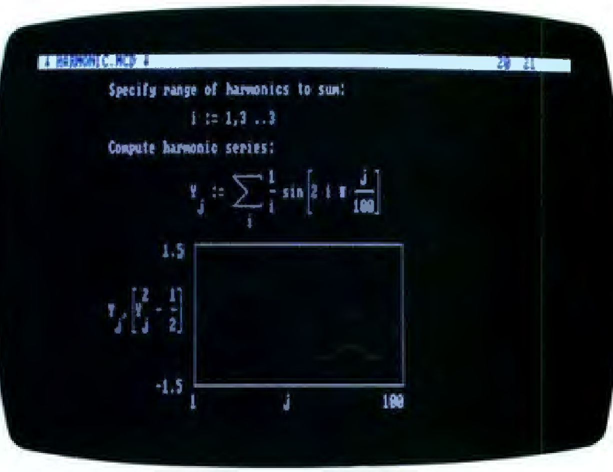
Other features include a built-in rechargeable battery pack that provides up to 8 hours of power, a real-time clock, RGB and composite color video outputs that are compatible with the IBM Color Graphics Adapter, an RS-232C serial port and Centronics parallel port, and a second disk drive port. A battery charger is included. The computer also comes with MS-DOS 2.11 and GW-BASIC 2.0 and runs all IBM PC-compatible software.

A second 3½-inch floppy disk drive and a 5¼-inch floppy disk drive are available as options.

The laptop is priced at $1595. A second 3½-inch floppy drive sells for $399.95, and a 5¼-inch floppy drive costs $379.95. For more information, contact Bondwell, 3300 Seldon Court #10, Fremont, CA 94539, (415) 490-4300.
Inquiry 551.

Program for Computer-aided Mathematics

MathCAD, a software package for computer-aided mathematics, is designed for engineers and other technical users who need to perform numerical analysis and document the results. MathSoft says its program works like a text editor and lets you use a microcomputer as a scratch pad. You can enter and edit equations that appear on screen just as they would on paper; the software sizes brackets and fraction bars interactively as you enter an equation. MathCAD also



Screen shot of MathSoft's MathCAD.

automatically places exponents, subscripts, square roots, and summation signs in arbitrarily complex combinations.

After you've entered equations, you press the equal-sign key and the software computes the results, which are displayed as a number or a plot.

Math capabilities include real and complex numbers in all expressions, iterative calculations, full dimensional analysis and error checking for undefined variables and constants and radices that are improperly formed, hexadecimal and octal conversion, and variable names of any length. Plots correspond to mathematics and change as you modify equations. You can plot data as lines, dots, steps, crosses, or error bars.

MathCAD runs on the IBM PC line under MS- or PC-DOS 2.0 or later. It requires 384K bytes of RAM and a Hercules monochrome, IBM color, or IBM Enhanced Graphics Adapter card. The software works with Intel's 8087 and 80287 coprocessors. MathCAD sells for $189. Contact MathSoft Inc., One Kendall Square, Cambridge, MA 02139, (617) 577-1017.
Inquiry 552.

Object-oriented LISP Runs on IBM PC AT

LISP Machine Inc.s ObjectLISP is an object-oriented LISP that runs under Golden Common LISP (from Gold Hill Computers) on the IBM PC AT. LMI says that unlike other object-oriented dialects, which are based on sending messages between objects, its version uses function calls. Because this "programming paradigm" uses the same syntax as normal LISP, you don't need to learn a separate syntax.

ObjectLISP's semantics don't distinguish between object classes and instances. The regular LISP environment is regarded as ObjectLISP's global object, and symbols are bound there to their ordinary global values. LMI says this function binding is similar to variable binding but associates a symbol with a definition instead of with a value.

ObjectLISP is written in, and is portable to any system that supports, CommonLISP. The software comes on a ½-inch magnetic tape with a user's guide and source code. A shipping and media charge of $195 applies to the first copy, and you may make subsequent copies without obligation to LMI. Contact LISP Machine Inc., Marketing Dept., 6 Technology Dr., Bldg. #4, Andover, MA 01810, (617) 682-0500.
Inquiry 553.

Programmable Calculators Reside in PC Memory

Symsoft has developed a pair of pop-up calculators that reside in 95K bytes of RAM and give your machine the capability to solve simple and complex mathematical problems. Pro/Sci, for engineering and scientific applications, and Pro/Biz, for business computations, let you exit the program you're working in, solve a formula, and then return to your program and bring the answer with you. And you can take a column of figures you've typed in one program and use them as part of a calculation without retyping them.

The primary differences between the two calculators are that Pro/Sci has options for displaying results in binary, octal, and hexadecimal and has trig and integration functions; Pro/Biz has predefined financial and date functions.

The calculators have two screens for computation: The main screen provides space for entering numbers, formulas, and values; the second screen replicates a calculator with an accounting-style tape output. Both programs have standard math functions, logic operators, constants, and conditional statements built in. They also offer functions for such calculations as standard deviation, variance, min/max, and averages. You can use as many as 10 variables and 100 characters (columns) per formula and loop groups of formulas in

(continued)

SuperKey, PC Magazine's "Product of the Year"

Without SideKick, SuperKey, and Traveling SideKick, your IBM PC is only half-awake

It's sleepwalking instead of sprinting. Dawdling instead of dashing, because it's not getting the *supercharge* of a high-speed productivity booster like SuperKey,® PC Magazine's "Product of the Year." Or the real-time desktop management of SideKick,® the #1 best seller for the IBM® PC. Or the electronic clout and Computer Age organizational skills of Traveling SideKick.™

SuperKey "macros" are electronic shortcuts to success

You avoid repetition like getting out of bed 47 times every morning, or cooking dinner 93 times every night—when once is obviously enough. But if you haven't yet discovered the time-saving power of SuperKey, you'll find yourself typing the same set of keystrokes over and over again. Which makes no sense when a SuperKey macro cuts all that out. Macros are electronic shortcuts that can turn 1000 keystrokes into 1.

Aside from macros, SuperKey also gives you powerful encryption technology that scrambles your files and keeps confidential files confidential. It also lets you lock your keyboard, and foils would-be intruders with secret password protection.

Combine the electronic wizardry of SuperKey with the practical efficiency of SideKick

The best way to get the most done in the shortest time is to put both SuperKey and SideKick to work. They're designed to work hand-in-hand, and their complementary talents are astounding.

What SuperKey brings to the party includes time-saving macros, encryption, secret passwords, and programmable and re-programmable keys.

What SideKick brings includes a notepad with full-screen editing and wordwrap, a phone directory, autodialer, calculator, appointment scheduler, and ASCII table. (If you don't own a word-processing program, don't buy one, because with SuperKey and SideKick, you probably don't need one.)

Both SuperKey and SideKick work with your existing software, like Reflex,™ 1-2-3,® MultiMate,™ Wordstar,® Turbo Pascal,® and dBase.®

Traveling SideKick gets personal organizers out of the Stone Age into the Computer Age

If you have SideKick, you need Traveling SideKick—and if you don't have SideKick, you need them both! Traveling SideKick is a revolutionary new combination of binder and software, making a completely new category in personal organizers: BinderWare.™ It prints out information that's already in your SideKick files, produces it in convenient familiar forms, then lets you gather it all together into your Traveling SideKick binder and hit the road.

Traveling SideKick includes report-generating software which produces up-to-the-minute telephone lists, address lists, meeting schedules, travel itineraries, calendars, and much much more. It also includes instant reference maps, airline and hotel reservation numbers, international telephone codes, and currency units. You get preprinted daily/weekly/monthly/yearly calendar forms, alphabetized address book forms, and even a receipt envelope that clips inside your binder. You can order refills at any time.

What's inside your Traveling Sidekick

Buy one, buy two, or all three at spectacular savings

Sold separately—SuperKey is $69.95, SideKick is $84.95, and Traveling SideKick is $69.95 (*until* September 1, 1986). Incredible values, but you can save even more. Here's how: SideKick *and* Traveling SideKick for only $125.00; you save $29.90! SideKick *and* Traveling SideKick *and* SuperKey, all three for only $175.00; you save $49.85!

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IBM PC, PCjr, XT, AT, or true compatible.
Trio—384K, SideKick—128K, Traveling SideKick—256K, SuperKey—128K.

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order to run iterative calculations.

Pro/Sci and Pro/Biz run on IBM PCs or compatibles with 128K bytes of RAM and MS-DOS 2.1 or later. Each calculator costs $99 (plus $5 shipping). For more information, contact Symsoft, POB 4477, Mountain View, CA 94043, (415) 962-9500. To order, phone (800) 227-6703; in California, (800) 632-7979.

Inquiry 554.

UNIX for $99

Wendin's multitasking, multiuser operating system for MS-DOS computers, PCUNIX, is packaged with a version of the Bourne shell, more than 70 commands, and complete source code for $99. It can support two additional users on remote terminals connected to your machine's asynchronous communications adapters; as a multitasking system, it supports a mix of timeshared and real-time processes with an event-driven scheduler similar to that of a mainframe.

Wendin's microcomputer UNIX can run MS-DOS program images in both .COM and .EXE formats, and most MS-DOS system calls are translated to PCUNIX system services automatically and in real time. Extra system services for programming can be called from BASIC, FORTRAN, Pascal, C, and assembly.

The operating system, packaged on four disks, runs on the IBM PC family and compatibles with at least 384K bytes; it can be installed and run on a 5-megabyte hard disk. Contact Wendin Inc., Box 266, Cheney, WA 99004, (509) 235-8088.

Inquiry 555.

The APC IV, NEC's 80286-*based computer.*

Relational Database Language for Atari 520ST

Mirage Concepts describes its H & D Base, a relational database management language for Atari's 520ST, as a dBASE II workalike that's more than a storage and retrieval package. Providing almost 300 commands for manipulating data, the program can be used for building systems that handle inventories, accounts, and lists.

H & D Base works with most dBASE II command files and with all SDF and "delimited" data files. It lets you sort on any field to any level and provides full math capability on any field or variable. The number of records per file is limited only by disk capacity. You're allowed 97 fields per record, 250 characters per field, and 2000 characters per record. Numeric accuracy is eight digits.

The software incorporates a basic text editor, a help facility, a report generator, and a sample mailing-list program. H & D Base is not copy-protected and sells for $99.95. Contact Mirage Concepts Inc., 4055 West Shaw #108, Fresno, CA 93711, (800) 641-1441; in California, (800) 641-1442; in a foreign country, (209) 227-8369.

Inquiry 556.

NEC Announces AT Compatible

NEC Information Systems' Advanced Personal Computer (APC) IV is the firm's first computer specifically designed for the U.S. market and its first computer inherently compatible with the IBM PC family.

The APC IV uses a NEC equivalent of the Intel 80286 microprocessor with a switchable clock speed of 6 MHz or 8 MHz; an 80287 math coprocessor is optional. The computer can accommodate 10.5 megabytes of RAM, with up to 1 megabyte on the motherboard itself (640K bytes is standard). Other standard features include two serial ports, a parallel port, and eight expansion slots, of which two are 8-bit full-size slots and six are 8/16-bit full-size slots. The APC's detachable keyboard has 84 keys and a numeric keypad. Display options include the Advanced Color Display monitor ($800), which has a resolution of 800 by 560 pixels. The Power Graphics Display Monitor ($1495), scheduled to be available next month, has 1120- by 750-pixel resolution. Both monitors have multiscan capability with a scan rate of 15.75 to 32 kHz.

The computer comes with a 1.2-megabyte floppy disk drive and can accommodate a total of five internal storage devices. Options include a second 1.2-megabyte floppy disk drive ($350), a 360K-byte floppy drive ($300), and 20- and 40-megabyte half-height hard disk drives, which cost $1400 and $1800, respectively.

NEC offers three optional graphics boards with the APC IV. The Color Graphics Board ($225) supports 640- by 200-pixel resolution and is compatible with IBM's Color Graphics Adapter. The Advanced Graphics Board ($525) is compatible with both the CGA and IBM's Enhanced Graphics Adapter, supports all of the EGA's modes as well as software written for the Hercules graphics board, and comes with 256K bytes of memory. NEC also offers the Power Graphics Board ($995), which is compatible with IBM's Professional Graphics Adapter. Available next month, the Power Graphics Board provides a resolution of 1120 by 750 pixels and can display 16 colors from a choice of 4096 colors.

The APC IV sells for $3795 with a single 1.2-megabyte floppy drive; $4645 with a 1.2-megabyte floppy and 20-megabyte hard disk drive; and $5045 with a 1.2-megabyte floppy and 40-megabyte hard disk

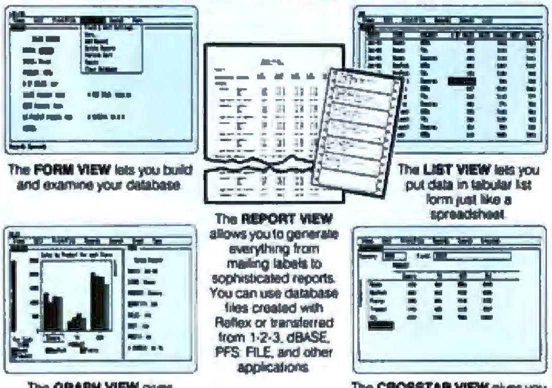
(continued)

Reflex, The Analyst upgrades and adds the new Reflex Workshop!

Why running your business without Borland's Reflex and the new Reflex Workshop is an act of blind faith

Running a successful business isn't something you can do with your eyes shut, but no matter what business you're in, Reflex™ and the new Reflex Workshop™ give you all the tools and views to see what all the numbers look like.

Reflex gives you five graphic ways of looking at your data, five different ways of analyzing your information.



The **FORM VIEW** lets you build and examine your database

The **REPORT VIEW** allows you to generate everything from mailing labels to sophisticated reports. You can use database files created with Reflex or transferred from 1-2-3, dBASE, PFS: FILE, and other applications

The **LIST VIEW** lets you put data in tabular list form just like a spreadsheet

The **GRAPH VIEW** gives you instant interactive graphic representations

The **CROSSTAB VIEW** gives you amazing "cross-referenced" pictures of the links and relationships hidden in your data

Using Lotus 1-2-3® or dBASE® without Reflex is like driving at night without lights

Products such as 1-2-3 or dBASE can do the numbers for you, but you may still not get the picture—simply because they can't show you analytical graphs and pictures of your data, nor can they analyze and summarize all the information you manipulate like Reflex can.

The best just got better. Introducing Reflex 1.1 NEW!

The new Reflex 1.1 with extended memory support allows you to manage huge databases of up to 8 megabytes of RAM, 32,000 records, and 250 fields per record with the now-legendary "Reflex Lightning Speed."

Furthermore, Reflex 1.1 with its EGA support displays 40 lines of information in its spreadsheet-style List View, compared to less than 25 lines displayed by traditional spreadsheets.

SPECIAL OFFER!

If you already bought Reflex 1.0, get Reflex 1.1 and the Reflex Workshop for only $69.95

Because you bought Reflex from us, you're "our kind of people." And since we're not the "take-the-money-and-run" kind of company, you can upgrade to Reflex 1.1 and the Reflex Workshop for only $59.95. If you prefer to simply upgrade to Reflex 1.1, you can do that for only $10.

SPECIAL OFFER!

*You get Reflex 1.1 and the Reflex Workshop for only $199.95**

Sold separately, the new Reflex Workshop is $69.95 and Reflex is $149.95, totaling $219.90—but you can get them both for a limited time only, at an amazing $199.95. So act now, rush to your nearest dealer, call us, or clip the coupon and put Reflex 1.1 and the Reflex Workshop to work for you right away!

NEW! Introducing the Reflex Workshop

Only $69.95

A major addition to Reflex, the new Reflex Workshop gives you a wide range of analytical tools written for specific applications. You can use these tools "as is" or modify them to suit your analytical and business needs. What you have to work with right away are 25 different tools.

For Finance/Accounting:

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- Line of Credit Tracking & Analysis
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- Purchase Order Entry & Analysis
- Purchase Order Tracking System
- Leasing Inventory Management
- Asset Inventory Tracking
- Cash Management Trial Balance

For Administration:

- Membership Dues Tracking and Analysis
- Mail List
- Time Management
- Appointment Scheduling
- Applicant Tracking & Inquiry System
- Facilities Planning

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- Sales Analysis
- Trend Analysis
- Research Questionnaire Analysis

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- Manufacturing Quality Assurance Tracking
- Assembly Repair Turnaround Tracking
- Commercial Real Estate Tracking & Analysis
- Project Scheduling
- Product Cost Analysis and Control

"The best database around . . . at any price.
Jean Lockwood, Computer Retail News

Everyone agrees that Reflex is the best-looking database they've ever seen.
Adam B. Green, InfoWorld

Reflex excels as an analytical tool . . . this program can become everyman's database manager.
Frank J. Derfler, PC Magazine

Borland has done it again.
Sheldon L. Richman, Washington Post"

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____ Workshop at $69.95 $____*
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(you must return your disks)
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Prices include shipping to all U.S. cities
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†Minimum System Requirements:
384K—Runs on IBM PC, AT, XT, and true compatibles. IBM Color Graphics Adapter, Hercules Monochrome Graphics Card or equivalent.

Reflex works with Intel's Above Board AT and Above Board/PC, AST's RAMpage! and RAMpage! AT, Quadram's Liberty-PC and Liberty-AT, Tecmar's 640 Plus, IBM's EGA and 3270/PC, AT&T's 6300, and many others.

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drive. All models are bundled with MS-DOS 3.1 and GW-BASIC. For more information, contact NEC Information Systems Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (617) 264-8000.
Inquiry **557.**

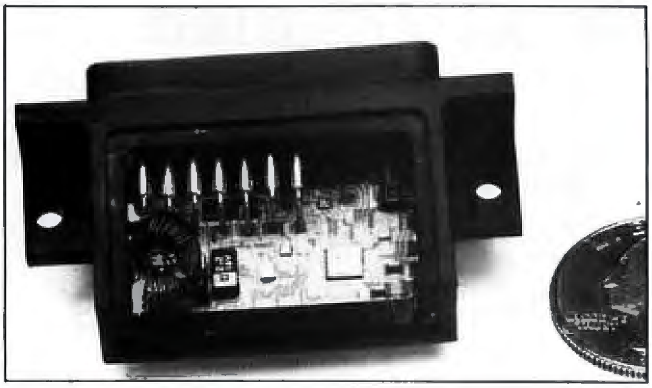
Microcoded IBM PC Board

Designed for building customized processors, the MVP Microcoded CPU/16 from Mountain View Press is an add-on board for the IBM PC that implements a high-speed microcoded processor. A wire-wrapped prototype of the board, which MVP demonstrated at the West Coast Computer Faire in April, ran one FORTH test program 50 times faster than an IBM PC alone. According to the company, the processor can execute over 2 million stack operations per second.

The card's 74-chip design includes a 16-bit ALU, two hardware stacks, an interface to the IBM PC, 128K bytes of static memory, a program counter, two 16-bit data registers, and room for 256 microcoded processor instructions. Each microcoded instruction is defined by up to eight 32-bit user-definable microcode instructions.

An Engineering Prototype Kit is available for $1500, and a printed circuit board version should be available this month. MVP includes the following software with the wire-wrap kit: MVP FORTH/16, a word-oriented FORTH that executes directly in the processor; the MVP-FORTH Programmer's Kit; a Number Extensions package; a microcode assembler; a cross-compiler; a set of diagnostic programs; and source code for all the preceding software.

For more information, contact Mountain View Press Inc., POB 4656, Mountain View, CA 94040, (415) 961-4103.
Inquiry **558.**



Rapitech Systems' Acticon serial connector.

Passport's Sequencer Runs on Apple, Commodore

Passport Designs has added to its MIDI Pro Series with Master Tracks, sequencing software that runs on the Commodore 64/128 and the Apple IIe/II+/IIc. The package provides real-time, step-time, and song modes.

In real-time mode, you have access to all 16 MIDI channels, with solo/mute on each track and unlimited overdubbing with the mix function. MIDI thru lets you hear any of 16 sound sources from your master keyboard. Advanced tape sync writes a variable tempo pulse to tape, reading tempo changes and allowing synchronization to visuals. The memory can handle 8000 events without loops or repeats.

The step-time editor lets you input and edit notes, rests, velocity, articulation, and tempo. You can also cut, copy, and paste phrases.

Song mode lets you assemble songs using sequences created in step time or real time. It also lets you build sequences as if using a drum machine. As many as 256 sequences can be assembled using any of 256 steps. You can play back individual sequences in any order or tempo.

Master Tracks retails for $249.95. Besides a computer, the software requires a Passport MIDI Interface or MIDI Pro Interface. Contact Passport Designs Inc., 625 Miramontes St., Suite 103, Half Moon Bay, CA 94019, (415) 726-0280.
Inquiry **559.**

Single-Chip EGA Controller

Paradise Systems introduced the PEGA 1 video controller, a single-chip implementation of the IBM Enhanced Graphics Adapter standard, which currently requires a four-chip set on the IBM and other EGA boards. According to the company, the PEGA 1 will run all EGA-compatible software, including Microsoft Windows, and all previous software written for the IBM PC and compatibles. The chip supports high- and medium-resolution IBM monochrome and color graphics, Hercules monochrome graphics, Plantronics ColorPlus graphics, and Paradise color simulation on a monochrome monitor.

Four main modules make up the 84-pin PEGA 1. These modules replace the five custom LSI parts on IBM's EGA board and a dozen supporting TTL circuits. The chip is available with a proprietary IBM-compatible video BIOS extension.

The PEGA 1 is available in sample quantities at a price of $900 per sample; production quantities are slated for delivery by the end of the second quarter. For more information, contact Paradise Systems Inc., 217 East Grand Ave., South San Francisco, CA 94080, (415) 588-6000.
Inquiry **560.**

Miniature Serial Interface

Rapitech Systems has developed a standard-sized serial RS-232C connector that contains all of the circuitry usually found on a serial interface card. Called the Acticon connector, the device replaces the serial interface circuitry that, the company says, normally occupies 8 to 12 inches on a computer's motherboard or expansion board.

The Acticon connector is designed to attach to the memory bus on a motherboard through a series of pins along the bottom of the connector. The company says that the new connector will be incorporated into computers now being designed, and computers that use the connector may be available in less than a year.

The Acticon's patented design can be licensed by any computer manufacturer; licensing fees depend on volume. For more information, contact Rapitech Systems Inc., 75 Montebello Rd., Suffern, NY 10901, (800) 367-8749; in New York, (914) 368-3000.
Inquiry **561.**

(continued)

THE F-15 JET FIGHTER. IF THE COMPUTER GOES DOWN SO DOES THE PLANE

The F-15 served as a test bed for a flight control system written in the Ada language.
Ada was designed to meet today's demands for a standard computer language, producing efficient, reliable and maintainable code.

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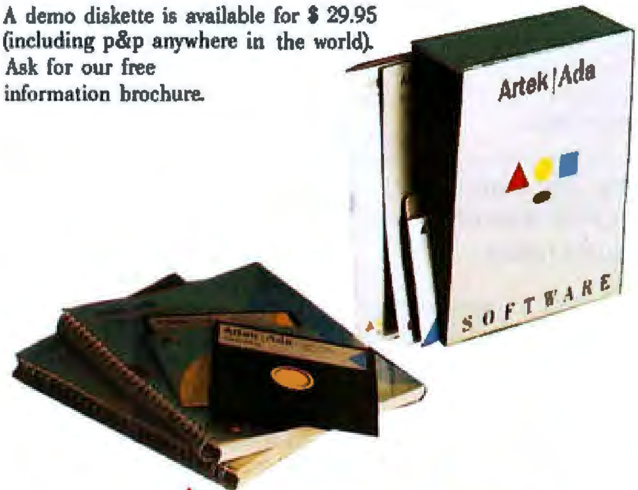
Artek Ada specifications

Artek Ada implements the Department of Defense 1983 Ada standard, including generics, derived types, overloading, packages, separate compilation, dynamic arrays, standard I/O, string handling, array and record aggregates and much more. The only major featue of Ada not implemented is tasking. Minimum hardware requirements are: IBM PC or a compatible computer, running MS-DOS or PC-DOS (2.0 or later version) with 384 Kb RAM and one double-sided floppy-disk drive. Artek Ada works with the IBM PC network. For further information see our information kit.

A demo diskette is available for $ 29.95 (including p&p anywhere in the world). Ask for our free information brochure.



Artek

Artek Corporation 100 Seaview Drive Secaucus NJ 07094

SYSTEMS

NEC V40-based Computer

The JC LIPS computer from JC Information Systems is based on a NEC V40 processor running at 9.54 MHz and compatible with an Intel 80186. The computer comes with 256K bytes of RAM that can be expanded to 640K bytes on the motherboard and two 360K-byte half-height floppy disk drives. Other standard features are a 14-inch monochrome monitor, an IBM PC AT-style keyboard, eight expansion slots, an RS-232C serial port, a battery-backed clock, a floppy disk controller, and a 135-watt power supply. The computer is also equipped with a video display card that provides a parallel printer port and supports Hercules monochrome graphics and IBM-compatible color graphics.

The LIPS computer runs under MS-DOS versions 2.1 or 3.0 and later. The base model costs $1495; models with hard disk drives, color monitors, and other options are also available. For more information, contact JC Information Systems, LIPS Division, 161 Whitney Place, Fremont, CA 94539, (415) 659-8440.
Inquiry 562.

The JC LIPS *computer, based on a* NEC V40 *processor.*

The On! Computer, a CP/M System from Oneac

A CP/M-compatible computer from Oneac Corp is designed to survive power-line glitches and to be left on for long periods of time. The computer, named On!, features a 4-MHz Z80 microprocessor and 2 to 4 megabytes of memory. The computer's memory, which is set up as a RAM disk, is intended to be the system's primary data storage device. The memory is backed up with a small battery, which Oneac claims can power the memory through outages of up to 12 hours. The system's 5¼-inch, 800K-byte floppy disk is intended for backing up data in memory.

Oneac claims that the RAM disk causes the system to perform eight times faster than an IBM PC running equivalent tasks. And because the system is always on, you never have to wait for it to warm up.

The computer is bundled with the New Word word processor, the ZCPR operating system, and a number of utilities and menus. The system has internal space for four modems, which makes it useful for unattended bulletin board systems. The company says that On! is compatible with most CP/M software packages.

With 2 megabytes of memory, the On! computer sells for $2000. It comes with a TeleVideo 955 terminal, which will be priced at less than $599 (exact price was not available at press time). For more information, contact Oneac Corp., 27944 North Bradley Rd., Libertyville, IL 60048, (312) 680-5999.
Inquiry 563.

Heath Introduces AT-Compatible Kit

Heath's HS-241 Advanced PC Desktop Computer kit is compatible with the IBM PC AT and uses an Intel 80286 microprocessor running at 6 MHz. Standard features include a serial and a parallel port, a single 1.2-megabyte 5¼-inch floppy disk drive, and 512K bytes of RAM, which can be expanded to 15 megabytes. The HS-241 uses a combined hard and floppy disk controller card that can accommodate two floppy and three hard disk drives.

Priced at $2899, the kit comes with an IBM PC-compatible detachable keyboard. Options include internal hard disk drives with 20 or 40 megabytes of storage. Contact Heath Co., Dept. 150-745, Benton Harbor, MI 49022, (616) 982-3210.
Inquiry 564.

Pick-based Multiuser System from Fujitsu

Fujitsu Microsystems' System 2020 is an addition to the company's Series 2000 line of Pick-based multiuser computers. The 2020 runs on an Intel 80286 microprocessor and can accommodate eight users. It has 512K bytes of RAM that can be expanded to 1 megabyte and comes with a 54- or 86-megabyte (unformatted) hard disk drive. According to the company, the computer's operating system is fully compatible with Pick-based software and features a number of enhancements, including electronic mail, full-screen editing, and a calculator function.

Prices begin at $8850 for the two-user system with 512K bytes of memory and 54-megabyte hard disk. Contact Fujitsu Microsystems of America, 3025 Orchard Parkway, San Jose, CA 95134, (408) 434-1160.
Inquiry 565.

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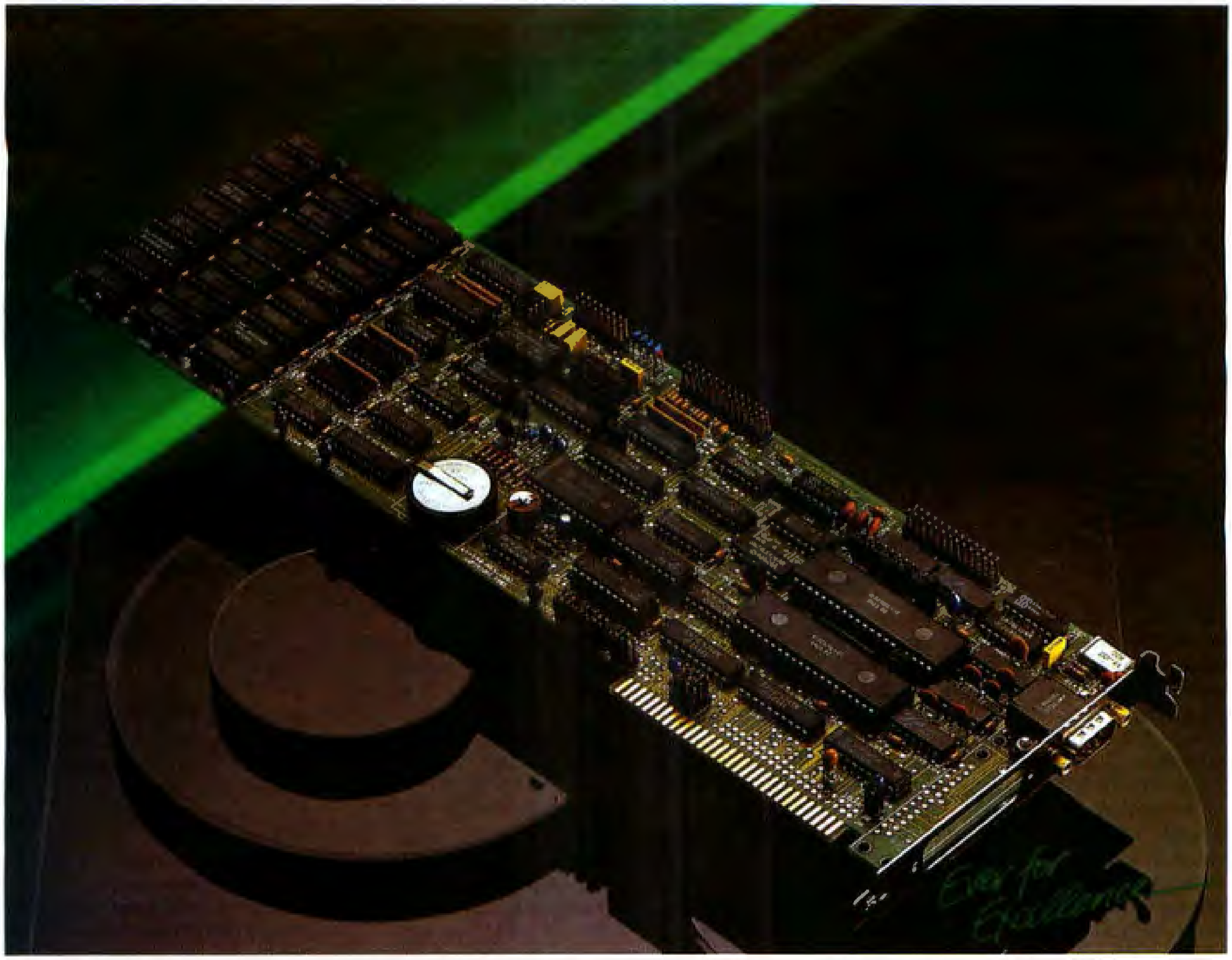

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The EVEREX Magic Card II is the multifunction card that has the features you want at a price you can afford. It can even take an original PC, with a 64K motherboard, to 640K of RAM. Installation is a snap with our unique TESTER program that runs independently and shows exactly where to install RAM and how to set the options.

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PERIPHERALS

Roland's Sound Samplers and Drum

Roland announced two sound samplers, the S-50 and the S-10. Both can sample sounds with a resolution of 12 bits at a rate of 32K per second, yielding a bandwidth of 17 kHz. The S-10 can store 4 samples at a time and comes with a 49-key keyboard. The S-50 can store 61 samples, one each for its 61 keys. The S-50 also has an RGB and composite monitor connection that lets you connect a monitor to display information visually. Both samplers have MIDI connections. The S-10 and S-50 cost $1250 and $2695, respectively.

Roland's TR-505 MIDI drum machine can emulate a wide range of drums, including Latin percussion instruments. The machine also generates MIDI information, which can be captured by a MIDI sequencer, modified, and played back through the TR-505. The drum machine costs $295.

Contact RolandCorp U.S., 7200 Dominion Circle, Los Angeles, CA 90040, (213) 685-5141.
Inquiry 566.

Dual Printer Buffer

The Proteus printer buffer and switch lets you connect two printers or other peripherals with parallel ports to your computer. The unit provides a buffer for each of the two peripherals. Both printers connected via Proteus can print at the same time, and you can switch between the two through software or manually by a switch on the front panel of the unit.

The device is available with 64K bytes or 256K bytes of memory. Each port is automatically allocated as much memory as available, up to the maximum capacity of the buffer. With a 256K-byte unit, for example, if you print a 64K-byte file to one port, 192K bytes of memory are automatically allocated to the other port. Each port also has multiple copy capability.

A 64K-byte version costs $199, and a 256K-byte version costs $299. Contact Computer Friends Inc., 6415 Southwest Canyon Court, Suite #10, Portland, OR 97221, (503) 297-2321.
Inquiry 567.

The TravelComm 1200 portable modem.

Pocket-sized Modem

TouchBase Design announced the TravelComm 1200, a pocket-sized modem that communicates at 300 and 1200 bps. You can plug the 6-ounce modem directly into a computer's RS-232C port or connect it by cable to a computer via a standard RS-232C connector.

To dial, you type a phone number on your keyboard; when the modem receives two carriage returns, it turns on automatically and selects the communication rate. At the end of a connection, the modem turns off automatically. Other features include a call-progress indicator and a 9-volt battery with a 3- to 6-month life.

The modem works with most portable computers and sells for $299. Contact TouchBase Design, 1447 South Crest Dr., Los Angeles, CA 90035, (213) 277-1208.
Inquiry 568.

Robotics System

The Microbot ARMLAB System is a combination of textbooks, software, and hardware designed to teach robotics and automated manufacturing. Intended for use in junior high and high schools, college, and industry, the system leads students through robotics theory to the actual automatic manufacturing of small products.

The hardware includes two 5-axis, fully articulated robot arms; a vision system; CNC mill and lathe; rotary table; gravity feeder; conveyor; electronic and pneumatic experimenter's kits; speech system; and workcell safety barrier.

The texts include *Robot Literacy* and *Applied Robotics* by Dr. J. Larry Heath, *Robotics Workcells and Systems Interfacing* by Prof. R. Dean Eavey and Dr. Heath, and *The Industrial Robot and Automated Manufacturing* by Dr. Del Kimbler. Prices start at $1430. For more information, contact Microbot Inc., 453-H Ravendale Dr., Mountain View, CA 94043, (415) 968-8911.
Inquiry 569.

40-megabyte Tape Drive

The TD440 tape backup drive provides 40 megabytes of backup capacity for the IBM PC, XT, AT, and compatibles. The drive uses ¼-inch tape cartridges that are formatted into one 32-megabyte logical drive or two 17.8-megabyte drives. The unit comes with a cable and an interface card that fits in a short expansion slot.

The TD440 emulates a hard disk drive, is file-addressable, and works with DOS 2.0 and later. This means you can use DOS commands such as COPY and ERASE to manage data files and can also use the drive to store large spreadsheets or databases that might not fit on a hard disk. You can run programs directly from tape and store data on tape directly from an application program without exiting the program to use a separate backup utility. The company also provides a sector-by-sector backup utility that backs up a 10-megabyte hard disk in about 10 minutes.

The tape drive lists for $1490. Contact Advanced Digital Information Corp., POB 2996, 10201 Willows Rd., Redmond, WA 98073, (206) 881-8004.
Inquiry 570.

(continued)


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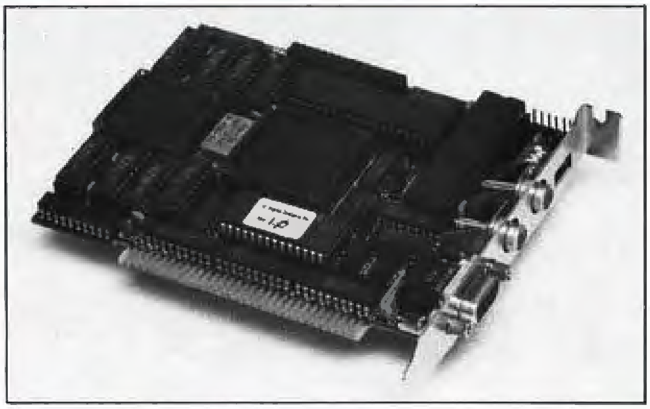
ADD-INS

Short-Slot EGA Board

Sigma Designs announced the SigmaEGA!, a high-resolution graphics board. Based on Sigma Designs' Color 350 board, the short-slot board supports software that runs with the IBM Enhanced Graphics Adapter (EGA), the IBM Color Graphics Adapter (CGA), the IBM Monochrome Display Adapter (MDA), and the Hercules Graphics Adapter. The board has 256K bytes of on-board RAM, which lets you run all EGA graphics modes without the need to add more memory.

The SigmaEGA! costs $595. It works with all IBM monitors and compatible monochrome and color monitors and comes with PC Paintbrush, a graphics package by Z-Soft. Contact Sigma Designs Inc., 2023 O'Toole Ave., San Jose, CA 95131, (408) 943-9480.
Inquiry 571.



The SigmaEGA! high-resolution graphics board.

Tecmar's Music Synthesis Board

Tecmar has announced a 16-oscillator music synthesis board for the IBM PC. Named the Music Synthesizer System, the new board uses what Tecmar calls harmonic interpolation synthesis to create up to 16 different notes in up to 16 different voices at one time. If fewer voices are needed, oscillators can be combined to form more intricate sounds. The board can hold up to 256K words of memory, where each word is 12 bits wide. This memory can be used to hold up to 256 wave tables, each comprising 1K words. The board can also play back sampled sounds that have been coded at the factory.

Output signals can be directed to either of two stereo output ports. Input can be from either the computer keyboard, an external piano-style keyboard, or an external MIDI interface. Under MIDI, the board can support up to 16 channels.

The Tecmar board includes software that allows it to function as a 64-track note recorder that can store up to 65,000 notes in a computer with 640K bytes of RAM. Up to four boards can be connected together, yielding 64 possible simultaneous sounds.

The Music Synthesizer System costs $795 and should be available this month. It runs on IBM PCs and compatible computers with a minimum of 256K bytes of RAM, a graphics board, and at least one floppy disk drive. Contact Tecmar Inc., 6225 Cochran Rd., Solon, OH 44139, (216) 349-0600.
Inquiry 572.

Z80 Coprocessor Board for IBM PCs

Earth Computers introduced the TurboSlave-PC, an 8-MHz Z80-based coprocessor board for the IBM PC, XT, AT, and compatible computers. The board features 128K bytes of RAM, two serial ports, a port-mapped FIFO, on-board diagnostics, monitor EPROM, and the SLR Z80 assembler, Z80ASM.

The board can be configured as a coprocessor under MS-DOS and is supported by the TurboDOS operating system. Compatible with CP/M and MP/M programs, TurboDOS will support up to 16 terminals with TurboSlave-PC boards.

Suggested list price is $395. For more information, contact Earth Computers, POB 8067, Fountain Valley, CA 92728, (714) 964-5784.
Inquiry 573.

Hard Disk Card Offers SCSI

The SCSI Hard Disk Card, from Micro Design International, is a 21-megabyte internal hard disk drive and SCSI interface for the IBM PC and compatible computers. The drive supports the ANSI X3T9.2 SCSI specification and is designed to plug into one and a half slots on the computer.

The SCSI section of the card can connect as many as six more SCSI peripherals, including internal or external tape or hard disk drives, optical disk drives, and printers.

The company also sells a version of the card for the Tandy 1000 computer. Both versions cost $675. For more information, contact Micro Design International Inc., 6566 University Blvd., Winter Park, FL 32792, (305) 677-8333.
Inquiry 574.

AT-Compatible Card for Kaypro PC

Kaypro Corp. announced the 286 PC Card, which gives the 8088-based Kaypro PC compatibility with the IBM PC AT. The card retails for $1065; if you trade in the Kaypro PC's 8088, the card costs $799.

For more information, contact Kaypro Corp., POB N, Del Mar, CA 92014, (619) 481-4300.
Inquiry 575.

Add Megabytes to Mac Plus

The MaxPlus memory modules plug into the expansion sockets of the Macintosh Plus to provide 2 or 4 megabytes of RAM. According to the company, the modules require no special software and no hardware modifications and will work with all Macintosh power supplies.

Bundled with RAM disk and print spooling software, one set of modules provides 2 megabytes of RAM. MaxPlus costs $499 for 2 megabytes of RAM and $998 for 4 megabytes. Contact MacMemory Inc., 473 Macara Ave., Suite 701, Sunnyvale, CA 94086, (408) 773-9922.
Inquiry 576.

Inquiry 172 →

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SOFTWARE • PROGRAMMING LANGUAGES AND AIDS

Modula-2 for Z80 CP/M

Workman and Associates is offering the FTL Modula-2 compiler for Z80 CP/M systems. A complete Modula-2, FTL has such features as separate compilation, procedures as parameters, open array parameters, and coprocesses.

The compiler supports real numbers with 15-digit accuracy, 2-byte integers from −32,768 to 32,767, and 2-byte cardinal numbers from 0 to 65,535. It does not offer a large integer type.

FTL provides version control through the linker, type checking between modules, and chaining between programs. It supports calls to the BIOS and BDOS of CP/M. The disk-based compiler directly creates Z80 code in the form of CP/M .COM files. Most of the libraries are written in Modula-2. The package's assembler is not compatible with other assemblers.

The editor's command structure is similar to WordStar's but adds the capability of editing three files simultaneously. You can customize the editor without getting into the source code: The install program lets you choose such characteristics as placement of the arrow key.

Workman says FTL conforms to the standard in the third edition of Niklaus Wirth's *Programming in Modula-2*.

FTL requires CP/M 2.2, 3.0, or later; a Z80; at least a 58K-byte transient program area; and one disk drive. Workman will supply the compiler on any of 190 CP/M disk formats.

For $49.95, you get the compiler, linker, editor, assembler, library modules, library source code, manual, and telephone support. Source code for the editor costs $39.95. Or you can buy it all for $79.95. Workman asks for no royalties on programs written in FTL. Contact Workman and Associates, 112 Marion Ave., Pasadena, CA 91106, (818) 796-4401.
Inquiry 577.

Modula-2 in Source Form

Modula-2 fans can now get the latest version of the compiler in source form. Modula Corporation says the new compiler, written by Niklaus Wirth, is faster because it's based on the single-pass principle. It can recompile itself in 80 seconds on a Lilith workstation, the company says.

The package includes the source to the compiler and a portable debugger in IBM PC or Lilith format, a copy of the third edition of Wirth's *Programming in Modula-2*, and technical reports on the structure of the compiler and debugger. The compiler consists of about 5000 lines of Modula-2 code.

Three versions are available: for the Lilith, the Motorola 68000 family, and the National Semiconductor 32000 family. The Lilith version produces M-code, a symmetric machine language for a pure stack computer. The other two versions have been derived from the M-code version.

Modula has ported the compiler to the IBM PC and the Macintosh.

The price for each compiler in source form is $1000. Contact Modula Corp., 950 North University Ave., Provo, UT 84604, (800) 545-4842 or (801) 375-7400.
Inquiry 578.

Multitasking OS for Atari ST

Micro RTX is a multitasking operating system kernel for the Atari ST series. Because it's compatible with TOS, it can run regular ST programs. The system automatically handles input, output, and memory management in a multitasking environment. Programs can make standard TOS calls to perform I/O and memory management.

Once you've installed the operating system, the ST becomes a multitasking machine in which all activities are performed by processes running under Micro RTX. The number of active processes is limited only by available memory. The system uses round-robin scheduling to keep a process from consuming too much CPU time.

Micro RTX is priced at $69.95. Contact Beckemeyer Development Tools, 592 Jean St. #304, Oakland, CA 94610, (415) 658-5318.
Inquiry 579.

Library for C Programmers

PforCe, a library package for programming in C, offers high-level functions for manipulating windows, screens of fields, and databases as objects. The object-oriented approach is designed to facilitate maintenance of modules and also to help you program in a structured style. Among the package's subsystems for handling complicated tasks are a database system with demand paging and B-trees to store access and index information; a windowing system; interrupt-driven communications; and background tasks. Source code is supplied for all functions and bundled utilities.

PforCe runs under MS- and PC-DOS and can be used with Microsoft, Lattice, Computer Innovations, and Wizard compilers. It supports all memory modules of each compiler. The library costs $395. Contact Phoenix Computer Products Corp., 320 Norwood Park S., Norwood, MA 02062, (617) 762-5030.
Inquiry 580.

FORTRAN Utilities

FORTRAN Cross-Reference Utility, from PJN International, reads source files written in FORTRAN 77 and generates a program listing with symbol cross-reference maps of variables, subprogram calls, and labels for each subprogram. PJN says its software generates cross-reference maps with the same detail provided by mainframe compilers; for example, the variable cross-reference map also shows variable type, length, allocation (array/scalar), and scope (local/common).

FORTRAN Utility Library is a collection of assembly language subroutines that can give programs such capabilities as screen and cursor manipulation, direct keyboard access, command-line access, memory peek and poke, and sound generation. There's a version for Microsoft/IBM FORTRAN and one for Ryan-McFarland/IBM Professional FORTRAN compilers.

Both utilities run on IBM PCs and compatibles under DOS 2.0 or later. The cross-reference package requires 128K bytes. Cross-Reference Utility costs $49.95. Utility Library costs $39.95. (For each, add $2 for shipping.) Contact PJN International, POB 201363, Austin, TX 78720-1363, (512) 837-2888.
Inquiry 581.

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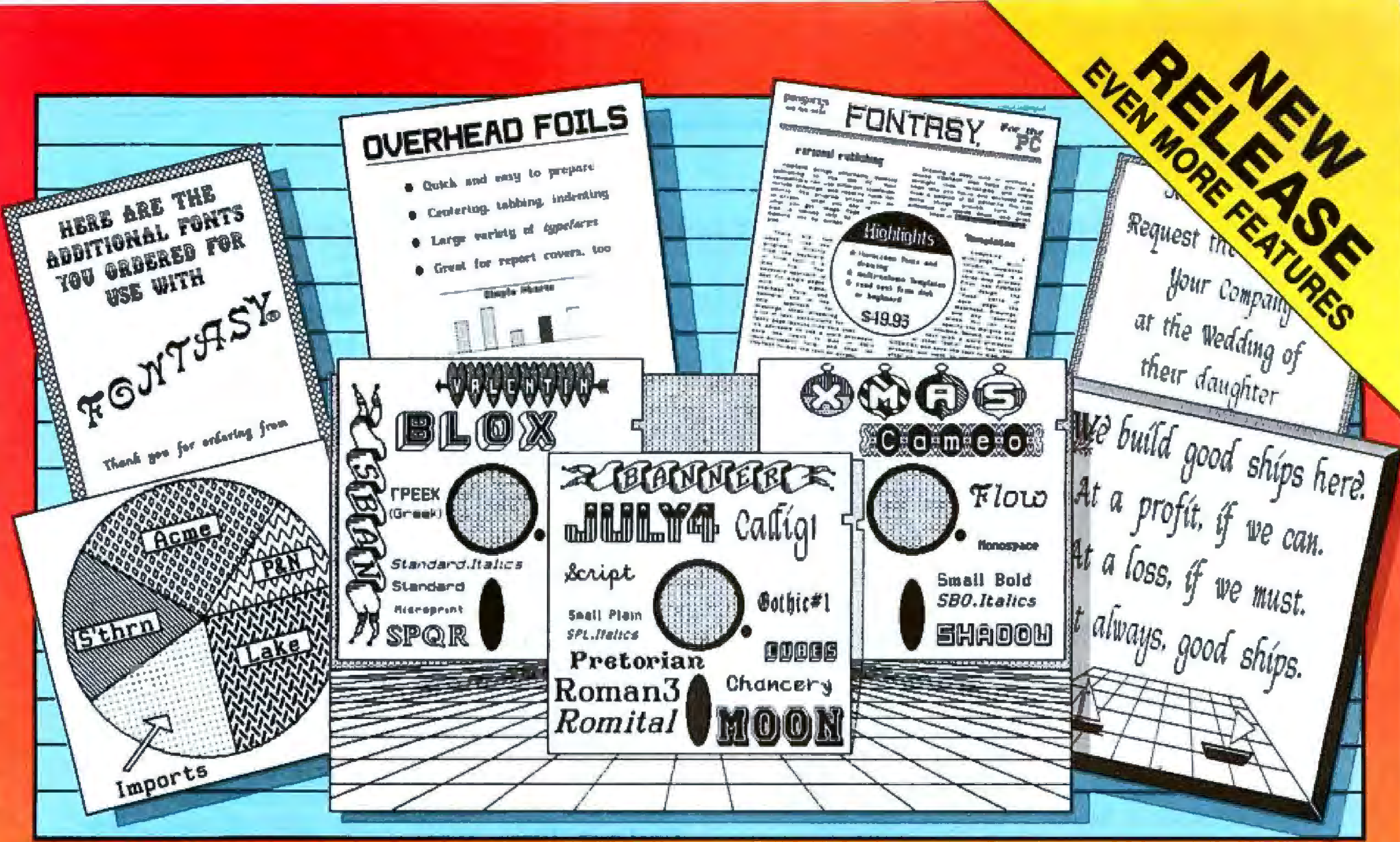

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Inquiry 279

SOFTWARE • SCIENTIFIC AND ENGINEERING

Talking Scientific Calculator

The Calc-Talk program from Computer Aids Corp. combines voice output and large-print display on the Apple IIc and IIe. It turns the keyboard into a scientific-calculator keypad and provides trigonometric and logarithmic functions. The voice-output facility works with most of the popular speech synthesizers for the Apple II, including Slot-Buster, DecTalk, and the Echo line.

Calc-Talk causes each keystroke to be voiced. Numbers, letters, and symbols are displayed in figures almost an inch high.

The software runs on a IIc or IIe with 128K bytes of memory and an 80-column card. It costs $75.

Also, the company has released a new version of Braille-Talk, its talking text-to-braille translator. The enhanced edition is ProDOS-based and can translate 10 double-spaced pages in slightly more than 2 minutes. It costs $125. Contact Computer Aids Corp., 124 West Washington, Lower Arcade, Fort Wayne, IN 46802, (800) 647-8255.
Inquiry 582.

Data Grapher for Scientists

Jandel Scientific has developed a program designed specifically for scientists who want to draw graphs and charts of data. Sigma-Plot, which runs on the IBM PC series and compatibles and works with HP-compatible plotters, can produce line, scatter, histogram, and bar charts. The program also features error bars, log-log scales, semilog scales, independent *x*, *y* plotting, cubic spline curve fitting, and linear regression.

The software uses menus that can be controlled with the keyboard or the cursor of a digitizer. Data can come from the keyboard, from files of programs such as dBASE II/III or Lotus 1-2-3, or from files of Jandel's Sigma-Scan measurement system.

Sigma-Plot costs $350. Contact Jandel Scientific, 2656 Bridgeway, Sausalito, CA 94965, (800) 874-1888; in California, Alaska, and Canada, (415) 331-3022.
Inquiry 583.

Electronic Design Software for Mac

Advanced Engineering Solutions has released the second product in its ParaGenesis series of CAE software. Digital MacroScope lets you perform gate and functional-level digital simulations on a Macintosh Plus or a 512K Macintosh with an external drive.

The package enables you to run three types of simulation: 12-state logical, physical, and parametric. The 12-state mode resolves true, false, strong, weak, conflicting, and undefined logic states. The physical mode computes the gates' output rise and fall times from the source and sink current driving load and input capacitances. The parametric mode lets you vary voltages and temperatures and monitor power consumption in the network.

The package's Simulation Design Language includes state and parametric information that you can edit. You can describe logical blocks or use standard gates and MSI chips that are defined in the component libraries.

You can enter the circuit to be simulated from the keyboard or from the company's Schematic Entry drawing program. As you design the circuit, Schematic Entry compiles a database of parts, pins, and nodes. This database automatically passes the interconnect information to Digital MacroScope.

Digital MacroScope sells for $1000, or you can buy it packaged with Schematic Entry, normally priced at $700, for $1500. Contact Advanced Engineering Solutions Inc., 75 Manhattan Dr., Suite 302, Boulder, CO 80303, (303) 499-2910.
Inquiry 584.

Package Turns Mac into Speech Lab

MacSpeech Lab from GW Instruments converts the 512K Macintosh into a workstation for analyzing speech and testing people who are speech-impaired. The package lets you view, edit, play, and store speech. With GW's MacADIOS data-acquisition hardware, you can digitally record words at rates of up to 20,000 samples per second.

You can view time and frequency representations of speech at positions you select with the mouse. Segments within utterances can be amplified, offset, normalized, saved, and played. The software produces sound spectrograms showing the progression of frequency spectra with time. It also draws pitch plots to show the changes of frequency within an utterance.

A complete MacSpeech Lab consists of software ($300), MacADIOS hardware ($2500), and a Macintosh computer ($2000). Contact GW Instruments, POB 547, Cambridge, MA 02142, (617) 577-1524.
Inquiry 585.

Tools for Designing Transformers, Inductors

Tech Software is selling a program that automates the process of designing transformers and inductors for switching power supplies. Applications include work with push-pull, single-ended, and flyback transformers or buck, boost, and filter inductors. The company says its product relieves engineers of having to perform long-hand calculations or checking vendor catalogs to choose magnetic cores and magnet wire.

The software lets you experiment with input parameter values (such as input power, core size, and number of windings) to find their effect on program outputs. Tech Software says magnetics modeling and automatic core selection are two essential features of these tools. The package uses design equations that determine core size, wire size, magnetization inductance, permeability, flux density, and air gap length. Lookup tables contain the physical parameters that characterize each magnetic core.

The software uses menu screens to take you through the design process. These screens show I/O parameters, engineering units, current values, and program options.

The package costs $149 and runs on these machines: IBM PC series and compatibles with 128K; CP/M 2.2 computers with 64K; and Apple II+, IIe, and IIc computers with 64K. Contact Tech Software Corp., POB 3126, Redmond, WA 98052, (206) 483-9699.
Inquiry 586.

(continued)

Inquiry 53

SOFTWARE • BUSINESS AND OTHER

MIDI Studio for Amiga

SoundScape software combines MIDI, sampling, and multitrack recording on an Amiga computer. Mimetics says its program is actually an operating system that resides simultaneously with the Amiga's DOS and Workbench.

The main program consists of a multitrack music sequencer with an unlimited number of MIDI-compatible tracks. You can put each track in play, record, mute, thru, or "match" mode (Match mode can be used to learn or practice a piece of music; it stops playback until you've played the notes in the selected track.) A time-oriented editing system lets you cut and paste using a mouse.

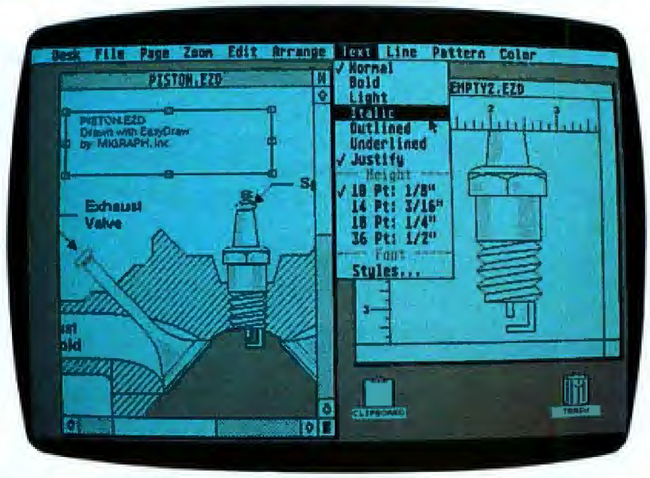
SoundScape works with keyboards plugged into the second game port, the internal sound synthesizer, MIDI I/O, pitch followers, and the computer's keyboard. It costs $149. Contact Mimetics, 16360 Stevens Canyon Rd., Cupertino, CA 95014, (408) 741-0117.
Inquiry 587.

Object-oriented Drawing Program Runs on Atari ST

Easy-Draw, an object-oriented art program for the Atari ST, can be used to create business and presentation graphics, line drawings, and multiple-layer illustrations. The package lets you move and manipulate objects, copy them, rotate them, and stretch and size them. You can zoom in on any area, pick from predefined patterns, use shadowing, and use rules and grids.

The program provides two windows for working in. You can move and copy drawings between windows. Easy-Draw uses high-resolution output for printing.

The sofware runs on a color or monochrome ST. Suggested retail price is $149.95. Contact Migraph Inc., 720 South 333rd St., Suite 201, Federal Way, WA 98003, (206) 838-4677.
Inquiry 588.



Easy-Draw, an object-oriented program for the Atari ST.

Music Plotter for Apples

Personal Music Engraver, described by developer Newgo Inc. as a professional music calligraphy program, automates the process of putting music to paper. The software, which works with an *x, y* plotter to produce music characters, runs on the Apple II+, IIc, and IIe.

Newgo says the program works like a word processor. It is smart enough to check your "musical grammar" while you type, and it automatically displays notes with the correct stem length and direction. The editor lets you change, delete, or insert measures anywhere in any part. The package also lets you transpose notes, control page format (including spacing between staves and number of staves per page), set horizontal spacing, and use 10 font sizes. Personal Music Engraver can print complete scores (with an upgrade), lead sheets, charts, exercises, and templates with blank measures.

The program requires an X-Y plotter with DMPL-IV language (for example, the Houston Instrument PC-695 or DMP-29). Personal Music Engraver sells for $1395; the upgrade that lets it produce complete scores costs $29.95. Contact Music Graphics Inc., POB 22, Winchester, VA 22601-0022, (703) 665-0239.
Inquiry 589.

Mail Program for LANs Features Multimedia Messages

PCC/Systems has released cc:Mail for local-area networks of IBM PCs and compatibles. The software lets you write, store, send, and receive electronic messages that can consist of anything you can create with your microcomputer, including text, graphics, and data files. The program has a word processor and a graphics package, and it's capable of capturing screens from application programs; you can then edit these snapshots and insert them in your messages. Each message can combine as many as 20 text, graphics, and file items.

It takes one keystroke to send mail. You can request a receipt telling you when the recipient got the message. You can store mail in up to 100 personal folders, each of which can hold 500 messages. Mail can be exchanged between cc:Mail systems on dissimilar LANs. The software is designed to operate on networks with single or multiple file servers. Communications use X.PC error correction. All database files are encrypted.

The software runs under DOS 2.0 or later on IBM PCs and compatibles with at least 320K bytes of RAM and a Hayes or compatible modem. A 10-user starter version of cc:Mail for LANs costs $995. Contact PCC/Systems, 480 California Ave., Suite 201, Palo Alto, CA 94306, (415) 321-0430.
Inquiry 590. ■

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.

LOOKING FOR THE BEST VALUE IN PC/AT COMPATIBLES?

INTRODUCING THE $1495 A★STAR™

Looking for a lower priced, higher quality PC/AT compatible than our new A★Star™ is like looking for a needle in a haystack. You're more apt to come up with a case of hayfever.

A★Star gives you features you won't get from *any* other vendor. Not IBM. Not Compaq. Not even those foreign manufacturers. Features like a 220 watt power supply, eight *available* expansion slots and "network ready" multi-user operation. All for only $1495. And that price includes a 1.2MB diskette drive, 512KB memory, a fixed disk/diskette drive controller, a tactile feedback keyboard (you'll love it!) and a 6/8MHz switch/software selectable 80286 CPU.

Best of all, A★Star is quality built right here in America by Wells American Corporation - an American Stock Exchange manufacturer. So now you can buy with confidence from a vendor you can trust, just like you've trusted IBM. And you'll get a genuine, top quality product (not a cheap imitation) for a price even less than those "questionable" mail order clones. And if that's not enough, it's all money-back guaranteed!

The $1495 Wells American A★Star.™

A PC/AT FOR ONLY $1495? THAT'S NOTHING TO SNEEZE AT!

(Hurry! This offer *is* limited.)

☐ I'm tired of sneezing! Have someone call me immediately to take my order.

☐ A★Star sounds terrific. Tell me more.

Name: ____________

Company: ____________

Phone: ____________

Address: ____________

City: ____________

State: ____________ Zip: ________

Wells American

803/796-7800•TWX 510-601-2645

Sunset Boulevard • West Columbia, SC 29169

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CLUBS AND NEWSLETTERS

MICRO MUSICIAN, 11514 Ventura Blvd. #A-3, Studio City, CA 91604, (818) 508-8079. Monthly news on software, hardware, synthesizers, and MIDI information. Annual subscription: $22.

INPUT/OUTPUT, Box 248, Station B, Ottawa K1P 6C4, Canada. Quarterly newsletter promotes peaceful uses of technology, especially computer technology.

THE SMART APPLE CLUB (TSAC), 53 Hemlock Ave., Narragansett, RI 02882. Public domain library, newsletter, and BBS.

GULF COAST COMPUTER CLUB, POB 1104, Port Richey, FL 34288-1104, (813) 868-0176. Meetings twice a month.

APPLE PORTLAND PROGRAM LIBRARY EXCHANGE (APPLE), POB 1608, Beaverton, OR 97075. Monthly newsletter, public domain software. Send SASE.

COMMODORE-PET USER GROUP (C-PUG), John Palmer, 2308 Houma Blvd., Apt. 724, Metairie, LA 70001. Send SASE for more information.

AVIATION AND COMPUTER ENTHUSIASTS (ACE), Carl Bogardus, 1220 Birch Dr., Las Cruces, NM 88001. Open to all; $5 annual dues includes quarterly newsletter.

DELLASONTA COMPUTER CLUB, 12 Jalan Tera, Bandung 40111, Indonesia. Special interest groups, regular meetings, monthly newsletter.

MICROTHEATER, Room 146, Fine Arts Center Building, University of Massachusetts, Amherst, MA 01003, (413) 545-0480. Free bimonthly newsletter for computerists in entertainment.

68000 CLUB, c/o Software Only, Meadow Park Plaza, 22753 Hawthorne Blvd., Torrance, CA 90505, (213) 373-0466. Newsletter, public domain library, tech support. Annual dues: $25.

PASADENA IBM USER'S GROUP, Steve Bass, 711 East Walnut St., Pasadena, CA 91101, (818) 795-2300. Monthly meetings. Dues: $2 per meeting.

TECH CLUB, c/o Software Only, Meadow Park Plaza, 22753 Hawthorne Blvd., Torrance, CA 90505, (213) 373-0466. News, library, and support for scientists, mathematicians, engineers, and programmers. Annual dues: $25.

DENVER AMATEUR COMPUTER SOCIETY (DACS), POB 477, Wheat Ridge, CO 80034. Monthly newsletters and meetings.

THE DELAWARE VALLEY DEC PC USER GROUP, c/o MICRODOC, 815 Carpenter Lane, Philadelphia, PA 19119. Newsletter and meetings.

BAY AREA NEC/MODEL 100 USER'S GROUP, c/o Truly Portable, POB 2916, Oakland, CA 94609. Meetings, newsletter, public domain software library. Annual dues: $10.

SANYO USERS GROUP OF WASHINGTON, Douglas Webbink, POB 2468, Fairfax, VA 22031, (703) 323-9663. Monthly meetings, newsletter, public domain library, SIGs; $15 annual dues.

DIGITAL ENCRYPTION STANDARD USERS GROUP, R. M. Richardson, POB 1065, Chautauqua, NY 14772, (716) 753-2654. Newsletter for microcomputer cryptoanalysts. Send SASE for details.

MATAMATA COMPUTER CLUB, C. James Elliot, Alameda Junior High School, 1211 Calle Luna, Santa Fe, NM 97501. Logo for students on HP 110 and Apple computers.

PUBLIC DOMAIN CLUB, POB 6877, Dept. 3, Hollywood, FL 33021. Free Apple and IBM public domain programs. Club membership free with first order.

THE III MAGAZINE, 3201 Murchison Way, Carmichael, CA 95608, (916) 485-6525. Published monthly; support for Apple III loyalists. Annual subscription: $40. ■

CLUBS AND NEWSLETTERS *is an acknowledgment of new clubs and newsletters received at* BYTE. *Allow at least four months for your club's mention to appear. Send information to* BYTE, *Clubs and Newsletters, One Phoenix Mill Lane, Peterborough*, NH 03458.

Inside Apple

Vol. 2, No. 2

We're just not making Macintosh™ computers like we used to make them.

We're making them better.

Now they're twice as powerful. They're more expandable. And they're significantly faster.

We call our newest Macintosh, Macintosh Plus.

By Plus, we refer to a full megabyte of RAM that gives Macintosh the power to take advantage of the most powerful software programs ever driven with a point and click.

By Plus, we refer to its new, 800K double-sided disk drive, that allows you to store twice as much by using both sides of a floppy.

By Plus, we refer to 128K of ROM that makes Macintosh perform more efficiently. And a sophisticated hierarchical filing system that enables you to find things faster than you used to lose them.

Look what our own engineers did behind our back.

And by Plus, we refer to the added cursor keys and a built-in numeric keypad that let you do your adding, subtracting, guess-timating and bottom-lining without lifting your hands from the keyboard. Or your eyes from the screen.

But to fully understand the biggest turn-around in Macintosh Plus engineering, all you need do is turn around any Macintosh Plus.

And behold, a Small Computer Systems Interface port.

Macintosh Plus.

Better known in computer circles as a SCSI port.

The SCSI port not only allows you to transfer data six times faster, but lets you connect up to seven high-speed peripherals at once. Including hard disks and tape drives.

Needless to say, we've given ourselves a considerable kick in the backside.

And if you read on, we'll show you how to turn the Macintosh that's sitting on your desk into the Macintosh sitting on this page.

Is there enough storage space in your office?

It's only 7⅞ x 1⅞ x 4¾ inches on the outside, yet big enough to store over 400 pages of data on the inside.

We're talking, of course, about our new and faster 800K external disk drive.

Like the internal drive in our new Macintosh Plus, our external drive also uses 800K double-sided 3½" disks. Which virtually eliminate the words "disk is full" from the Macintosh vocabulary.

And you can even daisy chain an extra external drive off an Apple® Hard Disk 20, giving you the capacity to work at extraordinary speeds with larger documents.

Like your own personal copy of the Des Moines white pages.

Now you can buy as much Macintosh as you need.

Now that there's more than one Macintosh to choose from, you're probably wondering which one to choose.

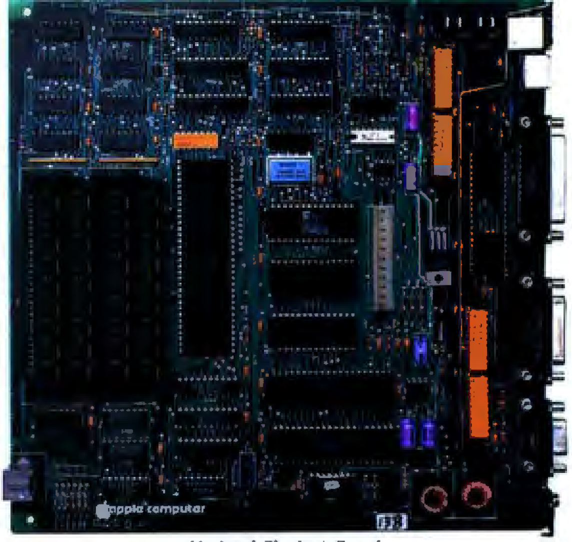
Well, for you power-mongers out there, we recommend the Macintosh Plus. The computer whose powerful features adorn the previous page.

But if you don't need a full megabyte of memory, we recommend the newly enhanced Macintosh 512K.

By enhanced, we mean we've taken our Macintosh 512K and added an 800K internal disk drive and 128K of internal ROM.

Which makes it more than capable of handling all your computing chores. Even though it costs considerably less than a Macintosh Plus.

Macintosh Plus Disk Drive Kit.



Macintosh Plus Logic Board.

Macintosh Plus Keyboard.

And should the day come that you want to sort out a database faster than you can take a sip of coffee, you can always upgrade from a 128K, a 512K or enhanced 512K to a Plus.

All at once. Or a little at a time.

We recommend you start with the Macintosh Plus Disk Drive Kit. That's where we install the new 128K of ROM, the hierarchical filing system and the 800K internal disk drive (Of course, the enhanced 512K already has these features).

After that, you can bump your RAM up to 1Mb with the Macintosh Plus Logic Board Kit. And add a new rear housing and SCSI port.

And finally, you can attach our keyboard that comes with the keypad and cursor keys.

The point being, the more you put into a Macintosh, the more you get out of one.

Apple Hard Disk 20.

Disk space vs. desk space.

It used to be, adding a hard disk to your computer meant giving something up: a big chunk of desktop.

Enter the new Apple Hard Disk 20. Since it has the same footprint as Macintosh Plus, it fits directly beneath it.

This not only makes Macintosh Plus a few inches taller, but about 25 times bigger. Because you can install all the programs you currently keep on floppy disks on the Hard Disk 20's disk. So you don't have to swap disks to switch applications.

And the Hard Disk 20's Winchester, 20-megabyte technology allows you to cut and paste, switch from application to application, and access information up to three times faster than you can using floppy disks.

The Hard Disk 20 really gives you the best of two worlds.

You get more disk space to work with. And more desk space to work on.

Meet the press.

Here's all the news that's fit to print about our new LaserWriter™ Plus printer.

For starters, it isn't just a printer. It's also a computer. Inside is the same Motorola 68000 microprocessor that's inside Macintosh Plus. Not to mention a hefty 1.5-megabyte of RAM and a full megabyte of ROM.

And inside the ROM is POSTSCRIPT,® the page description language that is quickly becoming the industry standard.

Translated, this means LaserWriter Plus can quickly and quietly print an amazing 300 dots per inch, and give you complete control over every single dot on the page. Which allows you to cover an entire page with virtually any combination of near typeset quality text and high resolution graphics.

Put this LaserWriter Plus printer together with a Macintosh Plus and you get a design studio, a type house and a print shop that fits on 3.1 square feet of desk.

POSTSCRIPT also allows the LaserWriter Plus to generate dozens of different type styles from its 11 built-in typeface families. Including popular business faces like Helvetica,® Times,® Palatino® and ITC Avant Garde Gothic.® And more families are becoming available all the time.

POSTSCRIPT allows the LaserWriter Plus to generate hundreds of different type sizes, too. So you can create legal documents with fine print as fine as 4-point. Or banners with blocks of type as big as 720-point.

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz — ITC Avant Garde Gothic

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz — ITC Bookman

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz — Helvetica Narrow

Some of the new faces you'll be seeing around the office.

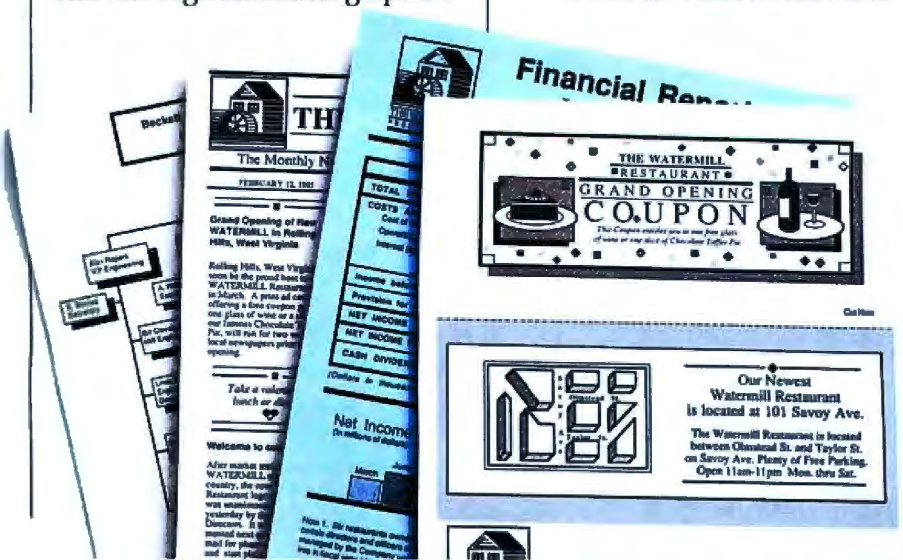
But those aren't the only pluses to the LaserWriter Plus.

When you hook one up to a Macintosh Plus, you become the proud owner of one of our Desktop Publishing Plus™ systems. A system that virtually puts a design studio, a type house and a print shop on your desk. Which means your newsletters, flyers, forms and manuals will stand out in a world full of typewritten pages thick with white-out.

We could easily go on and on. Instead, we'll let our LaserWriter Plus speak for itself in the form of the output pictured to the left.

While they may look like the handiwork of a professional artist, typesetter, and printer, we assure you they were created with nothing more than a LaserWriter Plus, a Macintosh Plus and software like our own MacDraw™ and MacPaint,™ Microsoft's Word and Excel, and Aldus' PageMaker.

And an ordinary pair of human hands.

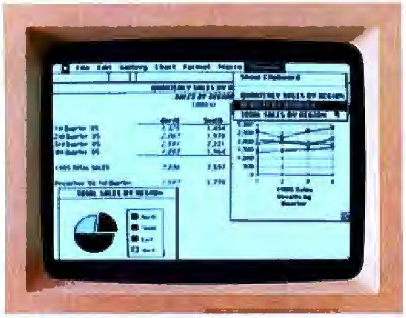


How the people who run things, run things.

If there's one thing every business person can use more of, it's power.

Which is why you'll be happy to hear that the most powerful personal computer software being written, is being written for Macintosh computers.

Take Excel from Microsoft, for example. It's the first spreadsheet program to combine automatic macros, user-defined functions, array-handling and two-way data



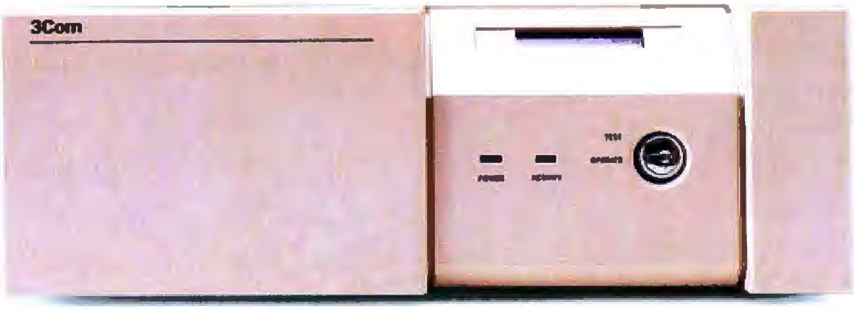
Excel from Microsoft.

Omnis 3 from Blyth.

file compatibility with Lotus 1-2-3 in one program.

Omnis 3 from Blyth is a relational database program that lets you create your own pull-down menus, on-screen buttons and dialog boxes. As well as share files over our AppleTalk™ Personal Network in the multi-user version.

And while we're on the subject of sharing, we should tell you that we've entered into a working relationship with what we consider



3Server from 3Com.

to be one of the highest ranking disk servers on the market. 3Server from 3Com.

For the uninitiated, disk servers are storage devices that allow your Macintosh Plus to share information and other services with other computers over a network.

Which, in conjunction with the powerful new software we described earlier, makes it a lot easier to start running your business.

Instead of chasing after it.

Here's our new business card.

Now you can automate your office without draining your company's checking account down to the right side of the decimal point.

With our new Apple Business Credit Card.

As the name suggests, it's a credit card for your business, issued in your company's name.

Make an initial purchase of $2,500, and it gives your company a line of credit that can be applied towards the Apple products of your choice.*

With the Apple Business Credit Card, there's never a down payment on anything you buy. It's possible to get credit approval in 24 hours. And you don't have to pay any interest if you pay your balance within 30 days.

To apply, visit any participating authorized Apple dealer.

The Apple Business Credit Card. Don't leave the office without it.

Trade Apple stock.

If you own a Lisa® or a Macintosh XL computer, this is your lucky ad.

Because from April 14th to August 29th, you can trade-in these computers for a Macintosh Plus and a Hard Disk 20 at the suggested retail price of only $1498.

So bring your authorized Apple dealer your Lisa and Macintosh XL computers.

And trade them for the stock on his shelf.

F·I·X·E·S A·N·D U·P·D·A·T·E·S

BYTE'S BUGS

Three Wrong Notes

Three wrong notes in the April Editorial we must correct:

Computers and music is not the theme of the July issue; it's the theme of the June issue, the one you're reading right now. Look at it this way: You don't have to wait another month.

Keyboardist Roger Powell, a member of Todd Rundgren's group Utopia, developed MIDI *sequencer* software, not MIDI squeezer software. The package, called Texture, runs on the IBM PC. (You can contact Roger at POB 328, Rhinebeck, NY 12572.)

And the editor of *Electronic Musician* is Craig Anderton, not Craig Anderson.

Sorry, readers. Sorry, Roger. Sorry, Craig.

Sorry, Wrong Number

In the April Fixes and Updates, in the table of addresses and telephone numbers relating to computer conferencing systems, we gave the wrong number for the New Jersey Institute of Technology. (NJIT runs the Electronic Information Exchange System.) The correct number is (201) 596-3437. Our apologies.

BYTE'S BITS

Hawaii Calling

The organizers of the Twentieth Annual Hawaii International Conference on System Sciences are seeking papers for their proceedings. HICSS, slated for next January 6–9 in Kona, is sponsored by the University of Hawaii and the University of Southwestern Louisiana, in cooperation with the ACM (Association for Computing Machinery) and the IEEE Computer Society. The stated purpose of the meetings is "to provide a forum in which quality researchers and practitioners in the information, computer, and system sciences can exchange ideas, techniques, and applications."

Topics for papers should focus on architecture (including high-performance personal machines, knowledge-based systems, and VLSI and technology issues); software (including design tools, environments, alternative language paradigms, and models of system and program behavior); and applications (including health care systems, legal information processing, and DSS model management).

The deadline for abstracts has passed, but full papers may be submitted until July 7. Notification of accepted papers will be mailed in September. For more information on the conference, contact Ralph H. Sprague Jr., conference cochairman, at the following address:

College of Business Administration
University of Hawaii
2404 Maile Way, E-303
Honolulu, HI 96822
(808) 948-7430

Nauseating

We get thousands of press releases every month, announcing all sorts of products. Some of the products sound an awful lot like some of the other products, and some of the names sound an awful lot like some of the other names. So we paused a bit when we read the release describing the Nauseater. We certainly can't explain it to you as well as the folks at MachoTech Industries can; hence, we quote their announcement.

"The Nauseater is a flashlight-type device that creates a slight feeling of queasiness in the stomach of any person in its path. The proprietary Nauseater design (patent pending) utilizes a low-powered, frequency-modulated laser humanely engineered to create just the desired effect."

MachoTech suggests you might want to use this device when waiting for a table in a restaurant. Aim it at a couple "lingering over coffee" and one of them will say, "Honey, I'm feeling squeamish. Let's leave."

The Nauseater (which is also spelled the Nauseator) is priced at $7995. And for the nervous kind of guy, MachoTech sells the Anti-Nauseater, a "belt-worn device which is a must for anyone who doesn't own a Nauseater." Only $995.

Uh, but before you rush out to buy, keep in mind that the announcement is dated April 1.

Houston Atariasts BBS

HASTE (Houston Atari ST Enthusiasts) is operating a public domain bulletin board system running on a 520ST with an upgraded memory of 1 megabyte. The group has an electronic newsletter that's available for downloading. The telephone number of the HASTE BBS is (713) 955-9532.

How to Access and Use BYTEnet Listings

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

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

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

BYTE listings are also available on BIX. After connecting with the system, type join listings at the main prompt. (For more information on BIX, phone (800) 227-2983 between 8:30 a.m. and 11:00 p.m. Eastern time, weekdays.)

A·S·K B·Y·T·E

Conducted by Steve Ciarcia

COMPAQ QUESTIONS

Dear Steve,

I am not very hardware-oriented, but I enjoy your articles very much, especially the one on keeping power-line pollution out of your computer (December 1983). After reading your article, I went straight to Radio Shack and purchased a voltage-transient surge protector. Since we do not have much lightning here (mostly irregular current supply), will this device protect my Compaq computer adequately?

Also, do you know of any board that would transform my Compaq into a telex machine so I can send telexes without dedicated equipment?

DANIEL POHORYLES
Herzlya, Israel

The transient surge-protection device will protect your computer equipment from transients produced by lightning as well as those produced by the switching of equipment connected to the same power line. If your area suffers from frequent brownouts (sudden drops in the supply voltage) or power outages, I would suggest that you purchase an uninterruptible power supply (UPS). A number of UPS manufacturers advertise in BYTE.

To send and receive telex messages, you require a serial port, modem, communications software, and access to either Western Union EasyLink or the MCI Mail Network. Both networks provide access to the international telex system as well as the ability to send hard-copy letters and electronic messages to other network subscribers. Additional information regarding these services can be obtained by contacting

MCI Mail
2000 M St. NW, Suite 300
Washington, DC 20036
(800) 424-6677

Western Union
9229 LBJ Freeway, Suite 234
Dallas, TX 75243
(800) 527-5184

(Western Union)
Ministry of Communications
POB 23179
Tel Aviv 61231, Israel
(972.3) 28 12 61
(972.3) 29 53 33

—Steve

TYPEWRITER CONVERSION

Dear Steve,

I have a Sperry/Remington Redactron word processor. I would like to convert the IBM Series 60 typewriter to stand alone as a letter-quality printer. Do you know of a company that has plans or parts to do the conversion? I can do it from scratch, but I would rather save time.

DENNIS A. POLLOCK
Albuquerque, NM

Here is the name and address of a company that advertises interfaces for your IBM Series 60 typewriter:

California Micro Computer
933 Warbler Ave.
Fountain Valley, CA 92708
(714) 964-9301

—Steve

APPLE RESOLUTION

Dear Steve,

I have an Apple II+ and feel envious of the 560-dot horizontal resolution available on the Apple IIe. I've had my Apple now for years, and I have accumulated co-processor cards, etc., that use their own memory rather than the Apple's memory.

I am interested in any modification to the Apple II+ that would permit true 560-dot horizontal resolution, either by allowing the display of both high-resolution screens at once or some other means. I am specifically interested in hardware modifications that would allow dots to be independently addressable.

THOMAS DONALDSON
Canberra, Australia

The Apple IIe gets its 560-dot horizontal resolution by bank-switching the two banks of video RAM and alternately displaying both banks slightly offset from each other. This produces the single image from the two 280-dot images. Since the Apple II+ lacks the alternate bank of memory at the high-resolution screen addresses, there is no practical way to duplicate the effect.

While it is possible to rapidly switch between the two high-resolution pages on the II+, it isn't possible to offset the pages horizontally to double the resolution as with the IIe.

The colors displayed by the Apple II+ are determined by whether or not a given dot is on, the horizontal coordinate of the dot (even or odd column), whether or not an adjacent dot is on, and whether or not the high bit of the byte that dot occupies in memory is on. Because of this, an individual dot cannot be changed without changing adjacent dots. I know of no simple hardware modification that will alter this. Smooth animation is achieved on the Apple by shifting all the dots in the animated image. In order to smoothly move an image across the screen, seven different bit-mapped shapes are required for each image. For information on this type of animation, see the article "A New Shape Subroutine for the Apple" by Richard T. Simoni Jr. in the August 1983 BYTE. Also refer to Apple Graphics and Arcade Game Design *by Jeffrey Stanton (1982, The Book Company, 11223 South Hindry Ave., Los Angeles, CA 90045).*—Steve

FREE BYTES

Dear Steve,

I am currently using an IBM PC XT with two floppy disk drives, and I am programming in Pascal, CBASIC, and FORTRAN. I

(continued)

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

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

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

The Ask BYTE staff includes manager Harv Weiner and researchers Eric Albert, Bill Curlew, Ken Davidson, Jeannette Dojan, Jon Elson, Roger James, Frank Kuechmann, Dave Lundberg, Edward Nisley, Dick Sawyer, Andy Siska, and Robert Siek.

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

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

NEW 3.0 ENHANCEMENTS

These and other powerful utilities now *included* in the C Programming System:
- **make: compiles only what's necessary from multiple modules, a powerful programming discipline**
- **diff: identifies differences between two files**
- **m4: macroprocessor expression editing and substitution**
- **egrep: extended pattern search**
- **MicroEMACS: full screen editor with source**

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

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

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

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

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

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

From source code to final product, only one takes you all the way: Mark Williams' C Programming System. All for only $495. **Ask about our 60-day money back guarantee when you call 1-800-692-1700 to order today.*** You'll be big on the total C Programming system from Mark Williams, too.

*In Illinois call 312-472-6659.

Mark Williams Company
1430 West Wrightwood
Chicago, Illinois 60614

Inquiry 204

Listing 1: *Assembly language routine to determine free disk space.*

```
    mov     DL,drive          ;drive=0 - default drive
                              ;drive=1 - A drive
                              ;drive=2 - B drive
    mov     AH,36H
    int     21H
    cmp     AX,0FFFFH         ;If AX returns FFFF, then drive...
                              ;...designation was in error
    je      error
    mov     sec_clust,AX      ;AX contains number of sectors...
                              ;...per cluster
    mov     free_space,BX     ;BX contains free space in clusters
    mov     bytes_sec,CX      ;CX contains bytes/sector
    ret
error:
    ret
```

Listing 2: *Sample* FORTRAN *code to call the routine in listing* 1.

```
      INTEGER*2 CLUST,SEC,BYTE
      INTEGER*4 FREE
      CHARACTER*1 DRIVE
      DRIVE=CHAR(1)
C SUBROUTINE DISK IS DEFINED IN LISTING 1
      CALL DISK(DRIVE,CLUST,SEC,BYTE)
      FREE=CLUST*SEC*BYTE
```

haven't been able to determine how many bytes are free on the disk from within a program. Do you know of a routine in any of the above languages or assembly language that can solve my problem?

Also, I am interested in adding a removable hard disk subsystem to my computer. I have seen many ads for such systems in BYTE, but I don't know anything about their compatibility, reliability, and speed. What is your opinion on some of these devices?

AHMAD RAZA
Lahore, Pakistan

You can determine free disk space in FORTRAN or CBASIC by calling an assembly language subroutine that uses DOS function 36H (DOS 2.0 or higher). In Pascal, you can write a procedure in assembly language or use a built-in DOS interrupt function call and retrieve the results directly from the AX, BX, and CX registers.

An assembly language code fragment to get the disk's free space is shown in listing 1. In order for this code to work, you must set up addressing in the call-

(continued)

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Inquiry 205

ing program for the drive designation and the returned variables, sec_clust, bytes_sec, *and* free_space. *These can be multiplied together on return by the calling program to get the free bytes.*

The sample FORTRAN code in listing 2 determines free space in drive A.

Your compiler manuals should give the information necessary to call assembly language subroutines, and you can get more information about using the DOS INT 21H *functions from the* IBM DOS Technical Reference Manual.

The Bernoulli Box is reputed to be an excellent device, as are the removable hard disk drives you mention. The Bernoulli Box is a little slower than the others, and I believe its disks are a little less expensive. All are compatible with the PC XT.—Steve

IBM PC AT Bus

Dear Steve,

I was disappointed to find that the articles in BYTE's *Inside the* IBM PC*s* issue did not include any information on the PC AT bus. I haven't been able to find any information on this bus. Bookstores have a tremendous range of material on PC software but nothing on the PC hardware design. I am interested in adding a PC-type bus to my SB180 single-board computer. I'd like to be able to plug in a high-resolution monochrome controller, an internal modem board, or any of the other boards designed for the PC. Can you help?

PETER LAUGHINGWOLF
Santa Rosa, CA

IBM publishes detailed technical information on its personal computers in the hardware technical reference manuals. The company publishes a separate manual for each model and sells them through authorized IBM dealers and IBM Product Centers. The Graphics Display Controllers used in the PC AT are the ones made for the PC. The AT has a couple of PC-type expansion slots for display boards and other compatible PC add-ons, so if you want to add a PC Graphics Display Adapter to your SB180, you need only the PC bus information. This is available in the PC Technical Reference Manual *and has also been published in a number of books and magazines.* —Steve ■

CIRCUIT CELLAR FEEDBACK

INSTALLATION PROBLEMS

Dear Steve,

Regarding your December 1983 article ("Keep Power-Line Pollution Out of Your Computer"), I've already installed metal-oxide varistors in a Radio Shack four-outlet power strip. I also have a six-outlet strip that is riveted together—this makes it tough to get inside the assembly to install MOVs. Any ideas? Radio Shack now carries an SNR-20A130K MOV, catalog #276-568. Is it adequate as a substitute?

I'd like to hook the Osborne up to a Prowriter printer via the Osborne's serial port (the Prowriter uses a parallel interface). I have read Alan Wilcox's "Serial to Parallel" article in the August 1983 issue of *Dr. Dobb's Journal*, but I need some help. All I need is a simple serial-to-parallel box that will work with the Osborne.

AMER NELSON
Seattle, WA

(continued)

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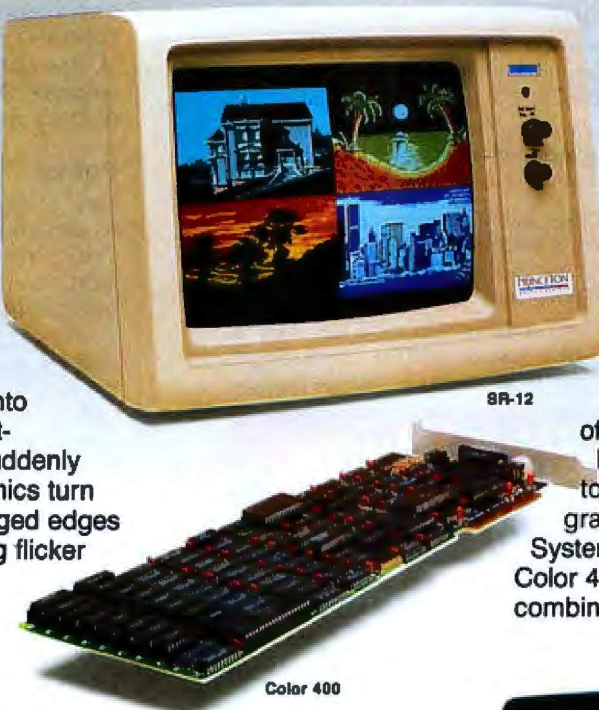

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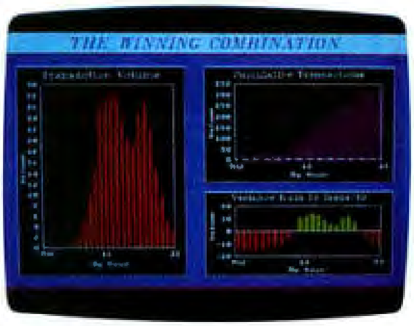

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Inquiry 272

To install MOVs in your riveted power strip, you need to drill out the rivets. The Radio Shack MOV you mentioned will work fine.

The article in Dr. Dobb's Journal *is what you need if the Osborne supports the use of the CTS (clear to send) signal, usually found on pin 5 of the RS-232C connector. This requires provision of the necessary hardware and software by Osborne—check your manual.*

Another way of controlling the data is by sending XON/XOFF codes back to the computer—often found as Control-S and Control-Q on many computers. An article describing a circuit for this appeared on page 225 of the April 28, 1983, issue of Electronic Design.*—Steve*

POWER

Dear Steve,

I design industrial control equipment. The company I work for has a steel-fabrication shop with a lot of heavy-duty electrical equipment. The utility bill for this shop is around $5000 a month. I was asked to look into the possibility of reducing this monthly cost.

I first looked at the cost calculations and found that the amount due is *not* calculated by multiplying the total kilowatt-hours used by the cost per kilowatt-hour; things like kilowatt demand and periodic averaging are primary factors in the calculations. The utility company was hesitant to discuss these subjects in detail. From what they did say, it seems that the current drawn is averaged every 15 minutes, and the highest average is used to determine the kilowatt demand factor. Also, if an average of any previous month is higher than any of the present month, the higher value is used. With all this equipment, it's obvious why the bill is so high.

I decided to build a power monitor, similar to the ones you described in the September 1984 and July 1985 Circuit Cellar articles. I am dealing with 440-V AC three-phase power; the monitor therefore requires three sensing resistors. I made three sensing resistors (out of steel bolts) of 0.001 ohm each and three calibrated precision rectifiers. I would like to get an analog graph of the current waveforms. Do you have any suggestions?

Do you know of any way to reduce the heavy currents drawn from the line at turn-on? I have devised a way to reduce surges in single-phase circuits using rapidly switched capacitor devices to source current pulses when required, but this particular device is not applicable with three-phase circuits.

Also, I would like to know the power

(continued)

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rating of the jumbo paper clip resistor of your September 1984 power monitor. In the current monitor in the July 1985 Circuit Cellar, you state that currents up to 100 amperes can be monitored; is the power rating of the paper clip sufficient to keep it from heating at this current?

DALE NASSAR
Amite, LA

First of all, let me say that I am impressed with your application of the power monitor circuit using steel bolt sensing resistors. To obtain an analog hard-copy graph, you could use one of the commercial high-speed oscillographic recorders. You can obtain these recorders with a wide variety of chart speeds and input voltage ranges. If you want to record the current of each phase at the same time, you can also obtain these recorders with multiple pen capabilities. One commercial source for this type of equipment is Hewlett-Packard. In Louisiana, you can contact

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Reducing the heavy current drawn from the line by a large three-phase motor at turn-on would wind up being a major job, and I couldn't attempt it here.

My paper clip was good for about 20 A continuous and 100 A with low-duty cycle.—Steve

BSR X-10

Dear Steve,

I am interested in building your Home Run Control System. However, I remember you did not speak favorably of the BSR X-10 system in your July 1983 article on the RTC-4 real-time controller. What has happened to change your mind about the BSR X-10 units? If they have improved their modules, how can I tell if I have the updated units?

CLIFTON WOOLMAN
Colorado Springs, CO

The BSR problems that I mentioned in that article were based on my experiences several years prior to that time. Since then, the modules have been improved significantly. The triac in the lamp modules was replaced with one having a higher power rating. Over the last several years, I have not had one fail, and others report the same thing. The original appliance modules had a solenoid and microswitch combination that has been replaced by a latching relay. The only way you could tell if your modules are the older types would be to take them apart and examine them. If you bought them within the last couple of years, however, you should have the newer models.—Steve

SB180

Dear Steve,

Along with about 2 million other Americans, I own a computer that runs CP/M 2.2 as its primary DOS (the computer is an Epson QX-10, and it has a nice high-resolution display). I'd love to upgrade my computer for faster speed and a more flexible operating system.

If the SB180 can be adapted as an outboard or in-board (my Epson has expansion slots) upgrade for CP/M machines, it would really put a crimp in Big Blue's bottom line by inhibiting sales to people who would otherwise dump their CP/M machines to get better performance. I resent IBM's stifling of innovation in the field. An upgrade board with the SB180 would do more to shift the marketing toward innovation.

I'm not technically competent in electronics—even so, your purpose came through loud and clear. You stimulated my interest in learning (rather than just using) computers; I've ordered ZCPR3 to explore this system.

MICHAEL LASKY
Brooklyn, NY

Thank you for your kind words about the SB180. While I haven't had the opportunity to work with the QX-10, I would guess that it might be possible to install an SB180 in it. However, you would be wise to team up with an electronics hacker to determine the true feasibility. You just might be able to salvage the disk drives, power supply, keyboard, and display.

By the way, look for an article on adding a high-resolution graphics display adapter to the SB180. It should come out some time this fall.

I hope that you continue using and learning about computers.—Steve ■

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

I am interested in hearing from any of you telling me what you've done with these projects or how you may have been influenced by the basic ideas. Write me at Circuit Cellar Feedback, POB 582, Glastonbury, CT 06033, and fill me in on your applications. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

MICROSOFT LANGUAGES NEWSLETTER Vol. 1, No. 6

News about the Microsoft Language Family

Your Microsoft® FORTRAN Programs Can Call Microsoft C Library Routines

Microsoft FORTRAN's long-established history includes powerful scientific subroutines drawn from a vast user community. Microsoft C has a rich operating systems background, strong string and bit manipulation support, and growing strength in the program portability arena. The following demonstrates how easily one can call C functions from a FORTRAN program.

Spawnlp creates and executes a child process. In this example, we suspend the parent program while the child program executes. When the child program terminates, the parent program resumes execution.

Spawnlp is declared in C as follows:

```
int spawnlp (mode, path, arg0, arg1, ..., argn)
int mode; char *path, *arg0, ..., *argn;
```

We declare the interface to FORTRAN with this program fragment:

```
integer*2 spawn
interface to integer*2 function spawn [c, varying, alias: 'spawnlp'] (mode)
integer*2 mode
end
```

Spawn is the function name we will use from FORTRAN. We declare the return type of spawn to be integer*2. [c] indicates the C language. [varying] tells that a variable number of arguments may be passed. An [alias] is used because the C name for the function spawnlp has 7 characters; names in FORTRAN are only significant to 6 characters. The string arguments are undeclared in the interface and assumed to be passed from FORTRAN by value.

The function can now be invoked as follows:

```
i = spawn(0,loc('exemod'c), loc('exemod'c), loc('demoexec.exe'c), int4(0))
```

The C spawnlp function expects addresses of strings, not actual characters, so we use the LOC( ) function. C strings differ from normal FORTRAN strings; we specify these by the "c" after each closing quote. We use INT4(0) to pass the last parameter, a C NULL pointer (32-bit integer zero).

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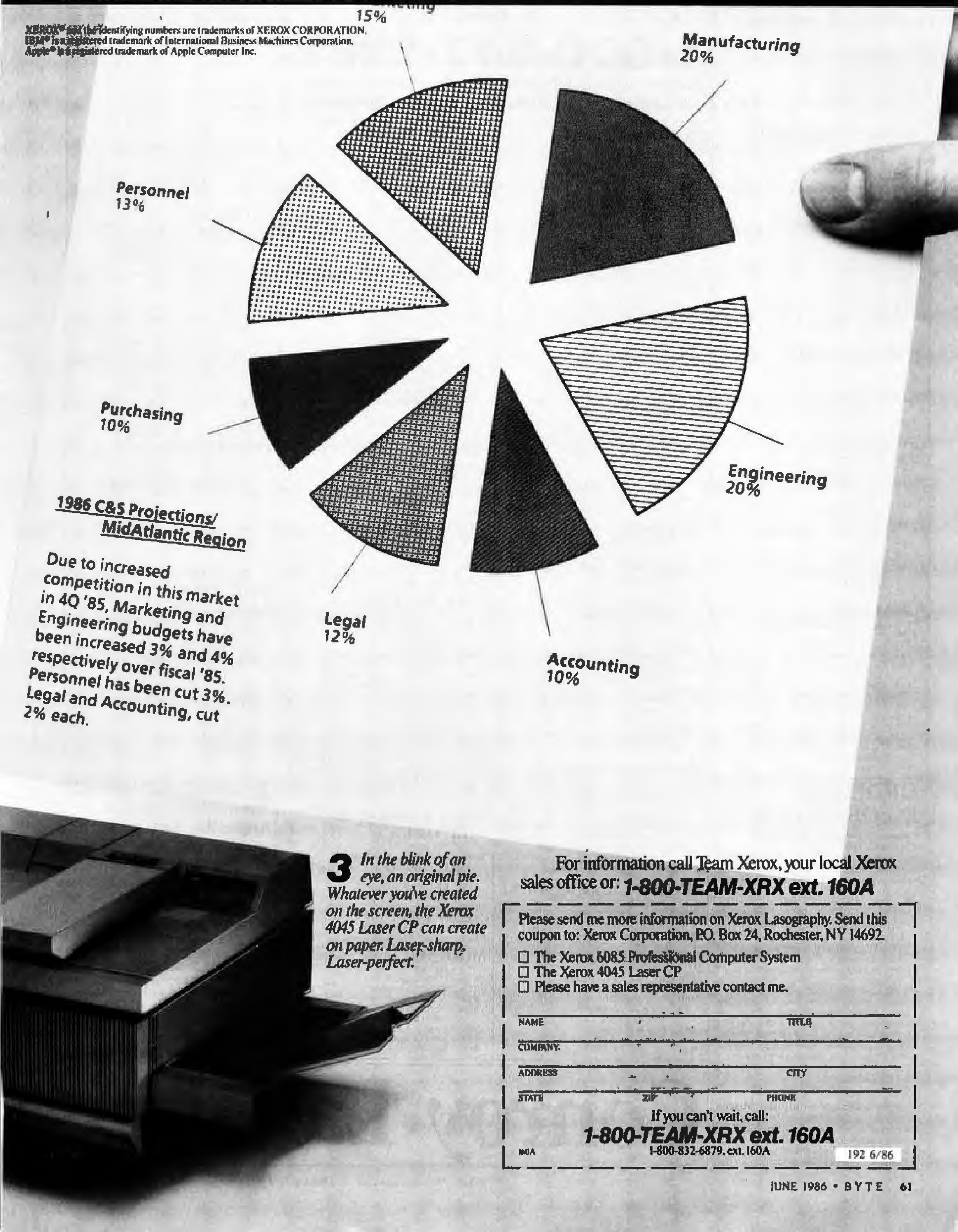
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MUSICAL APPLICATIONS OF MICROPROCESSORS, 2nd edition
Hal Chamberlin
Hayden Book Company
Hasbrouck Heights, NJ: 1985
802 pages, $39.95

COMPUTER MUSIC: SYNTHESIS, COMPOSITION, AND PERFORMANCE
Charles Dodge and Thomas A. Jerse
Schirmer Books
New York: 1985
381 pages, $29.95

FOUNDATIONS OF COMPUTER MUSIC
Curtis Roads and John Strawn, eds.
The MIT Press
Cambridge, MA: 1985
712 pages, $50

ELECTRONIC AND COMPUTER MUSIC
Peter Manning
Oxford University Press
New York: 1985
291 pages, $29.95

MUSICAL APPLICATIONS OF MICROPROCESSORS
Reviewed by Donald Swearingen

The second edition of Hal Chamberlin's *Musical Applications of Microprocessors* might be more accurately titled *Sound Synthesis from A to Z* because the contents speak more to seasoned electronic and computer music practitioners than computerists. The book is filled with a myriad of esoteric subjects ranging from the characteristics of operational transconductance amplifiers to the properties of binary arithmetic. While the book's basic orientation is often more in line with an engineering background than that of a musician, *Musical Applications* is nevertheless valuable for anyone interested in computer music applications.

The author offers background material on the goals, history, and practice of music synthesis: fundamental sound parameters, tape and voltage-control (analog) methods, direct computer synthesis, and the growing role of computers in sound processing. Although the material is not new, it represents a fairly good overview of basic sound synthesis issues. A brief history of microprocessors and microcomputers and a detailed discussion of the 6502 and 68000 is also included.

ANALOG

If you're constructing and interfacing to your own analog sound synthesis system, Chamberlin's discussion of computer-controlled analog synthesis will delight you. He details analog system hardware down to the level of transistors and operational amplifiers. While some readers may not be excited by discussions of MOSFET switches and R-2R resistive ladders, those with solid technical backgrounds will find a great deal of useful material. However, I found this discussion to be the most expendable. Chamberlin seems indecisive about the level of detail he wants to expose readers to. As a result, he combines a variety of topics under the general heading of controlled analog synthesis and even includes a discussion of vector and raster display devices (with circuit diagrams). I doubt many people are interested in constructing their own digital-to-analog converters, but there is material here for those who are. In the end, however, much of this section seems vaguely dated in an era when

(continued)

ILLUSTRATED BY JULIE SCOTT

sound synthesis is becoming almost exclusively the province of all-digital devices.

DIGITAL

The largest and by far the most useful section of the book focuses on digital sound synthesis and modification. If your primary interest is digital signal processing, this section provides a strong basis, both theoretical and practical, to explore this increasingly prevalent technology. With an eye to the trade-offs between hardware and software to best solve signal-processing problems, Chamberlin takes us on an enlightening excursion through topics central to the discipline. These include digital-to-analog and analog-to-digital conversions, digital filtering (including the simulation of reverberation), digital tone generation, and signal analysis.

In his discussion of the conversion between real-world analog signals and their numerical equivalents in digital form, Chamberlin includes an excellent overview of the difficulties involved in attempting to preserve the fidelity of the audio signal as it moves from one representation to the other. Since ultimately we perceive sound in analog form, the results of our processing of the digitized signals will of course be limited by the quality of the hardware handling the conversion. Chamberlin's discussion makes it clear that it is no easy matter to provide high-fidelity signals and that there is no one "best" approach to overcome all the difficulties inherent in the process.

The discussion of digital tone-generation techniques covers a range of useful methods, from simple table lookup to FM synthesis. Here, too, Chamberlin reminds us of the constraints imposed on our programming methods by the requirement that the signals must ultimately be converted to analog form: In the digital world we can never really ignore the fact that we are working with signals that have been sampled (or generated) in discrete time increments rather than continuously. From the generation of simple sine tones to the methods of percussive tone generation, Chamberlin provides the background to realize these functions entirely in software. However, with respect to the speed limitations of microprocessors faced with real-time signal-processing requirements, he includes a handy discussion on replacing some digital signal-processing algorithms with actual digital hardware, highlighting the trade-offs between execution speed and system complexity.

Chamberlin introduces us to digital filtering using models for the digital equivalents of several analog filters. With signal flow graphs, he shows how to construct digital filters of many types and characteristics: state-variable, all-pass, notch, etc. Included are models for a practical filter for "concert hall reverberation" and a parametric chorus generator. I was struck by the relative simplicity of the digital filters as compared with their more complex (and correspondingly more difficult to implement) analog cousins.

If you're interested in digital signal analysis, you may find Chamberlin's treatment of the subject brief; nonetheless,

(continued)

it is indicative of the discipline's broad scope of application. As with the filters, we are given the basis for an all-digital approach to the problem. The section on digital synthesis and modification concludes with a brief history and discussion of several music software systems. The bulk of the discussion centers on several algorithms and programs developed and used by Chamberlin in his own computer music applications.

The final section of the book concentrates on the design and workings of several real-world (commercially available) synthesizers and concludes with the author's view of the future of computer music synthesis.

In sum, the range of topics in the book is impressively comprehensive, though their treatment is not always as detailed as you might wish. For instance, if your interest in computer music has been piqued by the recent proliferation of MIDI (musical instrument digital interface) equipment, you will be disappointed by the all-too-brief discussion of this important subject. On the other hand, newcomers to the field of computer music should be prepared for a challenge in assimilating the book's many technical details.

Although I found the analog discussion dated, the hardware versus software issues weighted too much in the direction of hardware, and I would have liked to see more algorithms and fewer circuit diagrams, the information contained in *Musical Applications* is useful and instructive. You would have to collect many reference works to amass the details provided in this single volume.

Donald Swearingen (100 Valencia St. #261, San Francisco, CA 94103) is a freelance software developer, consultant, and musician.

COMPUTER MUSIC: SYNTHESIS, COMPOSITION, AND PERFORMANCE

Reviewed by Randall Graves

Judging from the level of mathematics used in *Computer Music: Synthesis, Composition, and Performance*, the intended reader will be significantly more a computer enthusiast than a musician. Charles Dodge and Thomas A. Jerse recommend their book as a class text, but I think most music students would have a hard time with much of the material. I envision the prime reader to be a personal computer hobbyist who would like to try some fairly involved exercises in musical physics.

This volume covers most of the commonly used methods of music synthesis, and the level of detail enables a reader to imagine what a variety of waveforms will sound like. This task is not left to the reader's imagination, however, as the authors supply several references to commercial music examples.

ISSUES

Several temperaments and the relative harmonic structures of the intervals contained therein are explored, but the authors withhold opinions on their merits or applica-

(continued)

tions. This rather aloof and cool presentation gives the book a somewhat stuffy feel.

A very good section covers the conversion of analog waveforms to digital equivalents and back again, along with the various integrating types of functions used to approximate the original signal when less than complete digital sampling is used. If your main interest is digital audio, you will find this section enlightening.

The thorough discussion of the ear and the hearing process contains sufficient examples to make clear some basic principles of "voicing." Voicing is the arrangement of pitches within a musical piece so that a listener does not tire from inappropriate clustering of pitch groups.

BASICS

Dodge and Jerse explain how the basic concepts of synthesis are interrelated. The components include amplitude envelopes, harmonic spectrums of different waveforms, and various styles of modulation, and the authors handle them in a manner that does not require a great knowledge of physics. Given the approach of the book, however, they should have included some examples of how to implement these functions in software. The advent of FM synthesis has caused many companies to rethink their hardware products, and a very good section in this book on FM will help both the computer owner and the user of performance-oriented synthesizers (such as the Yamaha DX series) to understand the programming nature of their instruments.

Subtractive synthesis is covered both conceptually and practically with the role of filters extensively discussed using mathematical computation and algorithmic examples. Music students might have trouble with this section, but I recommend it for an enhanced understanding of harmonic spectrums.

GAINS AND LOSSES

I found the chapter on speech synthesis useful only for synthesizing telecommunication recordings. I think a general reader would be more interested in sampling and musical-capture techniques whereby the limitless articulations of the human voice could be used as a direct source and, if desired, processed with a computer for a variety of effects.

Once a musical example is composed, the next thing I want is high-quality production of the sound, and that requires a good delivery system. The psychoacoustics involved in hearing a replay of a computer music score and the actual delivery itself are the focus of a section that appealed to me greatly. Some very practical help was offered in these areas, which also introduce some electronic signal processors for composition enhancement.

For my purposes, this book is strictly a reference. I would point the novice computer synthesist to a more example-oriented work. The few functional examples here are all in FORTRAN, which would not likely be the language of most personal computer owners, and they would require translation. The comprehensive glossary, however, is

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doubly useful, as it assumes the reader is new to the terminology. I recommend this book as an additional reference to an existing computer music library, but not as a first or only work on the subject.

Randall Graves (542 East 400 S, Springville, UT 84663) is a programmer/analyst for Dynix Inc. of Provo, Utah. He composes, records, and performs electronic music.

FOUNDATIONS OF COMPUTER MUSIC
Reviewed by Stan Czarnik

In *Foundations of Computer Music*, editors Curtis Roads and John Strawn bring together 36 articles demonstrating that the evolution of the "intelligent instrument" is destined to continue. The book is intended for both informed hobbyists and computer music professionals, but the sheer clarity of the contributions should quiet the fears of anybody curious enough to pull the book off the shelf.

THE BINARY BEAT
Computer music follows from a technology capable of representing sonic events in the form of binary digits. Indeed, digital conversion is what distinguishes computer music from its analog ancestor, electronic music. The first section of *Foundations* amounts to a survey of various digital-synthesis techniques, including additive synthesis, frequency modulation, and waveshaping.

The roots of the additive method go back to the ancient Greeks. This technique begins by decomposing sound in much the same way as a prism decomposes light into its primitive spectral components. The digital representations of these elements can then be transformed into highly precise analog signals, or the representations can be manipulated by the composer to make musical sounds never before heard. As contributor Neil Rolnick tells us, the restrictions imposed by additive synthesis forced his computer music team to do certain things "awkwardly or not at all."

These difficulties are overcome to some extent by newer modes of control described by Curtis Roads in two elegant articles on waveshaping and granular synthesis. Waveshaping operates directly on the waveform. The key to waveshaping is known as the transfer function, which can be thought of as a line on a grid with values between −1 and +1 on the horizontal axis and corresponding values on the vertical. Granular synthesis is another way of working with the waveform, only this time with little pieces of it. The number of ways in which grain samples can be rearranged using a computer is endless, and the results are entirely unique. By systematic grain deletion a sound can be made to "evaporate" or, by reversing the process, coalesce and crystallize from the inside out.

DEDICATED TO MUSIC
Some sections of *Foundations* are devoted to computer music hardware and software, and joint consideration

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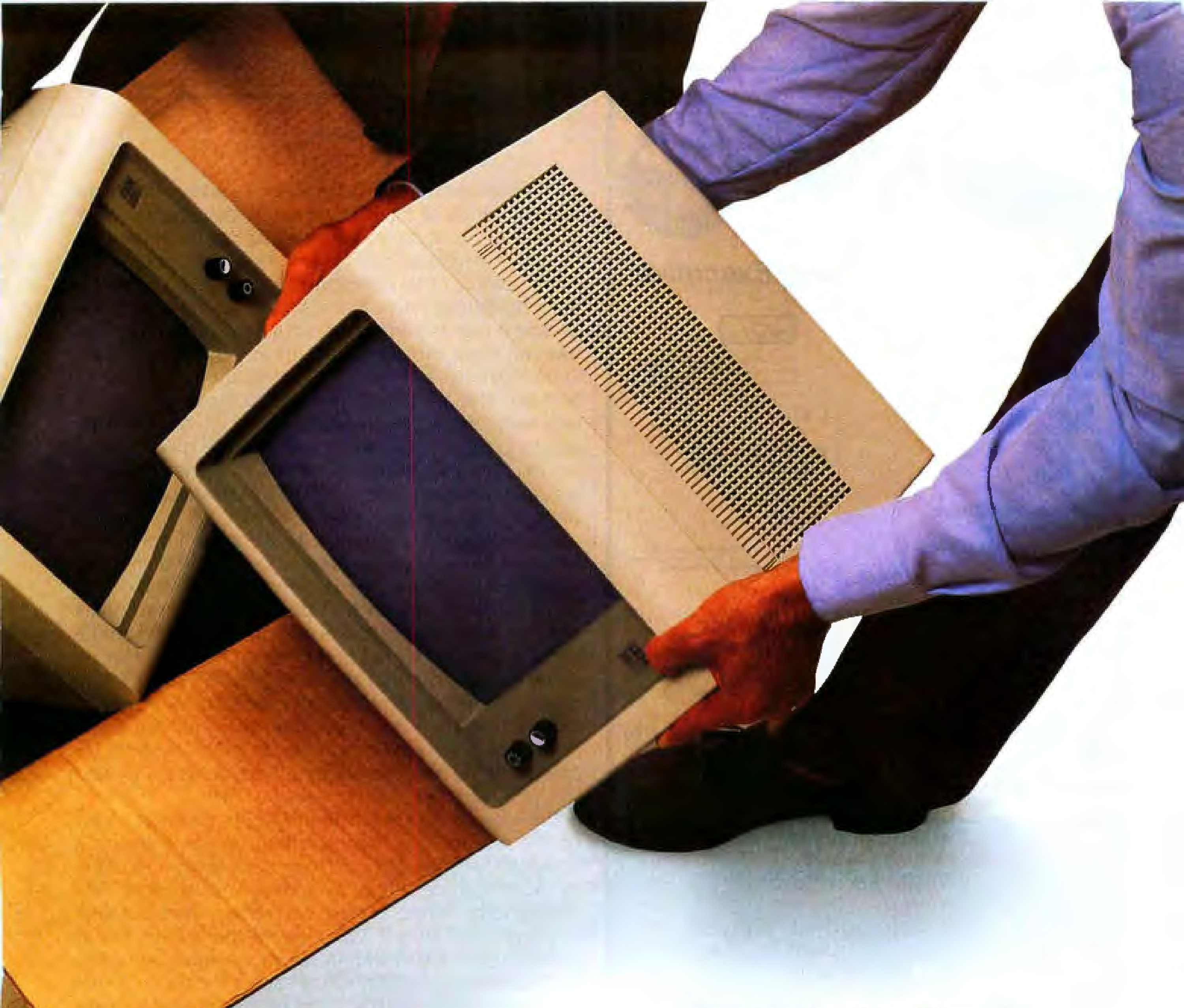

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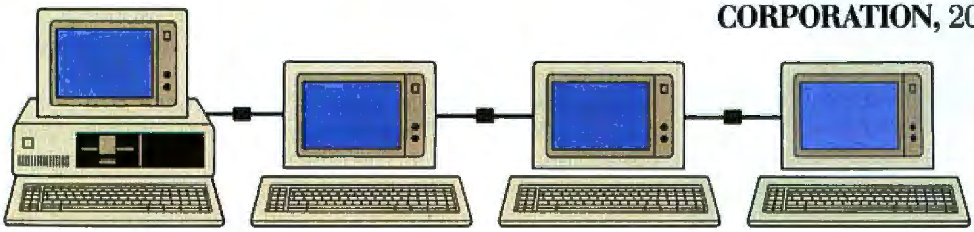

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seems appropriate. This is because of a noteworthy trend in the creation of intelligent musical instruments: What once went into software is now going into hardware—the design of dedicated real-time music computers.

One reason for this phenomenon is speed. The execution of computer music in real time calls for as much processing power as performers can get their hands on. This was one major impulse behind the well-known Structured Sound Synthesis Project (SSSP) at the University of Toronto. This need for speed is also behind the appearance of Chuck Hastings's piece on do-it-yourself emitter-coupled logic (ECL), some of the quickest stuff around. The project described is a 24-bit stored-microprogram computer capable of 900,000 fixed-point multiply instructions per second.

Another reason for turning to hardware involves the nature of musical composition, as Otto Laske points out. Rarely does a composer stick very long to a "top-down" or "bottom-up" approach to the material. Abrupt shifts between different musical perspectives lie closer to the norm. A change desired in the "feel" of a score may require subtle notational alterations; by the same token, replacing four eighth notes with eight sixteenths may affect the feel. This kind of flexibility is very difficult to get in musical software. Section III, "Software Systems for Music," shows how complicated it can be to get around this problem.

The joker in the pack is John Myhill's progress report on the creation of a "semistochastic music language, a computer program designed to produce sequences of frequencies that are neither random nor non-random." Entirely random "music" is noise. No problem there. But what is nonrandom music? Myhill found the answer lies in periodicity: In a nonrandom series of sounds, any given sonic duration "says something" about the duration that follows it. Myhill can now program a computer to make polyrhythmic music in which one voice becomes increasingly coherent while another voice disintegrates.

PERCEPTIONS

Roads and Strawn end the book with three articles focusing on how computers can not only help create music but understand it as well. Stephen McAdams and Albert Bregman, for example, explain how the automated manipulation of sounds can shed light on the workings of musical perception and illusion—why we hear what we seem to be hearing.

Foundations of Computer Music is one of those rare computer books that will not be out of date by the time you get a chance to read it. The editorial philosophy is underscored consistently from cover to cover. *Foundations* covers the basic things that everyone with a serious interest in the automation of music needs to know before breaking new ground in this realm of limitless possibility.

Stan Czarnik (2716 West Evergreen Ave., Chicago, IL 60622) is a teacher, musician, and technical writer whose hobbies include experimenting with high-voltage electricity.

(continued)

ELECTRONIC AND COMPUTER MUSIC

Reviewed by Gregory Lent

In this informative treatise on the history of electronic music, Peter Manning takes us back to 1897, when the Dynamophone was patented by Thaddeus Cahill in Holyoke, Massachusetts. It was the first fully developed sound-generator system that was operated via a keyboard. It weighed 200 tons and cost $200,000. Numerous interactions between composers and scientists prior to 1945 are highlighted at the beginning of the book. The four sections that follow cover developments from 1945 to 1960, new horizons in electronic design, the electronic repertory from 1960, and the digital revolution. A bibliography and lengthy discography are included, but unfortunately this historical perspective does not mention MIDI.

After World War II, the revival of the arts was accompanied by advances in technology that provided incentives for American institutions to support the development of electronic music. In Europe, Pierre Schaeffer's experiments led to the discovery of the amplitude envelope (attack, body, and decay). This work includes such technological leaps as the birth of the transistor in the 1950s and the first voltage-controlled synthesizer. The book contains figures showing frequency and amplitude controls, waveforms, etc., that assume the reader has a background in the science of sound. Conversely, there are also basic, almost mundane, descriptions of hardware, such as how joysticks were used to control some early synthesizers.

Computers become the focus of the book in the digital revolution section, with descriptions of hardware, languages, and the history of how computers were used to synthesize music. It seems that most of the work in the early 1970s was done at universities, with the exception of Bell Labs and IRCAM in Paris.

The desire to create interactive, real-time facilities resulted in systems such as the VOCOM, developed at EMS Studio in England, and the Synclavier, developed at Dartmouth College. Other synthesizers are discussed, although most have more memory or have been superseded since this book was written.

The main drawback of *Electronic and Computer Music* is its failure to mention MIDI, which became the standard after the winter NAMM (National Association of Music Merchants) show in 1982. Because this book was published in 1985, at least a mention in the "outlook for the future" concluding chapter would have contributed to its historical relevance. Of course, MIDI has advanced so rapidly since 1982 that Manning could have written another book of equal length on that topic alone.

Overall, this book is an excellent reference on the history of electronic music from the late nineteenth century to the mid-twentieth century. It fails, however, to bring the reader up to the present—an insurmountable task in an industry that doesn't stand still long enough for analysis. ■

Gregory Lent (POB 721, Peterborough, NH 03458) is a musician and composer currently working with the Synclavier and other MIDI-equipped instruments.

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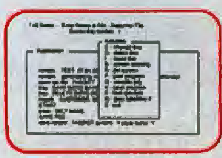

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VISION '86: APPLIED MACHINE VISION CONFERENCE AND EXPOSITION, Cobo Hall, Detroit, MI. Vision '86, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777. *June* 3–5

1986 NATIONAL EDUCATIONAL COMPUTING CONFERENCE (NECC '86), San Diego, CA. NECC '86, University of San Diego, School of Education, Alcala Park, San Diego, CA 92110, (619) 260-4539. *June* 4–6

THIRD ANNUAL CONFERENCE ON WRITING FOR THE COMPUTER INDUSTRY, Plymouth, NH. Dr. Richard Chisholm, Reed House, Plymouth State College, Plymouth, NH 03264, (603) 536-1550, ext. 301. *June* 7

ASSOCIATION OF SMALL COMPUTER USERS IN EDUCATION 19TH ANNUAL SUMMER CONFERENCE, Myrtle Beach, SC. Jack Cundiff, Horry–Georgetown Technical College, Conway, SC 29526. *June* 9–11

NATIONAL DATABASE & 4TH GENERATION LANGUAGE SYMPOSIUM, New York, NY. Software Institute of America Inc., 8 Windsor St., Andover, MA 01810, (617) 470-3880. *June* 9–12

NETWORK MANAGEMENT/TECHNICAL CONTROL, World Trade Center, Boston, MA. CW/Conference Management Group, 375 Cochituate Rd., Framingham, MA 01701, (617) 879-0700. *June* 9–12

SUMMER 1986 UNIX CONFERENCE AND EXHIBITION, Atlanta Hilton Hotel, Atlanta, GA. USENIX Conference Office, POB 385, Sunset Beach, CA 90742, (213) 592-3243. *June* 10–13

24TH ANNUAL MEETING OF THE ASSOCIATION FOR COMPUTATIONAL LINGUISTICS, Columbia University, New York, NY. Don Walker (ACL), Bell Communications Research, 445 South St., MRE 2A379, Morristown, NJ 07960, (201) 829-4312. *June* 10–13

CLINICAL LABORATORY COMPUTER SYMPOSIUM, Ann Arbor, MI. Betty Phillips, The Towsley Center for Continuing Medical Education, Box 057, The University of Michigan Medical School, Ann Arbor, MI 48109-0010, (313) 763-1400. *June* 12–13

C '86—INTERNATIONAL COMPUTER EXHIBITION COLOGNE: COMPUTER, SOFTWARE, ELECTRONICS, Cologne, West Germany. KölnMesse, POB 210760, D-5000 Cologne 21, West Germany; telephone: (0)221-821-1; Telex: 8873426 mua d; in the U.S., Hans J. Teetz, German American Chamber of Commerce Inc., 666 Fifth Ave., New York, NY 10103, (212) 974-8836. *June* 12–15

MANAGING INFORMATION SYSTEMS EFFECTIVELY, University of Western Ontario, London, Ontario, Canada. Canadian Information Processing Society, 243 College St., 5th Floor, Toronto, Ontario M5T 2Y1, Canada, (416) 593-4040. *June* 15–20

SYNERGY '86: CONFERENCE ON FUNCTIONAL INTERFACING FOR COMPUTER-INTEGRATED MANUFACTURING (CIM), Universal City, CA. Cheri Willetts, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500, ext. 374. *June* 16–18

1986 NATIONAL COMPUTER CONFERENCE (NCC '86), Las Vegas, NV. NCC '86, American Federation of Information Processing Societies (AFIPS), 1899 Preston White Dr., Reston, VA 22091, (800) 622-1986. *June* 16–19

FACULTY INSTITUTE ON STUDENT CENTERED COMPUTER EDUCATION—COMPUTERS: TOOLS FOR PROBLEM SOLVERS, Lincoln, NE. Mindy Brooks, Union College, Lincoln, NE 68506, (402) 488-2331. *June* 16–20

SECOND ANNUAL COMPUTER USERS CONFERENCE FOR DELAWARE TEACHERS, Delaware State College, Dover, DE. Dr. William J. Geppert, Department of Public Instruction, Townsend Building, POB 1402, Dover, DE 19903, (302) 736-4885. *June* 18

COMPUTER VISION AND PATTERN RECOGNITION, Miami Beach, FL. IEEE Computer Society, 1730 Massachusetts Ave. NW, Washington, DC 20036-1903, (202) 371-0101. *June* 22–26

AUTOCAD EXPO '86, McCormick Place, Chicago, IL. Peggy Steffens, Autodesk Inc., 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344, ext. 703. *June* 24–26

1986 INTERNATIONAL CONFERENCE ON COMPUTERIZATION OF MEDICAL RECORDS: SECOND GENERATION OF PATIENT INFORMATION SYSTEMS, San Francisco, CA. Institute for Medical Record Economics, 121 Mount Vernon St., Boston, MA 02108, (617) 523-4449. *June* 25–27

CAD AND ROBOTICS IN ARCHITECTURE AND CONSTRUCTION, Marseille, France. Viviane Bernadac, IIRIAM/CMCI, 2, Rue Henri Barbusse, 13241 Marseille cedex 1, France; telephone: 91 91 36 72; Telex: Mistel 440860. *June* 25–28

1986 CARNAHAN CONFERENCE ON HARMONIZING TECHNOLOGY WITH SOCIETY, Lexington, KY. John Jackson, Electrical Engineering Department, University of Kentucky, Lexington, KY 40506-0046, (606) 257-3926. *June* 26–27

FORESTRY MICROCOMPUTER SOFTWARE SYMPOSIUM, Morgantown, WV. Division of Forestry, West Virginia University, Morgantown, WV 26506, (304) 293-2941. *June 30–July* 2 ■

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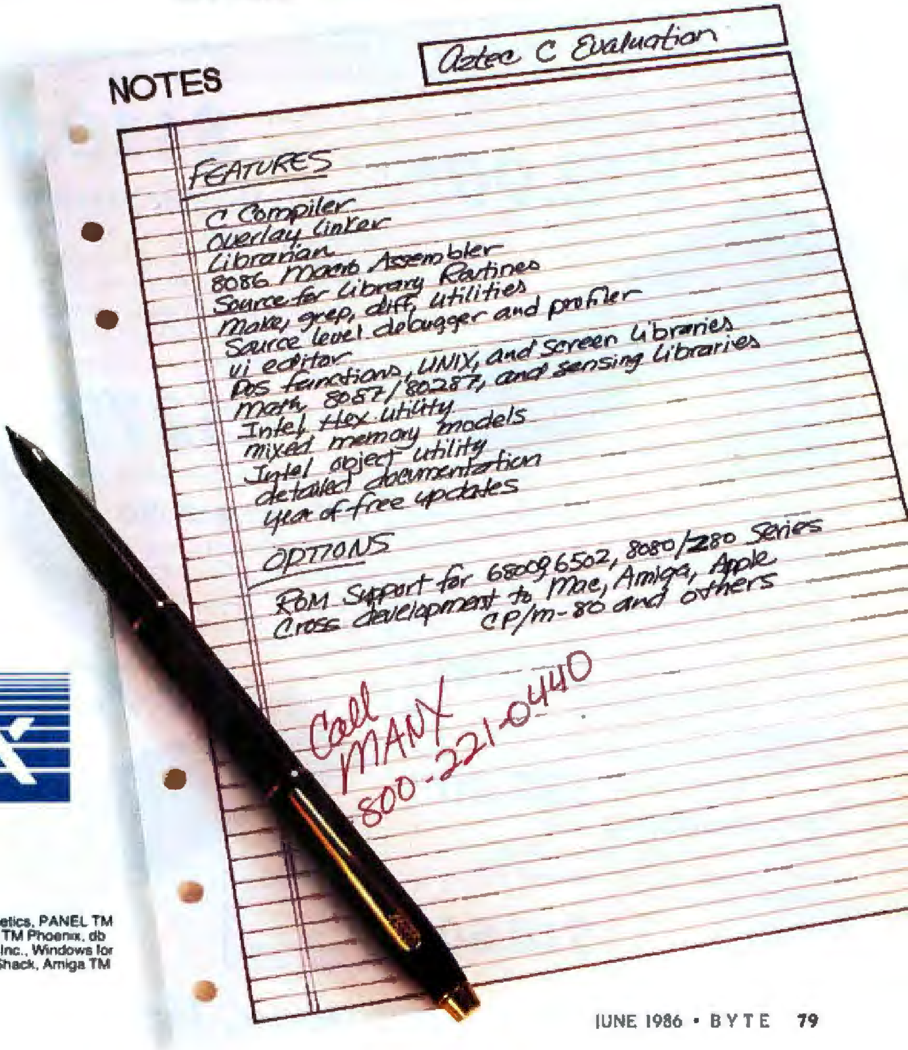

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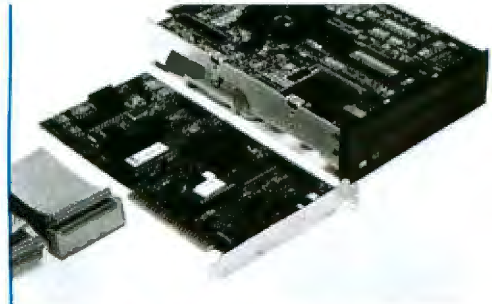

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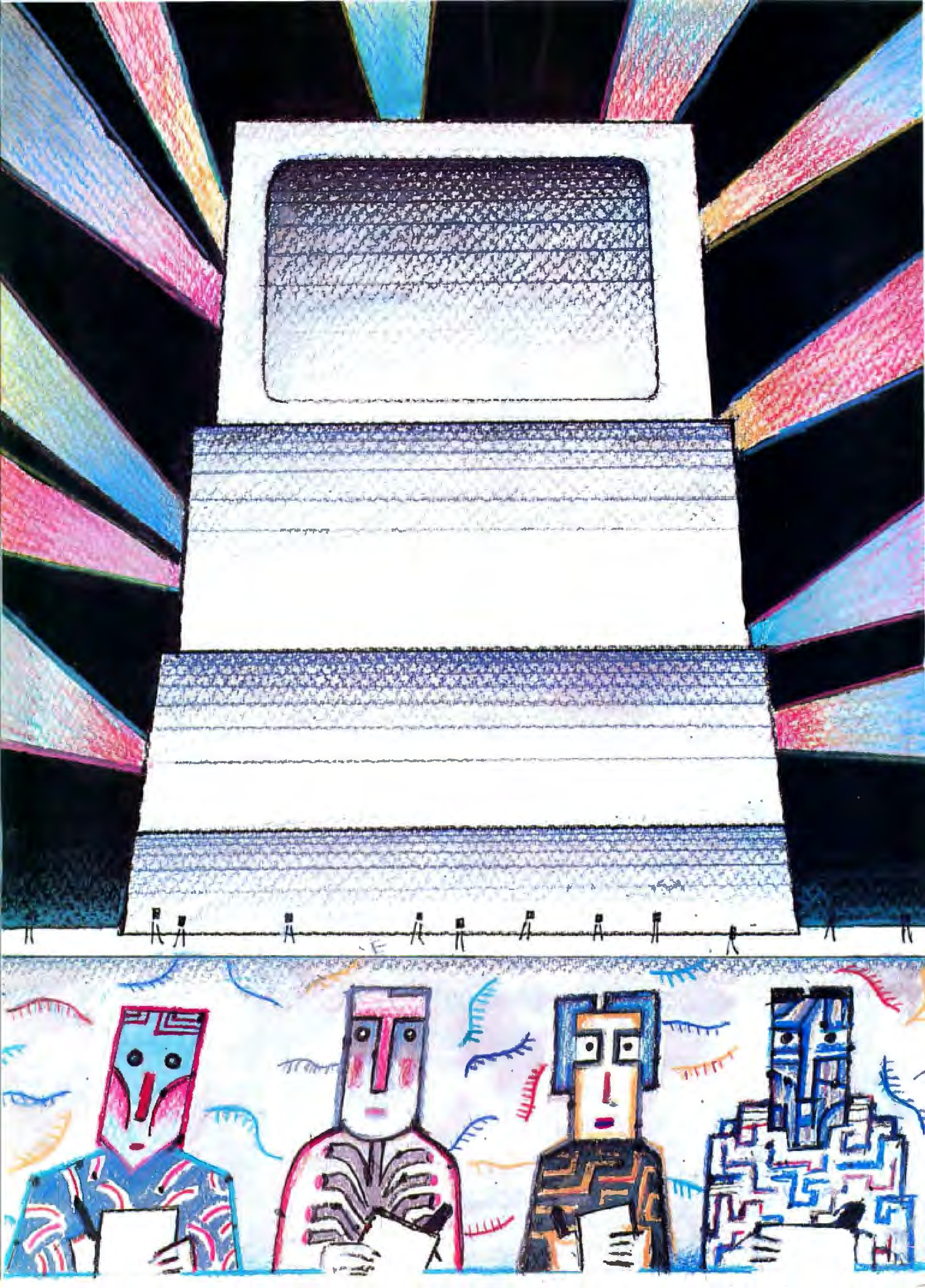

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IN THE PRODUCT DESCRIPTION that leads off this month's Features section, Phillip Robinson introduces us to the Macintosh Plus. This enhanced Mac offers double-sided drives, an SCSI interface, a megabyte of RAM, and a larger, faster ROM, among other welcome additions.

This month's Programming Project is an easy-to-implement technique for maintaining a sorted file that Bruce Webster discovered while working on a mailing list program. He hopes that it will save beginning programmers time and frustration and help others improve their programming skills.

In the Circuit Cellar, Steve Ciarcia concludes his project for adding an SCSI interface to his single-board computer. Following up on last month's tutorial, Steve now discusses in greater detail the SCSI bus's operational characteristics: the bus phases and how they are managed by the NCR 5380 chip.

The program that Antonio Silvestri outlines in his article is designed to eliminate long catalog searches by sorting the valid filenames in the volume and subordinate directories of the Apple ProDOS disk. Written in Applesoft BASIC, the program provides you with extensive visual feedback as it reads, sorts, and updates a disk.

If you are faced with the problem of transferring graphics created on a Macintosh to an IBM PC, you'll want to read "Decoding MacPaint on the IBM PC" by Mark Anacker. His Pascal program decodes and displays MacPaint images on the PC and, once you've accomplished the initial translation of the graphics, writing additional program code to manipulate the images is relatively easy, says Mark.

Looking for a less complicated way to draw a Hilbert curve, Michael Ackerman set out to write an Applesoft BASIC program that would have only one subroutine with a single entry point. In this month's Programming Insight you can examine his program for producing this elegant curve.

BY PHILLIP ROBINSON

THE MACINTOSH PLUS

It has more memory, double-sided disks, and an SCSI interface

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

The Macintosh introduced personal computer users to technology that has now become commonplace: bit-mapped displays, 3½-inch floppy disks, and iconic desktop environments. The Macintosh Plus adds welcome double-sided drives, a megabyte of RAM, an industry-standard SCSI interface, a numeric keypad, and a larger, faster ROM of operating system routines. The Mac Plus is also much faster than the 512K Mac, partly because of new software routines and partly because of the additional RAM. One feature that the 512K Macintosh had—free MacWrite and MacPaint software—is missing from the Mac Plus. Both programs are available separately for $125 apiece.

SYSTEM DESCRIPTION

Most of the technical details in BYTE's February 1984 description of the original, skinny (128K-byte) Macintosh are still apt descriptors for the Mac Plus. It is a desktop, 7.8336-MHz 68000-based microcomputer in a small-footprint case containing a built-in 3½-inch floppy disk drive and a 9-inch diagonal, bit-mapped, monochrome display of 512 by 342 pixels. It doesn't have any expansion slots, and it

(continued)

Phillip Robinson is a senior technical editor for BYTE. *He can be contacted at* BYTE/McGraw-Hill, 951 *Mariner's Island Blvd.,* 3rd *Floor, San Mateo,* CA 94111.

PHOTOGRAPHED BY PAUL AVIS

doesn't have a cooling fan. It possesses a number of I/O ports, a detachable keyboard, and a mouse.

KEYBOARD

At first glance, the Mac Plus keyboard looks like a Mac keyboard with an added numeric keypad on the right side. But there are other changes as well: Four cursor keys are located at the bottom right of the alphabetic section; there is only one Option key; the Enter key is placed with the numeric keypad; and the Return key is larger than on previous Macs. Other adjustments in key size and position are minor. Incidentally, the cursor keys aren't recognized by all applications or even by the Mac's own desktop.

IN BRIEF

Name
Macintosh Plus

Company
Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Price
$2599

Microprocessor
Motorola 68000, 32-/16-bit microprocessor (32-bit internal data path and registers, 16-bit external data bus) running at 7.8336 MHz

Main Memory
1 megabyte of RAM, expandable to 4 megabytes in the future
128K-byte ROM containing operating system code
256-byte EEPROM for user-settable parameters

Display
9-inch diagonal built-in screen that displays bit-mapped 512 by 342 pixels

Sound
Four-voice sound from 8-bit D/A conversion (22-kHz sampling rate)

Disk Memory
800K-byte 3½-inch double-sided floppy disk drive built-in

Keyboard
Detachable 78-key typewriter-style keyboard plus numeric keypad and cursor keys; offers 2-key rollover and software mapping

Clock/Calendar
CMOS custom chip built-in with 4.5-volt battery

Ports
Two RS-232C/RS-422 serial ports with maximum speed of 230,400 bps
SCSI port capable of 320K-byte-per-second communications
Mouse port (for mechanical mouse)
External disk port
Synchronous serial keyboard port
Loudspeaker jack

Optional Peripherals
800K-byte 3½-inch double-sided floppy disk drive
Imagewriter dot-matrix printer
Apple Modem 1200 (300/1200-bps modem)
Hard Disk 20, 20-megabyte hard-disk drive (operates through serial port)

Bundled Software
System tools

RAM

The Macintosh Plus has two main circuit boards, analog and digital. Although the analog board is little changed from the 512K Mac design, the digital board has been thoroughly modified. It is still designed around the 68000 CPU, but it has more RAM and more ROM—both socketed—than previous Macintoshes.

One full megabyte of RAM sits on the Macintosh Plus digital board. This memory takes up less space and consumes less power than the 512K in the Fat Mac. Apple's engineers accomplished this by employing four CMOS SIMMs (single in-line memory modules), each of which holds 256K bytes in eight 256K-bit CMOS dynamic RAMs. These RAM chips are enclosed in surface-mount packages and then soldered onto tiny PC (printed circuit) boards.

The RAMs most of us are familiar with are packaged in DIP cases. Surface-mount packages are smaller, so more chips can be squeezed into less PC board space. They are called "surface-mount" because the legs don't have to stick through a PC board to be soldered on the opposite side (as DIPs are). Instead, the legs fold over and contact the same side the chip packages sit on. For the Mac Plus, these packages are soldered onto four small boards that insert at an angle—and overlap—into special sockets on the Mac Plus digital board.

When 1-megabit surface-mount CMOS DRAMs are available, it will be relatively easy for manufacturers to create SIMM strips that hold a full megabyte. Such strips could replace the current Mac Plus SIMMs to upgrade the system to 2 or 4 megabytes of RAM. Applications that follow Apple's design rules can use all of the additional RAM.

ROM

With 128K bytes of ROM code, the Macintosh Plus has twice what the 128K and 512K Macs had. The old 64K-byte ROM contained equal parts

(continued)

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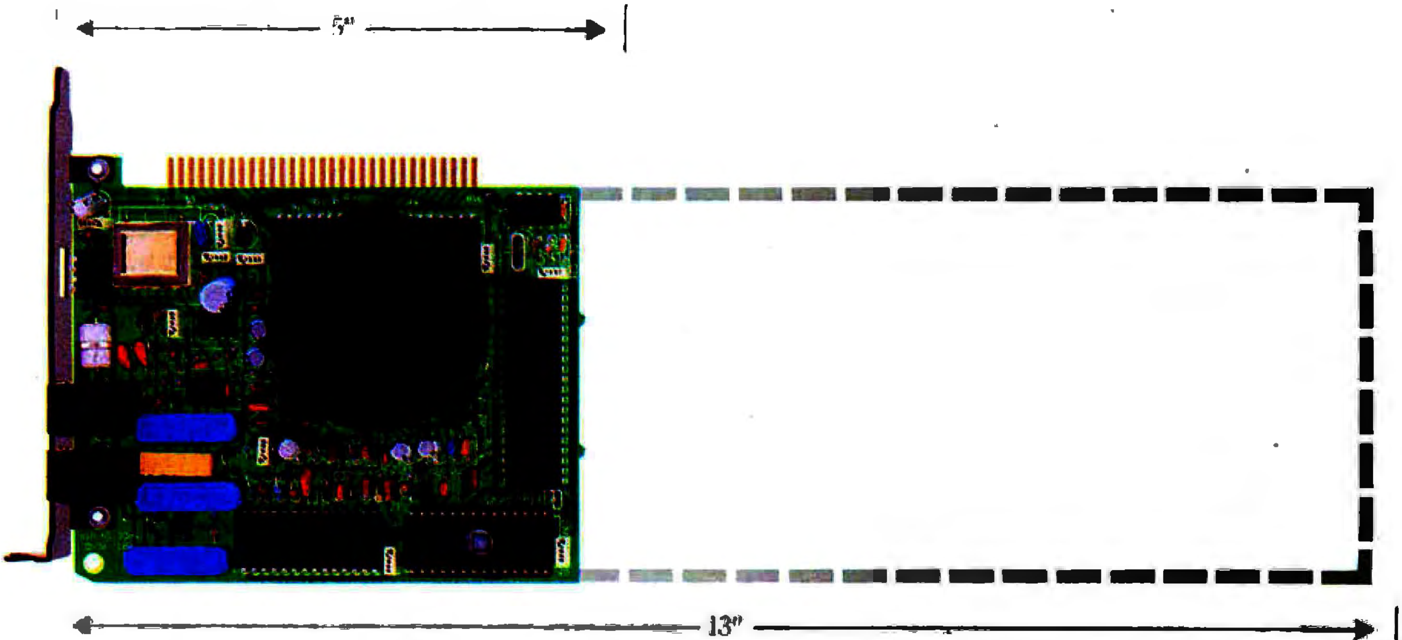

The new Hayes Smartmodem 1200B

Now you can get a lot more out of your PC, by putting a little more in. Our new Hayes Smartmodem 1200B includes the same quality and advanced features that have made it the leading 1200 bps modem. Now, advances in Hayes technology allow us to make it available in a size that fits either full slots or a "single" half slot.

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of Macintosh operating system, QuickDraw graphics routines, and the User Interface Toolbox. The 128K ROM keeps trimmed and optimized versions of those routines, adds new routines, and holds some routines that used to sit in the disk system files.

QuickDraw—which draws everything you see on a Macintosh display—was rewritten to be faster. New ROM drivers were written for the double-sided disk drives and for the Hard Disk 20. The operating system now allows the Mac Plus to boot from a hard disk, a feat the previous Macintoshes couldn't perform. And the new ROM has numeric computation routines: Applications aren't forced to have their own such routines and can depend on floating-point arithmetic and transcendental functions in the ROM.

The operating system shows up in some subtle environmental effects. An icon called a "zoom box" toggles a window between full-screen size and whatever other size it was last set to. There is also an additional choice under the View pull-down menu: Small Icon. This menu selection preserves the information about the file type that icons provide, but it allows many more icons to fit onto a single display.

The System file is listed as version 3.0, and the Finder is version 5.1. Most programs should work with both old and new ROMs, but the 128K ROM routines are still being integrated into the calls from applications software.

Desk Accessories

The Control Panel desk accessory contains some new controls. The biggest change is the addition of a RAM cache controller that lets programs load, run, and quit up to twice as fast as conventional operational methods. Frequently used routines can be read from disk only once and then run from RAM. The cache can be turned on or off and can employ anywhere from 32K to 768K bytes of RAM.

The Choose Printer desk accessory is replaced by the more general Chooser that lets you select any of the serial ports or the SCSI port. The AppleTalk network is now connected and disconnected via the Control Panel instead of Choose Printer.

HFS

The HFS (Hierarchical Filing System) first appeared in Finder 5.0 in the fall of 1985 with Apple's HD20 external 20-megabyte hard disk drive. It is now built into the new Finder 5.1 of the Mac Plus ROM.

The previous Macintosh Finders used a flat filing system (now called MFS for Macintosh Filing System). All files were listed in a single directory. Now the HFS puts files within directories and subdirectories, just as MS-DOS does for many microcomputers. You move through the directories by manipulating slightly more complex versions of the dialog boxes used by earlier Finders. You can pull down lists of the directories—shown iconically as nested folders on the Mac Plus—to see a path list. The number of files the HFS can handle is limited only by the disk space. Because it runs from ROM it is also faster than the MFS. Some programs will have to be rewritten to avoid path problems with the subdirectories of HFS.

The Mac Plus comes with a disk of system tools that includes an Installer utility for updating the system files on your older start-up disks.

The Mac Plus's 3½-inch floppy drives are double-sided and can read and write 800K bytes per disk.

Floppy Disk Drives

The original Mac depended on 3½-inch floppy disk drives, built by Sony, that recorded 400K bytes on a single side of the disk. The Mac Plus drives are still 3½-inch Sonys, but they are double-sided and so can read and write 800K bytes per disk. They can also read and write the single-sided format of the older drives. In effect, the double-sided disks provide more than twice the effective space of the old 400K-byte drives because much of the 400K was occupied by system files.

The Sony drives use a special, variable-rate rotation scheme where the spin of the disk depends on the track being accessed. The new drives use the same scheme but are twice as fast as the old drives for reading and writing. The transmission speed between the drives and the Mac (about 500,000 bits per second) hasn't changed.

Ports

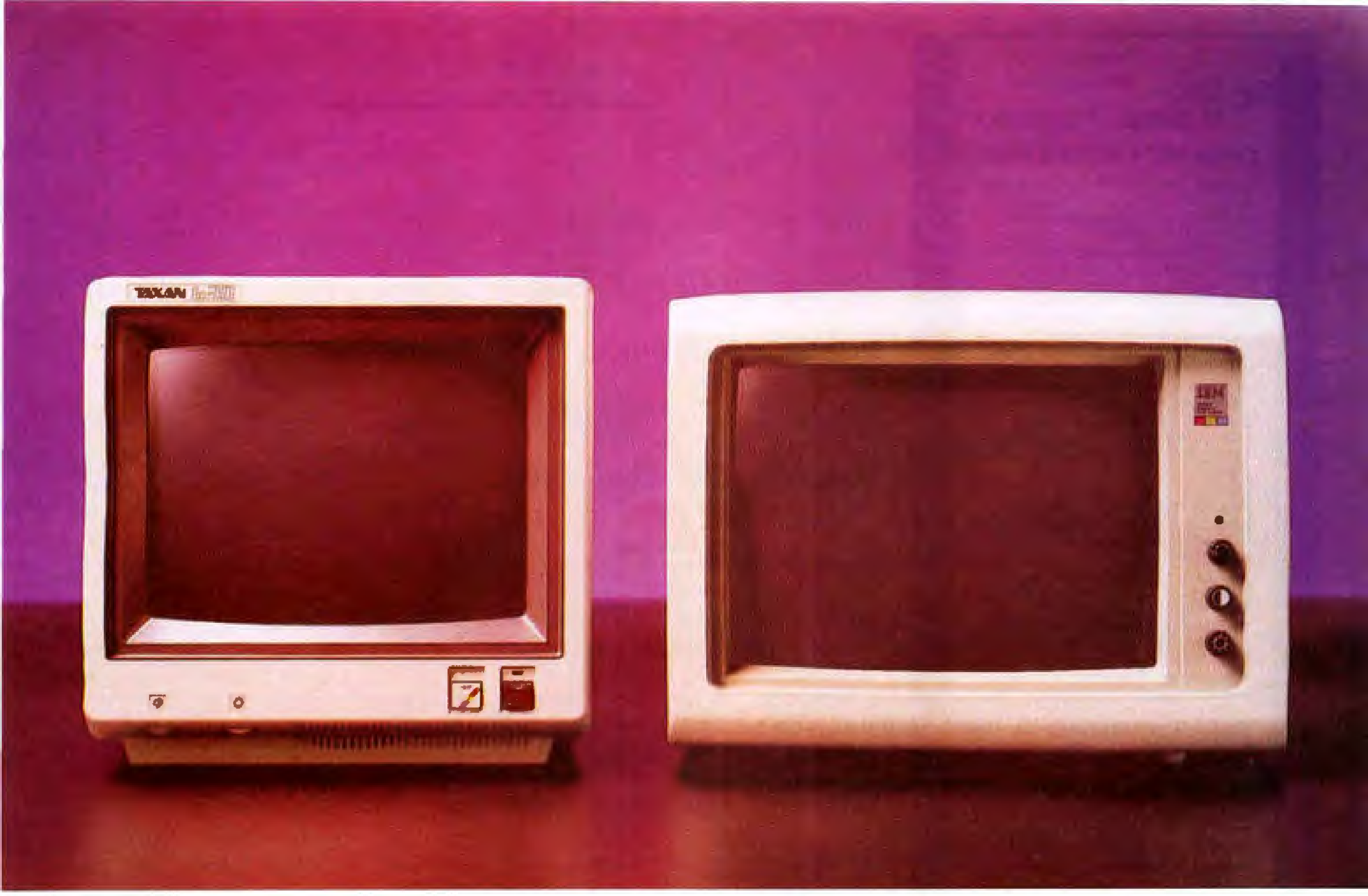
The biggest change in ports from the 512K Mac to the Mac Plus is the ad-

(continued)

LaserWriter Plus

Because Apple is so interested in "desktop publishing," it was no surprise that the Mac Plus wasn't the only enhanced product introduced in January. Apple also introduced the LaserWriter Plus, an enhanced version of the laser printer described in the February 1985 product preview "The Macintosh Office" by John Markoff and Phillip Robinson. Based on the popular Canon laser engine, this printer provides 300-dpi images from the PostScript printing codes sent by a Macintosh.

The LaserWriter Plus has a full megabyte of ROM instead of the half-megabyte in the LaserWriter. The extra ROM contains seven font families to add to the four families harbored by the LaserWriter. The new typefaces are Avant Garde Gothic, Bookman, Helvetica Narrow, New Century Schoolbook, Palatino, Zapf Chancery, and Zapf Dingbats. The LaserWriter Plus's driver supports the 128K Macintosh and offers downloadable fonts. The LaserWriter Plus costs $6798. The LaserWriter price dropped to $5999; for $799 you can buy a Font Kit that will upgrade the LaserWriter to the Plus.



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The SCSI interface communicates at 320K bytes per second—about 10 times faster than the old serial port.

dition of the SCSI port for fast communications. The other ports have been moved around, and some have different connectors. The external disk port can handle single-sided or double-sided floppy disk drives as well as the HD20 hard disk drive. The audio jack, the mouse port, and the external disk drive port retain their shape and size but have been moved.

The two serial ports typically used for modem and printer connections now employ mini DIN-8 connectors instead of the 9-pin D-type connectors used before. The new circular connectors eat up less room—a necessity with the addition of the large SCSI connector.

SCSI

The 128K and 512K Macintoshes relied upon an Apple-specific serial port that communicated at 230,400 bps using the Zilog 8530 SCC (serial communications controller) chip. Apple hoped that the general-purpose serial port would lead to "virtual slots," with add-on devices attached to the serial port instead of inserted within the computer. Unfortunately, the port just didn't have enough speed for many peripherals, including hard disks, tape backup systems, and scanners. So the Mac Plus design team looked around for a faster, more standard interface.

SCSI is an industry-standard, parallel, system-level interface bus for connecting peripherals to a variety of personal computers. It descended from the old SASI disk drive standard to become ANSI X3T9.2. Many peripherals such as hard disk drives already contain SCSI interfaces. All the Macintosh Plus needs to use those peripherals is the proper software drivers. Up to seven devices can be daisy-chained to the single Mac Plus SCSI port. If any SCSI devices are attached to the Macintosh Plus, at least one of them must be switched on for the Mac Plus to start.

The Macintosh Plus SCSI interface is designed around an NCR 5380 SCSI controller IC and communicates at 320K *bytes* per second: about 10 times faster than the old serial port. It uses an 8-bit parallel data connection, a variety of control lines, and a parity line for error checking.

UPGRADES

Apple devised a thorough upgrade program for those who have 128K or 512K Macintoshes and want Mac Plus power. You upgrade a system by buying and installing special kits.

The first kit—$299—includes the new 128K ROM and an internal double-sided disk drive. This drive replaces the single-sided drive and is only available to be installed by certified Apple dealers. (External double-sided floppy disk drives sell for $499.) This kit can be installed in Macs that have third-party RAM additions, but Apple doesn't guarantee that the upgraded Mac will be able to use all of the third-party RAM.

The second kit—$599 for 512K Macs and $799 for 128K and third-party-enhanced Macs—contains a new digital logic board and a new backpanel. The board replaces the old digital board. You need the panel with this kit because the new set of port connectors on the Mac Plus demands differently placed and sized openings.

The third so-called kit—$129—is simply the Mac Plus keyboard.

The only way to get the new ROM is to buy kit 1. And you cannot use kit 2—the digital logic board—without kit 1: The new digital board is built for a system with the 128K ROM and the double-sided internal drive.

The 512K Macintosh suggested retail price was dropped to $1999; the 128K Macintosh is no longer available from Apple. For Lisa or Macintosh XL owners, from April 15 through August 31, 1986, you can ante up $1498 and your machine and receive a Macintosh Plus with an HD20. ■

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ILLUSTRATED BY E. M. SCHONGUT

A SIMPLE FILE-INDEXING SCHEME

BY BRUCE WEBSTER

Learn how to maintain a sorted file and also improve your programming skills

This month's programming project is a simple, easy-to-implement technique for maintaining a sorted file. It's the kind of thing programmers discover on their own; I did so while working on a mailing-list program some years ago. Given the large numbers of new programmers out there, this article just might save some of you time and frustration.

The article has a second purpose as well, again geared toward those of you who are just getting your feet wet in programming. An excellent way to improve your programming skills is to study code written by others. This exposes you to solutions—both big and little—that others have hit upon, new approaches you may not have thought of. And you can even learn from others' mistakes. I trust that the short code examples in this article will help you—though I hope you will find few mistakes to learn from.

THE PROBLEM

Let's say you have an application of some sort—mailing list, database, sales information—that requires you to keep files of records in a certain order. The order is based on some portion of the record, called the key. The records are arranged so that the keys are ordered. For example, if the keys are names, they'll probably be in alphabetical order; if they're numbers, they'll be in numerical order.

You may be wondering why keeping the records in order is important. It has to do with searching for a given record, and, frankly, sometimes it isn't so important. If there aren't many records, you can just do a sequential search on the unsorted records by starting with the first record and looking at each until you find the one you want. Of course, you're going to have to look through the entire list to discover if the one you want isn't there—but that's why you do this only if the list is short.

As the number of records increases, the benefits of keeping the records sorted also increase. At the very least, sequential searches become, on the average, a little faster: If the record you're looking for isn't in the list, you'll know that as soon as you hit a record that would normally come after it. For example, if you were looking for "SMITH" and got to "SMYTHE," you could end your search, since "SMITH," if it were present, would have already been found.

Better still, though, is using a binary search to find the desired record. In a

(continued)

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binary search, you jump to the middle of the list you're looking at and see if that's the record you're looking for. If so, you stop. Otherwise, you divide the list in half and pick the upper or lower half, depending upon whether the desired key is less than or greater than the one found. You then jump to the middle of that list and repeat the whole procedure. This continues until you either find the key you're looking for or your list has shrunk to a length of one, in which case the desired key is not in the list.

The advantage of a binary search is readily apparent. If you are searching through *n* sorted records, a sequential search will average *n*/2 comparisons, while a binary search will require, at most, *n* log 2. Actual numbers mean more: For a list of 1000 records, a sequential search will average about 500 comparisons; a binary search will require, at most, 10 comparisons.

One problem with sorting your list involves the size of the list itself. If the file isn't large in size, you can keep all the records in memory, as an array or a linked list. This lets you add and delete records, as well as keep the list sorted, with little trouble. However, if the list gets too big to fit in memory, you'll have to store the list out on the disk. Since sorting usually requires swapping items in the list around, this could mean a lot of disk reads and writes. And if you're adding or deleting records, things can rapidly go from bad to worse since you may have to "shuffle" large numbers of records to accommodate the changes. How, then, do you deal with—and keep sorted—a large file and/or a file with a lot of records?

THE SOLUTION

The answer is quite simple: Don't sort all the records, just the keys. To do this, you create an index list. Each item in the list contains a key and its corresponding record number. You keep this list sorted and in memory. To find a record, you do a binary search on this list, then you use the record number to read in the corresponding record from the disk. You can easily sort and update the index list since it's always in memory. You access the disk only when you need to actually read or write a specific record.

There are complications. If the key isn't much smaller than the *record* itself, this approach is pointless. For example, each record might contain just a name and a phone number, with the name as the key. The index list will then be almost as large as the actual record list—in which case, your best bet is some research into disk-based sorts and merges and an investment in a fast hard disk.

Deleting records can also cause complications. The simple solution is to delete the entry in the index list, then delete the record in the file by moving all the records that follow it forward by one. Of course, that means a lot of disk I/O, especially if the deleted record is near the start of the file. However, since the disk file isn't sorted, a faster approach is to copy the last record in the file into the position of the now-deleted record.

Even with this approach, another complication occurs: How do you know where the "active" records end and the "deleted" records begin? For example, if you have 100 records in your file and you delete 10 of them, you will still have 100 records sitting out in your file; it's just that the last 10 won't mean anything. That's not a problem until you close the file, then reopen it later. The difficulty is resetting the "end-of-file" marker. Most Pascal implementations have no easy way of doing that, short of writing a new copy of the file. That will work, but if the file is very large, it will take time and disk space. Another solution is to set aside the first record in the file as a "header" record and store in it the number of active records; that's what I will use here.

THE IMPLEMENTATION

The implementation given here is neither complex nor overly developed. Most of you are going to be

(continued)

Listing 1: *Global definitions and declarations.*

```
const
  IndexMax         = 1000;
  RecCountErr      =   -2;
  NewFileCreated   =   -1;
  NoError          =    0;
  RecordNotFound   =    1;
  NoMoreRoom       =    2;
  AlreadyExists    =    3;
  OutOfRange       =    4;

type

  Keytype      = string[40];
  FileStr      = string[80];

  DataRec = record
    case Boolean of
      True    : (NumRecs      : Integer);
      False   : (Key          : Keytype;
                 theRest      : Whatever;
      { this represents the rest of your data fields } );
  end;

  IndexRec = record
    Key        : Keytype;
    Num        : Integer
  end;

  IndexList    = array[1..IndexMax] of IndexRec;

var
  KList        : IndexList;
  DFile        : file of DataRec;
  MaxRec       : Integer;
```

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able to take what you see here and develop it into what you need. I've written it in (almost) standard Pascal; the only assumptions I've made are that a built-in procedure, Seek, exists that moves the file pointer to a particular record and that the first record is 0; that is, Seek(DFile,0) will position the file pointer at the first record in the file.

Listing 1 shows the global declarations—constants, data types, and variables—for these routines. An arbitrary limit (IndexMax) on the number of records has been set; I'll mention a few ways around setting this limit later on. Also, four different error codes (used in the routines) are defined.

The data types are then defined. Keytype and DataRec are whatever you want them to be; this is, after all, your application. You can even rename the field Key in DataRec, but if you do, you need to change one statement in InitStuff:

KList[Indx].Key := TRec.*new name;*

Since that's the only place in these routines that this field is actually referenced, everything else can stay the same.

You'll notice that DataRec is a variant record. It has two sets of fields occupying the same space; that is, the field NumRecs occupies the same space as the field Key. This is done so that you can use the first record in the file to keep track of the number of active records in the file. Since NumRecs and Key occupy the same space, the size of each DataRec record is not increased by the definition of NumRecs. Also, note that the field theRest is not an actual field; I just put it there to represent whatever data fields you might define for the record.

Three global data structures are declared in the variable section. KList is the list of keys and record numbers; it's an array that will be kept sorted at all times. DFile is the actual file of records that are being written or read. MaxRec is the current number of records being used.

File I/O routines vary between Pascal implementations, especially

(continued)

Listing 2a: *File I/O routines specific to Turbo Pascal.*

```
{compiler-specific file I/O routines
 these procedures are specific to Turbo Pascal.  If you
 are using another Pascal compiler, you will need to
 modify them appropriately.  Note that Turbo Pascal does
 not support the standard routines GET and PUT, but instead
 uses READ and WRITE.                                      }

{$I-} { turn off I/O error checking }

procedure FRead(RNum : Integer; var Rec : DataRec;
                               var Error : Integer);
{     reads record #RNum into Rec }
begin
  if (RNum < 0) or (RNum > MaxRec)
    then Error := OutOfRange
  else begin
    Seek(DFile,RNum);
    Error := IOResult;
    if Error = NoError then begin
      Read(DFile,Rec);
      Error := IOResult
    end;
    if Error > 0
      then Error := 100 + Error
  end
end; { of proc FRead }

procedure FWrite(RNum : Integer; Rec : DataRec;
                           var Error : Integer);
{     writes record #RNum into Rec }
begin
  if (RNum < 0) or (RNum > MaxRec)
    then Error := OutOfRange
  else begin
    Seek(DFile,RNum);
    Error := IOResult;
    if Error = NoError then begin
      Write(DFile,Rec);
      Error := IOResult
    end;
    if Error > 0
      then Error := 100 + Error
  end
end; { of proc FRead }

procedure FOpen(FileName : FileStr; var Error : Integer);
{
tries to open FileName; if it doesn't exist, creates
it with the appropriate header record
}
const
  TurboNoFile = 1; { "no file" error code for Turbo Pascal }
var
  IOCode         : Integer;
  TRec           : DataRec;
begin
  Assign(DFile,FileName);
  Reset(DFile);
  IOCode := IOResult;
  if IOCode = TurboNoFile then begin { file doesn't exist }
    FillChar(TRec,SizeOf(TRec),0);
    Rewrite(DFile);
    TRec.NumRecs := 0;
    FWrite(0,TRec,Error);
```

```
    Close(DFile);
    Assign(DFile,Filename);
    Reset(DFile);
    IOCode := IOResult;
    if IOCode = NoError
      then Error := NewFileCreated
  end;
  if IOCode <> NoError
    then Error := 100 + IOCode;
end; { of proc FOpen }

procedure FClose(var Error : Integer);
{  closes file }
begin
  Close(DFile);
  Error := IOResult;
  if Error > 0
    then Error := Error + 100
end; { of proc FClose }

{$I+} { turn on I/O error checking }
```

Listing 2b: *File I/O routines specific to* UCSD Pascal.

```
{compiler-specific file I/O routines
 these procedures are specific to UCSD Pascal.  If you
 are using another Pascal compiler, you will need to
 modify them appropriately.                              }

{$I-} { turn off I/O error checking }

procedure FRead(RNum : Integer; var Rec : DataRec;
                               var Error : Integer);
{  reads record #RNum into Rec }
begin
  if (RNum < 0) or (RNum > MaxRec)
    then Error := OutOfRange
  else begin
    Seek(DFile,RNum);
    Error := IOResult;
    if Error = NoError then begin
      Get(DFile);
      Error := IOResult;
      if Error = NoError
        then Rec := DFile^
    end;
    if Error <> NoError
      then Error := 100 + Error
  end
end; { of proc FRead }

procedure FWrite(RNum : Integer; Rec : DataRec;
                              var Error : Integer);
{ writes record #RNum into Rec }
```

(continued)

```
begin
  if (RNum < 0) or (RNum > MaxRec)
    then Error := OutOfRange
  else begin
    Seek(DFile,RNum);
    Error := IOResult;
    if Error = NoError then begin
      DFile^ := Rec;
      Put(DFile);
      Error := IOResult
    end;
    if Error > 0
      then Error := 100 + Error
  end
end; { of proc FRead }

procedure FOpen(FileName : FileStr; var Error : Integer);
{ tries to open FileName; if it doesn't exist, creates
  it with the appropriate header record }
const
  UCSDNoFile = 1; { "no file" error code for UCSD Pascal }
var
  IOCode      : Integer;
  TRec        : DataRec;
begin
  Reset(DFile,FileName);
  IOCode := IOResult;
  if IOCode = UCSDNoFile then begin { file doesn't exist }
    FillChar(TRec,SizeOf(TRec),Chr(0));
    Rewrite(DFile,FileName);
    TRec.NumRecs := 0;
    FWrite(0,TRec,Error);
    Close(DFile,Lock);
    Reset(DFile,FileName);
    IOCode := IOResult;
    if IOCode = NoError
      then Error := NewFileCreated
  end;
  if IOCode <> NoError
    then Error := 100 + IOCode;
end; { of proc FOpen }

procedure FClose(var Error : Integer);
{ closes file }
begin
  Close(DFile,Lock);
  Error := IOResult;
  if Error > 0
    then Error := Error + 100
end; { of proc FClose }

{$I+} { turn on I/O error checking }
```

those for opening and closing files. Also, standard Pascal does not define a method for random access of files, though almost every microcomputer-based Pascal compiler does. In addition, Turbo Pascal—which has the largest installed base of compilers—does not support the standard Pascal routines Get and Put.

Because of this, I wrote four routines—FRead, FWrite, FOpen, and FClose—to handle all the compiler-specific code. FRead lets you read a specific record (in the range 0..MaxRec) from DFile. FWrite, in much the same manner, lets you write out to a specific record, again in the range 0..MaxRec. FOpen accepts a filename and tries to open it as DFile. If the file does not exist, it creates it, writing out a header record with NumRecs = 0. Likewise, FClose closes DFile. All four routines return an error code in Error, either one of those defined in the global constant section or a system I/O error code. If the latter is returned, an offset of 100 is added so as not to confuse, say, system I/O error 1 (whatever that may be) with RecordNotFound.

Listings 2a and 2b contain working versions of these routines for Turbo Pascal and UCSD Pascal, respectively. If you're using a different Pascal compiler, you'll have to write your own versions, though chances are they'll look pretty much like these routines.

A quick note on record numbers. The header record is assumed to be record 0, the first record in the file. All the data records are stored as records 1 through MaxRec. Both Turbo Pascal and UCSD Pascal consider the first record in a file to be record 0; however, some Pascal compilers consider the first record to be record 1. To adjust for this, just add 1 to RNum in your call to Seek in FRead and FWrite, that is, Seek(DFile,RNum + 1). If you make the change here, you can leave the rest of the program alone.

Listing 3 contains the routines InitStuff and CleanUpStuff. InitStuff should be called before doing any I/O on a given file. You pass InitStuff the name of the file you want to work with; it then calls FOpen and reads through all the records, building the list of keys and record numbers in KList. It then calls SortIndexList (also in listing 3), which sorts KList using a simple selection sort algorithm. CleanUpStuff saves the current number of active records in the header record (0), then closes the file by calling FClose. Both routines return error codes, so that your program can detect and handle any problems.

Listing 4 has three key routines: FindKey, GetRecord, and PutRecord. FindKey does a binary search on KList and returns the location in KList corresponding to the key passed to it. If no key matches, it returns −1.

(continued)

Listing 3: *Initialization and cleanup routines.*

```
procedure SortIndexList;
{sorts the array KList using a selection sort technique}
var
  I,J,Min       : Integer;
  Temp          : IndexRec;
begin
  for I := 1 to MaxRec-1 do begin
    Min := I;
    for J := I+1 to MaxRec do
      if KList[J].Key < KList[Min].Key
        then Min := J;
    Temp := KList[I];
    KList[I] := KList[Min];
    KList[Min] := Temp
  end
end; { of proc SortIndexList }

procedure InitStuff(FileName : FileStr;
                    var Error : Integer);
{
sets everything up for indexing system.  This assumes
there are no more than IndexMax (=1000) records, and the
records are numbered 1..IndexMax.  Record #0 is the header
record and is used to store the current number of records
actively being used in the file
}
var
  Indx,TErr             : Integer;
  TRec                  : DataRec;
begin
  Error := NoError;
  FOpen(FileName,Error);
  if Error <= NoError then begin
    MaxRec := 0;
    FRead(0,TRec,TErr);
    Error := TErr;
    MaxRec := TRec.NumRecs;
    for Indx := 1 to MaxRec do begin
      FRead(Indx,TRec,TErr);
      if TErr > 0
        then Error := TErr;
      KList[Indx].Key := TRec.Key;
      KList[Indx].Num := Indx
    end;
    SortIndexList
  end
end; { of proc InitStuff }

procedure CleanUpStuff(var Error : Integer);
{
 this just does an orderly shutdown and should be called
 before you leave your program (or open another data file)
}
var
  TRec                  : DataRec;
begin
  TRec.NumRecs := MaxRec; { save out # of records }
  FWrite(0,TRec,Error);
  FClose(Error)
end; { of proc CleanUpStuff }
```

Listing 4: *Basic record-access routines.*

```
function FindKey(Key : Keytype) : Integer;
{
looks for Key in KList; returns location in KList
if found; otherwise returns - 1
}
var
  L,R,Mid       : Integer;
begin
  L := 1; R := MaxRec;
  repeat
    Mid := (L+R) div 2;
    if Key < KList[Mid].Key
      then R := Mid-1
      else L := Mid+1
  until (Key = KList[Mid].Key) or (L > R);
  if Key = KList[Mid].Key
    then FindKey := Mid
    else FindKey :=  -1
end; { of proc FindKey }

procedure GetRecord(Key : Keytype; var Rec : DataRec;
                    var Error : Integer);
{
looks through KList for Key; if found, returns in Rec.
It and the routines that follow assume the procedure Seek
for random access of the file of records.
}
var
  Item                : Integer;
begin
  Error := NoError;
  Item := FindKey(Key);
  if Item > 0
    then FRead(KList[Item].Num,Rec,Error)
    else Error := RecordNotFound
end; { of proc GetRecord }

procedure PutRecord(Rec : DataRec; var Error : Integer);
{
writes Rec out to the file.  If a record with that
key already exists, then overwrites that record;
otherwise, adds the record to the end of the file.
If there's no more room for records, exits with an
error code
}
var
  Item          : Integer;
begin
  Error := NoError;
  Item := FindKey(Rec.Key);
  if Item >= 0
    then FWrite(KList[Item].Num,Rec,Error)
  else if MaxRec < IndexMax then begin
    MaxRec := MaxRec + 1;
    FWrite(MaxRec,Rec,Error);
    KList[MaxRec].Key := Rec.Key;
    KList[MaxRec].Num := MaxRec;
    SortIndexList
  end
  else Error := NoMoreRoom
end; { of proc PutRecord }
```

The code for this project was written with conversion to C in mind and should be pretty easy to port.

GetRecord calls FindKey to get the record number and, if found, reads it in from DFile and passes it back to the calling routine in Rec. PutRecord tries to write Rec out to DFile. It checks to see if a record with Rec.Key already exists; if so, Rec gets written out to that position. Otherwise, if there's enough space left, it puts the record at the end of DFile and adds the appropriate entry to KList (which is then resorted). If there's no room left, PutRecord returns an error code to the calling routine.

Listing 5 has two higher-level routines: AddRecord and DeleteRecord. AddRecord won't let you overwrite an existing record. If a matching key is found, it returns with an error code; otherwise, it just calls PutRecord. DeleteRecord checks to make sure that a record with the requested key exists, then it deletes that record from DFile and from KList. The file deletion is done by copying the last record in the file over the record being deleted. If the last record is the one being deleted, no movement is done. The appropriate entry is removed from KList, with all following entries shuffled forward, and MaxRec is decreased by 1.

A note for C users: This code was written with conversion to C in mind and should be pretty easy to port. You'll probably use fseek( ) for your random access, which requires a byte offset from the start of the file. Because of this, you may want to set up KList with byte offsets instead of record numbers. You can do this by changing the assignment to KList[Indx].Num in InitStuff and

(continued)

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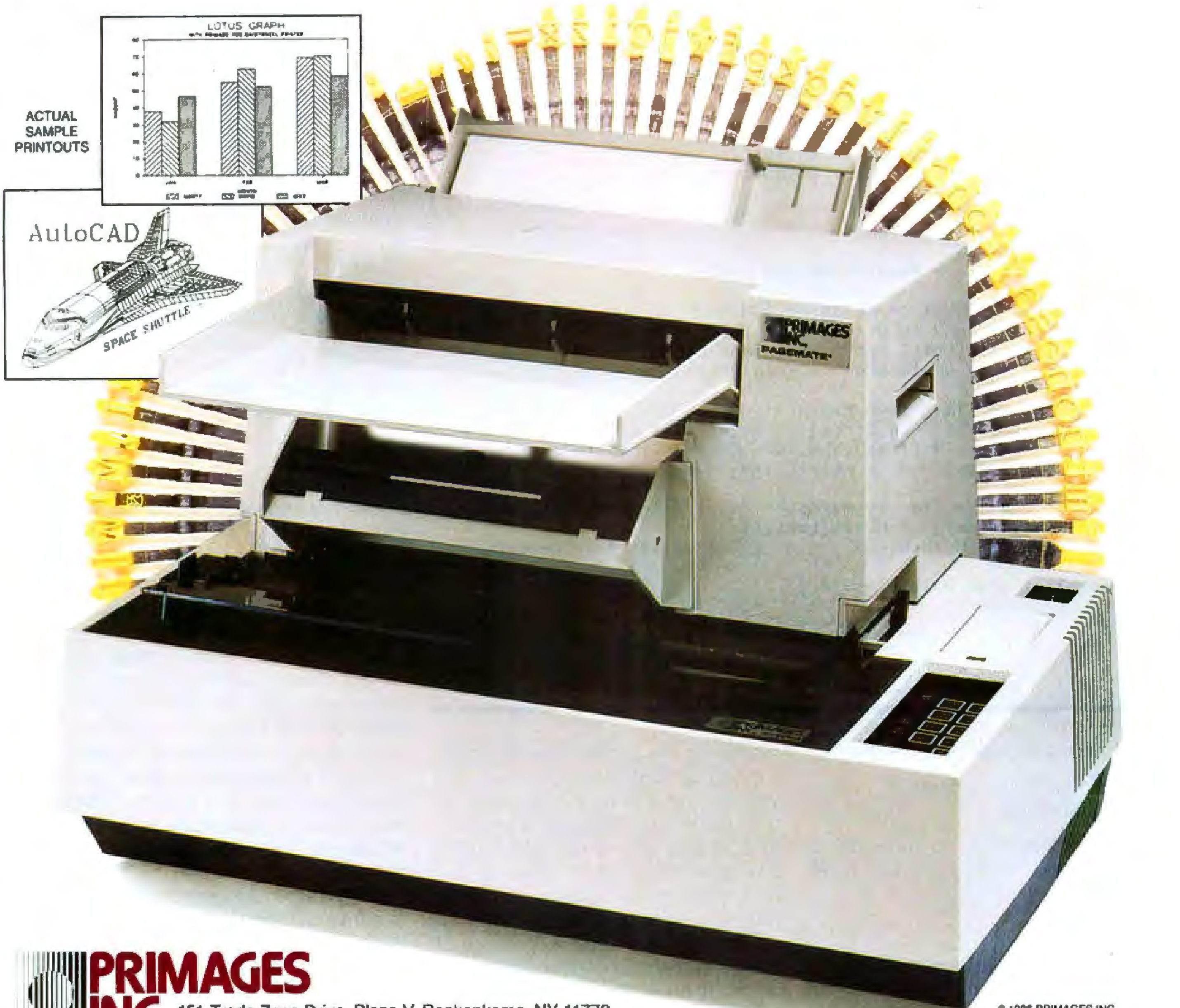

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Listing 5: *Higher-level record-access routines.*

```
procedure AddRecord(Rec : DataRec; var Error : Integer);
{
adds a record to the file.  If a record with the same
key already exists, then exits with an error code
}
var
  Item          : Integer;
begin
  Error := NoError;
  Item := FindKey(Rec.Key);
  if Item > 0
    then Error := AlreadyExists
    else PutRecord(Rec,Error)
end; { of proc AddRecord }

procedure DeleteRecord(Key : Keytype; var Error : Integer);
{
deletes the record with 'Key' by copying the last record
in the file to that slot, then modifies KList by shuffling
all the key entries up
}
var
  Item,Last,Max,MVal       : Integer;
  TRec                     : DataRec;
begin
  Error := NoError;
  Item := FindKey(Key);
  if Item = -1
    then Error := RecordNotFound
  else begin
    Max := 1; MVal := KList[Max].Num;
    for Last := 2 to MaxRec do
      if KList[Last].Num > MVal then begin
        Max := Last; MVal := KList[Last].Num
      end;
    if Max <> Item then begin
      FRead(MVal,TRec,Error);     { get last record in file }
      FWrite(KList[Item].Num,TRec,Error); { write over it }
      KList[Max].Num := KList[Item].Num
    end;
    for Last := Item to MaxRec-1 do  { delete KList[Item] }
      KList[Last] := KList[Last+1];
    MaxRec := MaxRec - 1           { adjust # of records }
  end
end; { of proc DeleteRecord }
```

PutRecord to read

KList[Indx].Num = (Indx) * sizeof(DataRec);

Similar adjustments to the calls to fread( ) and fwrite( ) should make things work fine.

VARIATIONS

You may chafe a little under having to set an arbitrary limit (IndexMax) on the number of records. The main reason for this is that Pascal does not support dynamic array allocation, and you thus have to fix the size of KList at compile time. There are a few ways around this. One is to make KList a linked list rather than an array. You lose the speed advantage of the binary search, each entry in the list will take up more space (because of pointers) than the corresponding entry in the array, and you will need the additional code and data-type definitions to support the linked list. On the other hand, you not only get rid of the arbitrary limit, but if you have a small number of records, you allocate only as much space for the list as needed, instead of always setting aside space for the entire array.

A trickier approach involves these modifications to the declarations:

```
type     . . .
  IndxList = array[1..1] of IndxRec;
  IndxPtr  = ^IndxList;
var
  KList    : IndxPtr;
```

You now create KList on the heap in the routine InitStuff with the call New(KList), and all references to KList are modified to show that it's now a pointer, for example, KList^[Indx]. This is a somewhat dirty approach to dynamic array allocation and requires several things. First, you must be able to turn off range checking when indexing into KList; that way, your program won't bomb when you try to reference any element other than KList[1]. Second, you must not dynamically create (using New) any other data structure after creating KList. Third, you must somehow verify that KList has a large enough block of contiguous memory to meet your needs. As I said, this is definitely a tricky approach.

CONCLUSIONS

Please note that this solution is a simple one. It is not the best or the fastest, but it is one of the easiest to understand and implement. Once you've mastered it, you can always go on to explore the indexed sequential-access method, virtual sequential-access method, B-trees, M-trees, and other techniques. But most programmers will find that this is an acceptable solution that gets rid of many problems without a lot of work. More important, it will give you a working foundation to build upon as you develop your own more complex solutions.

The listings in this article, along with a miniapplication written in Turbo Pascal using them, can be downloaded from BYTEnet Listings at (617) 861-9764. They are also available on disk (see page 445). ■

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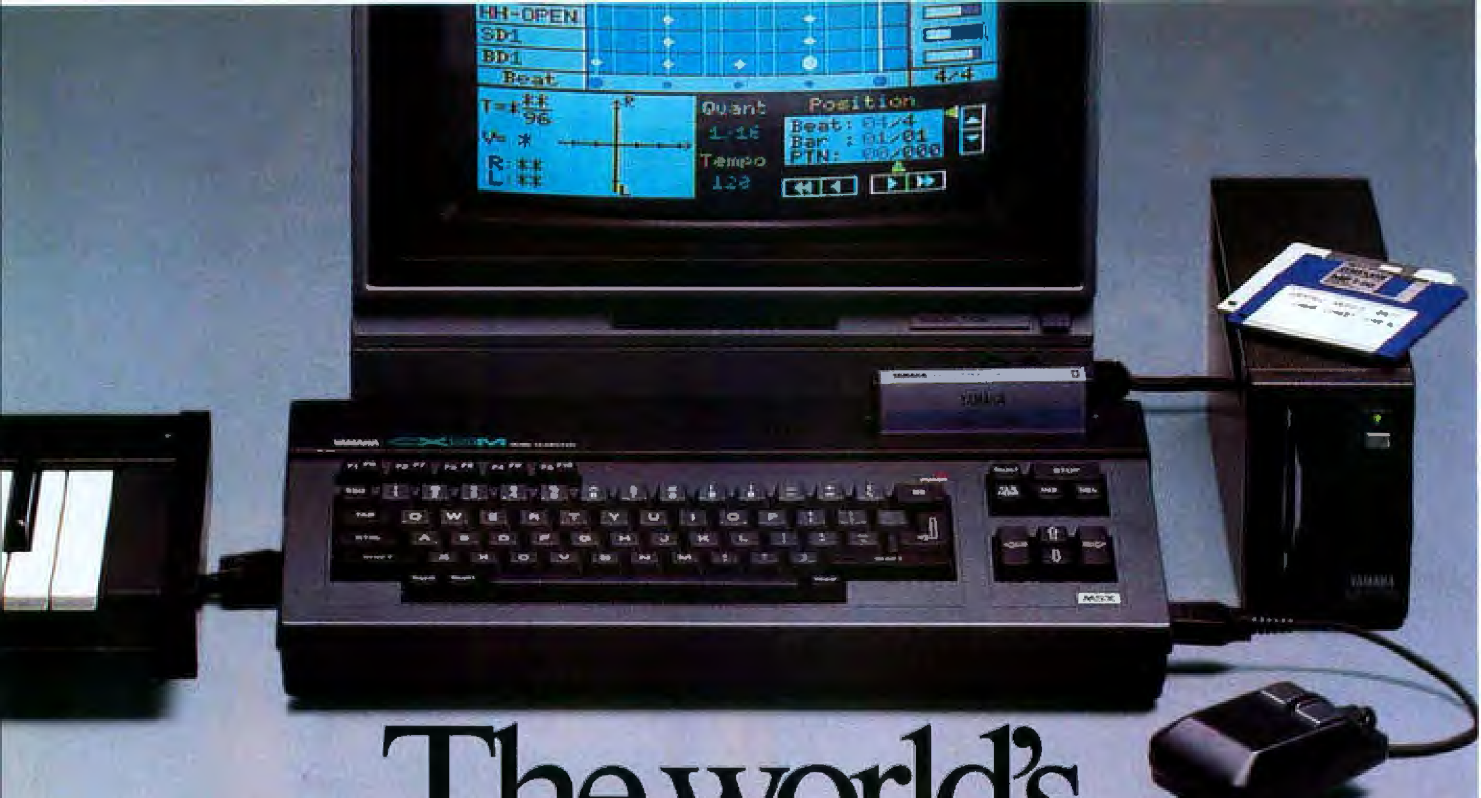

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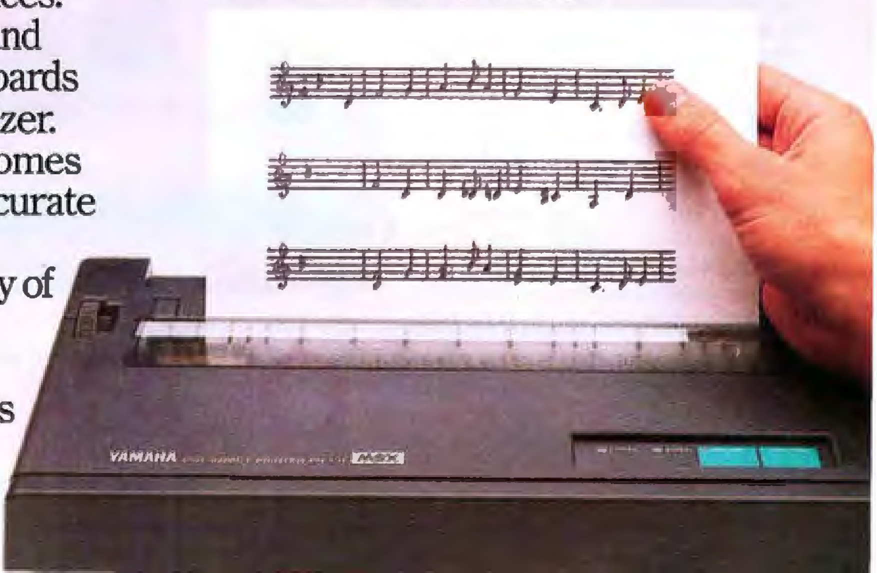

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ADDING SCSI TO THE SB180 COMPUTER

PART 2: BUS PHASES

BY STEVE CIARCIA

How bus phases are managed by the NCR 5380 *chip*

In this second half of my article on the SCSI bus, I will discuss in greater detail its operational characteristics: the bus phases and how they are managed by the NCR 5380 chip (see photo 1). I will even step through what happens if we issue a command to a hard disk attached to the bus and request the disk to write a sector of information. Be warned, though, that things will get intricate, and I urge you to keep last month's article on hand as a reference.

BUS PHASES

The bus protocol can be divided into the following phases: bus free, arbitration, selection, reselection, command, data in, data out, status, message in, and message out.

The arbitration, reselection, and message-out phases are used only in systems that support multitasking. Since the SB180 BIOS supports a single-user/single-tasking system, these phases are not supported. Also, in a single-user/single-tasking system, the message-in phase is used only for sending the command complete message.

In my upcoming descriptions of these phases, I will follow the common SCSI usage and refer to the host as the initiator and the peripheral device as the target. The directions in and out are always used with respect to the initiator.

BUS FREE

Bus free, as you might guess, is the idle state of the SCSI bus. No device is actively using the bus, and it is available for subsequent users.

ARBITRATION

Systems using the COMM180 with the current SB180 BIOS enter the selection phase directly without going through the arbitration phase. On systems that support multiple hosts or the disconnect/reconnect capability (a configuration not supported by the current SB180 BIOS), this phase is used to decide which device gains access to the bus when two or more devices request use of the bus at the same time.

Once the bus is determined to be free, a device may wish to arbitrate with other devices for use of the bus. For systems in which only one device initiates bus activity, the arbitration phase is optional and need not be implemented. A device places

(continued)

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. He is the author of several books about electronics. You can write to him at POB 582, *Glastonbury,* CT 06033.

Each device has an ID between 0 and 7 that corresponds to one bit on the data bus.

the bus in the arbitration phase by asserting the $\overline{BSY}$ signal and the appropriate bit on the data bus that indicates that device's ID. Since up to eight devices can use the bus, each device is assigned an ID between 0 and 7 that corresponds to one bit on the data bus. For example, if a device's ID was 3, it would assert bit 3 on the data bus along with $\overline{BSY}$ during arbitration.

A device loses arbitration if it detects either $\overline{SEL}$ true or a higher-priority ID active after allowing for an arbitration delay. Bit 7 is the highest-priority device. If a device loses arbitration, it must wait until the next bus free phase before reentering arbitration.

If after allowing for an arbitration delay and a higher-priority ID is not active, that device wins arbitration and asserts $\overline{SEL}$. This indicates to all other arbitrating devices that arbitration has been won, causing them to release the bus.

SELECTION

When the initiator has determined that the SCSI bus is free, $\overline{SEL}$ is asserted, and the initiator enters the selection phase, which is optional for single-user/single-tasking systems like the SB180. The selection phase is used to establish a communications link between the initiator and a target device for the purpose of performing an SCSI command. Where a host computer needs to write a sector of information to a disk drive, the host, acting as an initiator, would select the appropriate disk drive to perform the command.

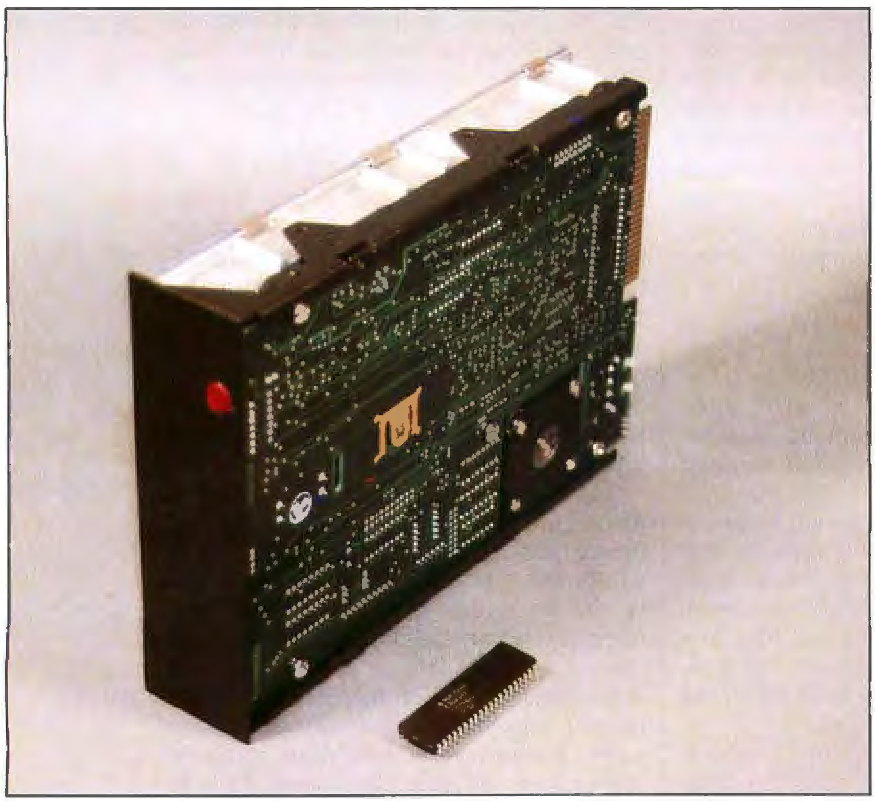


Photo 1: *The* NCR 5380 SCSI *chip, shown here next to an* SCSI-*compatible* 10-*megabyte hard disk drive.*

An SCSI target is considered selected when $\overline{SEL}$, the target bus device ID, and, optionally, the initiator bus device ID are active. When these conditions are met, the selected target asserts $\overline{BSY}$, and the selection phase is complete. If the target is not ready to be selected (e.g., it may be running a power-up or reset sequence), it cannot assert the $\overline{BSY}$ line. In this case, the SCSI specification recommends that the initiator abort the attempted selection if the target does not respond within 250 milliseconds. This time-out is especially important because a nonexistent device will act as one that is not ready to be selected.

INFORMATION TRANSFER PHASES

The remainder of the bus phases are collectively referred to as information transfer phases. The selected target device controls the flow of information with the initiator by setting the signals $\overline{MSG}$, C/$\overline{D}$, and I/$\overline{O}$ to the proper information transfer phase. These signals, known as phase signals, are used to determine the type of information being transferred and the direction of the data. Table 1 describes how the phase signals are coded.

These phases are used to transfer the necessary data and control information to complete an I/O operation. For each byte of information transferred, the following sequence of actions (called a REQ/ACK handshake) is required.

First, the target sets the phase lines (see table 1) to the desired bus phase and asserts the $\overline{REQ}$ signal either to request data from the initiator or to send data to the initiator; the direction is determined by the I/$\overline{O}$ signal. (I/$\overline{O}$ is true for in and false for out.) If the data is being sent from the target to the initiator, the data is asserted on the SCSI bus at this time.

Next, in response to the $\overline{REQ}$ signal, the initiator asserts $\overline{ACK}$ to send data to the target or accept data from the target. If the data is being sent from the host to the target, the data is presented on the SCSI bus at this time.

The target, in turn, will deassert $\overline{REQ}$, and the initiator will respond to a deasserted $\overline{REQ}$ by releasing $\overline{ACK}$.

This handshake is referred to as the asynchronous data transfer and is used in all the information transfer phases I will discuss below. A different handshake sequence is in effect when the synchronous transfer mode is used. However, since the COMM180 does not support this mode, I will not cover it.

COMMAND

An SCSI bus enters the command phase when C/$\overline{D}$ is asserted while $\overline{MSG}$ and I/$\overline{O}$ are inactive. This phase is used to inform the target device of the I/O function to be performed. The command blocks defined in the SCSI proposed standard are 6, 10, or 12 bytes in length. The length is determined by the group code located in the first byte of the command block.

DATA

The data phases are entered by deasserting C/$\overline{D}$ and $\overline{MSG}$. The state of the I/$\overline{O}$ line determines the direction of the data transfer. SCSI is a block-oriented bus, and data is usually transferred in segments. Consequently, when a computer is communicating with a disk drive via an SCSI bus, the data segment size is usually chosen as a multiple of the physical sector size.

STATUS

The status phase is entered when the target asserts C/$\overline{D}$ and I/$\overline{O}$ while $\overline{MSG}$ is inactive. The target uses this phase to transfer a status byte to the initiator at the termination of each command.

MESSAGE

The message phase is entered by asserting $\overline{MSG}$ and C/$\overline{D}$; I/$\overline{O}$ determines the direction of the message. This phase provides a means of managing the SCSI bus in complex system configurations. Only the command complete message is required in all SCSI designs. SCSI-bus devices indicate their ability to support messages other than command complete by asserting or responding to the $\overline{ATN}$ signal.

TYPICAL SASI TRANSFER

To give you a greater appreciation for the SCSI bus, I will examine in detail what occurs when a computer requests a disk drive to write a sector of information. I'll take the case of the computer and disk drive communicating through a SASI bus first, and then I'll look at a full SCSI implementation.

Table 1: *The SCSI bus phase signals and what they mean.*

Phase	$\overline{MSG}$	C/$\overline{D}$	I/$\overline{O}$
data out	0	0	0
data in	0	0	1
command	0	1	0
status	0	1	1
unspecified	1	0	0
unspecified	1	0	1
message out	1	1	0
message in	1	1	1

Table 2: *The address location of the* NCR 5380's *internal registers. The* R/W *column indicates whether the register is read only, write only, or read/write.*

	Address lines			
Register name	A2	A1	A0	R/W
current SCSI data	0	0	0	R
output data	0	0	0	W
initiator command	0	0	0	R/W
mode	0	1	0	R/W
target command	0	1	1	R/W
current SCSI bus status	1	0	0	R
select enable	1	0	0	W
bus and status	1	0	1	R
start DMA send	1	0	1	W
input data	1	1	0	R
start DMA target receive	1	1	0	W
reset parity/interrupts	1	1	1	R
start DMA initiator receive	1	1	1	W

SELECTION PROCESS

Since the system contains a single host and the peripherals are not capable of disconnection and reselection, the host is the only bus master and can enter the selection phase without arbitrating. It does this by asserting $\overline{SEL}$ and the data bit of the device being selected (the disk drive). The peripheral device operating as a bus target asserts $\overline{BSY}$ to complete the selection process.

To accomplish this with the NCR 5380, you write the bus device ID of the controller to the output data register. Then, to assert this ID bit onto the SCSI bus, you set the assert data bus bit in the initiator command register to a 1. Finally, you set the assert $\overline{SEL}$ bit, also found in the initiator command register, to activate the $\overline{SEL}$ line as described above. (Refer to table 2 and figure 1.)

$\overline{SEL}$ and the ID are concurrently active, and only a $\overline{BSY}$ from the controller is needed to complete the selection process. The SB180 BIOS polls the current SCSI bus status register waiting for the $\overline{BSY}$ signal to become active. If $\overline{BSY}$ is not asserted within 250 ms, the attempted selection is aborted.

If everything is operating properly, $\overline{BSY}$ will go active, and the processor resets the assert $\overline{SEL}$ bit in the initiator command register to 0. It then resets the assert data bus bits in the initiator command register to zeros.

COMMAND PHASE

Once connected, the target asserts the C/$\overline{D}$ signal, indicating command

(continued)

phase, and then asserts $\overline{\text{REQ}}$ to request the first byte of the command block. The first byte (byte 0) of the 6-byte command block contains the operation code 0A hexadecimal for the write command (see figure 2). The initiator sends the first byte by completing the REQ/ACK handshake and waits for the target to request the next byte. Upon receipt of the operation code, the target determines how many bytes to request from the initiator and decodes the operation to be performed. Using the REQ/ACK handshake, the initiator sends the remaining portion of the command block.

The information contained in bytes 1 through 3 of the command block provides the logical unit number and the logical block address (by incorporating the idea of a logical unit number, the SCSI protocol allows a single controller to control several physical disk drives). The logical block address is consequently converted by the target into the physical head, track, and sector locations to be addressed on the disk drive. Byte 4 contains the transfer length that specifies the number of logical blocks to be transferred. One logical block is often the size of the physical sector on the disk drive. The last byte of the command block, byte 5, is the control byte, which may contain vendor-unique information.

The firmware now polls the current bus and status register looking for the command phase and $\overline{\text{REQ}}$ to be asserted. Once the bus is in the proper phase, the software writes an 02 hexadecimal to the target command register. The 5380 will not allow data to be asserted on the SCSI bus unless the contents of the target command register reflect the current SCSI bus phase.

The command block can be transferred with the 5380, using programmed I/O, pseudo direct memory access, or normal DMA operation. Due to the small number of bytes to be transferred, the BIOS uses the pseudo DMA mode, which acts as programmed I/O operation but does not require the SCSI REQ/ACK handshake to be implemented overtly in the software. It therefore requires fewer I/O operations.

To implement this mode, the system asserts the DMA mode bit in the mode register of the 5380, sets the assert data bus bit in the initiator command register, and writes the start DMA send register. When the CPU addresses the start DMA send register with a write strobe, the 5380 begins the DMA process by asserting the DRQ signal to request the first byte of information to be transferred.

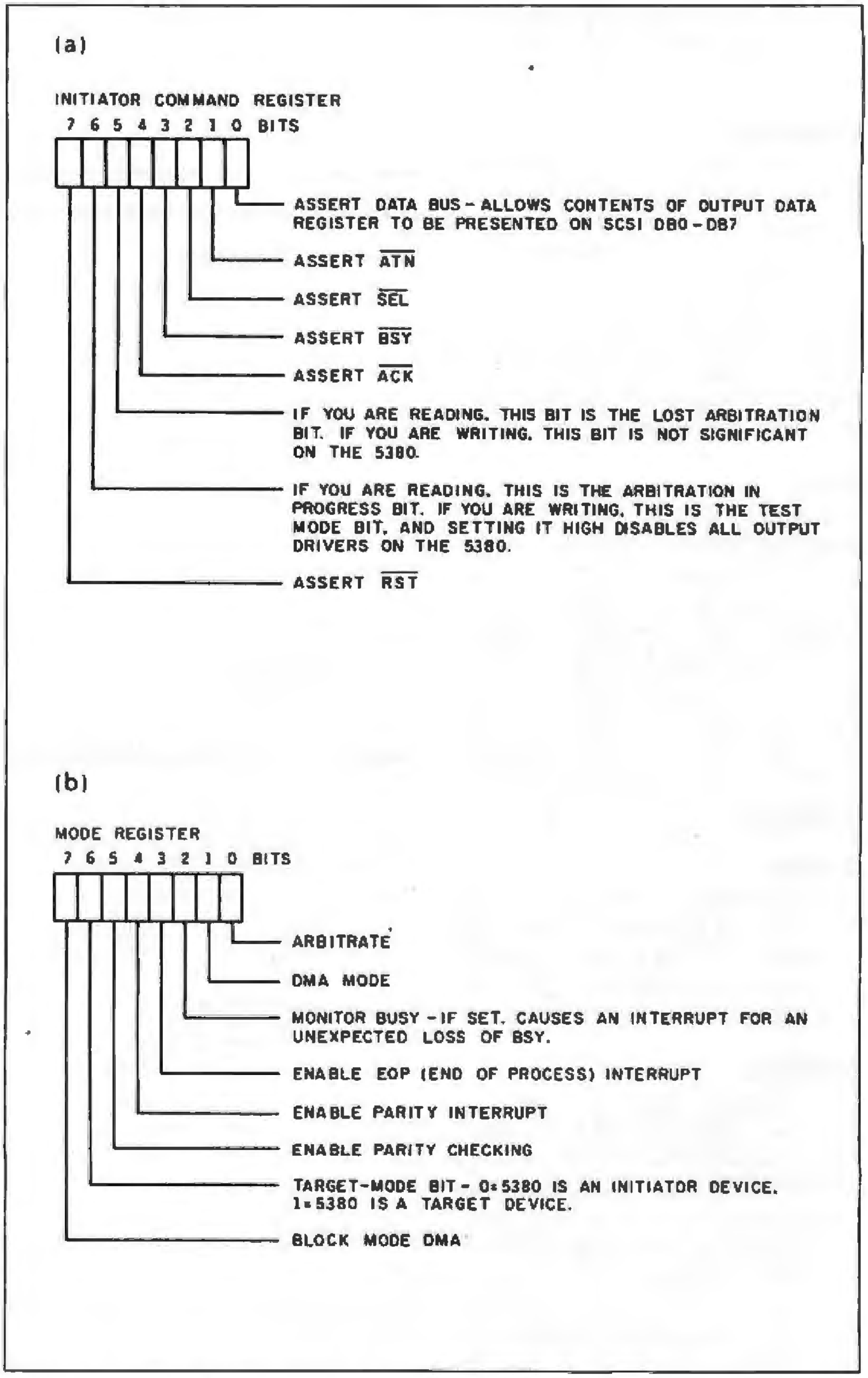
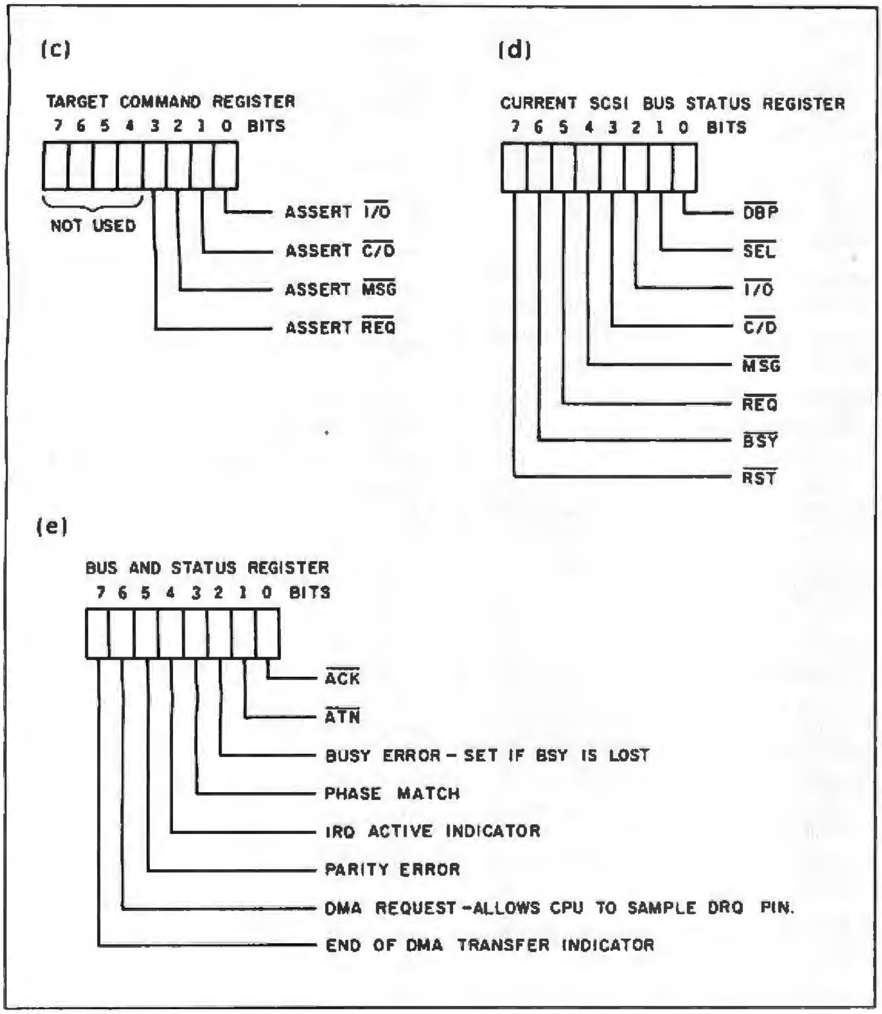


Figure 1: *Internal detail of some of the 5380's more important registers: (a) The initiator command register; (b) the mode register; (c) the target command register; (d) the current SCSI bus status register; and (e) the bus and status register. Refer to table 2 for address locations.*

(The data written to the start DMA send register is not significant.) This initialization sequence is identical to normal DMA operation. The primary difference is that the DMA channel is not controlling the transfer of data, the CPU controls the transfer.

The CPU samples the DRQ signal by reading the DMA request bit in the bus and status register. If this bit is active, the CPU knows that the 5380 is ready to receive data, and the first byte of the command block is written to the output data register at I/O address F0 hexadecimal.



BIT	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	0	1	0
BYTE 1	0	0	d	HIGH ADDRESS				
BYTE 2	MIDDLE ADDRESS							
BYTE 3	LOW ADDRESS							
BYTE 4	BLOCK COUNT							
BYTE 5	r	0	0	0	0	s	s	s

d = drive (0 or 1)
r = retries
s = step option

Figure 2: *Format of the write command. The op code (0A hexadecimal) is in the lower 5 bits of the first byte. The command's group code, which indicates how many bytes compose the command, is in the first byte's upper 3 bits.*

Once the data is written, the 5380 loads the data onto the SCSI bus and asserts ACK. In response to ACK, the target reads the data on the SCSI bus and deasserts REQ. The 5380 subsequently requests the second byte of data from the CPU by issuing the next DRQ. (This also sets the DMA request bit. BIOS polls this bit before issuing the next byte.) After the 5380 receives the second byte from the CPU, it deasserts the SCSI ACK signal, which has remained active since the first transfer. Subsequent to ACK going false, the disk controller issues the second REQ. The cycle above is repeated for the remaining bytes of the command phase.

As you can tell from the above description, the ACK signal asserted for the sixth command byte will remain asserted until an additional byte is issued to the 5380 or it is reset by other means. The SCSI bus, according to the proposed standard, cannot proceed to the next bus phase until ACK is deasserted. The SB180 BIOS resets the ACK signal by resetting the DMA mode bit in the mode register.

DATA-OUT PHASE

Having received the command block, the disk controller knows the location the data will be written to and performs a seek operation to position the heads over the proper track. Since the seek operation requires many milliseconds to complete, higher-performance controllers disconnect from the SCSI bus at this point and reconnect once the head is properly positioned. However, SASI designs remain connected to the host for the duration of the seek. When the head is properly positioned, the target changes the information transfer phase to data out and requests the initiator to send the number of bytes specified in byte 4 of the command block.

While the seek is being performed by the attached disk drive, the SB180 BIOS prepares the 5380 and DMA channel 0 of the Hitachi 64180 for the data-out phase. The DMA channel is programmed to respond to DMA re-

(continued)

GLOSSARY

BYTE: Eight bits of data.

CONNECT: This function occurs when an initiator selects a target to start an operation.

DISCONNECT: This function occurs when a target releases control of the SCSI bus, allowing it to go to a bus free phase. This can be done at the end of an operation or when a target releases the bus during an operation (such as during a seek).

INITIATOR: An SCSI device (usually a host system) that requests an operation to be performed by another SCSI device. For this system, the NCR 5380 on the COMM180 is the initiator.

LOGICAL UNIT: A peripheral device addressable through a target.

LOGICAL UNIT NUMBER: An encoded 3-bit identifier for the logical unit.

LUN: Abbreviation for logical unit number.

PERIPHERAL DEVICE: A piece of equipment that can be attached to an SCSI bus, for example, a disk, streaming tape, optical disk, or printer.

RECONNECT: This function occurs when a target reselects an initiator to continue an operation after a disconnect.

RESERVED: Bits, bytes, fields, and code values that are set aside for future standardization.

SCSI ADDRESS: The representation of the unique address (0 to 7) assigned to an SCSI device. This address is normally assigned and set in the SCSI device during system installation.

SCSI DEVICE: A host computer adapter, a peripheral controller, or an intelligent peripheral that can be attached to the SCSI bus.

SCSI DEVICE ID: The bit-significant representation of the SCSI address referring to one of the signal lines. This translates into one SCSI bus bit being set during the selection phase. Table A shows which bit on the SCSI bus (DB0 to DB7) is set for the different SCSI addresses. This configuration is placed on the bus during the selection phase to indicate which device is being selected. The bits set to x in the fields are set to 0 by the SB180 BIOS because it supports only a single-user/single-tasking environment. On systems that support multitasking, the ID of the initiator is also asserted so that when the target disconnects and reconnects, it will know who to reconnect to.

SIGNAL ASSERTION: The act of driving a signal to the true state.

SIGNAL NEGATION: The act of driving a signal to the false state or allowing the cable terminators to bias the signal to the false state (by placing the driver in the high-impedance condition).

SIGNAL RELEASE: The act of allowing the cable terminators to bias the signal to the false state (by placing the driver in the high-impedance condition).

STATUS: One byte of information sent from a target to an initiator upon completion of each command.

TARGET: An SCSI device that performs an operation requested by an initiator.

VENDOR-UNIQUE: Bits, fields, or code values that are vendor-specific.

Table A: SCSI *device* IDs *and their corresponding bits on the data bus.*

	SCSI ID							
SCSI address	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
0	1	x	x	x	x	x	x	x
1	x	1	x	x	x	x	x	x
2	x	x	1	x	x	x	x	x
3	x	x	x	1	x	x	x	x
4	x	x	x	x	1	x	x	x
5	x	x	x	x	x	1	x	x
6	x	x	x	x	x	x	1	x
7	x	x	x	x	x	x	x	1

quests from the 5380 by fetching data from a defined memory location and writing this data to the output data register of the 5380 (at I/O address F0 hexadecimal).

With the DMA mode bit reset and the assert data bus bit still active in the 5380, the BIOS writes a 00 to the 5380's target command register. This tells the 5380 that the current phase on the SCSI bus is data out (if it isn't, the 5380 issues a phase mismatch interrupt). The BIOS then reasserts the DMA mode bit and issues an I/O write to the start DMA send register; this initiates the DMA transfer process. As in the pseudo DMA transfer, the first DRQ is asserted after writing this register. Since the seek being performed by the disk drive can be a lengthy operation, it may be a long time between the first and second DMA requests. Data is transferred identically to the pseudo DMA mode except that the DMA channel responds to the DRQ signal and transfers the data from the SB180's memory to the 5380 rather than the CPU polling for the DMA request bit being active.

The BIOS supports sector lengths of 512 bytes. When the last byte is transferred, the DMA channel asserts the $\overline{TEND0}$ signal, which is fed to the $\overline{EOP}$ pin on the 5380. This sets the end-of-DMA bit in the bus and status register and signals the completion of the data-out transfer phase. The DMA mode bit is again reset to deassert the last $\overline{ACK}$ signal prior to the ensuing status phase.

MESSAGE AND STATUS PHASES

The target then switches to the status phase, sends a "good" status code to the host, changes to the message-in phase, and transfers the obligatory command complete message to end the I/O transfer. The $\overline{BSY}$ line is now released, disconnecting the target from the initiator and returning the bus to a bus free condition. Bus free allows the initiator to begin the next I/O transfer.

The SB180 reads the data of the status and message-in phases, using the pseudo DMA method previously described. In each case, the assert data bus bit is reset and the target command register is updated to the proper phase before reading the data from the 5380.

SCSI TRANSFER

Now for the SCSI version of the example. The SCSI bus differs from SASI in that it supports multiple bus masters through bus arbitration, and the disconnection and reselection of target devices are supported through the optional message-in and message-out bus phases.

In full SCSI implementations, the arbitration phase precedes the selection phase so that a device can gain control of the SCSI bus. When the selection phase is entered, the host asserts $\overline{SEL}$, its device ID, the target's device ID, and the $\overline{ATN}$ signal. The host presents its own device ID so that the target can know which device performed the selection. This is important in case the target disconnects from the SCSI bus for a lengthy I/O operation—it must know which host to reselect (this might be a multiprocessor system). The presence of the $\overline{ATN}$ signal informs the target of the initiator's desire to send a message and that the initiator is capable of supporting more than the mandatory command complete message. If the target is capable of supporting the additional messages required for disconnection and reselection, it responds by entering the message-out phase. Otherwise, the target replies by entering the command phase described in the SASI example.

Once the target issues $\overline{REQ}$ for the message-out phase, the initiator sends an identify message to the target. The identify message establishes a physical path between the initiator and the target for a particular logical unit and notifies the target of the initiator's ability to support disconnection and reselection. This message is also used by the target to reestablish the physical path with the initiator in a subsequent reselection.

After the identify message is transferred, the target requests the command block from the initiator by entering the command phase. (I will use the write command for this example, as I did in the SASI example.) If we assume that the write command will require the disk drive to perform a time-consuming seek operation, once the target receives the command from the host, it will disconnect from the SCSI bus. This frees the bus for other I/O operations. To disconnect from the bus, the target switches to the message-in phase and issues a disconnect message to the initiator. If the target was transferring several logical blocks of information and decided to disconnect between segments, it would issue a save data pointer message before issuing the disconnect. After the message is sent across the bus, the target releases $\overline{BSY}$ to complete the disconnection.

Although the target has broken the physical path with the host, the logical connection is maintained through the use of data pointers supported by the initiator. This concept is referred to as a logical thread. As long as the bus is free, the host can establish as many logical threads as can practically be supported by the system. Data pointers must be maintained for each logical thread.

When the head of the disk drive is positioned over the correct track, the target attempts to reestablish the physical path with the initiator by arbitrating for use of the SCSI bus. Once it has gained control of the bus, it reselects the host to complete the write command. When the reselection phase is complete, the target enters the message-in phase and sends the identify message to inform the initiator which logical unit is reconnecting. Since the initiator may have started several I/O operations, it performs an implied restore data pointer message to continue the I/O operation at the point of disconnection.

After the identify message has been transferred, the bus operation proceeds identically to the SASI example. Data-out, status, message-in, and bus free operational phases are consecutively performed on the SCSI bus, completing the write command.

IN CONCLUSION

You'll be seeing many computers and peripherals that are SCSI bus–compatible in the future, from peripheral manufacturers and the Circuit Cellar as well (see photo 2). In the early days of personal computing, it was enough for me to design projects that connected to a user's parallel port. Since then, however, personal computing has evolved to include a cornucopia

(continued)

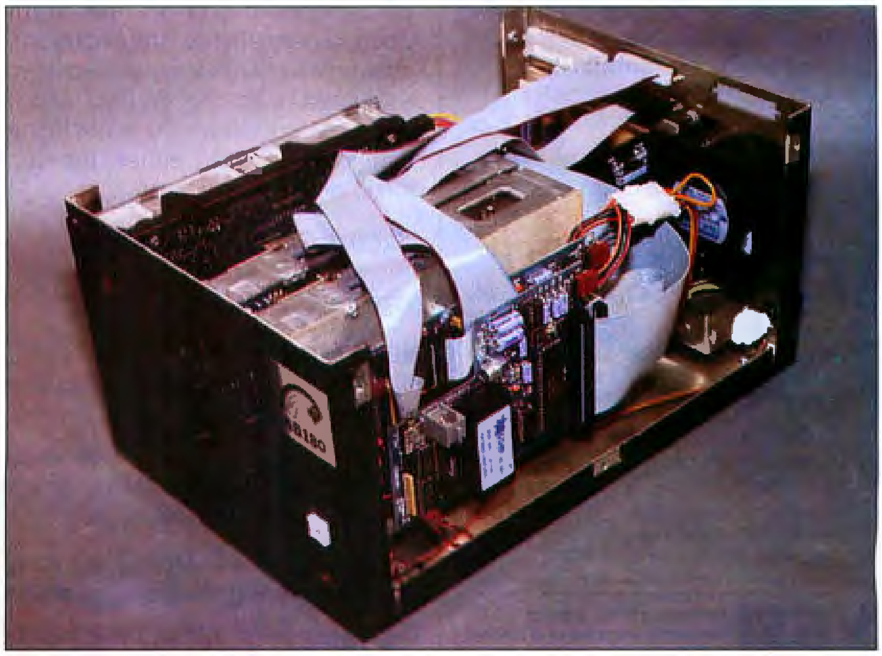


Photo 2: *The complete* COMM180 *board installed in a functioning* SB180 *computer system. The* SCSI *controller chip (note white outline) can be seen next to the larger* MOSART *modem chip.*

I expect that the SCSI standard will be heartily adopted. I am looking forward to using it again.

of backplane buses and interface standards that makes writing articles more like the Bus of the Month club. Presenting a project that is specifically IBM PC–compatible negates its value to Atari or Macintosh owners.

I expect that the SCSI standard will be heartily adopted. I for one am looking toward my next opportunity for using it.

Software Black Belts Take Notice

The current SB180 BIOS supports single-user/single-tasking systems. With thousands of SB180s in use among the software gurus of the world, no doubt one of you is going to implement the higher-level SCSI functions while I'm still drafting the specification. If you do, the North American One-Eighty Group (NAOG), software and hardware manufacturers associated with the SB180, and I would be very interested in obtaining such driver code, either through public domain or license.

Circuit Cellar Feedback

This month's feedback begins on page 54.

Next Month

I'll look at peripheral interface adapters. ■

Diagrams and information specific to the NCR 5380 *are reprinted with the permission of* National Cash Register Inc.

Special thanks to Mike McBride and Harry Mason for their contributions to this project.

There is an on-line Circuit Cellar bulletin board system that supports past and present projects. You are invited to call and exchange ideas and comments with other Circuit Cellar supporters. The 300/1200-bps BBS is on-line 24 hours a day at (203) 871-1988.

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SCSI hard disk drives, enclosures, cable sets, and various SB180 enhancement products are now available. Call for a price list.

Please include $10 (on items 1 and 2) or $6 (on items 3 and 4) for shipping and handling in the continental United States ($4 additional for Canada), $15 for surface or $35 for air mail elsewhere. Connecticut residents please include 7.5 percent sales tax.

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

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

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BY ANTONIO C. SILVESTRI

SORTING PRODOS DIRECTORIES

Sort subdirectories and files for cleaner catalogs

If you use Apple ProDOS, you have probably discovered that as files are added to and deleted from a disk its directory becomes filled with filename entries that the CATALOG command displays in a chaotic order. This is because ProDOS directories are simply built sequentially—the operating system does not sort by filename. Thus if you forget the exact spelling of a filename, you must catalog the disk and inspect each filename until you find the one you want. This procedure can be a nuisance when you are examining a long catalog, but many micro users take this in stride and dismiss it as part of operating a personal computer.

The program I describe in this article is designed to eliminate long catalog searches by sorting the valid filenames in the volume and subordinate directories of the ProDOS disk. It also permanently stores the sorted filenames on the disk so that an alphabetically sorted directory is displayed each time you request a catalog.

PROGRAM FEATURES

ProDOS, Apple's Professional Disk Operating System, is more sophisticated than its older but respected counterpart, DOS 3.3. Among ProDOS's features are an enhanced command set and support of a hierarchical directory structure that allows separate directories to coexist on the same disk. My program, for Apple IIc, IIe, and II+ computers with 64K bytes of RAM, will individually sort the volume, or root, directory and any of its subordinate directories that reside

(continued)

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ILLUSTRATED BY MIRIAM SCHAER

Table 1: *The format of a* ProDOS *directory block.*

Byte Offset in Directory Block	Entry Description
000–001	Block number of the previous directory block (low byte first). These bytes equal 0 if this is the first directory block.
002–003	Block number of the next directory block (low byte first). These bytes equal 0 if this is the last directory block.
004–042	Directory entry #1 or, if this is the first block of the directory (bytes 000 and 001 equal 0), the directory header.
043–081	Directory entry #2
082–120	Directory entry #3
121–159	Directory entry #4
160–198	Directory entry #5
199–237	Directory entry #6
238–276	Directory entry #7
277–315	Directory entry #8
316–354	Directory entry #9
355–393	Directory entry #10
394–432	Directory entry #11
433–471	Directory entry #12
472–510	Directory entry #13
511	<Not Used>

Table 2: *The format of a* ProDOS *directory header. Notice the differences in some bytes that distinguish a volume directory from a subdirectory.*

Byte Offset in Directory Header	Description
00	The high 4 bits equal 15 for a volume directory or 14 for a subdirectory. The low 4 bits equal the length of the directory name.
01–15	Directory name in ASCII.
16–23	Reserved.
24–25	The date that this directory was created (format:MMMDDDDD YYYYYYYM).
26	The minute at which this entry was created.
27	The hour at which this entry was created.
28	The version number of ProDOS that created this directory.
29	The lowest version of ProDOS that is capable of using this directory.
30	Directory access code.
31	The number of bytes occupied by each directory entry. This byte equals 39.
32	The number of entries that can be stored in each block. This byte equals 13.
33–34	The number of active files in this directory not including the directory header.
35–36	If this is a volume directory, these bytes specify the block where the volume bit map is located. If this is a subdirectory, these bytes specify the block in which the entry defining this subdirectory is located.
37–38	If this is a volume directory, these bytes indicate the size of the volume in blocks and equal 280. If this is a subdirectory, byte 37 is the directory entry number within the block specified in bytes 35 and 36. Byte 38 contains the number of bytes in each entry of the parent directory and equals 39.

on a ProDOS disk.

I wrote the program in Applesoft BASIC because speed is not important. The routine also includes some machine language code that is poked directly into memory.

To create a user-friendly utility, I have provided extensive screen output that allows you to monitor program execution. The routine takes some time to read, sort, and update a disk, particularly when you are working with a disk with numerous subdirectories containing many filename entries. This visual feedback gives you confidence in the utility's execution.

Any files you delete from a directory will still have an entry in that directory. However, since these entries are not viable files, the program does not include them in the sorting process. Updated directories are purged of deleted entries, which results in more efficient disk access.

PRODOS DISK DIRECTORIES

ProDOS organizes disk files by blocks, a block being a group of 512 bytes. An initialized ProDOS disk has 280 blocks numbered from 0 to 279 that can be used to store files, directories, etc. Any block can be allocated to a file or directory; this means that any long file or directory can be physically scattered throughout the disk.

All directories are accessed from the volume or root directory, which always resides at a fixed location, blocks 2 through 5, on the disk. Unlike the volume directory, subdirectories, which are treated as files, can be stored anywhere on the disk.

Since each directory block can hold thirteen 39-byte file entries, the volume directory can contain up to 52 entries. These entries describe a file's attributes by specifying its name, type, size, and disk location. The format of a directory block is shown in table 1.

The first block allocated to the volume directory (or a subdirectory) is called the key block and is arranged slightly differently than succeeding directory blocks. The 39-byte entry that normally describes the first file in the block is instead used to describe the directory itself. This entry is called the directory header. The format of a directory header is shown in table 2.

The remaining directory entries represent binary, text, Applesoft program, or subdirectory files. The offset byte map for these entries is shown in table 3. To determine what type of file a particular entry corresponds to, simply examine the file-type code that appears at offset 16 within the entry. Table 4 lists a few of the most common file-type codes.

DISK INPUT/OUTPUT

Data transfers to and from the disk occur on a block basis using the ProDOS MLI (machine language interface) protocol. This standard makes it simple for you to write small assembly language programs to perform disk I/O functions.

A typical subroutine to invoke disk I/O looks like this:

```
JSR  $BF00
DB   command_index
DB   low_para_addr
DB   high_para_addr
BCS  error
```

ProDOS's entry point is at BF00 (hexadecimal). Command_index is the command number assigned to a ProDOS function. Low_para_addr and high_para_ addr are, respectively, the least significant byte and the most significant byte of the address of the parameter list associated with the command. The parameter list contains the values of variables that the command needs to execute properly.

After ProDOS executes the command, control passes to the instruction immediately after the 3 bytes that follow the JSR instruction. If an error occurs in processing the command, ProDOS sets the carry flag—hence the BCS instruction as shown in the example.

The MLI command to read an individual block on a disk is command number 128. To write a block, you issue command number 129. The parameter lists for these two commands are identical and are constructed as shown in table 5.

Short machine language routines can be safely loaded at 300 (hexadec-

(continued)

Table 3: *The format of a ProDOS directory entry.*

Byte Offset in Directory Entry	Description
00	The high 4 bits equal 0 for an inactive file or nonzero for an active file. The low 4 bits equal the length of the directory name.
01–15	Entry name in ASCII.
16	File-type code (refer to table 4).
17–18	If this entry is a subdirectory, these bytes specify the location of its key block. If this entry is a standard file, this entry points to the first block where file data is stored.
19–20	File size in blocks.
21–23	File size in bytes.
24–25	The date that this file was created (format:MMMDDDDD YYYYYYYM).
26	The minute at which this file was created.
27	The hour at which this file was created.
28	The version number of ProDOS that created this file.
29	The lowest version of ProDOS that is capable of using this file.
30	File access code.
31–32	If this entry specifies a binary file, these bytes contain the load address for the file. If this entry specifies a random-access text file, these bytes contain its record length.
33–34	The date on which this file was last modified (format:MMMDDDDD YYYYYYYM).
35	The minute at which this file was last modified.
36	The hour at which this file was last modified.
37–38	The key block number of the directory that holds this file entry.

Table 4: *Some important ProDOS file-type codes.*

File-Type Code	Catalog Mnemonic	File Description
001	BAD	Bad block file
004	TXT	ASCII text file
006	BIN	Binary file
015	DIR	Directory file
252	BAS	Applesoft program file
255	SYS	ProDOS system file

Table 5: *The format of the parameter list used in ProDOS MLI calls to read and write disk blocks. (For disk block read and write calls, the first byte—the number of parameters—is always 3.)*

Byte #	Contents
1	Number of parameters
2	Disk slot and drive to be accessed (128 • drive # + 16 • slot #)
3	Low byte of the address of a 512-byte data buffer
4	High byte of the address of a 512-byte data buffer
5	Low byte of the block number to be accessed
6	High byte of the block number to be accessed

imal) since ProDOS reserves only a few bytes toward the end of this memory page for its own purposes.

You must allocate a 512-byte block in memory for block transfers. A program can make use of the buffer that is assigned for ProDOS activities. This buffer is pointed to by the contents of page zero locations 115/116 and is usually found at 38400 (9600 hexadecimal).

The Sorting Technique

The task of sorting a single directory involves three main steps. First, directory blocks are read into memory from the disk and the active directory entries are placed in an array. Next, the array is sorted by an algorithm such as the bubble sort algorithm. Finally, the sorted array of directory entries is written back in blocks to the original directory locations on the disk.

You have to modify this technique in order to sort a disk with a hierarchical directory structure. You must have a data structure such as a stack to keep track of subdirectory entries as they are encountered in the sorting process.

Each time a subdirectory entry is encountered, information about the subdirectory is saved on the stack. This information includes the key block location of this subdirectory as well as the path name of its parent directory. After sorting a directory, the program pops the next directory to be sorted, if one exists, from the stack. The information removed from the stack will be sufficient to repeat the three-step sorting process on this current directory. The entire sorting process ends when no directories are left on the stack.

The Bubble Sort Algorithm

Although there are more efficient array-sorting techniques, the bubble sort method is one of the easiest to program. The bubble sort is so named because it causes elements to "bubble" upward in the list being sorted. The routine moves through a list, comparing adjacent pairs of elements one at a time. If it finds an element that is greater than its higher-

(continued)

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B

Listing 1: *The ProDOS Catalog Sort Routine.*

```
10   REM                    PRODOS CATALOG SORT ROUTINE
20   REM                    ANTONIO C. SILVESTRI
30   REM                    SYSTEMS CONSULTANTS INC.

40   CLEAR: TEXT: HOME: DB = PEEK(115) + 256*PEEK(116)
50   FOR I=768 TO 792: READ H: POKE I,H: NEXT
60   DIM  DIM NA$(55), ST(30), ST$(30), DL(10): N = 0:
     V = 2: V$ = "": GOSUB 460

70   VTAB 2:HTAB 6:PRINT "PRODOS FILENAME SORT UTILITY":
     VTAB 9: HTAB 10: PRINT "INSERT DISK IN ";:
     FLASH: PRINT "DRIVE 1";: NORMAL: PRINT:
     HTAB 9: PRINT "HIT ANY KEY TO CONTINUE"
80   POKE  - 16368,0: WAIT  - 16384,128: POKE  - 16368,0

90   HOME: PRINT "SEARCHING FOR VALID FILENAMES": PRINT
100  IF N <= 0 THEN 450
110  GOSUB 480: BL = V: HE = V: HE$ = V$: CO = 0: BC = 0
120  POKE 791,BL - 256*INT(BL/256):POKE 792,INT(BL/256):
     POKE 776,128: CALL 768: IF PEEK(786) <> 0 THEN
     PRINT "ERROR IN READING BLOCK NO. ";BL: STOP
130  BC = BC + 1: DL(BC) = BL
140  FOR J=0 TO 12: IF J <> 0 THEN 180
150  IF BL=HE THEN DR$ = "":
     FOR I=0 TO 38:DR$=DR$ + CHR$(PEEK(DB + 4 + I)):NEXT:
     HE$ = HE$+"/"+MID$(DR$,2,PEEK(DB+4)-16*
     INT(PEEK(DB+4)/16)):PRINT "READING DIRECTORY: ";HE$
160  PRINT "BLOCK NO. ";BL;" READ"
170  IF BL = HE THEN 210
180  IF PEEK(DB + 4 + J * 39)=0 THEN PRINT "D";:GOTO 210
190  PRINT ".";: CO = CO + 1: NA$(CO) = "":
     FOR I=0 TO 38:
     NA$(CO)=NA$(CO)+CHR$(PEEK(DB+4+J*39+I)): NEXT
200  IF ASC(MID$(NA$(CO),17,1))=15 THEN
     V = ASC(MID$(NA$(CO),18,1)) +
     256*ASC(MID$(NA$(CO),19,1)): V$ = HE$: GOSUB 460
210  NEXT J: PRINT: PRINT: X = FRE (0):
     BL=PEEK(DB+2) + 256*PEEK(DB+3): IF BL <> 0 THEN 120

220  IF CO=0 THEN  HOME: VTAB 10: FLASH:
       PRINT "**WARNING**"; CHR$ (7);: NORMAL:
       PRINT "NO FILENAMES CAN BE FOUND": GOTO 290
230  IF CO=1 THEN 290
240  HOME:VTAB 10:PRINT CO;" FILENAMES FOUND";: HTAB 29:
     PRINT "NOW ";: FLASH: PRINT "SORTING";: NORMAL:
     NX = CO
250  VTAB 17: HTAB 8: PRINT "FILENAMES HAVE BEEN PLACED"
260  VTAB 17: HTAB 7 -  LEN(STR$(CO - NX)): PRINT CO - NX
270  FLAG = 0: FOR I = 2 TO NX:
     IF  MID$(NA$(I),2,15) < MID$(NA$(I-1),2,15) THEN
       H$ = NA$(I): NA$(I) = NA$(I-1): NA$(I - 1) = H$:
       FLAG = 1
280  NEXT: X = FRE(0): NX = NX - 1:
     IF FLAG = 1 AND NX <> 1 THEN 260

290  HOME: PRINT "STORING PURGED AND SORTED DIRECTORY":
     PRINT
300  A = 1: B = 0: FOR J = 1 TO BC
310  PRINT "NOW FORMING BLOCK NO. "; DL(J)
320  IF J = 1 THEN AX = 0: GOTO 340
330    AX = DL(J - 1)
340  IF J = BC THEN BX = 0: GOTO 360
350    BX = DL(J + 1)
360  POKE DB,AX-256*INT(AX/256): POKE DB+1, INT(AX/256):
     POKE DB+2,BX-256*INT(BX/256):
     POKE DB+3, INT(BX/256): POKE DB+511,0
```

(continued)

positioned neighbor, it exchanges these elements. The algorithm compares the next two elements and exchanges them if required. This process of comparing and exchanging positions continues throughout the entire list.

If any exchanges are made, the list is processed again. However, not all the elements need to be included in subsequent passes. Since each pass assures that the largest-valued element has been moved to the end of the list, time need not be wasted on checking these elements. When no exchanges are made in a pass through the list, it is sorted.

The BASIC Program Listing

The program is given in listing 1. [*Editor's note: The ProDOS Catalog Sort Routine and a short test routine are available for downloading from* BYTE*net* Listings *at* (617) 861-9764 *and are also obtainable on disk: see page* 445 *for details.*] Lines 40 through 60 perform program-initialization tasks, which include setting the variable DB equal to the address of the I/O data buffer and poking the MLI interface routine into memory. Line 60 defines some important arrays such as NA$, which is used to store directory entries.

Line 60 also defines and initializes a stack that is implemented using the stack pointer variable N and arrays ST and ST$. Array ST holds the block numbers of subdirectory key blocks, while ST$ stores the path names of a subdirectory's parent directory. The GOSUB 460 instruction pushes values on the stack and starts the sorting process with the volume directory.

Lines 70 and 80 give you the opportunity to remove the program disk and insert in drive 1 the disk to be sorted. The program issues a prompt and waits for a key press before continuing.

Line 100 checks the status of the stack: If it is empty, execution halts; if not, line 110 executes the GOSUB 480 instruction to pop the stack. Line 120 reads the retrieved directory block into the data buffer, and lines 130 through 200 extract directory entries from the buffer and store them in array NA$. Notice that line 200 ex-

(continued)

```
370  IF J = 1 THEN
     FOR K=1 TO 39: POKE DB+3+B*39+K,ASC(MID$(DR$,K,1)):
     NEXT: PRINT ".";:B = B + 1
380  IF A <= CO THEN
       FOR K=1 TO 39:
       POKE DB+3+B*39+K,ASC(MID$(NA$(A),K,1)): NEXT:
       PRINT ".";: GOTO 400
390  FOR K=1 TO 39: POKE DB+3+B*39+K,0: NEXT: PRINT "Z";
400  A = A+1: B = B+1: IF B < 13 THEN 380
410  PRINT: PRINT: B = 0:
     POKE 791,DL(J)-256*INT(DL(J)/256):
     POKE 792, INT(DL(J)/256): POKE 776,129: CALL 768
420  IF PEEK(786) <> 0 THEN
       PRINT "ERROR IN WRITING BLOCK NO.";DL(J): STOP
430  NEXT J: GOTO 90
440  DATA 169, 0, 141, 18, 3, 32, 0, 191, 0, 19, 3, 176,
          1, 96, 238, 18, 3, 96 , 0, 3, 96, 0, 150, 0, 0
450  END


460  IF N >= 30 THEN
       PRINT "STACK OVERFLOW": STOP
470  N = N+1: ST(N)=V: ST$(N)=V$: RETURN
480  IF N <= 0 THEN
       PRINT "STACK UNDERFLOW": STOP
490  V = ST(N): V$ = ST$(N): N = N-1:
     RETURN
```

Listing 2: *This program creates a scratch disk that you can use to test the sort program of listing 1.*

```
10  DATA  "/SCRATCH", "/SCRATCH/MASS", "/SCRATCH/RHODE",
          "/SCRATCH/VERMONT", "/SCRATCH/MASS/NY",
          "/SCRATCH/MASS/NJ", "/SCRATCH/RHODE/PA",
          "/SCRATCH/VERMONT/MAINE"
20  DIM A$(40):  D$=CHR$ (4):  ONERR GOTO 100
30  READ H$:  PRINT D$;"PREFIX ";H$:
    PRINT D$;"SAVE TESTFILE"
40  J=0:  L=INT(40*RND(1))+1:  PRINT:  PRINT:
    PRINT L;" FILES TO BE CREATED":  PRINT
50  FOR K=1 TO L:  TY$="":  FOR I=1 TO INT(10*RND(1))+1:
    TY$=TY$+CHR$(65+26*RND(1)):  NEXT:  X=FRE (0)
60  PRINT K;"  ";H$+"/"+TY$:  PRINT D$;"OPEN "+TY$:
    PRINT D$;"CLOSE "+TY$:  IF RND(1) < .30 THEN J=J+1:
    A$(J)=TY$
70  NEXT K
80  PRINT J;" FILES TO DELETE":  IF J=0 THEN 30
90  FOR I=1 TO J:  PRINT D$;"DELETE "+A$(I):
    PRINT I;"  ";H$+"/"+A$(I):  NEXT:  GOTO 30
100 END
```

plicitly checks each entry to see if it is a subdirectory. If it is, the program pushes that subdirectory's information onto the stack.

After the program processes each directory block, line 210 checks to see if that block is the last block of the current directory. If not, execution loops back to line 120 to read and process the next block; otherwise execution continues with line 220.

When program execution reaches line 220, variable CO contains the number of directory entries stored in NA$, DR$ contains the directory header, BC contains the number of blocks in the directory, and array DL contains the actual block numbers that form the directory.

Lines 220 through 280 perform the bubble sort of array NA$. Lines 290 through 430 write the sorted array back to the disk. After the program has written the directory to the disk, the entire procedure is repeated by a jump to line 90.

TESTING THE UTILITY

Because you are dealing with a program that directly accesses disk blocks, you should take care to verify that the copy you have acquired (either by typing or downloading) works properly. One small error can destroy a disk containing weeks of hard work. Listing 2 gives a small program you can use to test the utility.

This program creates a dummy disk with a random number of active and inactive entries stored in different subdirectories. To use this program, first format a disk with volume name /SCRATCH using the ProDOS Utilities Disk, then create the following subdirectories:

/SCRATCH/MASS
/SCRATCH/MASS/NY
/SCRATCH/MASS/NJ
/SCRATCH/RHODE
/SCRATCH/RHODE/PA
/SCRATCH/VERMONT
/SCRATCH/VERMONT/MAINE

Then run the program in listing 1.

Now run the sort utility program on this disk. This will give you a chance to get accustomed to the prompting. If the utility runs with no apparent problem, catalog each subdirectory to see if each catalog is sorted.

Next, go into each subdirectory using the PREFIX command and type LOAD TESTFILE. TESTFILE is the BASIC program that created the dummy disk and is stored in each subdirectory. If you can successfully load TESTFILE from each subdirectory without I/O errors, go through the following final test, which checks if data can be stored on the disk. Try to store a dummy program in each subdirectory, then reload the stored programs and verify that they are uncorrupted. If you can successfully store programs on the disk, this proves that all data pointers on the disk are intact and that the utility works reliably. ■

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ProDOS Technical Reference Manual. Apple Computer Inc., 1983.

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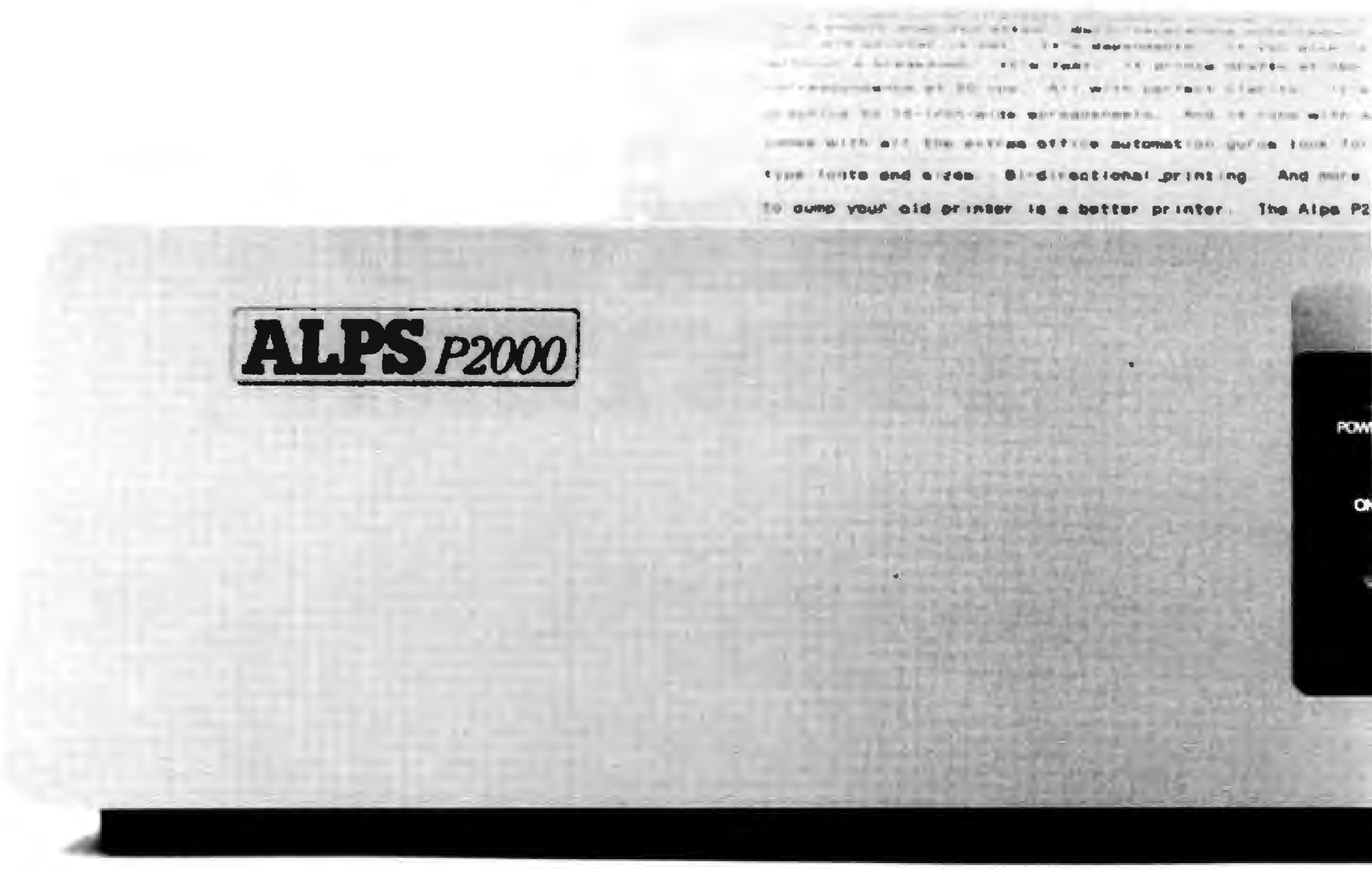

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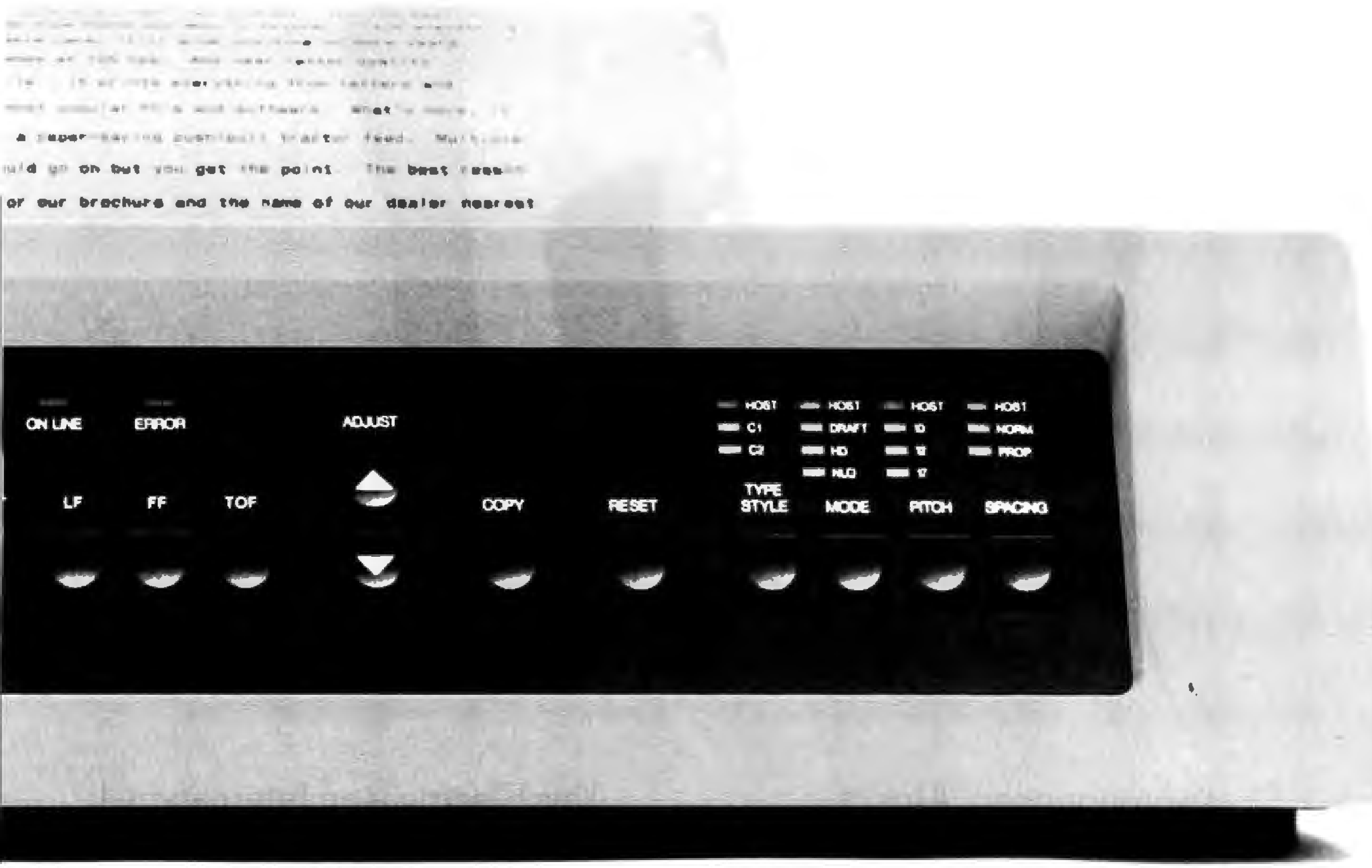

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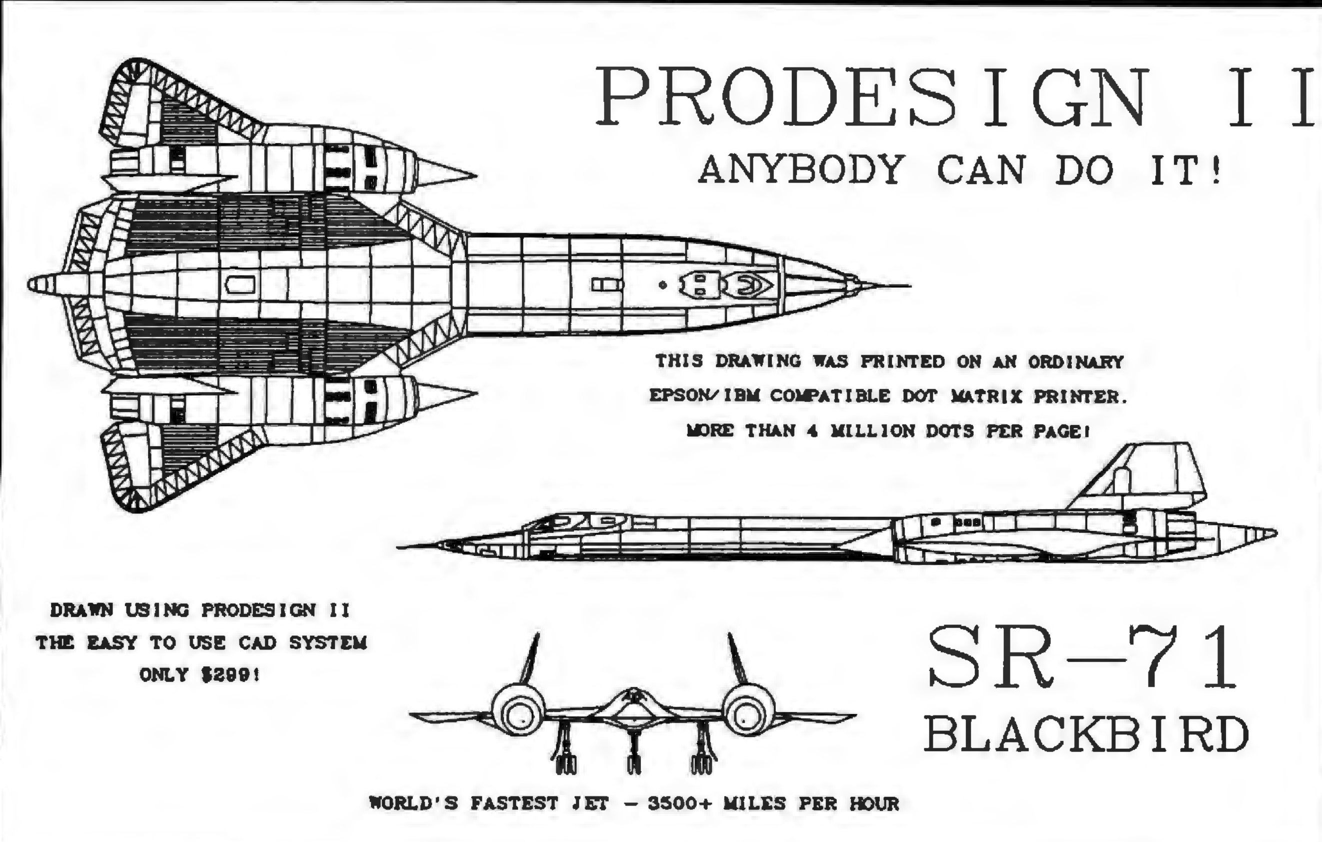

BY MARK ANACKER

DECODING MACPAINT ON THE IBM PC

Transfer graphics created on the Macintosh and manipulate them on your PC

You would be hard pressed to find two more dissimilar systems than the IBM PC and the Apple Macintosh—especially when it comes to graphics. And that can be a problem in an office where both systems are used. With a little effort, however, you can bring them closer together.

I've written a Pascal program for the IBM PC called MacView that decodes and displays MacPaint images on your PC display. [*Editor's note: MacView, which was written in Turbo Pascal, is available for downloading from* BYTEnet Listings *at* (617) 861-9764. *It is also available on disk; see page* 445.] Moreover, this software provides the foundation to a bridge between Macintosh and PC graphics; once Macintosh graphics are translated for the PC, it is relatively easy to write additional program code to manipulate the images.

First, of course, you must get the MacPaint file from the Mac to the PC. For the Mac, you can use a communications package such as MacLink or MacTerminal. For the PC, nearly any of the common asynchronous PC communication packages will do. As for connecting the Mac to the PC, you could use a dial-up modem link, but a direct cable between the two machines is best. Figure 1 is a cable schematic for a direct hookup.

Once you have completed the transfer, the MacPaint file can be decoded.

(continued)

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ILLUSTRATED BY STEPHEN GERVAIS

Each image occupies 720 horizontal scan lines of 72 bytes each, for a total of 51,840 bytes. Each byte represents 8 horizontal points on the screen, with the highest bit to the left (see figure 2). A 1 bit indicates a dark pixel, and a 0 indicates a white one.

To save disk space, however, MacPaint stores its images in a compressed bit-map format—reducing the image data to only about 10K bytes. (The subsequent decoding, which requires a great deal of processor power, is the reason the Mac takes so long to bring an image up on the screen.) The bytes in each scan line are encoded into two types of records: mixed-data and repeating-data (see figure 3).

A mixed-data record consists of a byte indicating the record length (from 1 to 72 bytes) and the raw data. This type of record is used when each byte in a scan line is different from its neighbor. Such a record actually takes up one more byte than the original scan-line data.

Repeating-data records are more efficient. Most images consist of repeated bit patterns, which can be represented easily with just a byte that indicates the number of bytes to repeat, followed by the actual bit pattern. This method allows you to compress as many as 127 bytes into as few as 2 bytes. And you can store a single scan line using a combination of mixed-data and repeating-data records. The eighth bit in the first byte of the record, the counter byte, distinguishes the record type; specifically, that bit is set to indicate a repeating record.

In addition to image data, the first 512 bytes of a MacPaint file contain some header information and the bit maps of the paint patterns that are displayed along the bottom of the MacPaint screen. For our purposes, that information is not necessary, and MacView begins reading the MacPaint file at the 513th byte.

As MacView reads the MacPaint file one byte at a time, it decodes the mixed-data and repeating-data record types. Since the Mac has a black-on-white display, the program must flip the bits with a NOT operator to make the image appear the same on a PC. The program then puts the resulting bits in a buffer that can be accessed via an array of pointers.

Once the image is in the buffer, the program displays part of it on the screen. I chose to write the image

(continued)

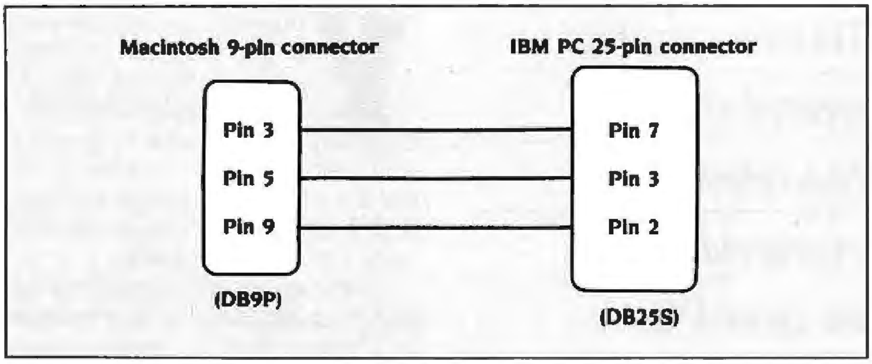

Figure 1: *Schematic for direct cable hookup.*

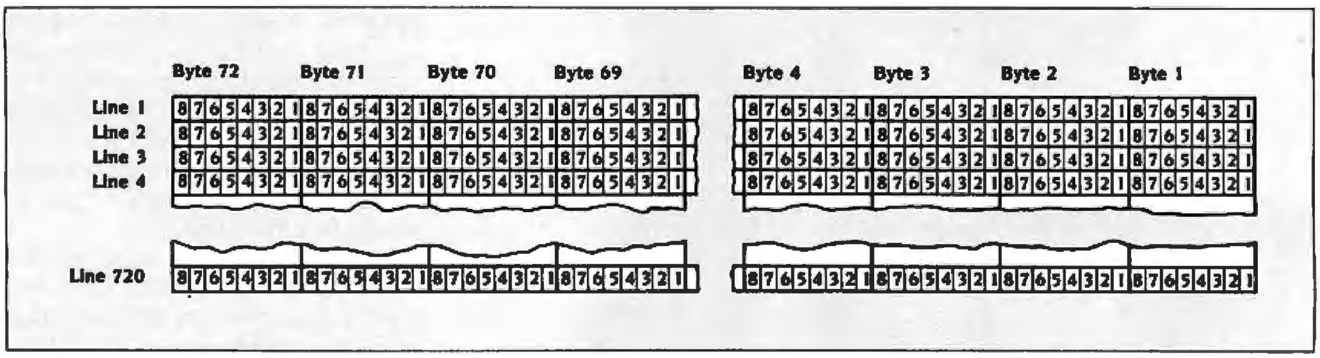

Figure 2: *The bit-mapped layout of a MacPaint image contains 51,840 bytes.*

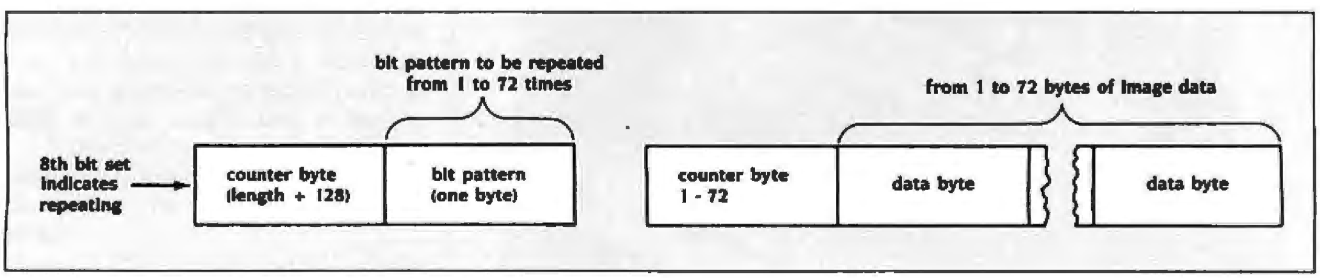

Figure 3: *Left, repeating-data record; right, mixed-data record.*

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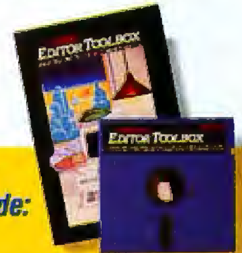

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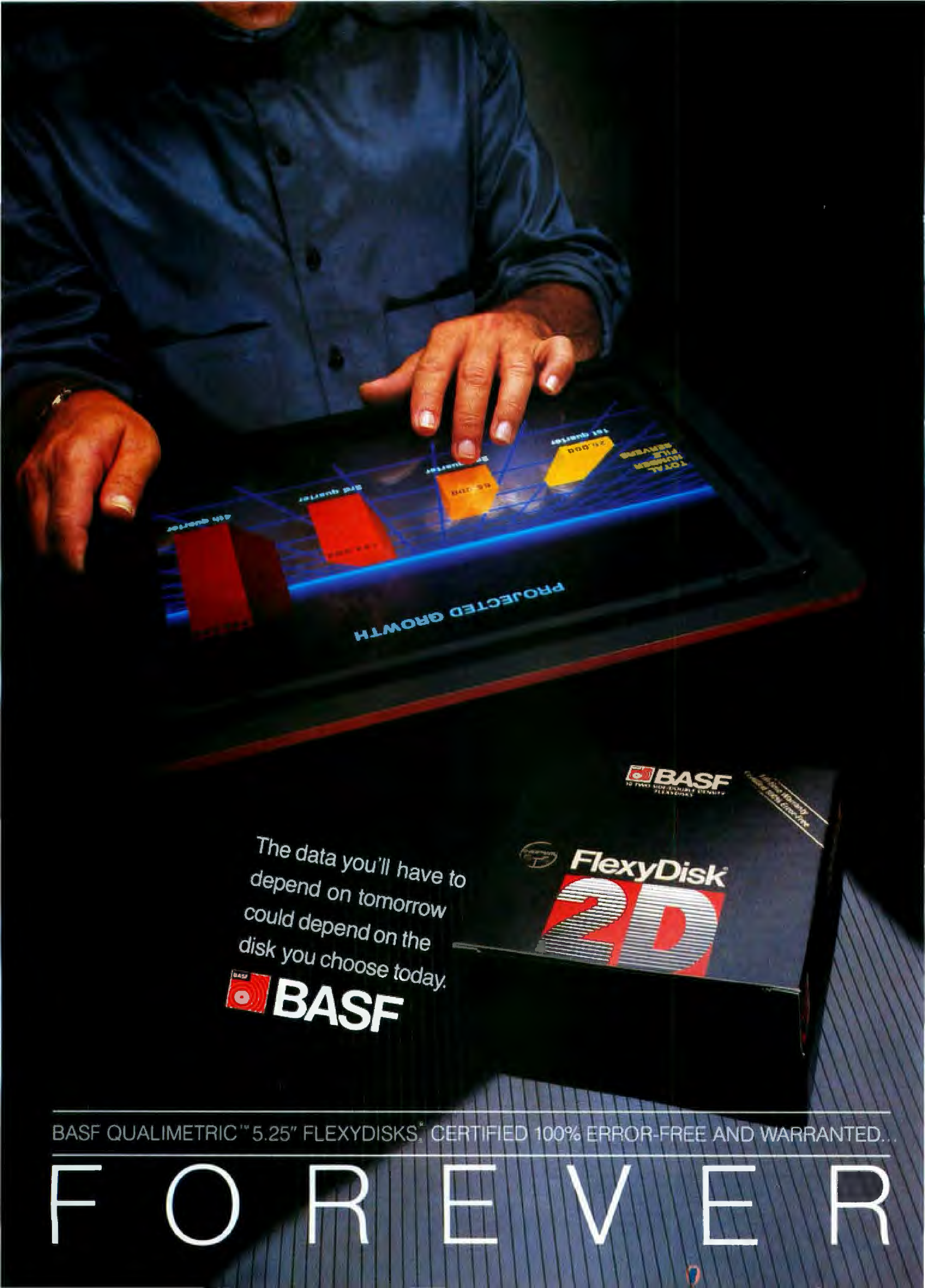
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The one thing MacView can't handle is the difference in aspect ratio between the PC and the Mac.

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The one thing my program can't handle is the difference in aspect ratio between the two systems. The pixels on the Mac screen are square, while the PC's are rectangular. This means that the images on the PC screen appear vertically stretched. Of course, you could compensate somewhat for the aspect ratio by skipping every other scan line when the image is displayed, but doing so causes a loss of detail. Some IBM PC compatibles—particularly those that use LCDs, which inherently use square pixels—may correct the aspect ratio problem.

I wrote the program in Pascal for speed, but you could translate it into BASIC or another language as well. But no matter what language you use, once you've made sense out of a MacPaint image on your IBM PC, you can begin to do things with it. I have written programs that enlarge and compress the images as well as print them on an IBM PC–compatible laser printer. I also use the large hard disk on my PC to archive the MacPaint images. There's really no limit to what you can create when you combine the graphics of the Macintosh and the IBM PC. ■

HILBERT CURVES MADE SIMPLE

BY MICHAEL ACKERMAN

This one-subroutine BASIC *program uses only global variables*

IF YOU ARE INTERESTED in fractal shapes, you are probably familiar with the Hilbert curve. It was among the first of many wild but "self-similar" shapes that astonished mathematicians around the turn of the century.

Hobbyists have discovered the beauty of David Hilbert's creation, and several have written programs to draw it on the high-resolution screens of personal computers. Unfortunately, most of the programs that produce the curve are quite complicated. The demonstration program that comes with the Apple Pascal system contains a procedure that itself contains two more procedures. I had a difficult time following the program's logic.

Niklaus Wirth, author of the Pascal and Modula-2 programming languages, includes a Hilbert curve program in his book *Algorithms + Data Structures = Programs* (Prentice-Hall, 1976). While this program is easy to understand, it contains four procedures that call each other again and again. I decided that there had to be a simpler way to

(continued)

Michael Ackerman (1539 Van Dyke Rd., San Marino, CA 91108) is a senior majoring in history at the University of California at Santa Barbara.

Listing 1: A *simple Applesoft* BASIC *program to generate Hilbert curves.*

```
1 GOTO 1000
2 REM *******************************************
3 REM * HILBERT BY MICHAEL ACKERMAN - 8/27/85 *
4 REM *******************************************
100 RDER = RDER - 1
110 TURN = - TURN
120 TEMP = DY:DY = - TURN * DX:DX = TURN * TEMP
130 IF RDER > 0 THEN GOSUB 100
140 X = X + DX:Y = Y + DY: HPLOT TO X,Y
150 TURN = - TURN
160 TEMP = DY:DY = - TURN * DX:DX = TURN * TEMP
170 IF RDER > 0 THEN GOSUB 100
180 X = X + DX:Y = Y + DY: HPLOT TO X,Y
190 IF RDER > 0 THEN GOSUB 100
200 TEMP = DY:DY = - TURN * DX:DX = TURN * TEMP
210 TURN = - TURN
220 X = X + DX:Y = Y + DY: HPLOT TO X,Y
230 IF RDER > 0 THEN GOSUB 100
240 TEMP = DY:DY = - TURN * DX:DX = TURN * TEMP
250 TURN = - TURN
260 RDER = RDER + 1
270 RETURN
1000 TEXT:HGR:HCOLOR=3:INPUT "ORDER <1-7>";RDER
1010 POKE 49234,1
1020 DY = 192 / 2 ^ RDER
1030 TURN = - 1
1040 DX = X = Y = 0
1050 HPLOT X,Y
1060 GOSUB 100
1070 END
```

draw this elegant figure.

Since recursive programs are hard enough to follow, I decided to write an Applesoft BASIC program that would have only one subroutine with a single entry point. The final program (see listing 1) not only helped me to understand the Hilbert curve better, but also let me use some interesting programming tricks. [*Editor's note:* HILBERT.BAS *is available on* BYTE*net Listings at* (617) 861-9764. *The program is also available on disk* (*see page* 445).]

A first-order Hilbert curve is very simple (see figure 1) and can be drawn by following the rough outline shown in table 1. I inserted four recursive calls into this outline so that the procedure could draw higher-order curves. These calls are conditional on the variable ORDER, which is decremented each time the procedure calls itself and incremented each time the procedure issues a return. Thus, the number of nested gosub statements is determined by the original value of ORDER (see table 2).

The final refinement was to insert commands to swap left for right. To understand this, it might be useful to compare a first-order curve (figure 1) to a second-order curve (figure 2). The first line segment in the first-order curve is horizontal, but the first segment in the second-order curve is vertical. In a third-order curve (figure 3), it is horizontal again. To remedy this flip in orientation, the program includes the variable TURN, which indicates a left turn when it equals 1 and a right turn when it equals −1. It also includes commands to invert TURN each time the curve routine flips direction.

You may notice that both table 1 and table 2 are almost palindromes; that is, they read the same backward as forward. The main subroutine in the BASIC program in listing 1 (lines 100 through 270) is palindromic as well. This symmetry is visible in the Hilbert curve itself. You can take a curve of any order and fold it so that one half exactly covers the other.

Another advantage of this program is that it runs well without using local variables. Both Pascal programs that I referred to earlier depend on local variables, which are neatly stored each time a procedure calls itself and restored when it issues a return. This program has only global variables, which are not stored automatically. The other BASIC implementations of the Hilbert curve that I have seen store variables in arrays each time the programs recur. This program eliminates the need to store variables by making sure that all relevant variables have the same values at the beginning and end of the main routine.

Since the program outline in table 1 has two left turns and two right turns, you end up pointing in the same direction you started in. ORDER also remains the same in table 2 because it is first decremented, then incremented. In listing 1, TURN is inverted four times, so it too is the same upon leaving the routine as it was upon entering. Most important, the variables are not changed by the GOSUB statements because they call only the routine itself. ■

Table 1: *A rough outline for generating first-order curves.*

```
turn left
draw forward
turn right
draw forward
turn right
draw forward
turn left
```

Table 2: *A modified procedure showing the placement of recursive calls.*

```
        ORDER=2
hil     ORDER=ORDER-1
        turn left
        gosub hil if ORDER>0
        draw forward
        turn right
        gosub hil if ORDER>0
        draw forward
        gosub hil if ORDER>0
        turn right
        draw forward
        gosub hil if ORDER>0
        turn left
        ORDER=ORDER+1
        return
```

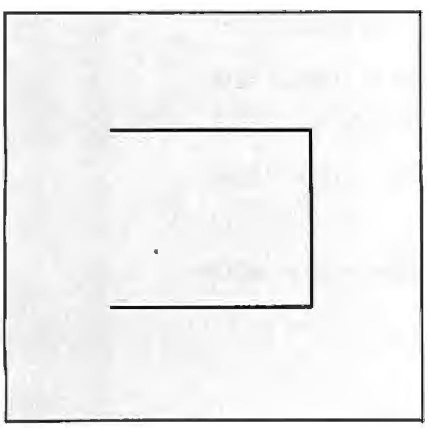

Figure 1: *A first-order* Hilbert *curve. Note that the first line segment is horizontal.*

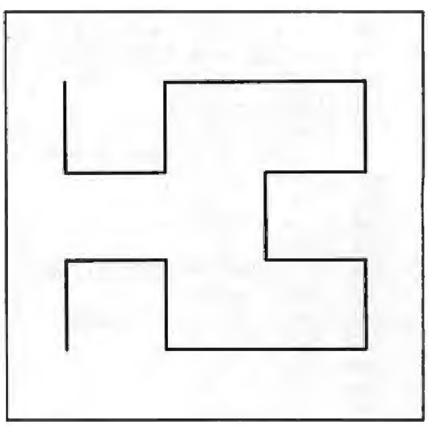

Figure 2: *A second-order* Hilbert *curve. Note that the first line segment is vertical.*

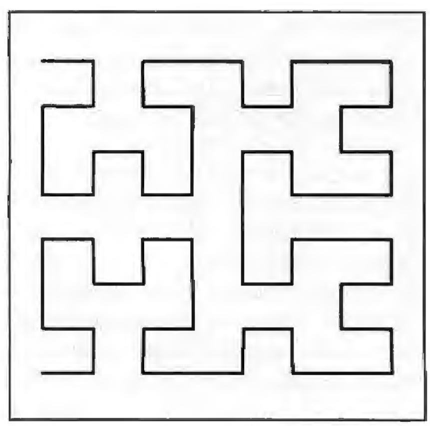

Figure 3: *A third-order* Hilbert *curve. Note that the first line segment is horizontal again.*

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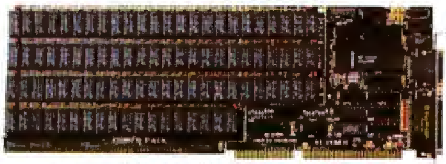

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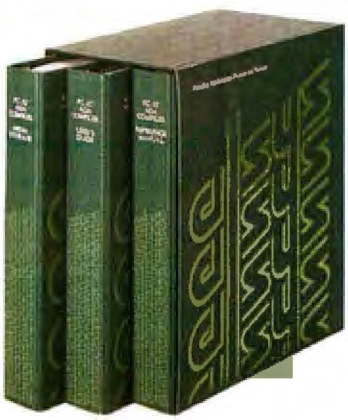

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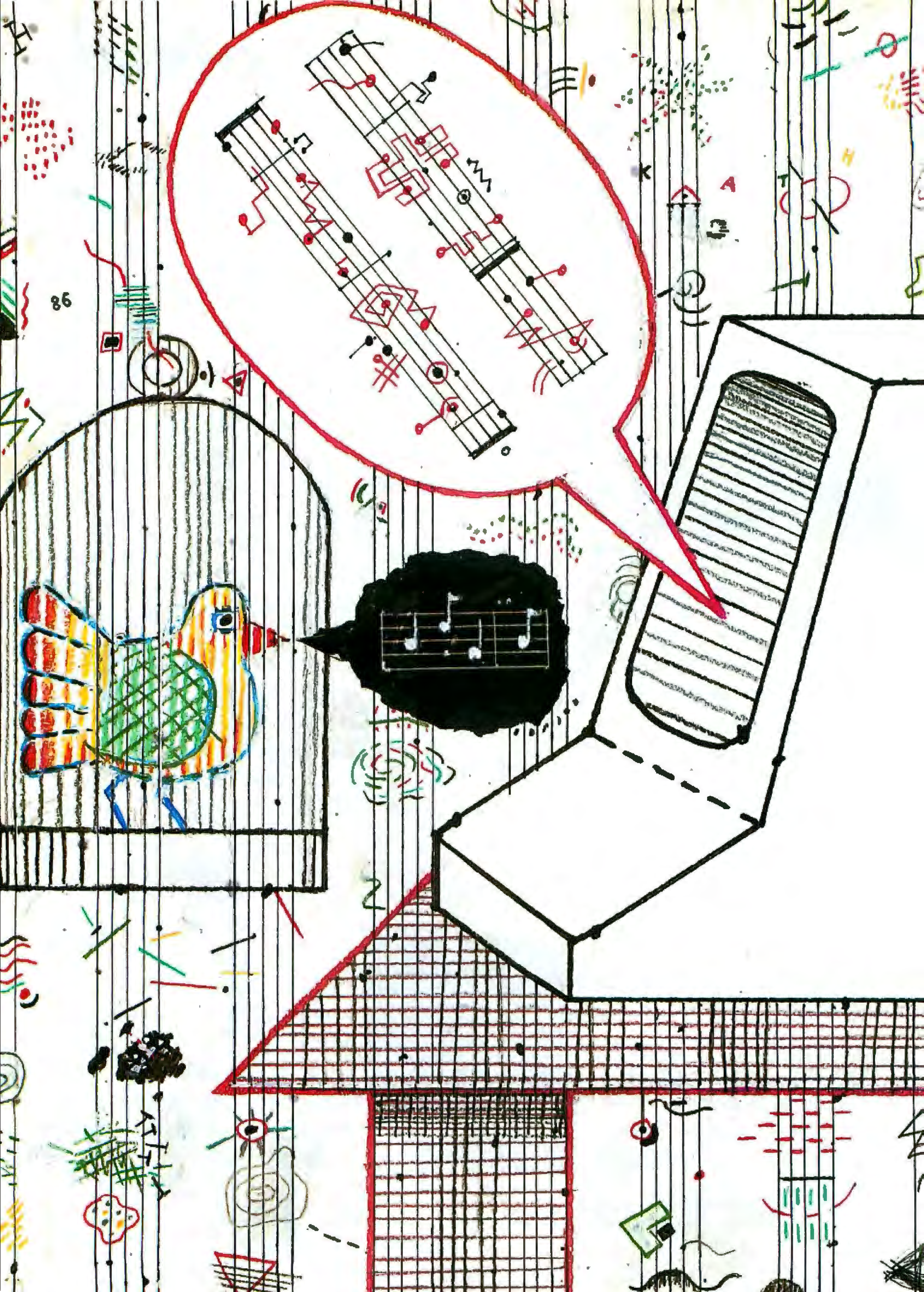

Computers and Music

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THE LAST TIME BYTE PRESENTED a Computers and Music theme issue was back in April 1980. Developments in that area have been so dramatic since then—particularly in the last two years—that we decided a concentrated look at computers and music was long overdue.

Many of our readers are already aware of the growing enthusiasm generated by the MIDI (musical instrument digital interface) specification; new software and MIDI-compatible devices seem to appear daily. However, if you need an introduction to what the infusion of computers into the art of musicmaking is going to mean, refer to our lead article, "The Challenge of Music Software" by Roger Powell.

"Digital Music Synthesis" is an overview of the different techniques currently used by today's popular synthesizers. It is authored by Robert Moog, whose name is synonymous with music synthesizers.

Christopher Yavelow offers more insight into the realm of digital synthesis, in particular, digital sampling on the Macintosh. He even provides us with enticing glimpses of some available sampling software.

Fractals are always turning up in unusual and interesting places in the computer world. We often find them associated with graphics, but Charles Dodge and Curtis Bahn introduce us to another application in "Musical Fractals."

We are particularly happy to present Jay Kubicky's "A MIDI Project." Not only does the author give an overview of the software end of MIDI and include the schematic for an IBM PC MIDI hardware interface, he also throws in multitrack MIDI recording and playback software.

Finally, Don Swearingen returns with a software follow-up to his MIDI recorder article, which appeared in the Fall 1985 special issue *Inside the* IBM PCs. This time, Mr. Swearingen shows us some Turbo Pascal software tools for modifying MIDI data stream information after it has been captured in your computer's memory.

Other related articles in the Reviews section include an excellent review of the Kurzweil 250 by former BYTE editor in chief Chris Morgan and a look at four MIDI interfaces by Roger Powell and myself. Mario Sergio Bernardo reviews the capabilities of two music software packages for the Macintosh, ConcertWare+ and SongPainter. In addition, four books dealing with computers and music are critiqued in this issue's Book Reviews section.

The industry is changing far too rapidly for us to examine every aspect of computers and music, but I would like to take this opportunity to point out Roger Powell's appearance on the masthead as a contributing editor. We are fortunate to have someone with Roger's considerable talents associated with BYTE, and we hope to call on him regularly to provide ongoing coverage of computers and music.

—Richard Grehan, Technical Editor

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THE CHALLENGE OF MUSIC SOFTWARE

BY ROGER POWELL

An overview of the current state of computers in music

THE MID-SIXTIES marked the beginning of an exciting new era in the field of music. At that time, both Dr. Robert Moog at his Trumansburg, New York, laboratory and Dr. Max Mathews at Bell Laboratories in New Jersey were creating electronic tools for the production of music. The Moog Synthesizer, although not the only device of its kind under development at that time, became universally accepted as a valid musical instrument, revolutionizing the electronic sound industry. But the Moog and other analog synthesizers are based on analog building blocks like oscillators, filters, and amplifiers—circuits that may tend to drift out of calibration, especially under environmental stress.

In another camp, Dr. Mathews and his colleagues were exploring the possibilities of digital sound reproduction using a general-purpose computer equipped with a D/A converter. They reasoned that sound could be sampled at regular intervals, much like a motion-picture camera snapping frames of images. The resulting stream of audio data represents a plot of the amplitude over time and can be faithfully "played back" by sending the data back out of the computer through the D/A converter. (This is the principle behind today's compact disk technology.) Of course, the cost and size of computing equipment at that time posed a serious deterrent to the average musician's or composer's desire to use computer techniques in his or her art. And, similarly, the early analog synthesizers were bulky, expensive instruments whose most natural environment seemed to be the university laboratory, a domain not normally frequented by the musically inclined. However, the economic barrier between sophisticated electronic tools and musicians no longer exists in today's world of high-performance personal computers and the new generation of music synthesizers, which now includes MIDI, a communications standard for music.

MIDI represents a formal set of hardware and software rules for sending and receiving musical-event data between computers and synthesizers. Music data such as notes or other performance parameters such as pitch-bending are typically input by the musician using a keyboard synthesizer equipped with a MIDI hardware interface. This MIDI hardware encodes the key depressions and transmits them serially at 31,250 bits per second over the MIDI port. The output of this port may be connected to the input of another MIDI port that is either attached to a computer or another synthesizer. The ability to "slave" remote synthesizers to the movements occurring on a master instrument is reminiscent of the antiphonal design of early pipe

(continued)

Roger Powell (Magnetic Music, POB 328, Rhinebeck, NY 12572) is a professional musician and computer programmer. He has been involved with music synthesis as a consultant for the Moog Synthesizer Company and Bell Laboratories, where he was introduced to computer music. A longstanding member of Todd Rundgren's band Utopia, Roger has also played keyboards for David Bowie and Meat Loaf and has released two solo synthesizer albums, Cosmic Furnace *(Atlantic, 1973) and* Air Pocket *(Bearsville, 1978). Recently, Roger has been producing his own line of MIDI-related software tools for music, including Texture, a 24-track MIDI sequencer for the IBM PC.*

organs found in the world's great cathedrals. The organist, seated at the console, could control distant multitudes of pipe ranks located throughout the building.

If you insert a computer into this network, data from the master instrument can be collected, stored, analyzed, and passed on to other devices. Here it's important to distinguish between musical-event data and sound-sample information. The MIDI standard currently focuses on slower-moving performance data like that which the musician's keyboard movements describe. Musical notes consist of key numbers and times of depression and release updating on the order of seconds and milliseconds. Sound samples, on the other hand, represent a quantification of an analog signal, and the data rate for any degree of high fidelity must approach the order of microseconds. MIDI encodes control signals that may be used to drive external sound-generating devices or fed into music-processing software.

While performing, a musician normally does more than just activate the notes to be heard. Personal inflections may be added by varying the "touch" or velocity with which keys are struck. Other devices on the synthesizer may influence the brilliance of the sound or produce a steady vibrato. All these parameters are defined in the MIDI standard, although not all are implemented in every synthesizer. Continuous controller devices such as pitch-bend and modulation wheels generate large quantities of inflection data. Musicians must use these devices judiciously to avoid clogging the MIDI serial channel or using excessive memory when recording into the computer. Nevertheless, the Japanese and American synthesizer manufacturers who cooperated to design the MIDI specifications were wise to include the ability to "capture" these multiple dimensions of a real-time musical performance as rendered on a MIDI-equipped instrument.

Once the synthesizer, performer, and computer have established a MIDI link, the musical process is open to deeper exploration through software utilities that manipulate musical phrases. Of the many applications programs that are presently offered to musicians, the largest category could be described as "sequencers"—programs that act as tapeless, multitrack recorders allowing you to create layers of sound data one track at a time. Using the virtual tracks established in software, a single musician/composer can build and refine musical structures in the same way that an author uses word-processing software to create literary works. Sequencer programs generally offer a rich set of editing and transformation functions for massaging music data into shape. There are cut-and-paste operations that allow you to move fragments of melody and rhythm around to desired locations earlier or later in the piece, copy functions for repeated phrases.

(continued)

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Most popular music features repetition of a few basic phrases.

transpose utilities for shifting the key signature, and other tools modeled after the text-editing environment. Beyond this, some programs have commands to assist composing using algorithmic methods. This set of tools performs extended manipulations on the phrases stored in memory; melodies may be rotated (end notes of phrase appear at beginning), inverted (high notes become low notes and vice versa), and compressed or expanded (pitch range of melody made narrower or greater). Note and performance streams of several tracks may be merged into one for dense patterns, and phrases may be overlapped with delays for echo effects. Most popular pieces of music feature repetition and variation of a few basic phrases. The task of the composer is to develop these fragments into a seamless whole. By assigning the mechanical work of actually moving and altering the note patterns to the computer, a high degree of spontaneity can be achieved during the creative process.

Music data can be represented graphically in several different ways, each with its own benefits and drawbacks. Common music notation—the normal character set of music symbols that musicians can read—provides a well-proven methodology and is an obvious choice for an operator interface given its large user base. There are roughly 80 symbols that you should know to be able to decipher a musical score. Half of these symbols are used frequently, suggesting that some counterpart of the NAPLPS graphic-communications standard could be adopted for low-level music-graphics applications. The formatting of music data to a video screen seems straightforward until you want to translate real-time performance data into common notation. The problem is that a human cannot play the prescribed notes of a musical score precisely on time or for the exact duration indicated, forcing the computer that is reading the incoming events to make decisions about note values and placement. The process of composing is reversed here (decomposing?) and the software has to make musically appropriate decisions regarding the player's intentions. Dr. Roger Dannenberg of Carnegie-Mellon University has made significant progress in the development of real-time heuristic techniques in this area. He has produced algorithms that actually can follow a musician's performance and continuously ascertain the proper rhythmic context, speeding up and slowing down as a human accompanist might react to the actions of a soloist. This information can also be used to draw a screenful of music notation entered via a MIDI host instrument.

In some applications, common music notation is either unsuitable or unnecessary and is replaced by other display means. Simple list editing of timed events may be sufficient, or you may be presented with a piano-roll-type notation where note events are shown as vertically spaced lines and dashes indicating pitch and duration. This depiction more accurately shows the exact timing relationships between notes and doesn't require familiarity with objects like stems and dotted 32nd notes indigenous to standard notation. Ideally, you would like the ability to switch-select the appropriate view and produce hard copy to match. I suspect that future software will support such options.

In a professional or semiprofessional studio environment, it is often necessary to synchronize the playback of tape machines and computer sequencers to run in tandem. The motion-picture industry has been synchronizing sound to film for years and has developed a time-code protocol called SMPTE (Society of Motion Picture and Television Engineers) specifically to assist that procedure. Unlike simple FSK (frequency-shift keyed) sync signals used to drive sequencer devices from tape, each block of SMPTE signal bits contains a unique time stamp to facilitate precise location for sound or film editing. In a sound lab, one track of a multitrack tape will be "striped" with SMPTE code for the length of the musical selection. Although MIDI does not recognize SMPTE directly, any time code may easily be translated into a MIDI-format message (the song position pointer) that the software may use to find a point in the score data. Several companies now manufacture units to read SMPTE and generate the MIDI location data. By using only a single track of tape, a computer sequencer can be "clocked" and made to send its data to an ensemble of synthesizers, freeing the other tape tracks for sounds that must be recorded through microphones (vocals, guitars, flutes, etc.). Instruments can be played by the computer as the final master tape is created (mixdown) preventing the loss of fidelity caused by analog-tape limitations.

MIDI has become useful in other applications in the sound and entertainment industry. MIDI control has been built into mixing consoles for automating computer-controlled mixdowns. A special MIDI interface can control stage lighting, both spotlight and laser-oriented. The growth in the use of MIDI-controlled equipment has also made it clear that the MIDI standard needs to be developed further to accommodate the things imaginative people have envisioned for it. Bandwidth will have to be increased or multiport interfaces will have to be designed to overcome the bottleneck that occurs at 31,250 bps when many devices are interconnected. Data delays are noticeable in large systems, especially when devices are "thru"-connected (chained). Several manufacturers produce MIDI data-distribution boxes to help eliminate this particular problem.

You may have the impression that MIDI is useful only to those with access to keyboard-controlled synthesizers, but, in fact, there exists a device that can track the sounds made by acoustic instruments (including the human voice) and produce MIDI data signals. By using such a pitch-to-MIDI converter, instrumentalists or vocalists can access electronic music tools without having to

(continued)

learn keyboard techniques. The act of playing or singing into the converter causes standard MIDI signals to be generated and sent to a receiving MIDI port on a synthesizer or computer. A flutist, for example, may control a bass-guitar sound on a synthesizer. The educational paths opened by the pitch-to-MIDI converter include intonation training, sight-reading drills, music theory, and tutoring of instrumental techniques—in short, the learning of any traditional instrument can be enhanced to make the process more enjoyable and effective.

The history of MIDI software development can be compared to that of business software. During the early period, business software consisted of a host of stand-alone programs, each fulfilling a particular task such as word processing or telephone communications. Later, integrated packages were produced that combined the most useful programs into one. MIDI software is currently undergoing the transition from a plethora of stand-alone products to integrated programs that combine the features of sequencing, notation, and synthesizer voice librarians. As in the business world, not everyone will be drawn to an integrated package—some may prefer to use a collection of favorite single-job programs installed into a desktop or workbench environment. In any case, the issues of music data structures and file compatibility gain more and more importance as the industry evolves. At this time, unfortunately, the musical-score data produced by most programs cannot be shared by other programs, a factor that limits the usefulness of the data generated. Imagine the consequences if there were no accepted standard format for ASCII text files! Of course, music files are far more complex than simple text files and a standard is more difficult to design, although not impossible. Getting software developers to agree on a proposed standard is another matter.

The chief focal point of computer software up to now has been the visual aspect. With computer hardware designers and manufacturers now realizing the advantages of combining sound and visuals, you can expect more emphasis on this previously overlooked asset in the form of more sophisticated internal sound generation for personal computers.

For example, software that allows creation of animated musical storyboards is already available for Commodore's Amiga computer. These storyboards may be used in designing motion-picture scenarios or actually producing complete video animation segments accompanied by a professional-quality sound track.

There is little doubt about the stimulating effect that MIDI has had on the electronic music field; activity among manufacturers and consumer musicians is at an all-time high. It's hard to stay abreast of the new developments in MIDI hardware and software occurring every few months. The ultimate beneficiary of this technological onslaught is the average person who has always wanted to experiment with music but felt there were too many financial and psychological obstacles. By increasing the productivity of professionals, the developers of music software have also provided affordable, comprehensible tools for the amateur. Flexible software can extend the useful life of musical equipment by allowing older gear to be used with newer instruments. A user can realistically plan to build a system piece by piece over a period of time and not be forced to discard last year's model because it can't talk to the newcomers. For these promises to be fulfilled, awareness of what's available and what it can do must increase among the targeted end users. This awareness must then grow into a two-way communications channel between the developers of software and the artists who use it. The realm of music is no longer off-limits to anyone with a personal computer. ■

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DIGITAL MUSIC SYNTHESIS

BY ROBERT A. MOOG

The many different shapes of the waveform of the present

MUSIC IS ONE of the most information-rich (wide-bandwidth) forms of human communication. A compact disk, for instance, uses nearly 1.5 megabits per second to faithfully transmit a stereo recording, as opposed to the several hundred bits per second needed to transmit a written message as fast as you can read it. Only video, the faithful transmission of which requires over 50 megabits per second, has a significantly higher information density.

Music is also a highly structured form of human communication. The hierarchy of a piece of music may be as deep as that of the federal bureaucracy: Notes, phrases, lines, sections, and movements are carefully arranged to heighten and clarify the intent of the music.

These two general properties of music, wide bandwidth and complex structure, happen to match the information-handling capabilities of today's personal computers. In addition to the personal computer's wide bandwidth (or high speed) and information-organizing and -processing capabilities, you can access a growing list of instruments, accessories, and components designed specifically to produce musical tones in response to high-level digital instructions. These devices owe their existence to rock 'n' roll, the consumerization of digital audio, and dramatic advances in LSI (large-scale integration). They employ a wide variety of sound-producing techniques, each with its own set of features and limitations. This article discusses the general attributes of musical sound and how to produce it, the capabilities of specific sound synthesis techniques, how musicians are using these techniques, and what you can expect the future to bring to digital music.

THE PROPERTIES OF MUSICAL SOUND

Music is an arrangement in time (and, to a lesser but still important extent, in space) of a collection of sonic events generally called notes. This is actually a subjective description of music. We hear individual notes only because our ears and mind pick acoustic information apart into events that we perceive to be distinct. What actually exists outside our ears is an ongoing series of vibrations of the air. The graph of air pressure versus time is the waveform, an unbroken pattern, present even in the quietest of soundproof rooms. The ratio between the height of a sound waveform that you can barely hear and one that is so loud that it begins to hurt is about one to a million. That's about 120 decibels. Music, speech, and other normal sounds occur in the upper 60 dB of your hearing range.

You can describe any waveform that tends to repeat as a collection of frequency components, each one of which has a sine waveform. This is the spectrum of a sound.

Thus, any sound has two complementary, equivalent representations: its waveform and its spectrum. The waveform is the sound's time-domain representation; the spectrum is its frequency-domain representation. Together they are capable of fully describing a sound. The relation of the waveform to the spectrum is

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described by a mathematical relationship called the Fourier theorem.

The waveform of a very simple sound—for example, a tone from a laboratory audio oscillator—does not change with time. Real musical sounds, however, are never steady. They constantly change as they evolve. Piano tones, for instance, begin loud and bright and then decay to silence in a complex way that's characteristic of the instrument. These variations are essential determinants of the sound's characteristic tone color. They are neither entirely random nor entirely regular, nor are they undesirable deviations from a perfectly steady tone.

In the early days of musical acoustics, the importance of the details of a tone's evolution was not generally recognized. Acoustics textbooks often showed a single cycle of a waveform and labeled it violin or oboe. Musical-instrument engineers now recognize that, in determining a sound's tone quality, or timbre, the steady-state waveform takes a back seat to the parameters that describe how sound changes as it evolves. For this reason, many synthesis techniques are important primarily because they allow important parameters of the generated sounds to be precisely and continuously varied. The exact shapes of the sound-parameter variations may be generated explicitly by a musician's real-time control or may be determined by a set of function generators that are connected to, but separate from, the sound-waveform generator itself.

Figure 1 illustrates this notion. The rightmost block indicates the audio-waveform generator, which produces the audio waveform itself. It may, for instance, be an analog synthesizer module, a hard-wired digital oscillator, or a waveform-generating routine run by a microprocessor. The block to its left represents the control-function generators, a set of time-varying function generators whose outputs continuously control the properties of the audio waveform. In general, the control functions are simpler and more slowly moving than the sound waveform and are often (but not always) produced by software routines.

The leftmost box on the bottom, representing coefficients and boundary conditions, produces the commands that specify the shapes of the control functions. Generally (but not always) these commands are a brief set of time-invariant numbers that provide the initial boundary conditions and coefficients of the control functions. Finally, the box on the top, real-time control, represents time-varying functions of arbitrary shape, such as those that a musician may wish to impart by hand. Real-time control may change the coefficients of the control functions or may be added to the control functions themselves to directly modify the sound waveform.

Figure 2 shows one specific example of this type of control hierarchy. The waveform generator is an analog

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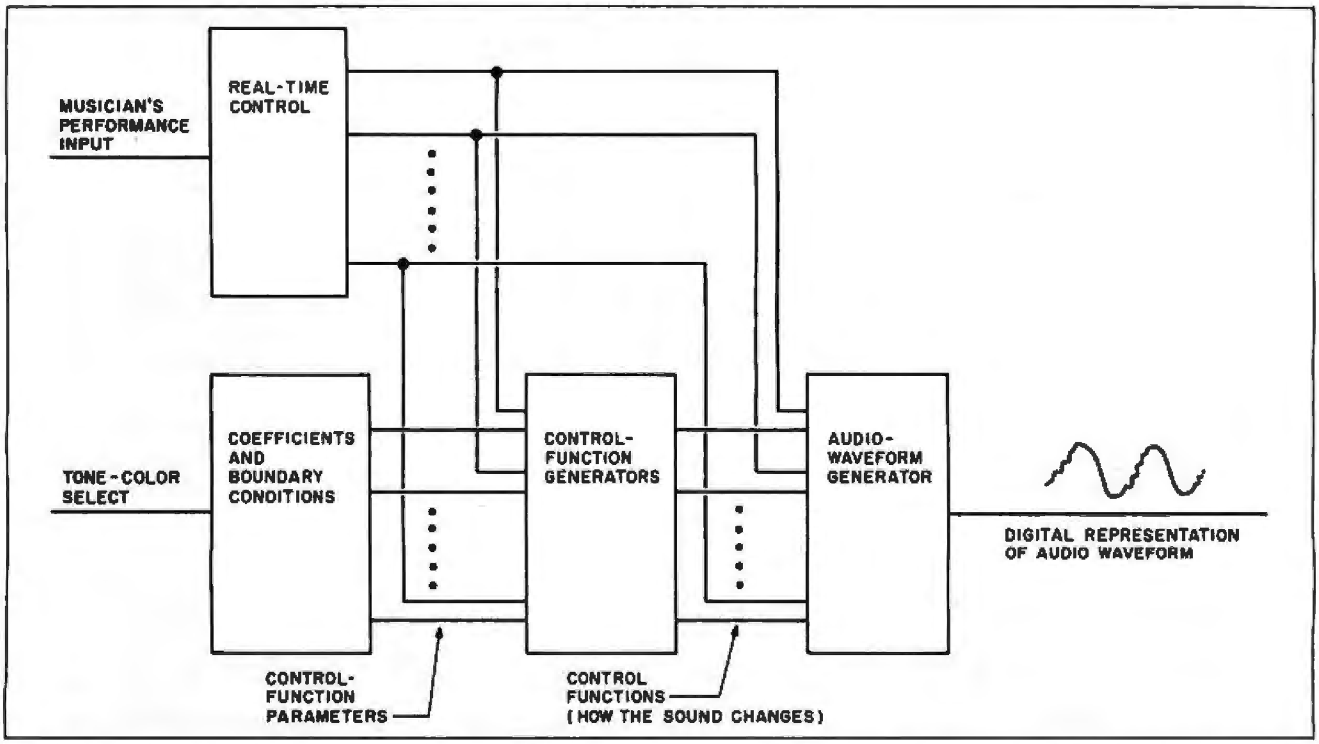

Figure 1: *Control hierarchy of a typical sound synthesis system. The audio-waveform generator produces an evolving waveform in response to a set of slowly varying control functions. The control-function generator produces control functions in response to a set of numerical coefficients and boundary conditions. The real-time control module allows the musician to shape continuous changes, either in the waveform itself or in the control-function parameters. The coefficients and boundary-conditions module defines the perceived tone color, while the real-time control module enables the musician to "play" the system.*

voltage-controlled oscillator (VCO) coupled to a voltage-controlled amplifier (VCA). Control functions consist of a low-frequency oscillator (LFO), two exponential rise-and-fall—or envelope (ENV)—generators, and slowly varying functions that control another VCA. The tone setup is a "tone-color preset" whose numbers give the time constants of the envelopes and the frequency of the LFO output. The real-time control is a keyboard controller whose outputs give the VCO's center frequency (musical pitch) and provide the trigger that starts the ENVs. The resultant tone has a frequency modulation (vibrato) that builds up at the rise time of the first ENV output; the tone itself builds up at the rise time of the second ENV output.

Digitally Controlled Analog Circuitry

The first synthesizers were analog. In analog synthesizers, VCOs produce waveshapes such as sawtooth and square because they are easy to produce and are rich in harmonics—spectrum components whose frequencies are whole-number multiples of the waveform's repetition frequency. One or more VCFs (voltage-controlled filters) alter the relative strengths of the harmonics, thereby modifying the overall brightness or quality of the sound. VCAs dynamically shape the amplitude of the tone as well as the amplitudes of control signals. The resultant class of tone colors from analog synthesis includes some interesting approximations of traditional instrumental sounds. More commercially important, however, were new sounds that fit into the emerging electronic pop music of the sixties and seventies. Smooth pitch glides of swept VCOs, the vocal-like "wow" sounds of swept VCFs, and the fat, rolling sound of several sawtooth waveforms at nearly the same frequency became basic weapons in the rock 'n' roll keyboardist's arsenal.

Microprocessor-controlled analog synthesizers first appeared commercially just eight years ago and continue to be popular today. The Oberheim Xpander, for example, is an advanced six-voice instrument with its own self-contained microprocessor-based programming panel (see photo 1). The Xpander is specifically designed for sophisticated communication with the outside world through MIDI. In fact, you can activate virtually all of the Xpander's panel features externally through Oberheim's MIDI system-exclusive code set. The panel features provide complete control over 15 analog operating parameters per voice (one of which is a 15-position filter-mode selector), as well as literally hundreds of microprocessor-computed control functions. Thus, although the actual generation and modification of the Xpander's musical tones are performed by analog circuitry, the amount of control that is accessible via MIDI gives this instrument (and many other contemporary analog synthesizers as well) the same order of programmability and versatility as many all-digital synthesizers.

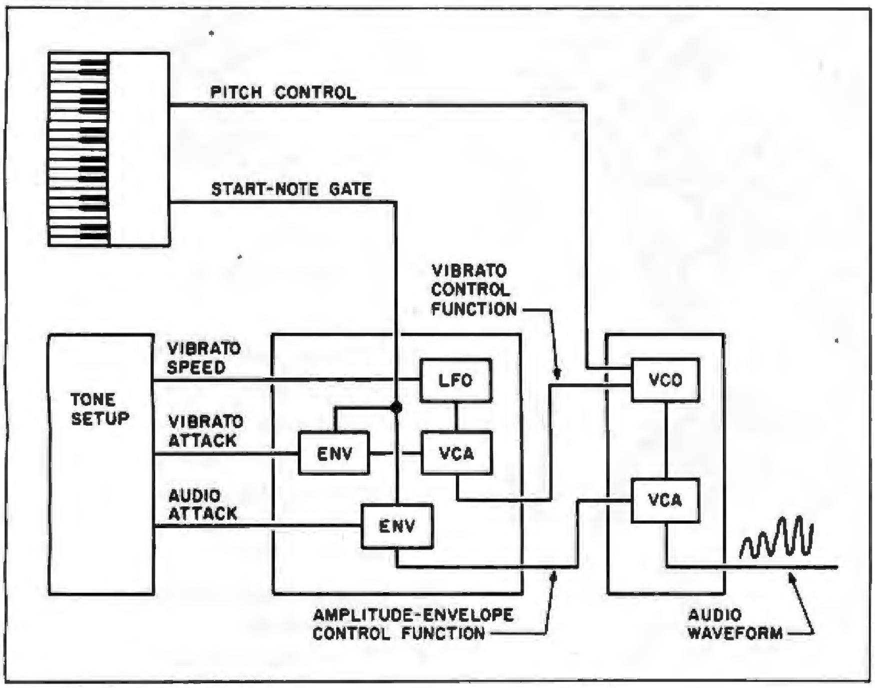

Figure 2: *A simple analog-synthesis control hierarchy. The audio waveform is produced by a voltage-controlled oscillator (VCO) followed by a voltage-controlled amplifier (VCA). There are three control functions: a number from the keyboard that tells which key is pressed (which pitch to produce), a slow periodic wave that builds in amplitude to provide delayed vibrato, and an amplitude-shaping envelope (ENV) function. The tone setup provides values for vibrato speed, rate of vibrato buildup, and rate of audio-tone buildup. A gate signal that goes on when a keyboard key is pressed starts the two ENV function generators.*

Phase Distortion: The Casio CZ Series

About three years ago, Casio introduced the CZ-101, the first in its line of fully digital, fully programmable synthesizers (see photo 2). It is a four-voice multitimbral instrument that has some similarity to analog synthesizers, both in the way it is programmed and in the sorts of sounds that result.

Like analog sound chains, the CZ algorithm has one parameter that determines the tone's pitch, a second that determines its brightness or tone color, and a third that determines its overall loudness. The main difference between the CZ and analog synthesizers lies in exactly *how* the tone's brightness is shaped. In the analog world, the VCF performs brightness control. Analog filtering is a frequency-domain operation, which, in analog technology, is no harder than time-domain operations.

The digital world, however, generally avoids frequency-domain operations because of the expensive hardware required to perform the many high-precision multiplications per waveform point. The time-domain operation of waveshaping, on the other hand, can achieve the same sort of spectral variation as dynamic filtering with little or no multiplication. Casio engineers designed their algorithm to produce waveforms whose shapes can be swept continuously from pure sine to one of eight user-selectable high-brightness "analog sound-alikes." The algorithm centers around a lookup table in which the instantaneous amplitude of a cycle of a sine wave is plotted against uniform increments of the sine wave's phase angle. When a pure sine-wave output is desired, the phase angle is advanced in equal increments per unit time; when a waveform of higher harmonic content (i.e., a somewhat distorted sine wave) is desired, the phase angle is incremented first more rapidly, then more slowly, during each cycle. Figures 3a and 3b show how the resultant waveform changes as the rate at which the phase angle changes is modulated during a single cycle. Casio calls this algorithm PD, for phase distortion.

By using the concepts of analog synthesis as a starting point but employing an algorithm that is efficiently matched to the capabilities of digital technology, the Casio CZ series instruments offer the musician many stock synthesizer effects, with the versatility and accuracy of control that you associate with any well-designed microprocessor-based operating system, at a low price. The CZ-101, for instance, sells for less than $500, an amount that, just 10 years ago, would barely have bought a medical minimum analog synthesizer with one voice and no program memory.

FM Synthesis: The Yamaha DX Series

Frequency modulation (FM) is the variation of the frequency of one repeating waveform, the carrier, by an amount proportional to the instantaneous amplitude of a second waveform, the modulating wave. The simplest application of FM is the modulation of one sine wave with another.

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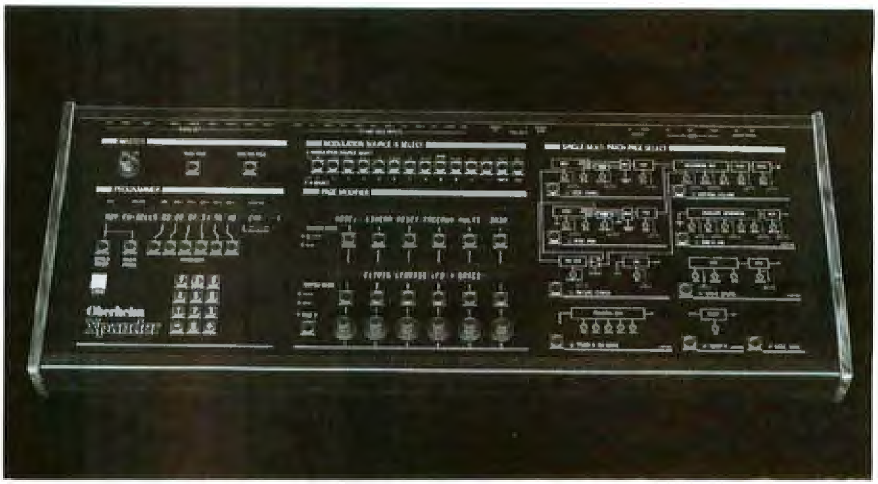

Photo 1: *The Oberheim Xpander microprocessor-controlled analog synthesizer.*

Photo 2: *The Casio CZ-101 phase-distortion, programmable digital synthesizer.*

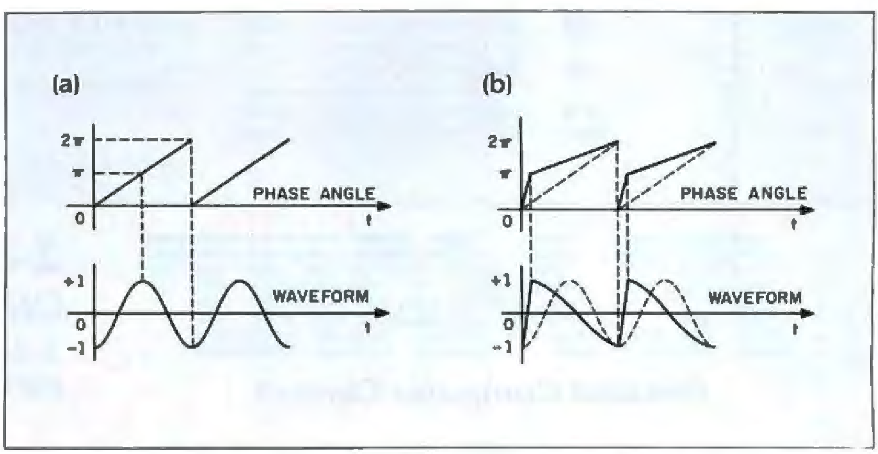

Figure 3: *Changing an audio waveform by varying the rate at which a sine lookup table is read out; (a) shows a constant rate of readout, while (b) shows a readout whose rate changes twice per cycle, distorting the sine wave into a sawtooth waveform.*

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The mathematical expression that describes this is $W(t) = P \sin (At + I \sin Bt)$. This equation tells us that waveform W is a sine wave of peak amplitude P and frequency A and is being sped up and slowed down a peak amount I at a frequency B. A is the carrier frequency, B is the modulating frequency, and I is called the modulation index.

The spectrum of W is a series of sidebands, or sum and difference frequencies: $A \pm B$; $A \pm 2B$, $A \pm 3B$, and so on. Calculation of the amplitudes of each of the sidebands requires an understanding of Bessel functions, which are mathematical functions describing how the amplitude of a harmonic changes. This is a complex subject in itself. The general results of these calculations, however, can be stated simply.

1. As I increases, the amount of energy in A goes down, and the amount of energy in the sidebands goes up.
2. As I increases, more and more frequencies become audible. In other words, the bandwidth of the total spectrum of W increases.

If you set the modulating frequency B equal to the carrier frequency A, the sideband frequencies are then whole-number multiples, or harmonics, of the carrier frequency. Starting with two sine-wave generators and tying the instantaneous frequency of one to the instantaneous amplitude of the other, you can generate a single complex tone with a large number of harmonics. Furthermore, you can change the overall harmonic content of the tone simply by varying one parameter, the modulation index I. By invoking this simple algorithm that operates in the time domain, you gain convenient control over the sound's spectrum.

The Casio PD algorithm uses time-domain processing to generate and control harmonics too. But the advantages of FM over PD lie in what you can do in FM by changing the ratio between the carrier and modulating frequencies.

Most acoustically generated musical sounds have a complex internal motion that makes them interesting and pleasant to listen to. An important part of this motion is due to the slight deviations in the frequencies of the harmonics from "perfect" whole-number ratios with the fundamental pitch. For instance, the harmonics of a piano tone are all slightly sharp (high). Translated into the time domain, this means that a piano waveform does repeat exactly every cycle but changes slowly and continuously as the tone evolves. The ability to detune the harmonics by slightly shifting the modulating frequency gives FM the ability to generate a wide variety of continuously changing waveforms that musicians often describe as warm, fat, or acoustic. Serious synthesists prize this capability and spend a lot of time exploiting it.

(continued)

The advantages of FM were understood by analog-synthesizer designers, but the analog technology of the sixties and seventies did not permit accurate, wide-range, and efficient production of FM waveforms. John Chowning was one of the first people to experiment with digital production of FM sounds. Using a research computer at Stanford University in the early seventies, he systematically explored the relationships between the values of the coefficients of the FM algorithm (*A*, *B*, and *I*) and the resultant tone colors. His work led to the development of a series of commercial keyboard instruments by Yamaha, the latest of which are the DX and TX series digital synthesizers. One of these, the Yamaha DX-7, has become enormously popular among electronic keyboardists; well over 100,000 DX-7s reportedly have been sold.

In the DX-7, the basic algorithmic element is a digital oscillator whose output is shaped by a four-segment envelope. Yamaha calls this element an "operator." Six operators are available for each voice; the complete instrument can simultaneously produce up to 16 voices. The musician may choose one of 32 preprogrammed algorithms, which are configurations of operators. Figure 4a shows what an operator is; figure 4b is an example of a simple algorithm; and figure 4c is an example of a more complex algorithm.

HARMONIC SYNTHESIS

The most powerful of all synthesis techniques, and the least amenable to intuitive exploration, is harmonic synthesis. This is where the musician explicitly specifies the amplitude envelope and frequency of each harmonic of the tone. In theory, harmonic synthesis is the only way to accurately synthesize arbitrarily complex, pitched tones. In order to do it, however, you have to specify as many as 100 or more harmonic amplitude envelopes for every tone color.

In the mid-seventies, Dr. Hal Alles of Bell Laboratories developed a sophisticated music system based on harmonic synthesis. The harmonics were generated by incrementing through a high-precision sine-wave lookup table at different rates. The problem became how to shape the amplitudes of all those harmonics without spending a fortune on high-speed multipliers. Alles's solution was ingenious: For every harmonic, read out two sine waves that are of the same frequency but displaced by a slowly varying phase angle. Subtract one from the other. The result is a sine wave whose amplitude is determined by the phase angle.

Alles's design eventually entered the marketplace as the computer-based General Development System and later as the Synergy, a keyboard synthesizer with limited internal programming capability but with a computer interface that provides full programming access (see photo 3). Few people ever met the programming challenge of these instruments. One person who did is Wendy Carlos, perhaps best known as the producer

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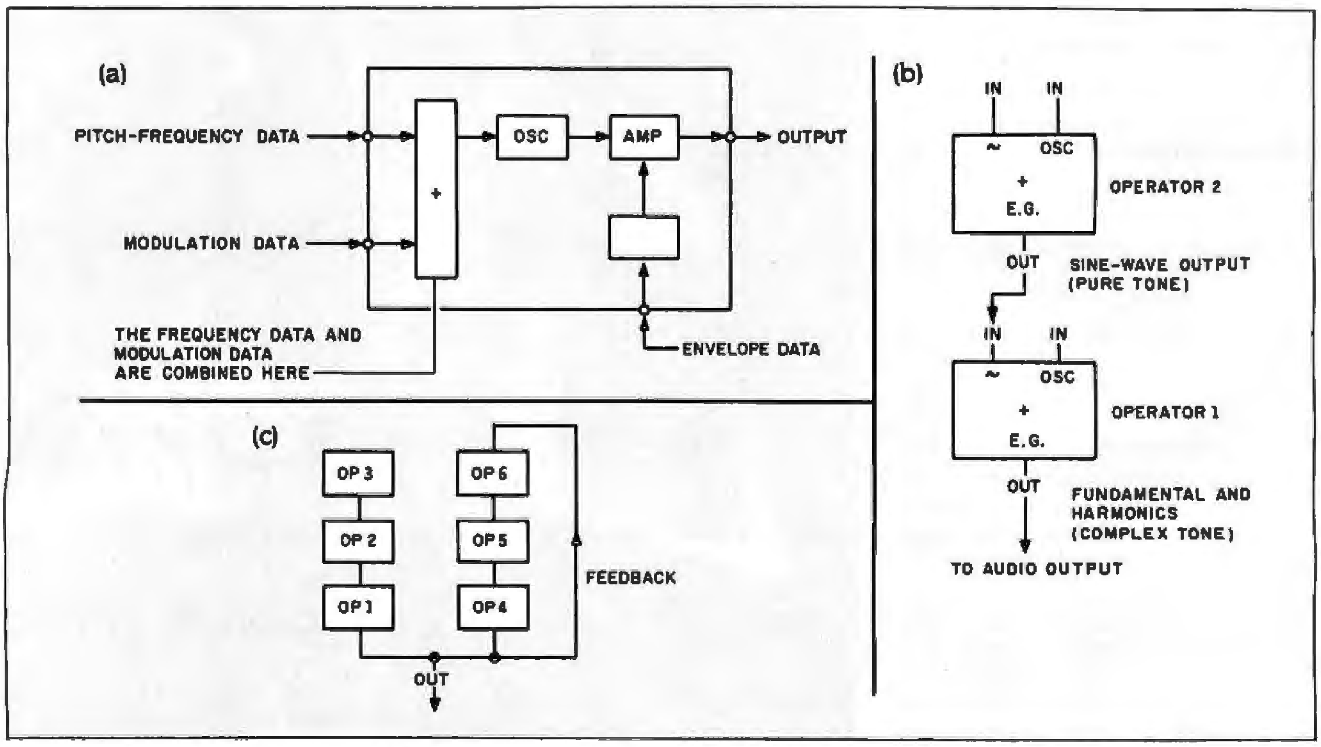

Figure 4: FM *waveform-generating building blocks used in Yamaha* DX *and* TX *instruments: (a) shows the basic "operator," which you can think of in analog terms as containing a control-summing circuit, oscillator, amplifier, and envelope generator; (b) diagrams a simple* FM *algorithm in which one operator modulates the frequency for another; (c) contains a more complex* FM *algorithm using six operators.*

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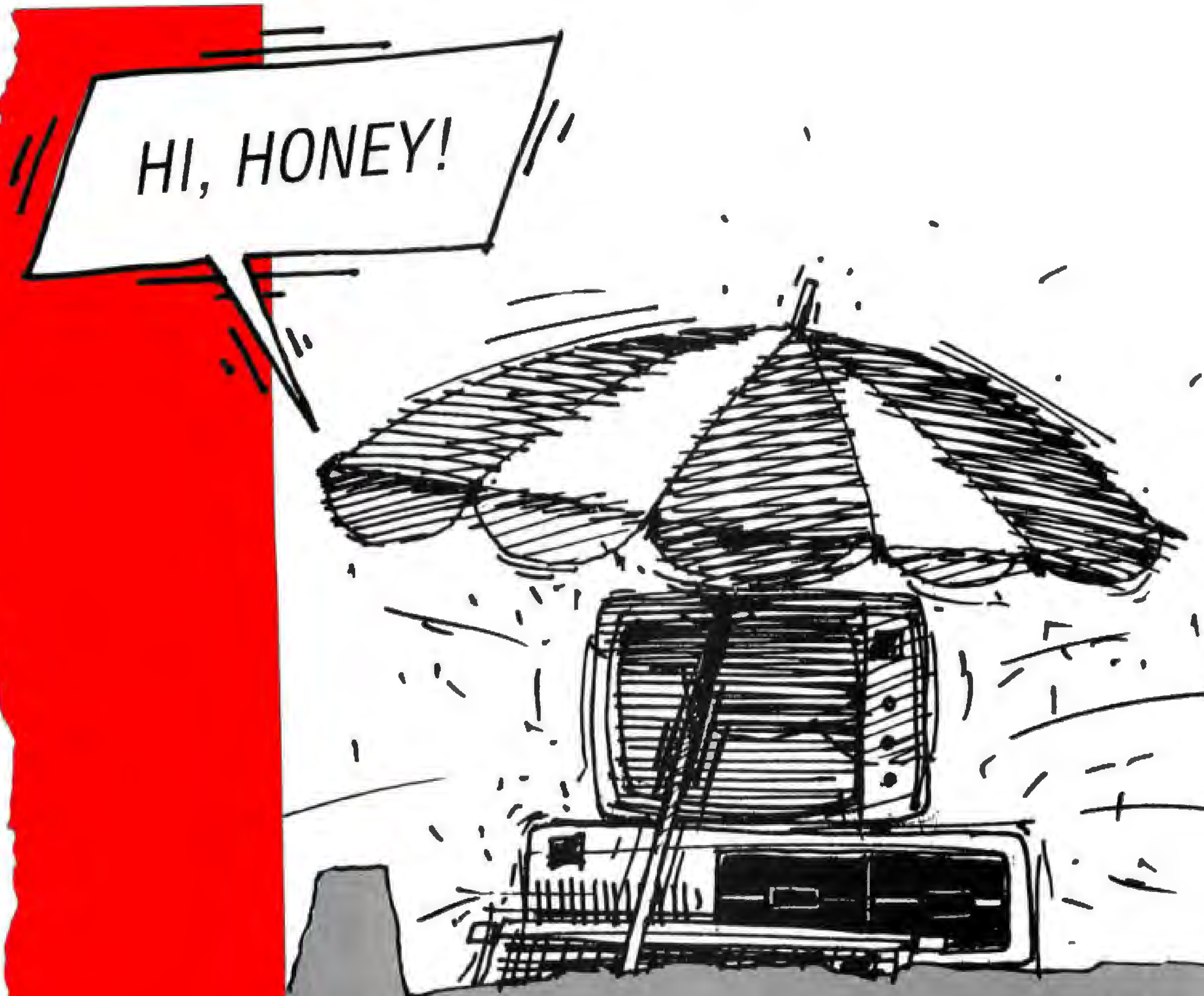
HI, HONEY!

of *Switched-on Bach*. A few years ago, Wendy combined her programming skills with unique musical intuition to develop a set of orchestral-like tone colors for the Synergy. She spent some 3000 hours over a two-year period to develop the sounds, which have been made available to Synergy owners. These sounds can be heard on Carlos's record *Digital Moonscapes* (the compact disk is Columbia MK 39340).

More recently, harmonic synthesis is being used in commercially available musical instruments whose sounds are preprogrammed by the manufacturer. One example is the Kurzweil 150, a MIDI-controlled expander that produces high-quality piano and similarly complex sounds by using proprietary synthesis techniques in addition to harmonic synthesis. Another recently announced product along the same lines is the Roland MKS-20. Both instruments provide the musician with access to a few global sound parameters but not to the fine details of the envelopes of the individual harmonics, which are factory-programmed.

SAMPLING INSTRUMENTS

A sampling instrument records, encodes, and stores one or more musical sounds from the external "real world" and then replays those sounds on command. Some sampling instruments—for example, the Kurzweil 250 (see photo 4 and "The Kurzweil 250 Digital Synthesizer" by Christopher Morgan on page 279)—use proprietary data-compression schemes to reduce the amount of waveform memory without degrading the quality of the sound. All, however, produce their sounds from completely general digital representations that allow any sound short enough to fit in the instrument's memory to be played back. The differences among the various sampling instruments lie in the sound quality an instrument's hardware is capable of and in the sound modification and manipulation algorithms it can perform.

Some musicians assert that sampling instruments are not really synthesizers because the waveforms are not generated by algorithms. I don't believe that algorithmic generation of waveforms is a necessary feature of synthesizers. The term synthesize means "to produce by combining separate elements." The more sophisticated sampling instruments enable the musician to mix waveforms, reverse their direction in time, displace them both in time and in frequency, and impart slow frequency modulation and complex envelopes. All of these are perceived as "separate elements" that the musician combines at his or her discretion. Ergo, sampling instruments are definitely synthesizers.

CHIP-LEVEL SYNTHESIS HARDWARE

There are also some music synthesis chips available if you would like to experiment with high-quality music synthesis but would rather build it yourself.

Complete high-performance analog functional modules exist as single chips that require a minimum of sup-

(continued)

Photo 3: *Wendy Carlos, in her studio, illustrating the Synergy, Hal Alles's harmonic-synthesis synthesizer.* (*Photo by Vernon L. Smith.*)

Photo 4: *The Kurzweil 250 sampling synthesizer, which includes an optional user-sampling program.*

port circuitry. Voltage-controlled oscillators, filters, and amplifiers, and an assortment of other musical functions, are available from Curtis Electromusic and Solid State Microtechnology. You program these chips with analog-control voltages, so you will need a high-resolution (at least 12-bit) multichannel D/A converter to go between your computer and the chips. The chip outputs are high-quality audio.

In the class of digitally controlled synthesis chips, there are programmable waveform generators that accept high-level mode-select and frequency commands and deliver waveform points in real time. The Cybernetic MicroSystems CY360, for instance, generates all the stock synthesizer waveforms, and much more, over the audio and subaudio frequency range.

If you'd like to try your hand at some sampling hardware, consider the Oki MSM 5218 real-time data-compression/expansion chip. Used with a conventional audio A/D converter and a modest amount of support circuitry, this chip reduces a 12-bit data stream (representing the uncompressed audio waveform) into a 3- or 4-bit data stream for efficient storage in your computer's memory and then restores the audio to its 12-bit glory upon playback.

There are many more chips that fulfill music synthesis functions. Many are proprietary designs that are used in commercial products. Generally, neither the applications data nor the chips are available to experimenters. For those of you who enjoy reverse-engineering custom LSI, that's an irresistible challenge.

SOFTWARE MUSIC SYNTHESIS ALGORITHMS

Most music synthesis devices use dedicated high-speed hardware to produce sound waveforms in real time. If you are interested in synthesizing music off-line at slower than real time, you need little more than a personal computer with plenty of memory and a high-quality D/A converter to turn the computer's waveform data into audio. This is where synthesis programs come into play.

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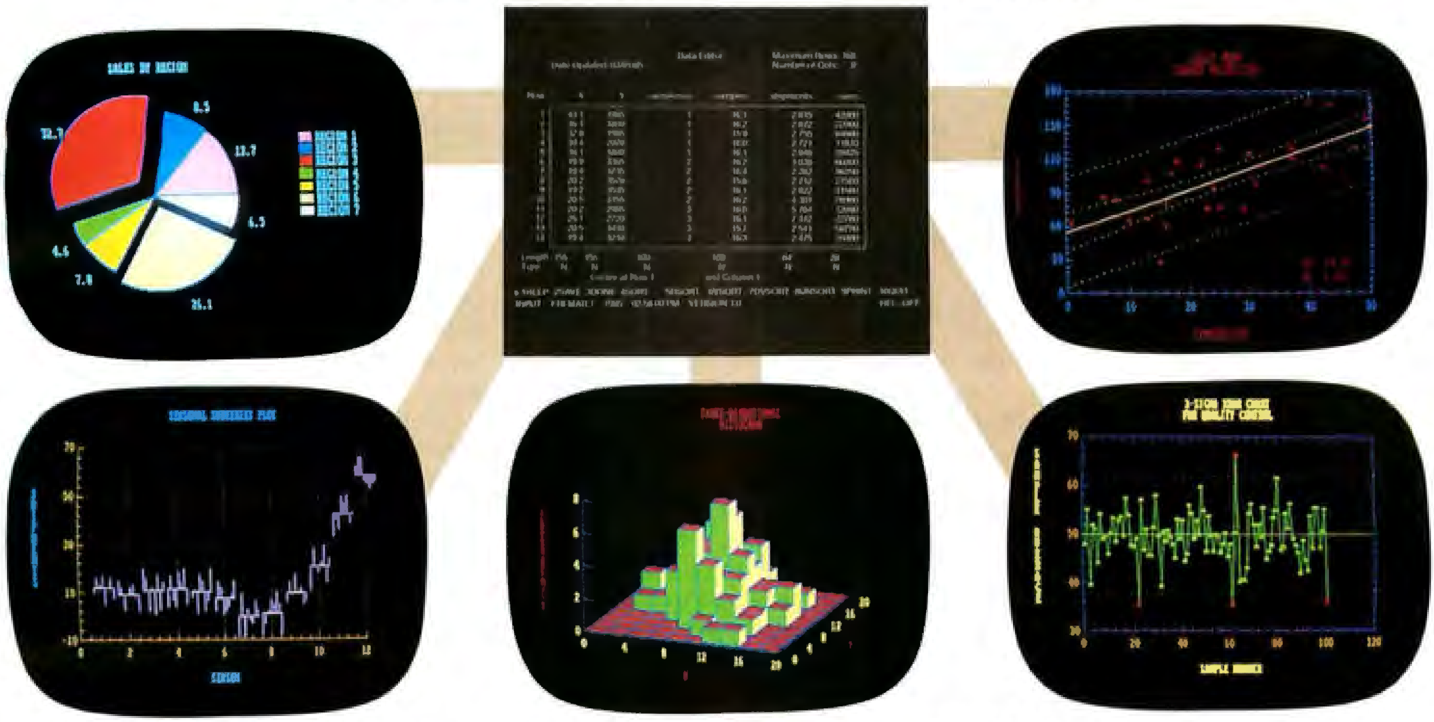

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Pressure-sensitive keyboards will allow keyboardists to control every note expressively.

Vosim, which stands for voice simulation, is a program that assembles waveforms from single sine cycles to create a wide variety of vocal-like tones. You specify three slowly varying control parameters: the number of sine cycles per waveform cycle, the time spacing between the sine cycles, and the rate at which the sine cycles die out within a single waveform cycle.

The Karplus-Strong algorithm provides an easy way of synthesizing sounds that evolve from bright to muted, like a plucked string. You start with a wave table of a single waveform cycle, then read the numbers out to create the sound. As you take a number from the table, you replace it with an average of that number and the one that was pulled out before it. This smooths out the sound waveform as it evolves, thereby reducing the high-frequency content of the sound.

FM produces a waveform by varying the rate at which numbers from a sine-wave table are read out. A wave table is a one-dimensional array. If you used a two-dimensional array of numbers instead and superimposed a closed, or almost closed, curve on that array, you could read numbers from it by following the curve. By changing the shape, size, and position of the curve, you change the resulting waveform. This is called "synthesis by functions of two variables." This is a wide-open area for exploration and would certainly yield sounds that we haven't heard yet.

Trends for the Future

As semiconductor memory prices continue to drop, it becomes feasible to increase the amount of memory devoted to waveform storage in sampling synthesizers and control-function storage in harmonic synthesis instruments. In both cases, the achievable sound quality improves.

Along with semiconductor memory, bulk data storage prices are dropping dramatically. In particular, the storage capacity of CD-ROMs (over 500 megabytes) allows instrument manufacturers to supply enormous sound libraries for any digital synthesizer, but especially for sampling synthesizers. In the near future, we can expect CD-ROMs to be common components in many types of synthesizers.

As the synthesis capability and sound quality of synthesizers continue to grow and the hardware goes down in price while traditional acoustic instruments continue to go up in price, microprocessor-based musical instruments will assume an increasingly larger role in our everyday music making. The next few years will see wide acceptance of home synthesizers, complete with authentic simulations of traditional tones, user-friendly operating systems, and provision for computer interfacing through MIDI.

More and more musicians of all persuasions will come to regard computers as basic music-production tools. Music will be composed directly on the monitor screen, and publication-quality scores will be generated on a laser printer.

Finally, the proliferation of high-performance, 16-bit microprocessors enables musical-instrument designers to build in sensitive, real-time performance control. More and more keyboards will be pressure-sensitive, allowing keyboardists to control every note expressively. And, as musicians accept the idea of pressure-sensitive keyboards, adventurous experimenters will design and build multidimensional user interfaces, allowing musicians to control several tone parameters with each finger. An example of this potential exists today in the Notebender (see photo 5), a keyboard on which each key moves up and down *and* back and forth, thus allowing the player to continuously control two parameters of each key that he or she plays.

The popular attitude is that there is something subhuman and mechanical about digital electronics. Today's musicians know that just the reverse is true—that the fantastic capabilities of microprocessors and synthesizers, and all the devices they connect to, offer musicians new and exciting resources, greater human control, and heightened creative potential. ■

Photo 5: *The Key Concepts Notebender keyboard with two axes of touch sensitivity.* (*Photo by Jonathan Goell.*)

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DIGITAL SAMPLING ON THE APPLE MACINTOSH

BY CHRISTOPHER YAVELOW

Uses of digital sampling for music applications

THE APPLE MACINTOSH is widely accepted as the best microcomputer for musical applications. If sheer numbers of software and hardware products alone are taken into consideration, the past year's nearly four dozen releases would provide ample evidence that this micro is the computer of choice for developers of musicware. Contributing to this fact are the Mac's high-resolution screen graphics, extra-friendly user interface, 32-bit MC68000 microprocessor running at 8 MHz, functional internal synthesizer, and portability.

Microcomputers are used to control sound that they produce themselves or to control other sound-generating devices. In either case, microprocessors are used with oscillators to create sounds for musical use. Sound can be created through additive or subtractive synthesis, FM synthesis, and waveshaping. Digital sampling and wave-table lookup are two similar techniques (see reference 1). In addition, analog oscillators can be placed under digital control and digital oscillators can be operated through analog control.

Both sound generation and sound control may play a role in computer music applications, of which there are five fundamental categories:

1. Score editing: to copy and edit musical scores for eventual printed output.
2. Performance: providing control of an external sound-generating device.
3. Sound laboratory: as a sound-generating/editing/analyzing device.
4. Composition/CAC (computer-aided composition): to generate or assist in the musical composition.
5. Music education: for a variety of CAI (computer-aided instruction) purposes.

All of these types of applications are currently supported by Macintosh musicware.

MACINTOSH MUSIC SOFTWARE

The first wave of Macintosh musicware focused primarily on score editing and secondarily on control of the Macintosh's internal four-voice synthesizer. Score editing, or using a Macintosh to deal with musical notes in a manner analogous to word processing, was released with varying degrees of success within Mark of the Unicorn's Professional Composer, Great Wave's ConcertWare, Utopian Software's MacMusic, Triangle Resources' MusPrint, South Bay's Music Character Set, Shaberazam's Music Type, and Hayden's MusicWorks. While only Mark of the Unicorn's Professional Composer provides score editing and printing capabilities on the level and quality demanded by serious musicians, other products such as ConcertWare, MacMusic, and MusicWorks offer integrated manipulation of the Macintosh's internal synthesizer and score editing (reference 2).

The current second wave of music software for the Macintosh is focusing on using the Macintosh to control external sound-generating devices. The three-year-old industry standard for communication between com-

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Christopher Yavelow (POB 821, Cambridge, MA 02238) is a professional performer/composer of computer-assisted music whose works have received awards in 19 international competitions.

puters and musical instruments that use microprocessors is MIDI. The primary concern of MIDI is the recording of sequences of notes, including information about pitch, timing, on velocity, off velocity, patch change, and various front-panel synthesizer controls. As the term suggests, MIDI sequencers allow for this information to be played back precisely through an external sound-generating device or synthesizer. In addition, because MIDI data consists entirely of numerical information, this data can be edited and manipulated in real time or as files at the composer's convenience (reference 3).

MIDI sequencer software offering both MIDI in and MIDI out is available with Mark of the Unicorn's Performer, Southworth's Total Music, Opcode's MIDIMAC Sequencer, Musicworks' MegaTrack, Great Wave's ConcertWare+ MIDI version, Creative Solutions' StudioMac, and Assimilation's MIDI Composer. Electronic Arts' Deluxe Music Construction Set and Hayden's MusicWorks offer MIDI out only. Some packages (e.g., Performer, Total Music, ConcertWare+, Deluxe Music Construction Set, and MusicWorks) provide for the conversion of MIDI data into conventional music notation, or sheet music. Finally, Musicworks Inc. markets a utility program called MIDIWorks, which converts files to and from the various formats used by the different manufacturers (reference 4).

The possibility for special "system-exclusive" (i.e., synthesizer-specific) information is also built into the MIDI specification. Through system-exclusive data, MIDI may also be used to edit patch parameters for specific synthesizers, usually of the FM synthesis–based variety. Opcode Systems markets a patch editor for the Yamaha DX/TX series and Casio CZ series of synthesizers. Patches may be saved to Macintosh disks providing storage space for up to 50 or more banks of patch information at a fraction of the cost of RAM cartridges. Musicworks Inc. has released a Macintosh-based patch librarian program storing and manipulating patches from the Yamaha DX/TX series, and Opcode sells librarian software for practically all the major brands of synthesizers.

An even more recent development is the provision that allows passing digitally sampled information via MIDI for subsequent waveform editing. Both Emu's Emulator II (using Digidesign's Sound Designer) and Ensoniq's Mirage (using Blank Software's Sound Lab) offer this capability. Other sampling keyboard manufacturers such as the renowned Kurzweil are following suit using both MIDI and non-MIDI communication (references 5 and 6).

Last but not least, the Macintosh is a flexible sampling machine in its own right. The remainder of this article will be concerned with the sound-sampling capabilities of the Macintosh and the various uses of sounds digitized thereby.

Macintosh Sound Hardware Capabilities

To understand the Macintosh in its aspect as a sound-sampling device, you must first consider the hardware. The Apple Macintosh generates sound in three ways. All Macintoshes come with a built-in ROM-resident sound driver that consists of three different synthesizers:

1. The four-tone synthesizer, which can produce four tones simultaneously and utilizes 50 percent of the microprocessor's time.
2. The square-wave synthesizer that does just what it implies, using about 2 percent of the processor's time.
3. The free-form synthesizer that is used to generate complex music and speech and requires about 20 percent of the processor's time.

Of these three possibilities, only items 1 and 3 have serious musical applications. Furthermore, when considering the Macintosh as a sampling machine, an application may utilize the free-form synthesizer or send sound samples to the built-in audio

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output jack in a unique way to exceed the four-voice limit that item 1 seems to imply.

Due to hardware limitations, the highest frequency the Macintosh can currently produce is 11,116 Hz. *Inside Macintosh* (reference 7) gives the following explanation for this limitation: The sound driver and disk-motor speed-control circuitry share a 740-byte buffer, of which the sound driver uses the 370 even-numbered bytes. Every horizontal retrace interval (i.e., every 44.93 microseconds, when the beam of the video screen moves from the right edge of the screen to the left), the MC68000 automatically fetches 2 bytes from this buffer and sends the high-order byte to the speaker. Thus, all frequencies generated by the sound driver are multiples of this 44.93-microsecond period. The highest frequency physically possible for the sound driver is twice this period, or 89.96 microseconds, which translates to a frequency of 11,116 Hz. Likewise, every vertical retrace interval (every 16.6 milliseconds), the sound driver fills its half of the 740-byte buffer with the next set of values.

These limitations notwithstanding, the Macintosh also comes with a built-in monophonic audio output jack that can be attached to any standard stereo system or cassette.

Introduction to Digital Sampling

Digital sound sampling is a new enough field that an explanation of the technique might be in order. It can be easily understood by making an analogy to motion pictures. In a film, many consecutive still photographs of a continuous (analog) motion are projected rapidly to recreate the illusion of continuous motion. Sound also exists within an analog continuum, and sound sampling, or digitizing, captures a specified number of "snapshots" of a sound that are subsequently played back at a rate typically between 5000 and 100,000 samples per second in order to recreate the original sound (see figure 1).

Regarding questions of fidelity of the reproduction to the original, both sound and film share common concerns. You must consider two factors with respect to sound sampling: rate and resolution. To clarify these two considerations, I will return to the motion-picture analogy. The size of a single frame in a film represents its resolution and thus places actual physical limitations on the fidelity with which a film can reproduce visual information. Varying degrees of quality are dependent upon whether 8mm, 16mm, 35mm, or 70mm film is used to capture the still photographs of analog motion. Working hand-in-hand with resolution is the rate of speed at which the still photographs are projected. Typical 35mm film used in commercial movie houses is projected at 24 frames per second, and the general audience accepts this rate as adequate to achieve the illusion of continuous motion.

Sampling rate and resolution play an even larger role in determining the degree of credibility within the do-

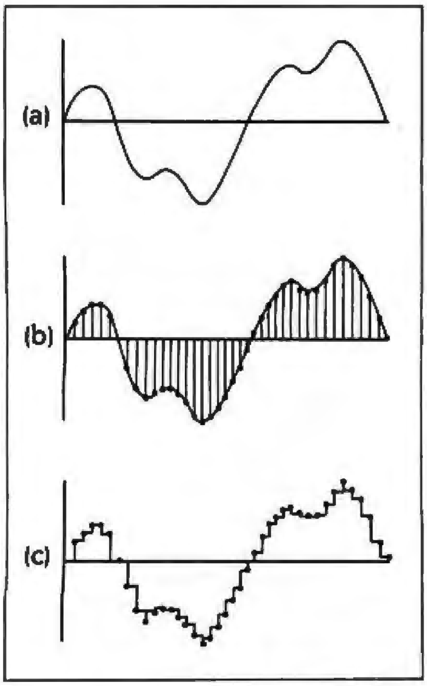

Figure 1: *Digital sampling of an analog sound wave: (a) The analog wave; (b) digital samples taken of the wave; (c) digital reconstruction of original waveform.*

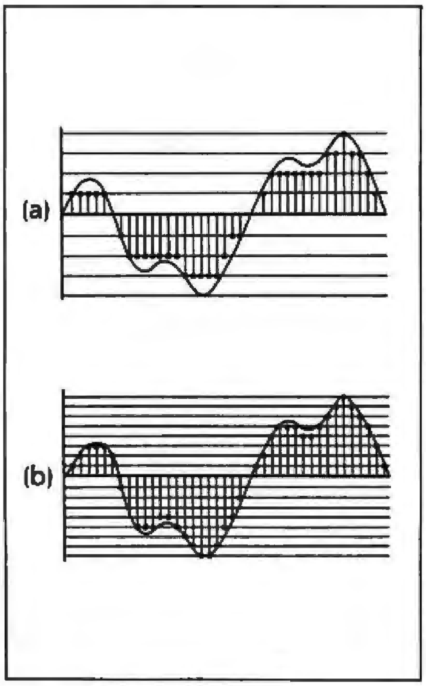

Figure 2: *The number of digital values used to represent samples affects the accuracy of the reproduction of the sound wave. Note the difference in the reconstruction of the waveform, even though the sampling rate is identical.*

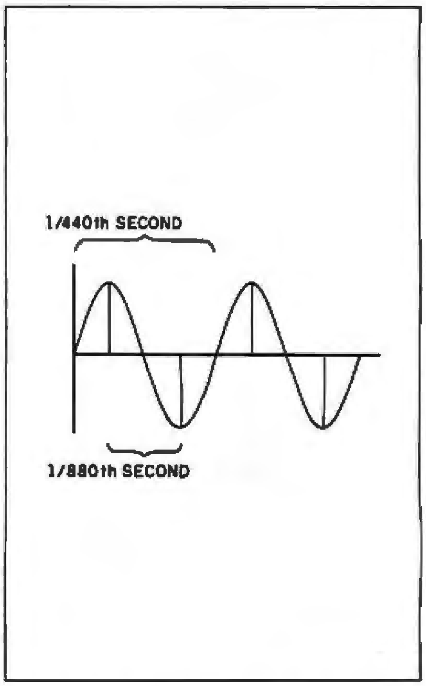

Figure 3: *A minimum of two samples are required to represent a sound wave.*

main of sound reproduction. Average listeners are far less forgiving than film-goers. The "size" (or resolution) of each sound sample is analagous to the size of film in a motion picture. Since a single sample consists of the measurement of an analog (i.e., continuous) voltage via an A/D converter, using a larger range of numbers for measuring this voltage permits a more accurate representation of the voltage. Digital computers use binary bits to represent numbers, so the maximum number of bits available for each measurement will determine the highest number of voltages that can be represented and thus the incremental range within which all measurements must be scaled. The largest number that can be represented by 8 bits is 256; thus, 8-bit sampling requires that all voltages be rounded off to only 256 different values. Twelve-bit sampling offers resolution to 4096 different steps and 16-bit sampling provides a range of 65,536 (see figure 2). Theoretically, each additional bit adds approximately 6 decibels to the signal-to-noise ratio. However, in practice, many sampling devices periodically send an additional 4, 6, or 8 bits of data along with their samples for the purpose of providing additional information about the sound's waveform. This process may raise the dynamic range considerably.

The rate at which sound samples are captured, as well as how fast they are output, is almost as important as sample resolution when considering the fidelity of a digitally sampled sound to the original analog signal. According to Nyquist's theorem, a minimum of two samples per sound wave is necessary to represent a given sound wave. Therefore, to represent a pure sound with a frequency of 440 Hz (cycles per second), you are required to sample that sound at a minimum rate of 880 samples per second (see figure 3). In reality, most sounds are complex waveforms with overtones extending well beyond the average human range of hearing, or 20,000 Hz. Thus, for the accurate reproduction of most musical sounds, a minimum sampling rate of 40,000 samples per second would be optimum. On the other hand, the degree to which overtones of frequencies higher than 10,000 to 12,000 Hz contribute to one's perception is debatable. These high overtones are of such low dynamic intensity (i.e., volume) that many people argue that a sampling rate of 25,000 samples per second is adequate. As a reference point, the fundamental frequency of the highest note on a piano (C8) is 4186 Hz.

Sampling with the Macintosh

The hardware capabilities of a Macintosh computer limit the sampling rate to approximately 22,000 samples per second with an 8-bit resolution. The internal speaker of the Macintosh is unable to handle sound of this quality, although the backpanel monophonic audio output jack can send a signal of this quality to an external amplifier such as a typical home stereo system. For purposes of comparison, most CDs (compact disks) use a 44.1-kHz sampling rate with 16-bit sample resolution.

At the time of this writing, there are three sampling packages available for the Apple Macintosh. All products include both software and the necessary A/D-converter hardware. MacNifty's SoundCap is a low-cost hobbyist/hacker-oriented product with distinct third-party applications. GW's MacADIOS is a high-end digitizer geared toward scientific laboratory applications. Finally, the Berkeley Mac Users' Group markets a low-cost do-it-yourself digitizer kit. Due to the fact that the purpose of this article is to examine computer music applications, MacADIOS will be described only briefly.

MacADIOS

MacADIOS (Macintosh Analog/Digital Input/Output System) is a professional hardware/software package consisting of a waveform-oriented, general-purpose data-acquisition system providing oscilloscope, spectrum analysis, and XY recorder functions. In the oscilloscope function, 25 milliseconds of analog voltage data sampled at a rate of 20,833 samples per second is plotted on the screen three times per second. Other applications are limited only by the available RAM. Uses include controlling and monitoring scientific experiments and processes. The hardware provides four analog voltage outputs (12 bits), eight analog voltage inputs (12 bits), 16 digital outputs, 16 digital inputs, timer, programmable clock, and a 20,833-values-per-second maximum sample rate (see photo 1).

Included with the hardware is a general-purpose data-acquisition program called MacADIOS Manager. This software provides a Monitor Window, a Graphic Editor Window, a Value Editor Window, and a View 4 Window (similar to a programmable four-trace digital oscilloscope). In some applications, three snapshot windows may be opened to allow the user to quickly view waves in low resolution. The software can also produce sonograms in seconds and spectrograms in minutes. Fifty routines are provided

(continued)

Photo 1: *The MacADIOS digitizer unit.*

for executing highly specific tasks with MacADIOS from a user's C or Microsoft BASIC program (see figure 4).

MACNIFTY AUDIO DIGITIZER WITH SOUNDCAP SOFTWARE

The MacNifty audio digitizer package consists of a hardware digitizer (A/D) and associated SoundCap software. The hardware includes an RCA audio input jack, a 1/16-inch remote-control jack, a gain control, and a 9-pin male connector with cable for the Macintosh's modem or printer RS-232C ports. The primary SoundCap program was developed by Fractal Software. Other secondary applications included in the package are SoundInit, BeepInit, Type Writer, and SoundPlay.

The primary software, SoundCap, permits 8-bit sampling at four sampling rates: 22, 11, 7.4, and 5.5 kHz. Therefore, the Nyquist frequencies (the highest recordable frequency) are 11, 5.5, 3.7, and 2.75 kHz, respectively. Because fewer samples are taken for slower sampling rates, as the Nyquist frequency drops, the maximum sampling duration increases. With 512K-byte RAM, sampling at 22 kHz will allow 15 seconds of sound to be recorded. The lower sampling rates will permit 30, 45, and 60 seconds of sampled sound, respectively. Owners of Macintoshes with more than 512K RAM can expect longer sampling durations limited only by the amount of linear RAM available to SoundCap for usage. Once sounds have been sampled, an option to save the soundfile using data compression is provided for conserving disk space. Furthermore, an option to save the soundfile as a "Studio Session" (discussed below) instrument is available. In addition, you can open standard Studio Session instrument files for precise editing in SoundCap (see figure 5).

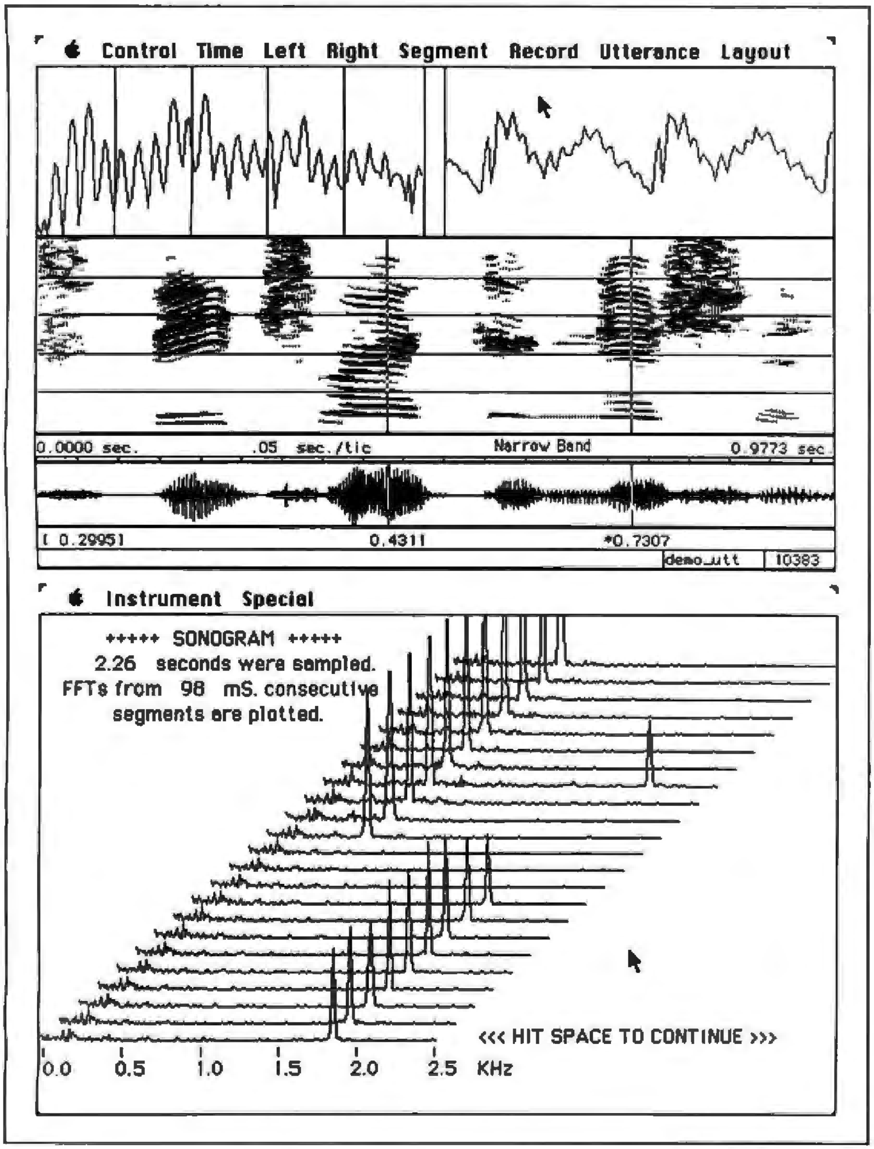

Figure 4: *Two of the many screens of* MacADIOS.

SoundCap's main screen displays five mode buttons. The buttons are labeled with icons representing record, playback, oscilloscope, reverberation, and spectrum-analysis modes. Pressing the record button with the mouse pointer presents you with a request for a record duration to be specified in seconds and milliseconds. Pressing playback initiates playback. The other three buttons address real-time functions. One use of the real-time oscilloscope mode is to allow you to take accurate record levels prior to sampling. The reverberation mode turns the Macintosh into a real-time digital reverberator and also permits you to test out reverb parameter settings prior to applying them to a soundfile (an operation that cannot be "undone"). The real-time spectrum analyzer may be used to ascertain the optimum sampling rate for the sound being recorded. Spectra are displayed as a bar chart—the vertical axis represents amplitude, and the horizontal axis, frequency ranging from 0 to 9740 Hz. The user may specify the resolution, in samples (128, 256, 512, or 1024), used for the Fourier transform.

Sampled sounds are displayed graphically on the main screen, with amplitude as the vertical axis and time as the horizontal axis. The sound may be both horizontally scrolled through or "zoomed" into or out of for viewing more samples on the screen at once. As you zoom into the sound at various resolutions, the waveform's amplitude envelope (attack or growth, sustain, and decay

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phases) becomes evident.

Sounds may be modified in a number of ways. Dragging over a portion of the sound with the mouse selects that region for editing and changes the edit region into reverse video. In this manner, regions of samples may be cut, copied, and pasted anywhere in the soundfile in the normal Macintosh fashion. A second horizontal scroll bar at the bottom of the screen (referred to as the "scratch bar") may be used to finely adjust the output speed of the samples and thus the pitch.

Once a soundfile or region of a soundfile has been selected for editing, a number of operations may be applied to it. Accessing the Sound Effects menu presents you with 12 options for sound modification. Sounds or portions thereof may be reversed or amplified. In the latter case, you can specify the coefficient by which all sample values will be multiplied for amplification. Reverb and flange operations may be applied to the selected region. You can also specify reverberation parameters, delay (in milliseconds), echo loss fraction, and regeneration normalization. In addition, the flange delta may be defined in terms of a specified number of samples. The amplitude envelope of a selected region of samples may be ramped up or down and the sound may be retuned via the scratch bar. Retuning recomputes the samples at the selected rate. Other edit operations include transferring sound to the clipboard for subsequent mixing within the same or a different soundfile. Mixing is accomplished through additive synthesis. Silence or digitally simulated "white noise" may be inserted at any point in a soundfile or may be used to replace a portion of a sound.

Finally, two time-consuming edit operations may be performed on a soundfile or region thereof. Sound may be "downsampled" to one of the available lower sampling rates for purposes of reducing the size (in kilobytes) of a soundfile. Also, a "low-pass" operation may be applied to the sound while downsampling in order to eliminate frequencies that exceed the Nyquist frequency of the lower sampling rate.

The Options menu is where you set amplification, reverberation, and flange parameters as well as the number of repetitions of the soundfile (similar to looping an analog tape). Through this menu, it is possible to specify a sustain loop in the soundfile of up to 6 seconds. A sustain loop repeats a selected portion of the soundfile indefinitely and is of particular use when sampled sounds are to be sustained for varying rhythmic durations in a musical context. This is an absolute necessity when saving sound files as "instruments" in the Studio Session format discussed below.

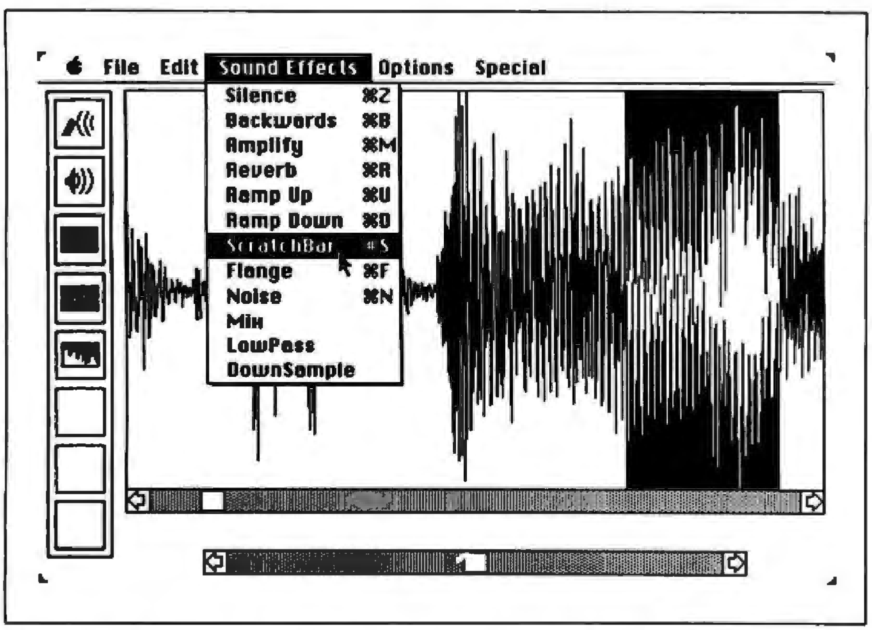

Figure 5: *The main screen of MacNifty's SoundCap for editing of sounds sampled with the MacNifty audio digitizer.*

USES OF MACINTOSH-SAMPLED SOUNDS

Sound sampling is in its infancy and thus provides fruitful territory for a wide range of applications. Many of the uses for sampled sounds have yet to be imagined by innovative thinkers. I will discuss a few of the current applications in the following paragraphs.

PITCH RECOGNITION AND TRANSCRIPTION: Developers of Macintosh sampling software consider pitch recognition and subsequent automatic transcription into conventional music notation (CMN) to be inevitable. The relatively simple conversion of this information into MIDI data would allow easy control of much more complex sound-generating devices or an expensive dedicated sampling keyboard such as the Kurzweil 250.

Through digital sampling, the Kurzweil 250 can credibly recreate all the sounds of a full symphony orchestra, including any single instrument or combination of instruments. Through pitch recognition and MIDI conversion, it would be possible to access these sounds without using a piano-style keyboard. Vocalists could control an entire symphony orchestra in this way as well. The implications inherent in the freedom for creative expression brought about by the separation of instrumental technique from sound source are just beginning to be realized (reference 8).

VOICE RECOGNITION AND REPRODUCTION: Other ideas related to pitch recognition include MacNifty's plans for voice recognition through its audio digitizer. Using FFT (fast Fourier transform) spectral data captured by SoundCap, it is hoped that the Macintosh will eventually become responsive to a library of voiced commands.

The ability to sample the human

(continued)

voice has other applications as well. Language instruction programs could make use of this feature to illustrate correct pronunciation at the touch of a button. There are applications for children's reading programs, too. Finally, the possibility for sending voice mail over a network is already a reality using MacNifty's digitizer.

FUN: The MacNifty audio digitizer comes with four additional applications that use their sampled soundfiles in purely fun ways. SoundInit does to soundfiles what Bill Atkinson's public-domain utility ScreenMaker did for MacPaint files. With ScreenMaker, you can substitute a screen of your own creation for the normal Welcome to the Macintosh startup screen. With SoundInit, bootup will automatically be accompanied by a soundfile of your choice that could be anything from Albert Einstein saying "Good morning, let's get down to serious business," spliced together in SoundCap from old videotapes, to the full orchestral introduction to Wagner's "Flight of the Valkyrie" (as is the case with Silicone Beach's Airborne game).

BeepInit allows for similar personalization of the Macintosh's beep sound. Instead of a dull computer beep, you can substitute anything from a digitized "Oops!" to the opening notes of Jimi Hendrix's Purple Haze. Finally, the application Type Writer allows the injection of user-sampled sounds at each keyboard strike, providing for different sounds to be played through the space bar and return keys. With an ironic sense of humor, the developers have included sample files for this purpose that substitute the sounds of a noisy keyboard, space bar, and carriage return typical of an IBM Selectric typewriter.

ANIMATIONS: The latest version of MacroMind's popular VideoWorks program, which is currently published by Hayden Software, includes the option to import sampled soundfiles for synchronization with user-created animations. VideoWorks permits the quick and easy creation of Walt Disney–quality animations. The original release supported adding a synchronized soundtrack from a selection of 80 melodies and sound effects provided in the program. Sounds could be synchronized to animation in two ways. First, a sound or melody could be selected to play at a designated point, from beginning to end, at its original tempo and pitch. Secondly, sounds could be "synergistically interfaced" with the animation, in which case the position and motion of a specific sprite (animated object) would affect the pitch and/or tone quality of the sound attached to it.

The new VideoWorks lets you incorporate up to 16 digitizer soundfiles in the VideoWorks music palette for soundtrack use. Other new features include the ability to import whole music files from MacroMind's MusicWorks application (mentioned above) and the ability for speech synthesis through use of either of the two available Macintosh speech drivers: First Byte's SmoothTalker or Apple's own MacinTalk.

SOFTWARE AUTHORING SYSTEMS: MacroMind's VideoWorks Guided Tour Authoring System has been chosen by Apple for the creation of the company's popular "Guided Tours" of various software applications for the Macintosh. Third-party developers are taking advantage of this program as well. This authoring system, which is currently the only extensive software authoring system available for the Macintosh, is essentially identical to the new VideoWorks described in the preceding section of this article and thus provides access to all of the innovative approaches to sound offered by the Macintosh, including sounds sampled with SoundCap.

One significant feature makes this an entirely new product: A Do menu is added to the VideoWorks environment that permits the creation of interactive VideoWorks animations. This menu allows you to define any VideoWorks object (sprite) as a button for branching to other parts of the same VideoWorks animation or to altogether different VideoWorks files. In addition, any screen object defined as a button may be set to cause another application or desk accessory to open. Because of this feature, MacroMind has realized the possibilities for creating interactive animated guided tours of any software product available, hence the name "VideoWorks Guided Tour Authoring System." This title is perhaps a misnomer, since the program is equally applicable for extending the range of interactive educational software to include truly astounding possibilities. At least one third-party developer is currently using this system to author a software-based interactive music-theory instruction program.

MUSIC: At the time of this writing, only one music software application makes use of soundfiles sampled with SoundCap. This program is Bogas Software's Studio Session, and its implementation of digitized sounds is truly fascinating. Studio Session has undergone some name changes throughout its development, having first been titled Sideman and later Jam Session. The developers consider their package to be "the MusicWorks

(continued)

PRODUCTS DISCUSSED

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of sampled sounds," referring to MacroMind's largely intuitive music editing program that uses the Macintosh's internal synthesizer for playback.

Bogas's package includes a music editor (Studio Session Editor) and both the player (Studio Session Player, see figure 6) and a miniplayer (which allows for a larger number of soundfiles or instruments to be saved on a single disk by sacrificing some of the animated graphics of the main player application). With Studio Session it is possible to play back pitched music in six parts through the Macintosh's internal speaker or through an external sound system connected to the Macintosh's audio output. The software uses linear interpolation to recompute the sampled soundfiles at various pitches.

Several disks included with the package provide nearly 70 presampled instruments, and you can edit these or create new instruments using MacNifty's SoundCap (discussed above). The program can access up to 16,000 different instruments, although between 20 to 25 seems to be a practical limit for the 512K Macintosh.

Music is entered using the Studio Editor program, which functions in two modes. In the note-editing mode, notes and symbols may be dragged from a palette containing 32 items. The cursor assumes the symbol of the selected item until a new symbol is selected. Note values range from a whole note to a triplet 32nd note, and putting them on the staff is as easy as point and click with the mouse. Note placement is facilitated by the fact that the cursor jerks to both horizontal and vertical grid steps. The horizontal grid steps correspond to insertion or replacement locations and the vertical grid corresponds to musical half-steps on the staff. During editing, each instrumental voice is thought to be a separate track, with up to six tracks possible. Regions of tracks may be looped for up to 999 repetitions, and loops of varying length may be occurring at different places on separate tracks simultaneously. Loops, which are represented by musical repeat signs, are nestable for up to 10 levels. Cut, copy, and paste operations are supported, as are transposition and the insertion of tempo indications on the score and in real time.

The second type of editing provided by the Studio Editor is called block editing and is extremely innovative. It uses a database approach to the organization of musical ideas and the manipulation of musical data on the phrase level. I have repeatedly stressed the necessity for incorporating database-like library, sorting, and searching operations in MIDI sequencer software, but it seems that the first constructive implementation of this concept is destined to come to us from the sampled sound world.

The block-editing mode lets you view your musical composition in a display similar to a Multiplan spreadsheet. Phrases are labeled with one of 32 descriptive names (16 of which may be user-defined). The names of the phrases appear in the various spreadsheet cells in the proper spatial (i.e., temporal) relationship to one another. It is possible to zoom in or out of this display from 2-bar resolution to 4-bar or 16-bar resolution. Phrases are stored in the phrase library, which may hold up to 16,384 phrases. Sorting and searching are available by specifying type, meter, phrase length, or multiple search criteria. Phrases may be dragged with the mouse into the spreadsheet-like block editor display. In addition, phrases may be dragged around and placed into new juxtapositions within the block editor itself in a manner and philosophy similar to dragging headings and text windows around in Living VideoText's ThinkTank idea processor. A "draft play" window on the left of the screen includes the options of real-time soloing or muting for individual tracks with the click of a mouse. In the block editor display all looped phrases display all their repetitions, but saving the file compacts the loops (see figure 7).

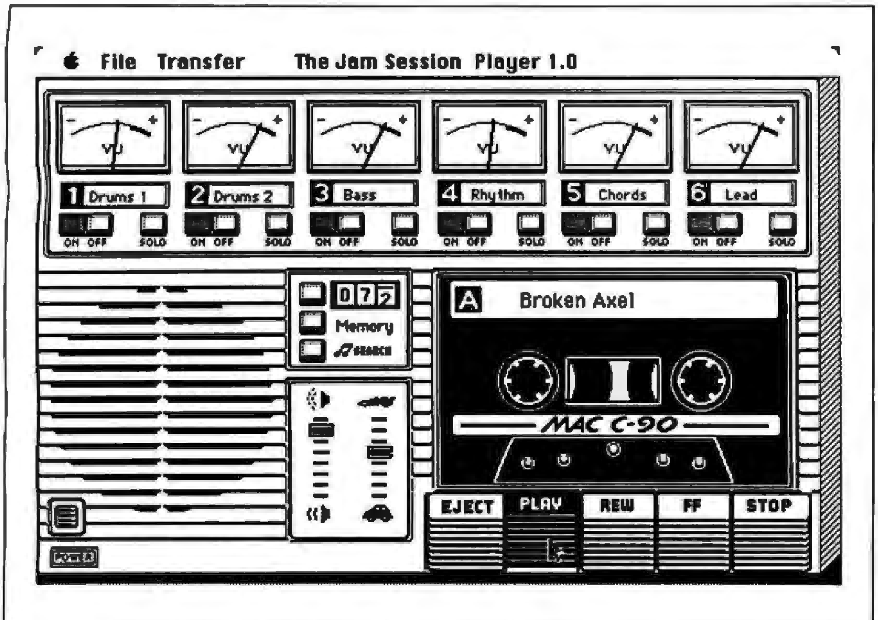

Figure 6: *Bogas Software's Studio Session Player with animated cassette recorder emulation.*

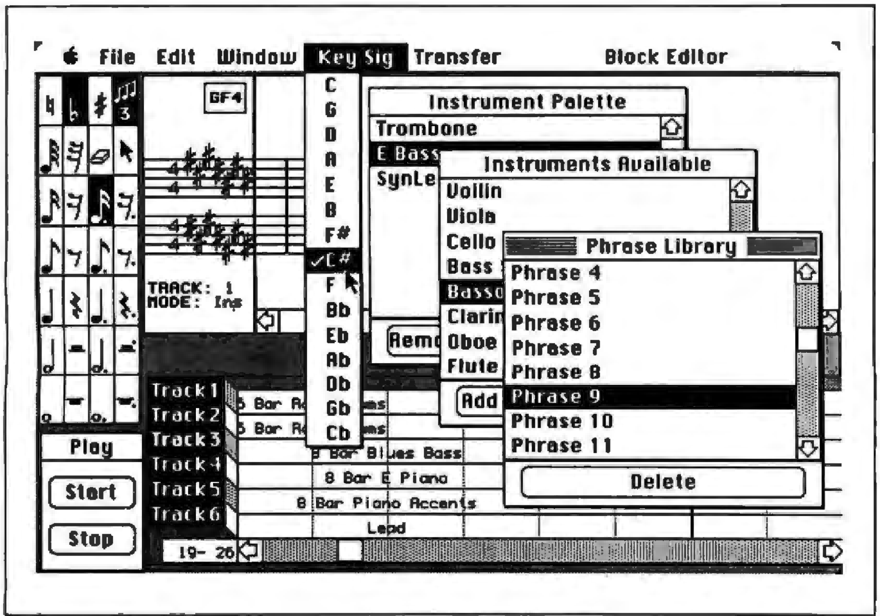

Figure 7: *Bogas Software's Studio Session Editor showing typical database menus.*

Such an approach to musical composition is truly ground-breaking. The ability to organize musical ideas in database fashion fosters creativity and experimentation by allowing us to view our musical ideas on a more global level. Bogas Software must be wholeheartedly commended for having the foresight to take the first step in unlocking a door to the true creative potential of a microcomputer.

CODA

The possibilities opened up by the capability of sound sampling with a personal microcomputer interpenetrate many different disciplines, both musical and otherwise. New and far-reaching applications for these techniques are being discovered every day. As with any creative tool in its infancy, with respect to applications of sound digitizing it is safe to say that the best may be yet to come with regard to music composition. ■

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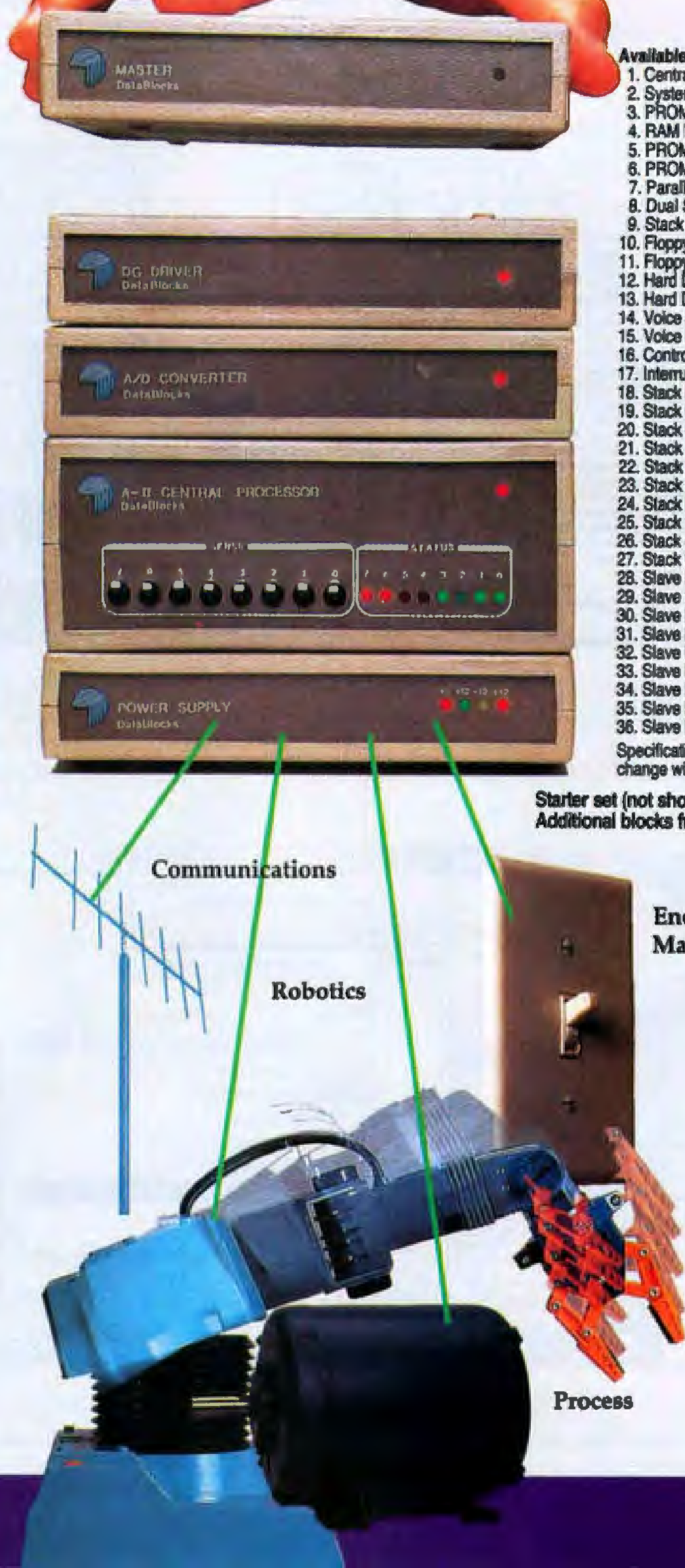

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MUSICAL FRACTALS

BY CHARLES DODGE AND CURTIS R. BAHN

Mathematical formulas can produce musical as well as graphic fractals

FRACTAL GEOMETRY has exerted a strong influence on a remarkable variety of disciplines in recent years. The sciences are using fractal structures to study a diverse range of phenomena from turbulence to bone structure. In the arts, fractal geometry provides computer graphics with unprecedented possibilities for creating a new universe of visual forms, many of which have an astoundingly realistic, natural look. In music, you can employ the same principles to take advantage of a panoply of new relationships.

In *The Fractal Geometry of Nature* (see reference 1), Benoit Mandelbrot is careful to point out that the realistic and natural-appearing fractal graphics are not modeled on photographs of nature; rather, they are graphics of mathematical relationships that come surprisingly close to resembling occurrences in nature. So it is with examples of computer-aided composition. They do not sound like rock, or bebop, or symphonies. Rather, they embody abstract relationships that assume the characteristics of certain kinds of music.

There are a number of parallels between computer graphics and computer music. Discussions about fractals and computer graphics usually distinguish between the high-resolution pictures made on powerful institutional computers and those made at home. The same schism exists between highest-quality sound synthesis and home synthesis.

This article discusses some of the basic techniques of computer-aided musical composition and includes some programs for generating musical fractals on home computers. [*Editor's note: The programs* WHITE.BAS, BROWN.BAS, 1OVERF.BAS, VARIATN.BAS, *and* RANDOM.BAS *are written in* MSX BASIC *using* MUSIC MACRO *commands for the Yamaha* CX5-M *music computer. Their source code is available for downloading from* BYTEnet *Listings at* (617) 861-9764. *They are also available on disk (see page* 445).] The output of the software shown in this article is a list of commands for the computer's internal synthesis hardware rather than actual music. Other details can be found in the text box "About the Programs" on page 196.

A LONGSTANDING RELATIONSHIP

Since the time of ancient Greece, Western music has embodied proportions and abstract numerical relationships. There are many examples. A famous motet of 1436, *Nuper Rosarum Flores* by Guillaume Dufay, uses the same relations of tempo between its sections as the ratios in size between parts of the Florentine cathedral for whose dedication it was composed. Numerology played a part in certain choices of elements in some of the religious music of J. S. Bach.

In our own era, Bela Bartok, the great Hungarian composer and folk music expert, used the Fibonacci numerical series to govern pro-

(continued)

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Curtis R. Bahn is a research assistant and student at the Center for Computer Music. He is also an adjunct assistant professor teaching computer music at NYU. *He attended Interlochen Arts Academy, has a* B.A. *from Indiana University, and is currently working on his* M.A. *at Brooklyn College.*

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portions in a number of his works. More recently, Charles Dodge's computer music composition *Earth's Magnetic Field* (Nonesuch Records, 1970) interprets an index of solar radiation's effect on the magnetic field surrounding the earth to create its melodic and rhythmic activity.

In the mid-fifties, Lejaren Hiller and Loren Isaacson wrote their first programs for computer-aided composition (see reference 2) and Max V. Mathews created his widely used algorithm for the digital oscillator (see reference 3). Today, computer-based audio synthesis, processing, and recording pervade all styles of music. Even classical concert music now includes a wide variety of computer music, as evidenced by the New York Philharmonic's three-day minifestival of computer music within its landmark contemporary music festival, Horizons '84.

After an initial flurry of activity in computer-aided composition (CAC), however, musicians and engineers have concentrated on digital synthesis and processing of sound. Only recently have a number of composers begun to reexamine some of the possibilities of CAC. If you define computer-aided composition as the use of a computer program to calculate some aspect of a musical score, you can eliminate the common misconception that the words "computer music" are limited to the computer performance, or realization, of music composed in the past (by this definition, "switched-on" classics are not new compositions but new realizations). A composer commonly uses computer programs to compose and then makes electronic realizations of the composition on the computer. You can describe this process as computer-realized CAC.

There is an obvious analogy between this and the field of computer graphics, in which you use computer programs to create visual structures to be realized by computer technology. Because of the parallel structures within the two fields, you can adapt recent applications of Benoit Mandelbrot's fractal geometry to computer graphics (see reference 4) for use in computer-aided composition.

Composing by Computer

Using the computer to compose raises a number of issues about the nature of the creative process and the nature of music itself. Many of the best musicians in various epochs have incorporated mathematical relationships into their music. No one would argue, however, that all you need for effective composing is a well-developed mathematical technique. Any musical application of mathematical relationships must take into consideration the interactions of the basic elements of musical texture: pitch, rhythm, loudness, and tone quality. The way in which a composer structures these basic elements determines to a large degree the nature of the music created. Figures 1b, 2b, and 3b come from random processes that provide the means of choosing values for some of the necessary building blocks. Figure 4c is a musical fractal that elaborates and builds on the elementary motivic structure shown in figure 4b. All the examples given use the 12-tone equal-temperament pitch collection. Mapping the results of the programs given onto different pitch collections will make a most significant difference in the sound of the music.

Three types of random processes are often associated with CAC. These processes have been widely applied to the choice of compositional parameters—pitch, for example. You can characterize each process by its *power-density spectrum*, the variation of the random sequence's energy versus its frequency. The spectral characterization applies only to the random variable's sequence of values; it says nothing about the acoustical spectra of the music's actual sounds. These spectra depend on the characteristics of the instruments—electronic or otherwise—used to play them.

The first and most basic random process is white noise, which by definition has a flat spectrum. This means that its spectral energy is dispersed evenly with the frequency, and thus it varies with the frequency

(continued)

in a $1/f^0$ relationship. Figure 1a shows a graph of the power-density spectrum of white noise (see reference 5). Figure 1b is a musical example made by selecting pitches and rhythms at random using the white-noise mathematical relationship. The range of pitches used is the two octaves above middle C, using all chromatic pitches of 12-tone equal temperament. The four rhythmic values used are the quarter, the half, the dotted-half, and the whole note. The music notation shows conventional pitch and rhythmic values, along with bar lines and meter signatures.

As with all our BASIC language programs, we used the internal clock to seed the random generator, resulting in a completely new sequence on each run. Regardless of the seed, a passage of music generated by white noise exhibits little internal coherence or relatedness. If you generate white-noise music several times with the program in listing 1, you will notice that the melody is different each time. If you use the diatonic-pitch collection (the pitches of a major scale), for example, and a different group of rhythmic values, you get other melodies as well.

A random variable, whose next value is generated by adding a Gaussian-distributed random variable with a mean value of 0 to the current value, creates noise with a spectrum of $1/f^2$. Figure 2a shows a graph of $1/f^2$ noise, sometimes called Brownian noise. Due to the Gaussian distribution, small changes in value are more likely than large ones. Figure 2b is an example of Brownian music. We chose the same ranges of pitch and rhythmic values to project the musical line that we selected for figure 1b. The Brown-

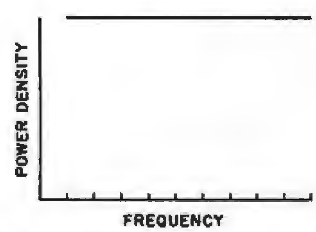

Figure 1a: *The power-density spectrum of white, or $1/f^0$, noise.*

Figure 1b: A *musical example created by random selection of pitches and rhythms using the white-noise mathematical relationship.*

Listing 1: *WHITE.BAS, a program to generate white noise.*

```
10 _INIT:_INST(1)
20 X=RND(-TIME)
30 FOR X = 1 TO 25
35 REM notes in range of 25 to 120
40 N = INT(RND(1)*95)+25
45 REM lengths in range of 1 to 4
50 L = INT(RND(1)*4)+1
60 _PHRASE(1,"L=L;","N=N;")
70 NEXT X
80 _PLAY(1,1)
90 _WAIT(1)
100 INPUT"AGAIN";DD:GOTO 80
```

ian music moves along from one pitch to another within a small span of intervals. The music seems to wander around with no clear direction. The code in listing 2 will generate Brownian music.

Both white noise and Brownian noise are members of a class of processes called *fractional noises*, whose spectrum diminishes following the formula $1/f^{y}$, where $0 \le y \le 2$. A particularly interesting case occurs when $y = 1$, also known as $1/f$ noise. Figure 3a contains a graph of the power-density spectrum of $1/f$ noise. Surprisingly, the $1/f$ relationship occurs naturally in a great many ways: as variations in annual amounts of rainfall, in patterns of sunspot activity, and as noise in electronic devices, to name only a few. In fact, physicists Richard F. Voss and John Clarke analyzed several recordings of nonrandom music in various styles and found the loudness and frequency distribution was nearly $1/f$ (see reference 6). Figure 3b shows a musical line with the same range as figures 1b and 2b but with a $1/f$ correlation between successive pitches and rhythms.

Values in a sequence generated by the $1/f$ formula correlate logarithmically with past values. Thus, for example, the averaged activity of the last 10 values has as much influence on the current value as does that of the last 100, the last 1000, and so on. This remarkable property means that the process has a relatively long-term memory. In fact, it has the best memory of any fractional noise-generating formula.

Figures 1b, 2b, and 3b show monophonic (single-line) music. Since most Western music is polyphonic (more than one line), these examples are perhaps better for illustrating the differences among the generating processes than for creating compositions. Because of $1/f$'s superior memory, lines of music generated with $1/f$ noise, such as the one shown in figure 3b, have the best overall musical effect of the lines created using fractional noises. Relating note and rhythm choices to both the recent past and the more distant past seems

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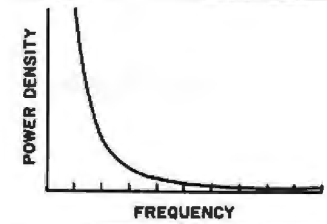

Figure 2a: *The power-density spectrum of* Brownian, *or* $1/f^2$, *noise.*

Figure 2b: *An example of* Brownian *music using the same range of pitches and rhythms as figure 1b but with the* Brownian *formula.*

Listing 2: *BROWN.BAS, a program to generate* Brownian *noise.*

```
10 _INIT: _INST (1)
20 X=RND(-TIME)
30 N=60:L=2
40 FOR X = 1 TO 25
50 R=3:GOSUB 130:N=N+D: REM R varies the range
60 IF N>120 or N<25 THEN N=N-2*D
70 R=.667:GOSUB 130:L=L+D
80 IF L<1 OR L>4 THEN L=L-2*D
90 _PHRASE(1,"L=L;",N=N;")
100 NEXT X
110 _PLAY(1,1):_WAIT(1)
120 INPUT"AGAIN";DD:GOTO 110
130 REM    BROWNIAN ROUTINE
140 S=0:REM  S is Sum
150 FOR I = 1 TO 12
160 S=S+RND(1)
170 NEXT I
180 D=INT(R*(S-6))
190 RETURN
```

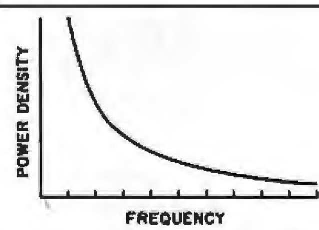

Figure 3a: *The power-density spectrum of* $1/f$ *noise.*

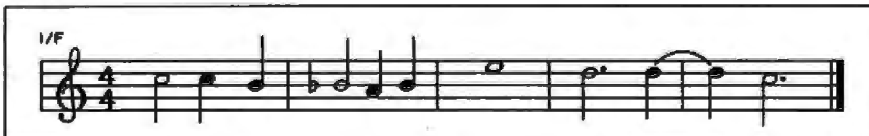

Figure 3b: A *line of* $1/f$ *music generated from the pitches and rhythms in figures 1b and 2b but using the* $1/f$*-noise formula.*

Listing 3: *1OVERF.BAS, a program to generate 1/f noise.*

```
10 _INIT:_INST(1):LL=8:LN=16:S=60:X=RND(-TIME)
20 FOR X = 1 TO 25
30 D=N:GOSUB 130
40 N=D:SN=N+S
50 D=L:GOSUB 130
60 L=D:SL=LL+1
70 _PHRASE(1,"L=SL;","N=SN;")
80 NEXT X
90 _PLAY(1,1)
100 _WAIT(1)
110 INPUT"AGAIN";DD
120 GOTO 90
130 REM   1/F ROUTINE
135 REM L is last value.  K is 1/2 poss
136 REM  values.  PROBIT=1/K
140 L=D:D=0:K=16:PROBIT=.03125
150 J=INT(L/K)
160 IF J=1 THEN L=L-K
170 U=RND(1)
180 IF U < PROBIT THEN J=1-J
190 D=D+J*K
200 K=K/2
210 PROBIT=PROBIT*2
220 IF K>1 THEN GOTO 150
230 RETURN
```

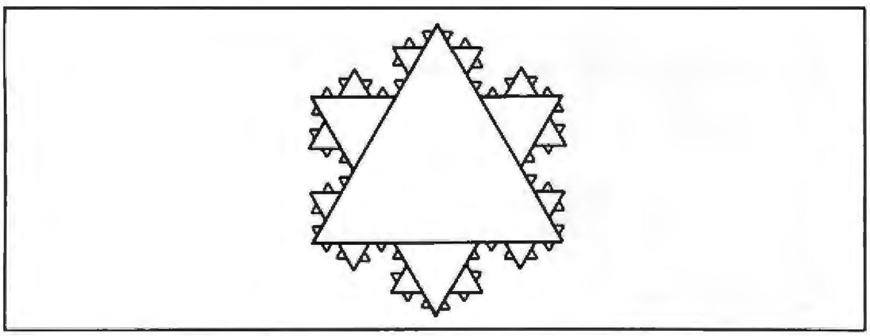

Figure 4a: *The Koch snowflake, a scaling fractal.*

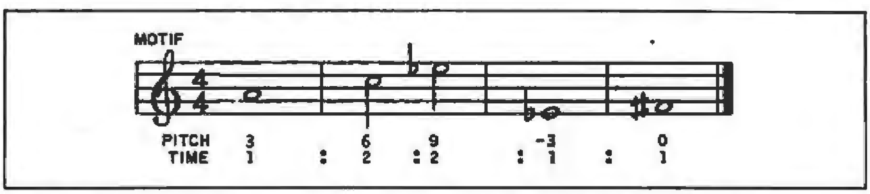

Figure 4b: *A "generating motif" of music composed of a few intervals and durations (analogous to the largest triangle in the Koch snowflake).*

to be an important part of musical coherence. Listing 3 provides the code to generate some 1/f music. Even musical lines made from the first two types of fractional noise have their possible applications. You can use them in simple musical contexts and together with other lines in more complicated ones.

Although 1/f noise may have the same power-density spectrum as a recording of a symphony by Mozart, the raw application of 1/f noise to compositional choices leaves out an important aspect of composition: musical structure. The application of fractals can be significantly useful in this area and provides an excellent point of departure for helping to mold the overall form of a piece of music.

Fractals and Musical Structure

Scaling, the space-filling curve, and self-similarity are three important concepts in fractals. Figure 4a shows a very regular fractal, the Koch snowflake. It is made from an equilateral triangle in the following way: Add another equilateral triangle of smaller scale to each side of the original, then add still smaller and smaller equilateral triangles recursively down to the resolution of the display. The Koch snowflake is a *scaling* fractal because it is made from the same shape reapplied at different scales. It is a *space-filling* curve because the edge of the snowflake—when you add an infinite number of triangles recursively—becomes infinitely long. (The edge assumes a form in between a one-dimensional line and a two-dimensional plane. This defines the snowflake as having a fractional dimension—thus, it is a fractal.) The Koch snowflake also exhibits *self-similarity;* that is, the small detail is

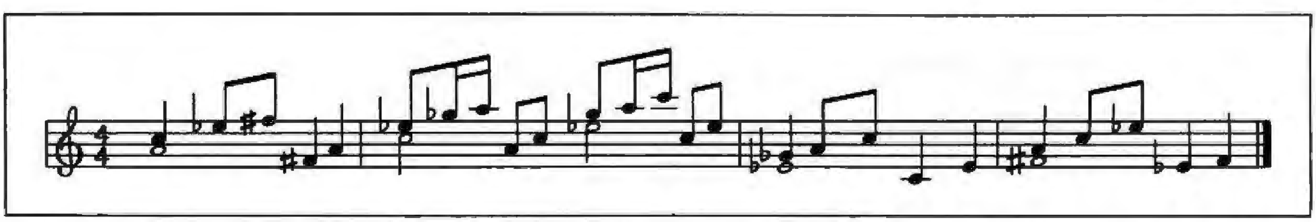

Figure 4c: *The first and second layers of a polyphonic musical composition. The first layer is the original motif, while the second layer is merely a faster repetition of that motif added to each of its notes.*

similar to the large detail. Self-similarity, although not a mathematical requirement of a fractal, is characteristic of all the fractals that we have found to be musically interesting.

The awareness of self-similarity abounds in studies of musical structure. In the early twentieth century, Viennese music theorist Heinrich Schenker developed a way of analyzing classical music that reflects the parts of a musical form as self-similar structures. Schenker's analytical techniques have had a growing influence in recent decades on a variety of musical ideas. Certain long-standing compositional procedures, such as those of canon, fugue, and motivic development, depend entirely on making new musical material by systematically transforming previous musical material. In many instances, these procedures result in clearly self-similar musical structures.

You can make an analogy in polyphonic music to the space-filling curve. If you choose a "generating motif" of a few intervals and durations (see figure 4b), it will serve as the slowest moving line in your musical fractal. (Its purpose is analogous to that of the largest triangle in the Koch snowflake.) Then, using the program in listing 4, you add a faster repetition of the motif to each of the notes in the original motif (see figure 4c). Then you add still faster motivic repetitions to each of the notes generated in the previous step as well. The result is a time-filling musical structure analogous to the space-filling curve of the Koch snowflake.

The program in listing 4 generates a three-line polyphonic composition. You can create an entire piece of music out of essentially one motif. The program places that motif in a self-similar structure by displaying it simultaneously in three different time spans.

You can change the nature of the resulting music radically by altering the motif. Changing only one pitch or time relationship can result in very different music because the change is perpetuated through every occurrence of the motif in all three layers

(continued)

Listing 4: *VARIATN.BAS, a program for determinate fractal and Brownian variation.*

```
5 REM**********************************************************
6 REM Copyright 1986 Curtis Bahn, Creative Associates Inc.
7 REM**********************************************************
10 CLS
20 DIM P(6):DIM AP(6):DIM BP(36):DIM CP(216)
30 DIM D(6):DIM AD(6):DIM BD(36):DIM CD(216)
40 DT=0:CC=0:BC=0:AC=0:GP=0:R=0:HP=100
50 _INIT:_INST(1):_INST(2):_INST(3)
100 INPUT"HOW MANY NOTES IN SET?"; PN:
    IF PN>6 OR PN<1 THEN GOTO 100
110 PRINT"INPUT";PN;"PITCH RELATIONSHIPS"
120 FOR LOOP=1 TO PN
130 INPUT P(LOOP):IF ABS(P(LOOP))>12 THEN PRINT"TOO BIG":
    GOTO 130
135 IF GP<P(LOOP)THEN GP=P(LOOP):
    IF BP>P(LOOP)THEN BP=P(LOOP)
140 NEXT LOOP
150 PRINT "INPUT";PN;"TIME RELATIONSHIPS"
160 FOR LOOP=1 TO PN
170 INPUT D(LOOP)
180 NEXT
185 INPUT"BROWNIAN RANDOMIZER APPLIED TO PITCH (1 OR 0)";
    R:IF R>2 GOTO 185
190 PP=ABS(BP)+ABS(GP)
195 LP=HP-(3*GP):SK=100/(3*PP)
200 REM FRACTAL ROUTINE
205 PRINT"COMPUTING FRACTAL"
210 FOR A=1 TO PN
220 AP(A)=P(A)+RC:AD(A)=D(A)
230 FOR B=1 TO PN
240 BC=BC+1:IF R =1 THEN GOSUB 700
245 BP(BC)=AP(A)+P(B)+RC:BD(BC)=D(B)*D(A)
250 FOR C=1 TO PN
260 CC=CC+1:IF R=1 THEN GOSUB 700
270 CP(CC)=BP(BC)+P(C)+RC:CD(CC)=D(C)*BD(BC):DT=DT+CD(CC)
280 NEXT C: NEXT B: NEXT A
290 TS=255/DT
300 REM PLAYING ROUTINE
310 BC=0:CC=0
320 FOR A=1 TO PN
330 _SOUND(1,1,AP(A)+LP):CIRCLE(TC,90-(AP(A)*SK)),6
340 FOR B= 1 TO PN
345 BC=BC+1
350 _SOUND(2,1,BP(BC)+LP):CIRCLE(TC,90-(BP(BC)*SK)),3
360 FOR C= 1 TO PN
370 _SOUND(3,1,CP(CC)+LP):CIRCLE(TC,90-(CP(CC)*SK)),1
380 FOR LOOP=1 TO CD(CC):TC=TC+TS
385 REM all play statements for mono playback
390 _SOUND(3,0,CP(CC)+LP)
400 NEXT LOOP
410 NEXT C: NEXT B: NEXT A
420 _STOP(1): _STOP(2): _STOP(3)
430 INKEY$=DD$:IF DD$="" THEN GOTO 430
440 GOTO 300
500 REM      BROWNIAN ROUTINE
510 S=0
520 FOR I= 1 TO 12
530 S=S+RND(1)
540 NEXT I
550 RC=INT(2*(S-6))
560 RETURN
```

of the musical structure.

In listing 4, we have limited the number of layers to three, but given the hardware, you could add layers to the musical structure until you achieve a point of aural saturation. You reach saturation when the input exceeds your aural resolution (when an additional layer makes the music move so fast that its tones become blurs) or surpasses the limitations of the synthesis system (when the tones in a new layer are too high for the synthesizer to play).

You can make a musical fractal that sounds less mechanical by incorporating a certain degree of randomness into the previous, nonrandom example. The idea is to produce random offsets of the original, nonrandom values. The program shown in listing 4 gives you the option of calling for Brownian random offsets in the selection of pitch intervals on the second and third layers. For the second layer the program will impart a change in the range of 0 to 6 semitones above or below the pitch value specified. The same range and distribution are applied for the third layer to those tones produced for the second layer.

The technique for creating this musical fractal is quite closely related to the technique in computer graphics for making fractal, Brownian mountain ranges (see reference 7). This complex computer graphic is made by nesting triangles, where the sides of the triangles are offset by some random amount proportional to the length of that side. In the musical fractals produced by the Brownian variation that is given in listing 4, an analogous technique is applied.

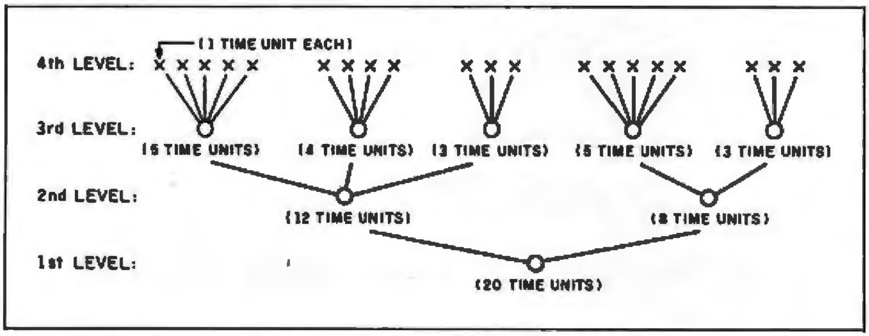

Figure 5a: *The relationship in time of four levels of generated notes.*

The final musical fractal uses a technique similar to the one described above: You generate an original layer and then add faster layers to it. You generate all layers through a 1/f-noise algorithm producing self-similar patterns. Because it is a random process, its similarity is statistically, rather than literally, the same. This fact lends a varied yet consistent surface to the resulting music. (The code is provided in listing 5.)

A Layered Structure

To understand how the layers are made, you need to understand the concept of *pitch class*. A pitch class is a C or an F#, for example, without regard for its register. In other words, the highest and lowest Cs on the piano keyboard share the same pitch class, C; they differ only in octave.

You don't specify the number of notes in the first layer directly. Instead, you begin by specifying the number of different pitch classes you want to generate in the first layer. You may have noticed that the 1/f algorithm commonly produces repeated notes. Therefore, the contents of the layer are related to pitch-class diversity, not simply to the number of pitches in the layer. The number of pitches in the layer does determine the perceived

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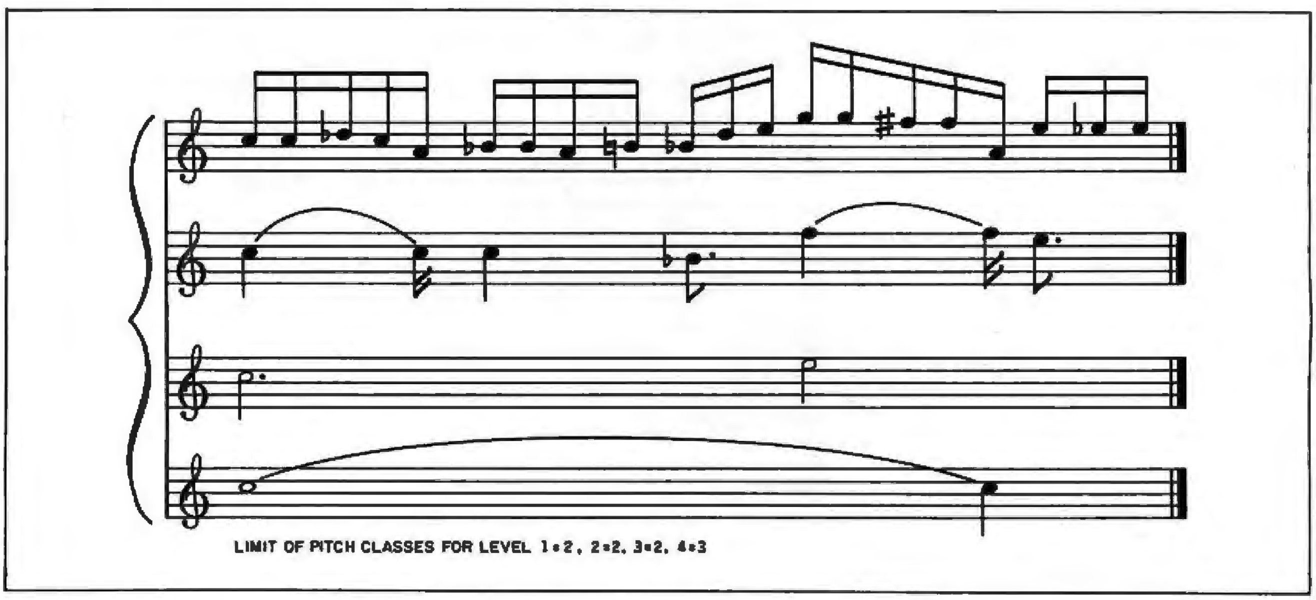

Figure 5b: A *four-layer musical structure generated using the 1/f-noise algorithm.*

Listing 5: *RANDOM.BAS, a program to generate 1/f random fractals.*

```
5 REM*****************************************************
6 REM   Copyright 1986 Charles Dodge, North Cape Music
7 REM*****************************************************
10 CLS
20 DIM AP(10):DIM BP(100):DIM CP(255):DIM DP(2,255):TC=20
30 DIM BD(10):DIM CD(100):DIM DD(255)
40 DT=0:DC=0:CC=0:BC=0:AC=0:DIM CT(4)
50 DIM CF(4,12):DIM LAST(4):KN=50
60 X=RND(-TIME):LAST(1)=INT(RND(1)*32)
70 _INIT:_INST(1):_INST(2):_INST(3):_INST(4)
80 _MODI(1,5):_MODI(2,40):_MODI(3,15):_MODI(4,16)
100 FOR LOOP = 1 TO 4
110 PRINT"ENTER PITCH CLASS LIMIT OF LEVEL #";LOOP
120 INPUT PL(LOOP)
130 IF PL(LOOP)>6 THEN PRINT"TOO BIG":GOTO 120
140 IF PL(LOOP)<1 THEN PRINT"TOO SMALL":GOTO 120
150 NEXT LOOP
160 L=1
170 FOR A = 1 TO 10
180 GOSUB 820
190 IF CT(L)>PL(L) THEN GOTO 230
200 AC=AC+1
210 AP(A)=LAST(L)
220 NEXT
230 REM   FRACTAL ROUTINE
240 SCREEN 2
250 FOR A = 1 TO AC
260 CIRCLE(DI/2,197-(AP(A)*5+20)),9
270 LAST(2)=AP(A)
280 FOR B = 1 TO 10
290 L=2
300 GOSUB 820
310 IF CT(L)>PL(L) THEN GOTO 570
320 BI=BI+1:BP(BI)=LAST(L)
330 CIRCLE(DI/2,197-(BP(BI)*5+20)),6
340 LAST(3)=BP(BI)
350 FOR C = 1 TO 10
360 L=3
370 GOSUB 820
380 IF CT(L)>PL(L) THEN GOTO 550
390 CI=CI+1:CP(CI)=LAST(L):IF CI=255 THEN AC=A:GOTO 590
400 CIRCLE(DI/2,197-(CP(CI)*5+20)),3
410 LAST(4)=CP(CI)
420 FOR D = 1 TO 10
430 L=4
440 GOSUB 820
450 IF CT(L)>PL(L) THEN GOTO 530
460 DI=DI+1
470 CIRCLE(DI/2,197-(LAST(L)*5+20)),.5
480 IF DI>255 THEN GOTO 500
490 DP(1,DI)=LAST(L):GOTO 520
500 DP(2,DI-255)=LAST(L)
510 IF DI=510 THEN AC = A: GOTO 590
520 DC=DC+1:NEXT D
530 DD(CI)=DC:DC=0:CT(L)=0:GOSUB 1020
540 CC=CC+1:NEXT C
550 CD(BI)=CC:CC=0:CT(L)=0:GOSUB 1020
560 BC=BC+1:NEXT B
570 BD(A)=BC:BC=0:CT(L)=0:GOSUB 1020
580 NEXT A
590 LINE (0,0)-(255,0):LINE (255,0)-(255,197):
    LINE(255,197)-(0,197):LINE(0,197)-(0,0)
600 DD$=INKEY$:IF DD$="" GOTO 600
610 REM     PLAY LOOPS
640 FOR A = 1 TO AC
650 _SOUND(1,1,AP(A)+KN)
```

(continued)

```
660 FOR B = 1 TO BD(A):BC=BC+1
670 _SOUND(2,1,BD(BC)+KN)
680 FOR C = 1 TO CD(B):CC=CC+1
690 IF CC>255 GOTO 770
700 _SOUND(3,1,(CP(CC)+KN)
710 FOR D = 1 TO DD(C):DC=DC+1
720 IF DC>255 GOTO 740
730 _SOUND(4,1,DP(1,DC)+KN):GOTO 760
740 _SOUND(4,1,DP(2,DC-255)+KN)
750 IF DC=510 THEN GOTO 770
760 NEXT D:NEXT C:NEXT B:NEXT A
770 _STOP(1):_STOP(2):_STOP(3):_STOP(4)
780 DD$=INKEY$:IF DD$="" GOTO 780
790 BC=0:CC=0:DC=0
800 GOTO 610
820 REM       1/F ROUTINE
830 LL=LAST(L):NP=0:K=16:PROBIT=.03125
840 J=INT(LL/K)
850 IF J=1 THEN LL=LL-K
860 U=RND(1)
870 IF U<PROBIT THEN J=1-J
880 NP=NP+J*K
890 K=K/2
900 PROBIT = PROBIT*2
910 IF K>=1 GOTO 840
920 LAST(L)=NP:TEST=NP
930 REM         PITCH CLASS TEST
940 FOR I = 0 TO 11
950 IF INT((TEST+I)/12)=(TEST+I)/12 THEN CF(L,I)=1:GOTO 920
960 NEXT I
970 CT(L)=0
980 FOR I = 0 TO 11
990 CT(L)=CF(L,I)+CT(L)
1000 NEXT I
1010 RETURN
```

form of the resulting composition, however, because each note of the first layer, when elaborated with the notes of the subsequent layers, is heard as a section of the composition.

You choose the notes of the second layer by the same method as the first—indirectly—by specifying the number of new pitch classes to generate before going on to the next note. Thus, each first-layer note will be elaborated, on the average, by a different number of second-layer notes. Therefore, the whole composition will sound less geometrical and more natural. The number of pitch classes you specify for each second-layer elaboration of first-layer notes is important. Too few (one or two) may sound too uniform, and too many (more than five or six) may make the first-layer notes too long. You use a similar method to indicate the pitch-class diversity of the third layer. Here again, you specify the number of new pitch classes for the *third-layer notes* to be played in the same time span as a second-layer note. The fourth layer is also created in exactly the same way as the earlier ones.

The means for calculating rhythm in this example is quite simple. The program assigns a short duration to each fourth-layer note. The duration of a third-layer note equals the total time

(continued)

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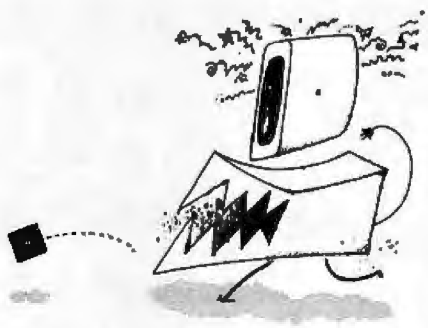
ABOUT THE PROGRAMS

The programs in listings 1 through 5 are written in MSX BASIC extended with the MUSIC MACRO commands for the Yamaha CX5-M music computer. We chose this particular machine because it is the most accessible computer that allows polyphonic (multivoice) sound production. Since most BASIC dialects contain commands to generate only monophonic (single-line) music, we wrote these programs so they could be modified easily for monophonic performance.

The programs in listings 1 through 3 produce short, monophonic musical segments by applying random processes to the parameters of musical pitch and time. In MUSIC MACRO, you prepare a short PHRASE that you then PLAY. Depending on the requirements of the system you use, you can fill an array or character string and send it later to your sound generator.

In listings 4 and 5, the longer fractal algorithms, the 64 rhythmic values of MUSIC MACRO were not enough for the exponential character of the relationships of the scaled time. Therefore, we introduced another scheme to produce many more time relationships. It uses a series of four nested loops, the indexes of which are either a result of the generating motif, as in figure 4b, or the result of a random process, as in figure 5b.

If your machine allows only monophonic sound generation, you can still realize the polyphonic music. Just place all your sound generation statements at the center of the nested loops, separated by small time factors. This will arpeggiate the example. By listening closely you will hear the differing rates of change of the layers articulated in this single line.



The program in listing 4, for making the first fractal, scales a given motif to three layers. The theme is entered as a series of relationships to an abstract reference pitch. This is like entering the *x*-axis values in relationship to zero for a linear graph in either a positive or negative direction. For example, the values 0, 3, and −2 will create a string of pitches starting on the reference pitch, moving to a pitch three semitones above it, and ending on the pitch two semitones below it. The program in listing 4 provides a "switch" to produce a Brownian random displacement of pitch on layers two and three. Using this feature will result in a less strictly patterned musical segment.

The program handles time as a ratio of values greater than 1, such as 1:1:2:3:1:1. Because of the exponential character of the relationships between the layers of the fractal, small numbers seem to provide the best results. Relationships of pitch and time are scaled to a range of values appropriate to the system. The notes of the score are displayed graphically during the performance. Hitting any key will repeat the performance.

The program in listing 5, to produce the second fractal, asks for the limit of pitch classes allowed for each layer of the fractal. A call to the 1/*f* subroutine chooses a note based on the previous note of that layer or the last note of the previous layer. As the various arrays of durations and pitches are filled, they are graphically displayed on the screen. When the segment is completely generated, a border appears around the screen. Hitting any key initiates a performance. If the number of notes in the fastest layer exceeds 510, the program stops filling arrays. The performance is truncated at the last note of the first layer reached before the array of fastest notes was filled. You can alter the program for larger arrays, according to your machine's capabilities.

span of all the fourth-layer notes generated to play with it. Then, the total duration of all the third-layer notes for a given second-layer note determines its duration. Similarly, the total of all the second-layer notes for a given first-layer note determines its duration, and so on until all notes in the piece have an assigned duration. The relations in time of the various layers is illustrated in figure 5a.

We chose 1/*f* noise to select the elements in figure 5b because of its unique memory. However, you can obtain interesting results if you mix the fractional noises used to generate the various layers. For example, using white noise to calculate the fourth layer would lead to a greater diversity of timing.

CONCLUSION

The exploration of fractal geometry's musical applications is in its infancy. The musical fractals offered above are relatively simple. There remains a large universe of fractal geometry yet to be broached by musicians. ■

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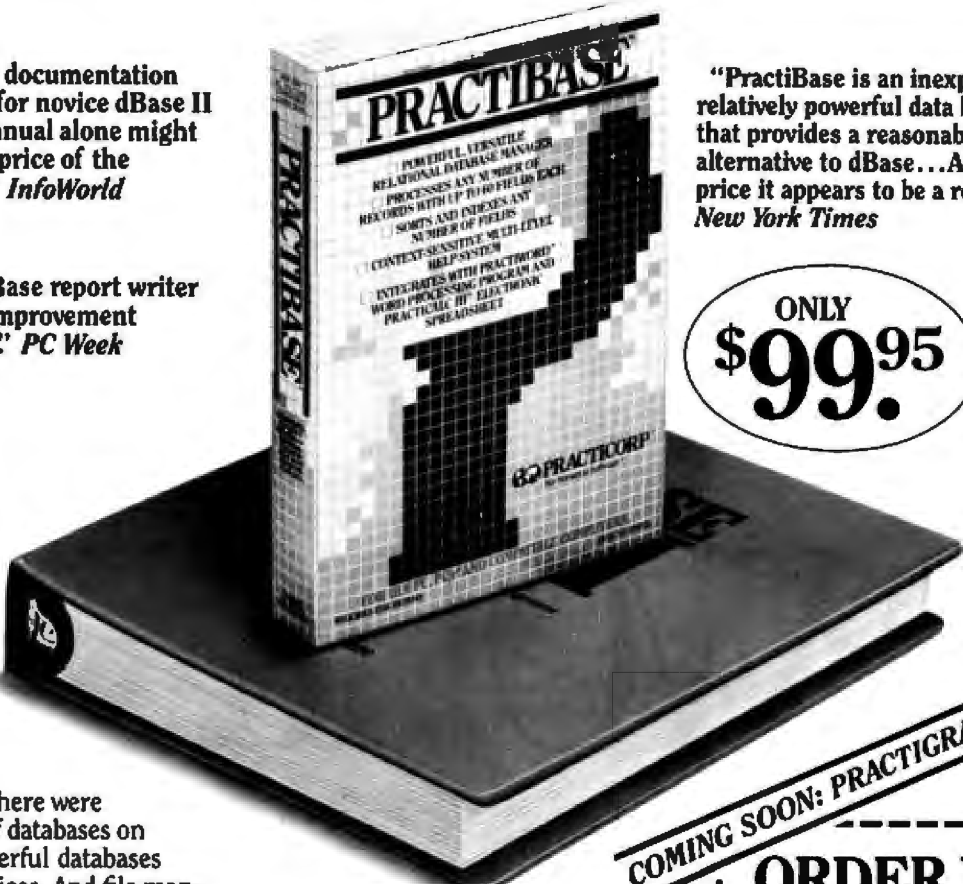

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A MIDI PROJECT

BY JAY KUBICKY

A MIDI *interface with software for the* IBM PC

BEFORE I DESCRIBE my project, I'd like to discuss the MIDI specification. This standard defines a hardware interconnection scheme with a software specification for the purpose of connecting electronic musical instruments to a computer.

As the name implies, an electronic musical instrument is any instrument that produces sound electronically. The most common electronic musical instrument is the synthesizer. The first synthesizers looked like part of a piano keyboard attached to a long, flat box covered with dials and switches. But today there are many other forms; a modern synthesizer might well have no keyboard but might have a MIDI-in jack.

All synthesizers produce sound through a system of oscillators, filters, and other wave-shaping devices. One way to classify synthesizers is by the number of voices they have. At any given instant, each voice can produce one individual note. For example, an eight-voice synthesizer can produce eight simultaneous notes. In synthesizers with multitimbral capability each of these voices can produce a different sound.

On a modern synthesizer, the control values of the voices are stored within the synthesizer in what are known as "patches" or "programs." These programs hold all of the values for each sound the synthesizer can produce. Different sounds can be loaded into the synthesizer's sound-generating circuitry by changing the program. Most synthesizers can store from 32 to 128 programs.

Sequencers are a particularly interesting class of devices associated with MIDI interfaces. These allow you to store sequences of notes played from a MIDI-compatible keyboard or other MIDI device. Since only the codes for the notes are stored and not the actual notes, the sequencers can later play back this music at any speed without altering the pitch.

Besides synthesizers, MIDI also ties together drum machines, guitar synthesizers, and other MIDI-compatible devices.

THE MIDI PROTOCOL

The MIDI protocol is a complex set of messages pertaining, in general, to various functions of the MIDI system, and, in particular, to functions of synthesizers.

Two types of bytes can be sent over the MIDI interface bus—status and data. Status bytes are 8-bit bytes with their most significant bit being bit 7, always set to 1. Data bytes may never have their MSBs set.

Messages are made up of a combination of these two types of bytes. The status byte is sent first, and usually it is followed by one or more data bytes. Real-time messages have no accompanying data bytes and may be sent at any time, even inside of other messages.

MIDI messages are generally divided into two types—channel messages and system messages. The channel voice messages are an important subset of the channel messages. They are used to alter the status of the synthesizer's voices.

The *note-on* channel voice message is sent whenever a key is pressed. The data bytes in this message specify the number of the note and its velocity, which is determined by how hard the key was struck (this only applies to velocity-sensitive keyboards). The *note-*

(continued)

Jay Kubicky (934 North Orange St., Media, PA 19063) is a high school sophomore. He has studied music since age five and has been interested in computers for five years.

off message is sent whenever a note is released. As with note-on, there is an accompanying note byte and velocity byte (again, only pertinent on velocity-sensitive keyboards). The *program change* message is sent whenever a program is changed. The data byte is the new program number.

The *polyphonic key pressure/after-touch* message is sent after a key is pressed if the key pressure is reduced. Accompanying the status byte is the note number and pressure. The *channel pressure* message designates the volume for a given channel.

Most synthesizers have at least some sort of note-bender or pitch wheel built into them. In terms of MIDI, this is known as a continuous controller. A special MIDI code known as a control change pertains to all continuous controllers in the MIDI system. The *control change* message is meant for any type of controller in the MIDI system other than the keyboard or pitch wheel (such as pedals, modulation controllers, etc.). After the status byte, the controller number and value is sent. Controller numbers 122 through 127 are reserved (these codes are explained in the section on channel mode messages).

Since the pitch-bender is the most commonly used controller, it is assigned a *pitch wheel change* message of its own. This message is sent when the value of the pitch-bending device (wheel, joystick, etc.) is changed. Two accompanying data bytes are sent, giving a 14-bit resolution.

CHANNEL CONTROL

Since the MIDI system can support many synthesizers at once, message arbitration must be accomplished through the use of "channels."

A channel is designated by the lower four bits of the first byte of any of the channel voice messages. These four bits direct the MIDI message to one of 16 devices that may be attached to the MIDI interface bus. Each device is responsible for recognizing its channel number and responding to its assigned messages. This allows up to 16 separate parts (voices) to be simultaneously played over a single MIDI interface bus.

There are four channel modes governing how devices will respond to channel-oriented messages.

CHANNEL MODES

The following four channel modes apply to transmitter/receiver voice messages:

- *Omni-on poly*: Voice messages are received from all channels and are assigned to the voices polyphonically.
- *Omni-on mono*: Voice messages are received from all channels and control only one voice, monophonically.
- *Omni-off poly*: Voice messages are received from only one channel and are assigned to voices polyphonically.
- *Omni-off mono*: Voice messages are received in voice channels N through $N+M-1$ and are assigned monophonically to voices 1 through M, respectively, where M is the number of voices and N is the start channel (usually 0).

Channel modes are set by sending a control change message to controllers 122 through 127.

The channel-oriented scheme lets you play up to 16 separate parts at once. There are many ways this can be accomplished. For instance, you could have 16 synthesizers hooked up to a single MIDI system bus (a rather expensive setup), or you could connect a few multitimbred synthesizers to a single MIDI interface bus.

On a multitimbred synthesizer, voice one could be strings, voice two could be brass, etc. A typical multitimbred synthesizer allows you to assign each of its six voices to a separate channel and to give each voice a different sound. Then you simply play different parts over different channels.

The only disadvantage with this type of setup is that you can assign only one voice per channel. This allows only one note to be played in each channel at any given instant.

[Editor's note: Be sure to check your synthesizer channel numbers. Channel 0 in Jay Kubicky's program corresponds to channel 1 on most synthesizers.]

SYSTEM REAL-TIME MESSAGES

System real-time messages apply to all devices in the system and can be sent

(continued)

any time, even between the bytes of another message. These messages control timing and synchronization of the system and are especially important when dealing with sequencers and drum machines.

The *timing clock* message synchronizes all time-relevant devices in the system such as sequencers, drum machines, etc. This message is sent at the rate of 24 beats per quarter note.

The *start* message tells all real-time devices in the system, such as sequencers and drum machines, to start. The *continue* message tells all stopped devices in the system to continue at the time of the next clock. The *stop* message tells all real-time devices to stop.

The *active sensing* message is optional. It is a dummy status byte sent at least every 300 milliseconds, regardless of other activity on the bus. Once the first active sensing message is received, all other devices on the bus that are capable will respond. If 300 milliseconds passes without the occurrence of a data transfer, the receiver will turn off all voices and return to normal operation.

The *system reset* message initializes all receivers to the condition of just having turned on system power. It is to be used sparingly, preferably under manual control only. It should not be sent automatically on power-up.

System-Common Messages

System-common messages are not channel-oriented and apply to all devices in the system. They implement the following functions:

The *song position pointer* message sets the internal beat-counter of sequencers, drum machines, etc., to a specific value. The two data bytes (with their MSB set to 0) contain the new beat-counter information and are sent with this code.

The song position pointer is really an internal register that contains the number of MIDI beats since the beginning of the song. It is normally set to 0 when the start message is sent.

The *song select* message defines the song to be played in sequencers, drum machines, etc. The one data byte used allows one of 128 possible songs to be selected.

The *tune request* message requests that all analog synthesizers in the system tune their oscillators.

System-Exclusive Messages

The *system-exclusive* message makes up for all of MIDI's deficiencies. After a system-exclusive message and appropriate manufacturer identification is sent, any amount of any type of data can be sent over the bus (just as long as the MSBs of all data bytes are set to 0).

Upon receiving any sort of status byte other than a real-time message, the receiver automatically terminates system-exclusive mode.

The main purpose of the system-exclusive mode is to send actual program and sequencer data to be stored, analyzed, or changed in another synthesizer or computer.

An *EOX* (end of exclusive) message terminates the system-exclusive mode (manufacturer ID numbers are supplied by the MIDI committee).

The MIDI Project

My MIDI project consists of two phases. In phase one I will show you how to build the hardware interface board and explain its inner workings. In phase two I will describe the software, how it works, and how to use it.

Phase 1: Building the Hardware

At the hardware level, MIDI is an asynchronous serial interface (see photo 1). Typically, a MIDI-compatible device will have a MIDI-in port that receives MIDI data, a MIDI-out port that transmits MIDI data, and optionally a MIDI-thru port that echoes data received at the MIDI-in port back out again.

The operating speed of the serial interface is 31,250 bits per second (plus or minus 1 percent), with one start bit, eight data bits, and one stop bit. This speed is a convenient breakdown of 2 megahertz.

The interface circuit is a 5-milliampere current loop (see figure 1). The receiver is optoisolated and should require no more than 5 mA to drive. The MIDI interface cables use 5-pin DIN male plugs and the total bus length should be no more than 50 feet.

Since the MIDI interface transmits in a serial data format, a UART is needed to transfer data to and from it. The Zilog DART (dual asynchronous receiver/transmitter) serves this purpose nicely. The DART provides two

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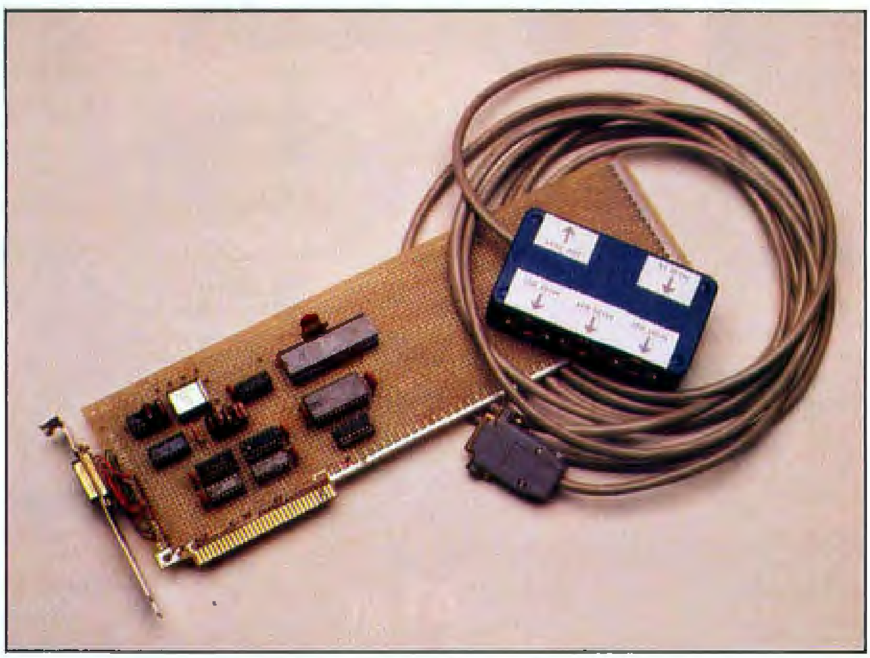

Photo 1: *Jay Kubicky's* MIDI *interface board.*

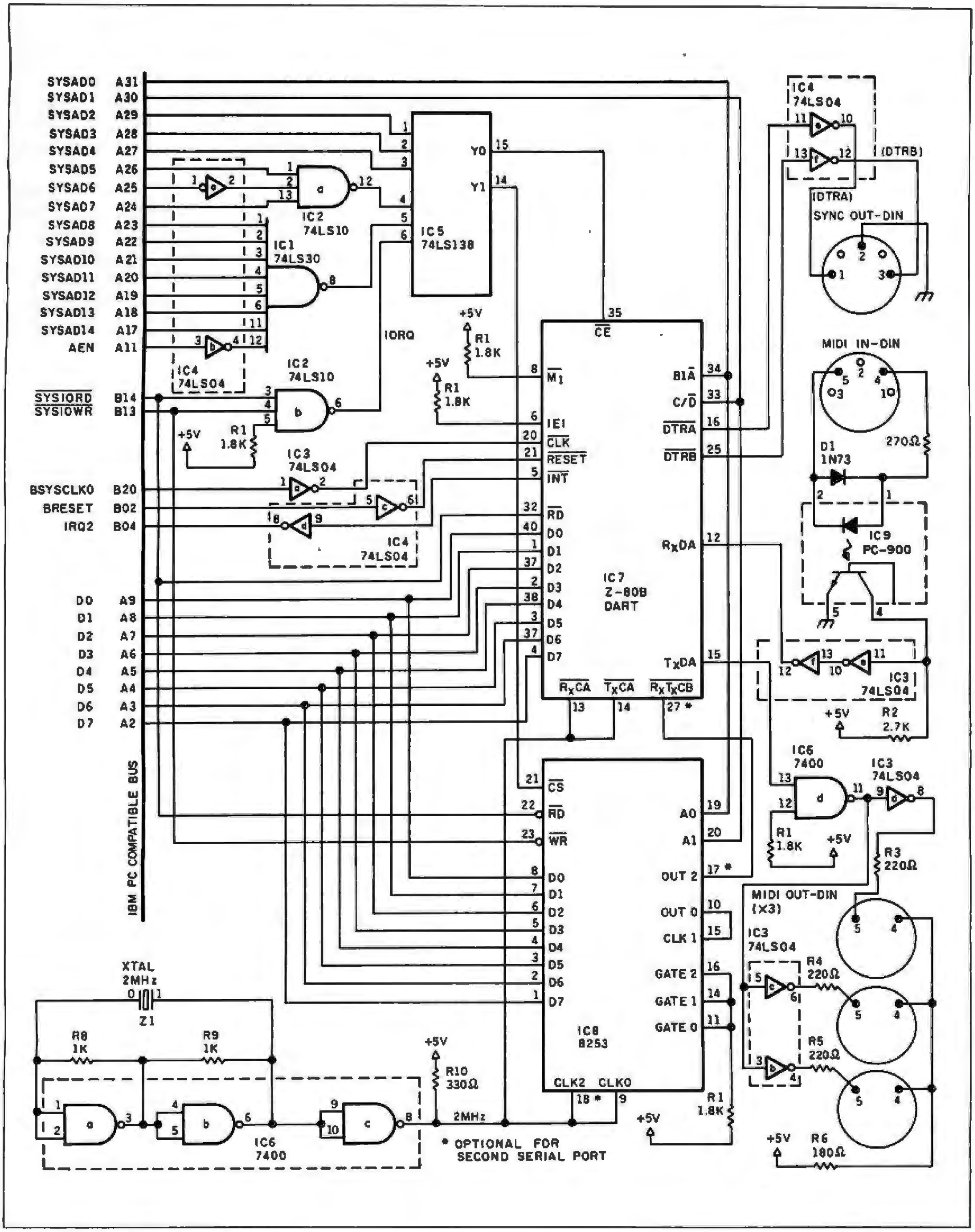

Figure 1: *The* MIDI 1.0 IBM *Board.*

channels of asynchronous communication at speeds up to 800,000 bps (only one channel of this chip is needed for the interface).

One of the major software goals of this project is to implement a sequencer that stores notes in a digital format for later playback. To do this you must keep track of when notes are received so you know when to play them back.

To keep track of the incoming data I used a dedicated timer, an Intel 8253 programmable interval timer (PIT), in the IBM PC. This timer provides three programmable down counters. This MIDI interface uses two of them.

The interface circuit consists of three major parts: selection circuitry, DART and MIDI bus interface circuitry including the synchronizer interface, and the 8253 PIT and associated crystal oscillator.

SELECTION CIRCUITRY

Almost everything else in the IBM PC uses nine bits to select an I/O address, but I used 15 bits to avoid having conflicting addresses with anything else in the system.

The DART has a status and a data port for each channel. The data ports (for channels A and B) are located at addresses FFA0 and FFA1 (all addresses are in hexadecimal notation). The status ports are at addresses FFA2 and FFA3.

The counter has a port for each timer plus one control port. The counter registers are at addresses FFA4 and FFA6, and the control register is at address FFA7. The DART, not being native to the IBM PC's Intel heritage, requires an IORQ (input/output request) signal that is generated by performing an OR operation on $\overline{\text{SYSIORD}}$ (input/output read) and $\overline{\text{SYSIOWR}}$ (input/output write).

The DART serves as the main link to the MIDI interface bus. Channel A receive data (RxDa) of the DART is connected to the bus by a Sharp PC-900 optoisolator. The incoming MIDI signal is protected by a 1N751 diode (D1) and buffered by inverters IC3 pin 10 and IC3 pin 12.

(Note: The MIDI 1.0 specification calls for an interface circuit using the Sharp PC-900 optoisolator. The TIL-111 could cause problems when used with certain synthesizers.)

Channel A transmit data (TxDa) drives NAND gate IC6 pin 11 and is then buffered by inverters IC3 pin 4, IC3 pin 6, and IC3 pin 8. The outputs of these inverters are serially terminated by 220-ohm resistors to match the MIDI interface bus impedance. This configuration gives you two extra outputs at very little cost. Most experimenters will find these extra outputs very useful.

The DART also provides sync outputs from $\overline{\text{DTRa}}$ (data terminal ready) and $\overline{\text{DTRb}}$. The sync output ($\overline{\text{DTRb}}$) provides a constant pulse of 24 beats per quarter note to external sync devices such as drum machines.

The sync interface also uses a 5-pin DIN connector. Pin 1 (DTRa) is start/stop (which starts and stops the external MIDI device), pin 2 is ground, and pin 3 is sync. Sync is a positive TTL-level square wave pulse. DTRa and DTRb are inverted (and buffered) by IC4 pin 10, and IC4 pin 12, respectively.

The 8253 PIT is used by the 16-track digital recording software that I will discuss later. The PIT has three programmable down counters capable of counting at over 2 MHz each. Note: The three gate leads (gate 0, gate 1, gate 2) of the PIT (pins 11, 14, and 16) must be tied to a logic high for the counters to function properly.

Timer 0 is clocked by the 2-MHz crystal oscillator circuit composed of crystal Z1, resistors R8 and R9, and IC6 pin 3, IC6 pin 6, and IC6 pin 8. Timer 0 divides the 2-MHz frequency down to the 24-beat-per-quarter-note level, which is then used as the clock for timer 1.

Timer 1 is used in conjunction with the music-recording software and sync interface.

Counter 2 (the third counter) may be optionally tied to the 2-MHz clock along with counter 0, and its output may be wired to the clock input of channel B of the DART, yielding an additional high-speed serial port.

PHASE 2: THE MIDI SOFTWARE

My software implements a 16-track polyphonic recording system (I will sometimes refer to tracks as buffers). With this software you will be able to record up to 16 tracks of polyphonic music and later play them all back together. Music can be entered to one track while other tracks are being played. Combine this capability with multiple synthesizers and you can simulate a whole band.

This software is written in C and 8088 assembly language and consists of three major parts—the receive-MIDI-data portion, the transmit-MIDI-data portion, and the support portion. [*Editor's note: Jay Kubicky's* MIDI *programs* MIDI111.C (*source code*) *and* RXINT11.A *can be downloaded from* BYTEnet *Listings at* (617) 861-9764. *They are also available on disk as explained in Disks and Downloads on page* 445, *or in hard copy by writing* BYTE, *One Phoenix Mill Lane, Peterborough*, NH 03458.]

RECEIVE FUNCTION

The receive portion of the program is responsible for receiving all incoming MIDI data and then storing the data in a buffer in the correct format (with two accompanying timing bytes from counter 1 of the 8253). Since counter 1 is clocked by counter 0, the music's tempo can later be altered by changing the preset of counter 0.

The receive portion of the program consists of two function levels. The top level is the record function, known as recbuff( ), which asks you which track you wish to record to. If there is data already in that track, recbuff( ) gives you an option to abort. If you decide to record to a track, recbuff( ) shows you the Track Enable screen. This screen allows you to choose which buffers are to be enabled to play and which channels they will be played on.

After selecting a track (buffer) and a channel, you select a metronome speed. This is presently from 40 to 200 beats per minute but would probably still work at around 300 beats per minute.

Next you are given various sync options. The first is audio sync, which beeps the IBM PC's internal speaker. The problem with this option is that it takes a long time, and if you are trying to play any other buffers while you record, it sounds choppy.

(continued)

The next option is drum sync, which sends 24 pulses per quarter note out over the sync-out connector. The last option is MIDI sync, which sends out 24 MIDI timing clocks per quarter note, as well as accompanying MIDI starts and stops.

When you have finished selecting options, the program lets you enable the interrupt and start the play( ) routine. The receive function is interrupt-driven so that data may be played and recorded at the same time. The DART is programmed to interrupt on all RxDs (receive data) and then Rxint (receive interrupt) is enabled.

The receive-interrupt function is ideal for this, since it operates independently of, and concurrently with, the rest of the program, and it takes up little time. The function setint( ) sets up Rxint as interrupt 0A. The functions inton( ) and intoff( ) turn the interrupt on and off by enabling it or disabling it in the DART. This is important because any extraneous playing at the keyboard might otherwise prove disastrous.

The use of multiple segments in the program presents a problem to the interrupt operation. For instance, when Rxint is called, there is no telling what the processor was doing prior to the MIDI interrupt. Thus, the DS (data segment) could be set at anything, and the program would have no access to external variables of buffer space. To avoid this potential problem, I store the DS at a fixed spot in low memory so that Rxint knows where to find it when it is called. This spot is located at 04FA and is reserved by DOS as a space for "intra-application communication."

Since the 8088 disables further interrupts when it executes any interrupt, you must be careful to turn the interrupts back on when entering Rxint so that system tasks such as supporting a timer can still be supported. The program must also issue an EOI (end of interrupt) to the 8259 PIC (programmable interrupt controller) just before returning. The Rxint function records the following types of MIDI data: note-on, note-off, program change, control change (all types), channel velocity, and note-bender. Figure 2 shows the format used to store MIDI data in memory.

As you can see from figure 2, four bytes are required for both note-on and note-off bytes. This stores a high resolution 16-bit timing byte and the note velocity. I chose to implement the sequencer this way because it is the easiest and most straightforward way possible. It is also possible to simply store a note and a duration byte (and perhaps one or two velocity bytes), but this would require much more complicated software.

To save memory, I chose to store

(continued)

Message Type:	First	Second	Third	Fourth	Fifth
note-on	00vvvvvv	LLLLLLLL	MMMMMMMM	1nnnnnnn	———
note-off	00vvvvvv	LLLLLLLL	MMMMMMMM	0nnnnnnn	———
control change	11000000	LLLLLLLL	MMMMMMMM	0NNNNNNN	0ccccccc
program change	01000000	LLLLLLLL	MMMMMMMM	0ppppppp	———
channel velocity	01000001	LLLLLLLL	MMMMMMMM	0aaaaaaa	———
note bender	10wwwwww	LLLLLLLL	MMMMMMMM	———	———

vvvv - top 6 bits of velocity byte
LLLLLLLL - low-order byte of time
MMMMMMMM - high-order byte of time
nnnnnnn - note number
NNNNNNN - controller number
ccccccc - controller value
ppppppp - new program
aaaaaaa - channel pressure
wwwww - top 6 bits of high-order byte of pitch-bender

Figure 2: *Memory format for* MIDI *program data.*

only the top 6 bits of the 14-bit pitch-bender code. To store all 14 bits would have required 5 bytes, and since pitch-bends don't usually take up a lot of space, 6 bits is enough. Control changes, however, do take up a lot of space (5 bytes). So I recommend that anything that outputs a control change be used sparingly.

Channel pressure (or velocity) is simply a way to transmit overall volume control over MIDI and is generally implemented on remote keyboards only.

PLAY FUNCTION

The play portion of the program compares the timing bytes of the data stored in each track against the value of the 8253's counter 1 and sends out the appropriate codes when it finds a match.

The playnote function consists of four levels. The first level (pbuffs( )) is used for setup. This function asks you to select buffer assignments, metronome speed, and sync options, just like the recbuff( ) function. When the selection process is completed, the program starts the play( ) routine.

This function loops through all the active tracks (up to 16 tracks). (A track doesn't have to be active, even if it has music in it.) If the program finds an active track, the program then calls playfrom( ). If all active tracks, or just track 0 (the conductor track), have run out of data, the playfrom( ) function returns. Otherwise, it loops through each track and checks timing information after each loop. Then after all 16 loops, it polls the keyboard and checks for a critical-error return from Rxint.

Playfrom( ) compares the next message stored in the buffer with the current timing value of the 8253. Then it decides if the counter value is equal to or less than the value in memory (remember, the 8253 is a down counter). If it is time for a given message to be sent out, the playfrom( ) function switches the top two bits of the first byte of the message to create the necessary MIDI function required.

The final layer of the play loop contains three functions that are written in machine language for the speed advantage. The rest of the program is devoted to support and added features.

RUNNING THE PROGRAM

When executed, the program seizes all contiguous RAM until it runs out of either buffers or memory. A minimum of two and a maximum of sixteen 24K-byte (3200-note) buffers are available for recording and playback.

After the memory allocation, a main menu displays all available options: Erase a Track, Record to a Track, Play from a Track, Track Information, Save a Track, Load a Track, Set MIDI Modes, Modify Input Filter, and Quit.

Only one option requires explanation. Track Information displays the transmit channel number, the memory used, memory remaining, and total memory in a given track. This is important information because Rxint has no memory-size checking and will let you play over track boundaries, "bleeding" onto the next track(s). This means you must be careful not to record onto tracks that have been "bled on." The input filter is associated with the Rxint routine and filters out certain commands (such as pitch-bend, etc.) before they are saved in the buffer.

My MIDI interface program provides no editing capabilities, but these could easily be added. It also does not provide auto-correction, which is the process of rounding notes off to the nearest eighth note, sixteenth note, etc., to make up for sloppy playing.

The entire MIDI interface program was written with the DeSmet C compiler, and certain elements of it may be compiler-dependent.

Other MIDI interfaces are available for the IBM PC, and the software associated with them provides added features, but they are often expensive. Typical MIDI interface hardware for the IBM PC costs $200. The software needed for the interface can cost from $50 to $500. This entire interface can be built for under $75 including the software.

Editor's note: Copies of the MIDI specification can be obtained by sending $35 to the International MIDI Association, 11857 Hartsbrook St., North Hollywood, CA 91607, (818) 505-8964. ■

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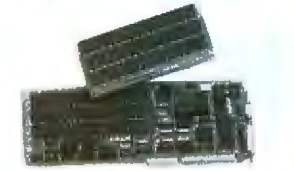

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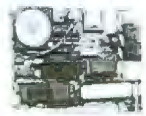

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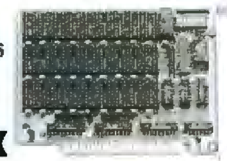

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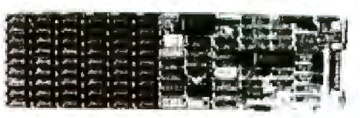

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MIDI PROGRAMMING

BY DONALD SWEARINGEN

Processing the MPU-401 *track data stream*

IN A PREVIOUS BYTE article ("A MIDI Recorder," *Inside the IBM PCs*, Fall 1985), I described a software system, written in FORTH, for recording and playing back keyboard music using a MIDI-equipped synthesizer and Roland Corporation's MPU-401 MIDI interface for the IBM PC. The program in that article, MPU401.PCF, handles the communication requirements of the MPU-401 device and the MIDI protocol to store and play back MIDI data. MPU401.PCF stores the MIDI data received from the MPU-401 for each of eight "tracks" (which make up the track data stream) in the memory of the IBM PC as an array of 4096 contiguous bytes.

In this article, I will present a number of software algorithms, written in Turbo Pascal for the IBM PC, for processing such a track data stream. Among these are procedures for transposing MIDI pitches, scaling MIDI velocity values, modifying MIDI channel information, and quantizing timing values.

MIDI PROCESSING CONSTANTS

The MPU-401 track data stream consists of a succession of track events (see figure 1). To simplify the processing of the track data stream, I have defined a number of constants and data structures that are useful in manipulating the basic track events and MIDI information in the track data stream.

The program constants (listing 1) establish certain values that are used throughout the track data stream processing procedures. (Good programming dictates that you isolate such values in a single section of the program rather than scatter "magic numbers" throughout your code. This way, you only need to make modifications to any quantities in question in one place.)

The MPU-401 constants are values expected in track events received from the MPU-401. They represent either a special timing overflow byte or one of several MPU "marks" that the MPU-401 transmits in the track data stream. The MPU-401 default timebase and tempo constants will be used to calculate actual track event times as a function of the relative event timing bytes contained in each track event.

The MIDI command constants represent the eight basic MIDI commands that are contained within MIDI status bytes (figure 2). Listing 1 also defines a text string for each MIDI command, to be used in translating the track events within a track data stream into a readable format.

Following the MIDI text, listing 1 defines a number of general-purpose constants that the MIDI processing functions require: error flags for function results, the size of data files containing track data, some MS-DOS file system constants, and text for hexadecimal conversions.

MIDI PROCESSING DATA TYPES

The MIDI data types (listing 2) define the basic structures around which the MIDI processing functions will be designed.

The hex_str type is used for conversion of a single byte to its hexadecimal equivalent in ASCII.

The track_event_type summarizes the various types of track events the program may expect to receive from the MPU-401. The track_event structure is designed to store a single

(continued)

Donald Swearingen (100 Valencia #261, San Francisco, CA 94103) is a freelance software developer, consultant, musician, and composer.

	Track Events				Event type	Description
	Timing byte	Event message bytes				
1-byte event	F8				OVFL	Timing overflow
2-byte events	00–EF 00–EF 00–EF	F8 F9 FC			MARK	MPU Marks NOP (F8), Measure end (F9) Data end (FC)
3-byte events	00–EF 00–EF 00–EF	00–7F 00–7F C0–DF	 00–7F 00–7F		MIDI	MIDI messages using current running status
4-byte events	00–EF 00–EF	80–BF E0–EF	00–7F 00–7F	00–7F 00–7F	MIDI_RS	MIDI messages establishing new running status

Figure 1: *The* MPU-401 *track data stream consists of track events, which may be one of four types and may be from 1 to 4 bytes long.*

Listing 1: *Constants used in processing the* MPU-401 *track data stream.*

```
const
  TIMING_OVERFLOW = 248;        { MPU-401 Constants }
  NOP = 248;
  MEASURE_END = 249;
  DATA_END = 252;
  MAX_TIMING_COUNT = 240;

  TIMEBASE = 120.0;             { MPU-401 Default Timebase }
  TEMPO = 100.0;                { MPU-401 Default Tempo }

  MIN_MIDI_DATA = 0;            { Minimum MIDI Data Value }
  MAX_MIDI_DATA = 127;          { Maximum MIDI Data Value }

  NOTE_OFF = 0;                 { MIDI Commands }
  NOTE_ON = 1;
  AFTER_TOUCH_K = 2;
  CONTROL_CHANGE = 3;
  PROGRAM_CHANGE = 4;
  AFTER_TOUCH_P = 5;
  PITCH_WHEEL = 6;
  SYSTEM_EXCLUSIVE = 7;

  MIDI_MESS_TEXT :              { MIDI Command Text Strings }
    array[0..7] of string[20] =
    ('Note Off',
     'Note On',
     'After Touch (key)',
     'Control Change',
     'Program Change',
     'After Touch (poly)',
     'Pitch Wheel',
     'System Exclusive');

  ERR = -1;                     { Function error flags }
  NOERR = 0;

  TRACK_DATAFILE_SIZE = 4096; { MPU-401 track data file }

  FILENAME_LEN = 14;            { MSDOS filename length }
  RECORD_LEN = 128;             { MSDOS record length }

  DIGITS :                      { Hex conversion digits }
    array[0..15] of char =
      '0123456789ABCDEF';
```

track event. The track_event_block structure (figure 3) contains a single track event and the "environment" in which the event occurs, including the running status for the track from which the event was extracted, the event length, and the event type.

The track_data_stream structure simply provides storage for a single track data stream. The track_data_block structure (figure 4) contains a complete track data stream (tds) and several other items useful in stepping through the track events contained in the track data stream: a pointer to the next byte to be accessed in the track data stream (tds_ptr), an end-of-data indicator (edat), and the track event currently being processed in the track data stream (curr).

A final track event block constant (OVFL_EVENT) is defined for use as a timing spacer in a track data stream.

Simple MIDI Utilities

You can use the basic MIDI utility functions (listing 3) apart from the MPU-401 processing environment. They operate strictly on MIDI data, independent of track data stream considerations.

The Boolean function midi_status determines whether a prospective MIDI data byte is a MIDI status byte. Function midi_chan returns the MIDI channel (0–15) from a MIDI status byte. Function midi_cmnd returns the MIDI command portion from a MIDI status byte. Function nmdat

(continued)

BIT	7	6	5	4	3	2	1	0
VALUE	1	COMMAND			CHANNEL			

Figure 2: *A* MIDI *status byte contains a 3-bit figure that represents one of the eight basic* MIDI *commands and a 4-bit figure that directs the* MIDI *message to one of up to* 16 MIDI *devices connected to the system.*

Listing 2: *Data types used in processing the* MPU-401 *track data stream.*

```
type
  hex_str = string[2];      { Result of byte-->hex conversion }
  track_event_type =               { MPU-401 Track event type }
    (
    OVFL,                                   { Timing Overflow }
    MARK,                                          { MPU mark }
    MIDI,                   { MIDI using curr. running status }
    MIDI_RS,                { MIDI setting new running status }
    UNKNOWN                           { Undefined track event }
    );
  track_event =                         { Single track event }
    record
      time : byte;                      { Event relative time }
      mess : array[1..3] of byte;          { Event directive }
    end;
  track_event_block =      { Track event access environment }
    record
      running_status : byte;{ Current track running status }
      event_len : 1..4;{Event length,including timing byte }
      event_type : track_event_type;
      event : track_event;
    end;
  track_data_stream =    { In memory track data stream file }
    array[1..TRACK_DATAFILE_SIZE] of byte;
  track_data_block ={ track data stream access environment }
    record
      tde : track_data_stream;                  { track data }
                                   { track data read pointer }
      tds_ptr : 1..TRACK_DATAFILE_SIZE;
      edat : boolean;           { indicates end of track data }
      curr : track_event_block;        { current track event }
    end;

const
                                { Track overflow event constant }
  OVFL_EVENT : track_event_block =
    (                             { used to insert timing spacers }
    running_status:0;                 { into Track Data Stream }
    event_len:1;
    event_type:OVFL;
    event:
      (
      time:MAX_TIMING_COUNT;
      mess:(0,0,0)
      )
    );
```

returns the number of data bytes associated with a given MIDI running status. Function midi_data_limit limits MIDI data to values within the accepted MIDI data range, as necessitated by certain types of processing of MIDI data values (e.g., scaling velocity data).

Use of these basic MIDI utilities enhances the understandability of the source code while providing for a more efficient MIDI programming environment.

MANAGING THE TRACK DATA STREAM

The procedures and functions for managing the track data stream (listing 4) move track data between MS-DOS files and track data blocks. They also provide access to data bytes within the track data stream and allow you to display (dump) a track data stream in hexadecimal format.

The Turbo Pascal routines described in this article can process the unaltered track data stored by the FORTH program MPU401.PCF. However, the data arrays used by MPU401.PCF for storage of track data must somehow be made available in the Turbo Pascal environment. To accomplish this, you can store a track data stream array (all 4096 bytes) from the FORTH environment into an MS-DOS block file. Then you can easily read the file into a track data block structure for processing in Turbo Pascal. You can then load the output files created by the Turbo Pascal routines back into the FORTH environment for playback.

The procedure reset_track_data resets the "environment" variables in a track data block so that the track data block can be accessed from the beginning. Procedure load_track_data prompts the user for the name of the MS-DOS file to be loaded and then loads the file into a target track data block. Procedure save_track_data saves a track data block in a specified MS-DOS file.

The function this_byte returns the current data byte in the track data stream within a track data block. The procedure advance moves the track data stream pointer in a track data

(continued)

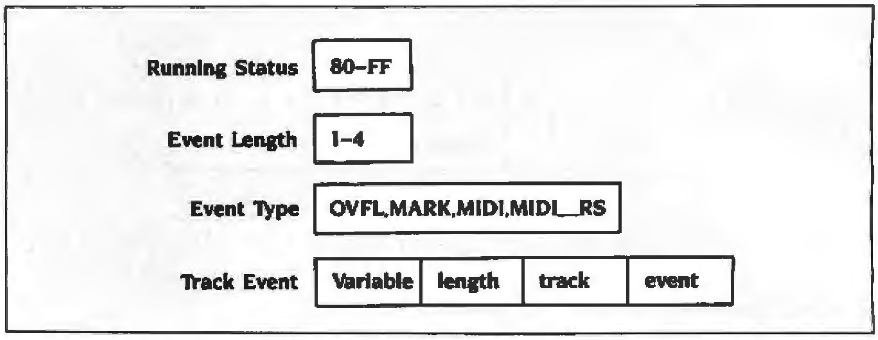

Figure 3: *The track event block contains the running status for the track from which the event was extracted, the event length (from 1 to 4 bytes long), the type of event, and the actual track event.*

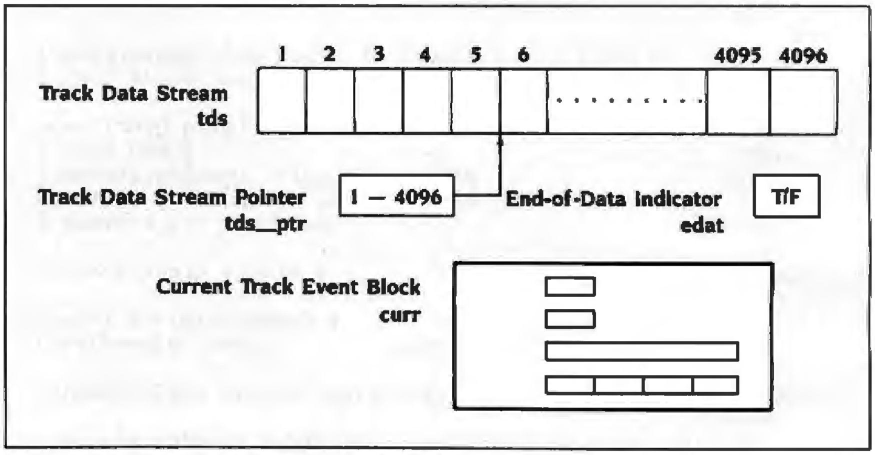

Figure 4: *The track data block structure (as defined by listing 2) contains a complete track data stream (up to 4096 bytes long) made up of variable-length track events, a pointer to the next byte to be accessed, an end-of-data indicator, and the track event currently being processed.*

Listing 3: *Basic MIDI utility functions.*

```
{ Return true if input is a MIDI status byte
}
function midi_status(midi_data_byte:byte):boolean;
begin
if (midi_data_byte > MAX_MIDI_DATA) then
  midi_status:=true
else
  midi_status:=false;
end;

{ Return the channel # from a MIDI status byte
}
function midi_chan(running_status:byte):byte;
begin
midi_chan:=running_status and 15;
end;

{ Return the command portion of a MIDI status byte
}
function midi_cmnd(running_status:byte):byte;
begin
```

```
midi_cmnd:=(running_status shr 4) and 7;
end;

{ Return # of data bytes associated
  with a given MIDI status byte
}
function nmdat(running_status:byte):byte;
begin
if (midi_cmnd(running_status) in
  [PROGRAM_CHANGE, AFTER_TOUCH_P]) then
  nmdat:=1
else
  nmdat:=2;
end;

{ Limit input to valid MIDI data range
}
function midi_data_limit(midi_data_byte:integer):byte;
begin
if midi_data_byte < MIN_MIDI_DATA then
  midi_data_limit:=MIN_MIDI_DATA
else if midi_data_byte > MAX_MIDI_DATA then
  midi_data_limit:=MAX_MIDI_DATA
else
  midi_data_limit:=midi_data_byte;
end;
```

Listing 4: *Basic track data stream procedures and functions.*

```
{ Reset status and pointer variables in track data block
}
procedure reset_track_data(var tdt:track_data_block);
begin
with tdt do
  begin
  tds_ptr:=1;
  edat:=false;
  curr.running_status:=0;
  curr.event_type:=UNKNOWN;
  end;
end;

{ Load track data stream from user
  specified file into track data block
}
procedure load_track_data(var tdt:track_data_block);
var
  tdf : File;
  tdfn : string[FILENAME_LEN];
begin
reset_track_data(tdt);
write('Track data filename: ');
readln(tdfn);
assign(tdf,tdfn);
reset(tdf);
blockread(tdf,tdt.tds,TRACK_DATAFILE_SIZE div RECORD_LEN);
close(tdf);
end;

{ Save track data stream from track
  data block to user specified file
}
procedure save_track_data(tdt:track_data_block);
var
  tdf : File;
```

(continued)

The track event management functions constitute the core of the MIDI *data processing routines.*

block forward to point to the next data value.

The function itox and the procedure dump_track_data work together to provide a hexadecimal dump of a track data block on the console device.

Track Event Management

The track event management functions (listing 5) constitute the core of the MIDI processing routines. These functions and procedures serve to simplify the actual processing of the track events in the MPU-401 track data stream.

The procedures track_event_message and next_track_event work together to copy the next track event in the track data stream within a track data block into its current track event block. The action of these procedures is built entirely around the structure of the MPU-401 track event (recall figure 1), which can be from 1 to 4 bytes in length.

Procedure next_track_event scans the next byte of the track data stream (assumed to be a timing byte) to determine the appropriate action to take. If the byte represents a timing overflow event, the procedure places the single-byte event in the current event block and the procedure takes an exit. If the track event is a multibyte event, the procedure passes control to track_event_message so that the message bytes of the track event can be placed in the current event block.

Procedure track_event_message handles MARK, MIDI, and MIDI_RS track event types. In the case of MARK events, the practice stores the single message byte in the current

(continued)

```
  tdfn : string[FILENAME_LEN];
begin
write('Track data filename: ');
readln(tdfn);
assign(tdf,tdfn);
rewrite(tdf);
blockwrite(tdf,tdt.tds,TRACK_DATAFILE_SIZE div RECORD_LEN);
close(tdf);
end;

{ Return current track data byte from track data block
}
function this_byte(tdt:track_data_block):byte;
begin
this_byte:=tdt.tds[tdt.tds_ptr];
end;

{ Advance pointer to next track data byte
  in track data block
}
procedure advance(var tdt:track_data_block);
begin
tdt.tds_ptr:=tdt.tds_ptr+1;
end;

{ Convert byte to hexadecimal ASCII string
}
function itox(i:byte): hex_str;
begin
itox[0]:=chr(2);
itox[1]:=DIGITS[i div 16];
itox[2]:=DIGITS[i mod 16];
end;

{ Dump track data stream in hexadecimal format
}
procedure dump_track_data(var tdt:track_data_block);
label
  return;
var
  n,st,off : integer;
begin
writeln('Track Data Stream Dump...');
writeln;
write('      ');
for n:=0 to 15 do
  write(itox(n):4);
writeln;
n:=0;
while (n < TRACK_DATAFILE_SIZE div 16) do
  begin
  st:=n*16;
  write(itox(st div 256):2,itox(st mod 256):2,' ');
  for off:=0 to 15 do
    begin
    write(itox(ord(tdt.tds[st+off+1])):4);
    if (tdt.tds[st+off+1] = DATA_END) then
      goto return;
    end;
  writeln;
  n:=n+1;
  end;
return:
writeln;
end;
```

Listing 5: *Procedures and functions for processing track events.*

```
{ Fill in the message bytes of the current
  Track Event in a Track Data Block
}
procedure track_event_message(var tdt:track_data_block);
var
  i : byte;  { index counter }
label
  return;
begin
with tdt.curr do
  begin
  case this_byte(tdt) of
    NOP, MEASURE_END, DATA_END:
      begin
      event_type:=MARK;
      if (this_byte(tdt) = DATA_END) then
        tdt.edat:=true;
      event.mess[event_len]:=this_byte(tdt);
      event_len:=event_len+1;
      advance(tdt);
      goto return;
      end;
    128..239: { MIDI status byte }
      begin
      running_status:=this_byte(tdt);
      event_type:=MIDI_RS;
      event.mess[event_len]:=this_byte(tdt);
      event_len:=event_len+1;
      advance(tdt);
      end;
    else
      event_type:=MIDI;
    end; { case }

  { fill in MIDI data bytes }
  for i:=1 to nmdat(tdt.curr.running_status) do
    begin
    event.mess[event_len]:=this_byte(tdt);
    event_len:=event_len+1;
    advance(tdt);
    end;
  end; { with tdt.curr }
return:
end;

{ Advance to the next Track Event in a Track Data Block
}
procedure next_track_event(var tdt:track_data_block);
label
  return;
begin
if (tdt.edat) then { end of data }
  goto return;
with tdt.curr do
  begin
  event_len:=1; { count event time }
  case this_byte(tdt) of
    TIMING_OVERFLOW:
      begin
      event_type:=OVFL;
      event.time:=MAX_TIMING_COUNT;
      advance(tdt);
      goto return;
      end;
    0..239: { timing byte }
      begin
```

(continued)

```
        event.time:=this_byte(tdt);
        advance(tdt);
        track_event_message(tdt);
        end;
      end; { case }
    end; { with tdt.curr }
return:
end;

{ Store a Track Event in a designated Track Data Block
}
procedure store_track_event(var tdo:track_data_block;
                            eblk:track_event_block);
var
  i : byte;  { index counter }
begin
case eblk.event.time of
  MAX_TIMING_COUNT:
    begin
    tdo.tds[tdo.tds_ptr]:=TIMING_OVERFLOW;
    advance(tdo);
    end;
  0..239:
    begin
    tdo.tds[tdo.tds_ptr]:=eblk.event.time;
    advance(tdo);
    for i:=1 to eblk.event_len - 1 do
      begin
      tdo.tds[tdo.tds_ptr]:=eblk.event.mess[i];
      advance(tdo);
      end;
    end;
  end; { case }
end;

{ Display a track event on the user console
}
procedure disp_event(eblk:track_event_block);
var
  i : byte;  { index counter }
label return;
begin
with eblk do
  begin
  write(event.time:4);
  if (event_len = 1) then
      begin
      write(' Timing Overflow':16);
      goto return;
      end;
  if (event.mess[1] in [NOP,MEASURE_END,DATA_END]) then
    begin
    case event.mess[1] of
      NOP :
        begin
        write('NOP':16);
        goto return;
        end;
      MEASURE_END:
        begin
        write('Measure End':16);
        goto return;
        end;
      DATA_END:
        begin
        write('Data End':16);
        goto return;
        end;
    end; {case}
    end; {if}
```

```
    i:=1;
    if (midi_status(event.mess[1])) then
      begin
      write(MIDI_MESS_TEXT[midi_cmnd(event.mess[1])]:16);
      i:=i+1;
      end
    else
      write(' ':16);
    while (i <= (event_len - 1)) do
      begin
      write(event.mess[i]:4);
      i:=i+1;
      end;
    end; { with eblk }
  return;
  writeln;
  end;

  { Display all of the Track Events in a Track Data Block
  }
  procedure disp_track_data(var tdt:track_data_block);
  var
    time : real;  { Actual time of current track event }
  begin
  time:=0.0;
  reset_track_data(tdt);
  while not(tdt.edat) do
    begin
    next_track_event(tdt);
    time:=time+tdt.curr.event.time;
    write( ((time*60)/(TIMEBASE*TEMPO)):8:3  );
    disp_event(tdt.curr);
    end;
  end;
```

Listing 6: *Procedures and functions for processing* MIDI *key (pitch) data.*

```
{ Return offset of MIDI key data in
  Track Event message, if present
}
function midi_key_offset(var eblk:track_event_block;
                         chan:byte):integer;
begin
midi_key_offset:=ERR;  { default return value }
with eblk do
  begin
  if ((event_type in [MIDI, MIDI_RS])
    and (midi_cmnd(running_status)
      in [NOTE_OFF, NOTE_ON, AFTER_TOUCH_K])
    and (midi_chan(running_status) = chan)) then
      begin
      midi_key_offset:=1;
      if (event_type = MIDI_RS) then
      midi_key_offset:=2;
      end;
  end; { with eblk }
end;

{ Return MIDI key data from Track Event, if present
}
function get_midi_key(var eblk:track_event_block;
                      chan:byte):integer;
var
  key_offset : integer;
begin
```

The range of actions you might want to perform on the track events is limited only by your imagination.

event block (edat is set to true if the mark is a DATA__END mark) and the procedure takes an exit. For MIDI event types, the procedure copies the proper number of MIDI data bytes for the track data block's current running status into the current event block's message field. In the case of MIDI__RS event types, the procedure updates the track data block's current running status.

Procedure store__track__event stores a single track event from a track event block into a target track data block. This procedure completes the set of functions for accessing and storing track events contained within track data blocks. You can now manipulate the track events between the time they are accessed and the time they are stored without considering the access and storage mechanisms.

I have included two additional utility procedures for displaying a translated track data stream: disp__event displays a single track event on the console device, and disp__track__data displays all the track events in a track data block. Note that disp__track__data makes use of the MPU-401 TIMEBASE and TEMPO constants to display the actual time offset (in seconds) of each event from the beginning of the track data stream.

MIDI Information Processing

Given the constants, data structures, procedures, and functions discussed above, you now have the resources to begin processing the track events in the MPU-401's track data stream. While the range of possible actions you might want to perform on the track events is limited only by your imagination, the following examples may

```
get_midi_key:=ERR; { default return value }
key_offset:=midi_key_offset(eblk,chan);
if (key_offset <> ERR) then
  get_midi_key:=eblk.event.mess[key_offset];
end;

{ Set MIDI key value in a Track Event,
  if Track Event is of appropriate type
}
procedure set_midi_key(var eblk:track_event_block;
                           chan,key:byte);
var
  key_offset : integer;
begin
key_offset:=midi_key_offset(eblk,chan);
if (key_offset <> ERR) then
  eblk.event.mess[key_offset]:=key;
end;

{ Transpose all MIDI pitch (key) data
  for a channel in a Track Data block
}
procedure transpose_pitch(var tdi,tdo:track_data_block;
                              chan,trans:integer);
var
  curr_key : integer;  { MIDI key value from
                         current track event }
begin
reset_track_data(tdi);
reset_track_data(tdo);
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  curr_key:=get_midi_key(tdi.curr,chan);
  if (curr_key <> ERR) then
    set_midi_key(tdi.curr,chan,
                 midi_data_limit(curr_key+trans));
  store_track_event(tdo,tdi.curr);
  end;
end;
```

Listing 7: *Procedures and functions for processing* MIDI *velocity data.*

```
{ Return offset of MIDI velocity data in
  Track Event message, if present
}
function midi_vel_offset(eblk:track_event_block;
                           chan:byte):integer;
var
  offset : integer;
begin
midi_vel_offset:=ERR;  { default return value }
         { only MIDI key events have velocity }
offset:=midi_key_offset(eblk,chan);
if (offset <> ERR) then
  midi_vel_offset:=offset+1;
end;

{ Return MIDI velocity data from Track Event, if present
}
function get_midi_vel(eblk:track_event_block;
                        chan:byte):integer;
var
  vel_offset : integer;
begin
get_midi_vel:=ERR;  { default return value }
```

```
vel_offset:=midi_vel_offset(eblk,chan);
if (vel_offset <> ERR) then
  get_midi_vel:=eblk.event.mess[vel_offset];
end;

{ Set MIDI velocity value in Track Event,
  if Track Event is of appropriate type
}
procedure set_midi_vel(var eblk:track_event_block;
                       chan,vel:integer);
var
  vel_offset : integer;
begin
vel_offset:=midi_vel_offset(eblk,chan);
if (vel_offset <> ERR) then
  eblk.event.mess[vel_offset]:=vel;
end;

{ Scale all MIDI velocity data for
  a channel in a Track Data block
}
procedure scale_vel(var tdi,tdo:track_data_block;
                    chan:integer; vel_fact:real);
var
  curr_vel : integer;
begin
reset_track_data(tdi);
reset_track_data(tdo);
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  curr_vel:=get_midi_vel(tdi.curr,chan);
  if (curr_vel <> ERR) then
    set_midi_vel(tdi.curr,chan,trunc(curr_vel*vel_fact));
  store_track_event(tdo,tdi.curr);
  end;
end;
```

serve as an introduction to the subject.

One of the most common actions you might want to apply to MIDI data is to change the pitches in a track data stream by a constant factor (transposition). The procedures and functions for processing MIDI key data (listing 6) provide the necessary tools. The functions get_midi_key and midi_key_offset work together to return the key (pitch) value from a track event's message portion. These functions check to determine whether the track event is of the proper type (i.e., whether it represents a MIDI command where a key value is present) and return an error flag if no key data is present so that the track event can be skipped in any MIDI key processing. Procedure set_midi_key sets the MIDI key value of a track event (if the event is of the appropriate type). Finally, the procedure transpose_pitch transposes the key (pitch) values in all of a track data block's (tdi) track events, creating a new track data block (tdo) containing the pitch-altered track events. Note that all the key processing routines accept a MIDI channel input (chan) as the targeted MIDI channel for the transposition action. Also note that the transpose_pitch uses the function midi_data_limit to ensure that the transposed key data does not fall outside the range of valid MIDI data.

Another useful MIDI processing action is to scale or change (multiplying by a constant) all MIDI velocity (loudness) values in a track data stream. The MIDI velocity data procedures and functions (listing 7) provide this capability. These routines are written and function analogously to the MIDI key processing routines discussed above.

(continued)

Listing 8: *Procedures and functions for processing* MIDI *channel data.*

```
{ Redirect MIDI channel data in a
  Track Data Block to a new channel
}
procedure change_chan(var tdi,tdo:track_data_block;
                          old_chan,new_chan:byte);
begin
reset_track_data(tdi);
reset_track_data(tdo);
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  with tdi.curr do
    begin
    if (event_type = MIDI_RS) and
      (midi_chan(running_status) = old_chan) then
      event.mess[1]:=((event.mess[1] and $F0) or new_chan);
    store_track_event(tdo,tdi.curr);
    end;
  end;
end;

{ Extract a single MIDI channel from a Track Data Block
}
procedure extract_chan(var tdi,tdo:track_data_block;
                           chan:byte);
begin
reset_track_data(tdi);
reset_track_data(tdo);
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  with tdi.curr do
    begin
    if (event_type in [MIDI_RS,MIDI])
      and (midi_chan(running_status) <> chan) then
        begin { convert to NOP }
        event_type:=MARK;
        event_len:=2;
        event.mess[1]:=NOP;
        end;
      end;
  store_track_event(tdo,tdi.curr);
  end;
end;

{ Filter a MIDI channel from a Track Data Block
}
procedure filter_chan(var tdi,tdo:track_data_block;
begin                     chan:byte);
reset_track_data(tdi);
reset_track_data(tdo);
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  with tdi.curr do
    begin
    if (event_type in [MIDI_RS, MIDI])
      and (midi_chan(running_status) = chan) then
        begin { convert to NOP }
        event_type:=MARK;
        event_len:=2;
        event.mess[1]:=NOP;
        end;
    end;
  store_track_event(tdo,tdi.curr);
  end;
end;
```

The channel processing routines modify the portion of a status byte that sends a MIDI *message to one of* 16 *possible* MIDI *devices.*

The MIDI channel portion of the MIDI status byte directs a MIDI message to one of 16 possible destinations (synthesizers or other MIDI devices). Often, you need to modify the channel information in one way or another. The MIDI channel processing routines (listing 8) provide a number of useful routines of this nature. Procedure change_chan redirects all of a track data block's (tdi) track events for a given MIDI channel (old_chan) to another channel (new_chan), creating a new track data block (tdo). Procedure extract_chan extracts a single MIDI channel's track events from a track data block. The procedure passes that channel's track events unaltered to the output track data block while turning track events for all other MIDI channels into NOP (no operations) events. Procedure filter_chan performs the inverse of the operation performed by extract_chan, passing track events for all channels except the channel designated for filtering.

EVENT TIME QUANTIZATION

A final example of MIDI processing involves the "quantization" of the relative timing bytes in track events received from the MPU-401. This process consists of synchronizing the track event to the nearest multiple of a fixed timing constant quantum. While there are many possible ways to approach this problem, I have selected an algorithm that seeks to minimize the difference in the total elapsed time between the input track data stream and the output track data stream.

(continued)

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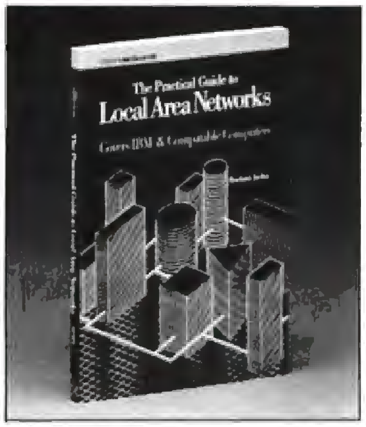

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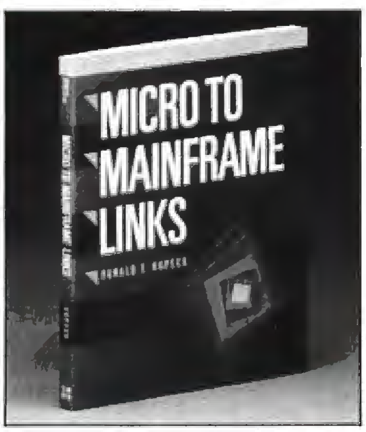

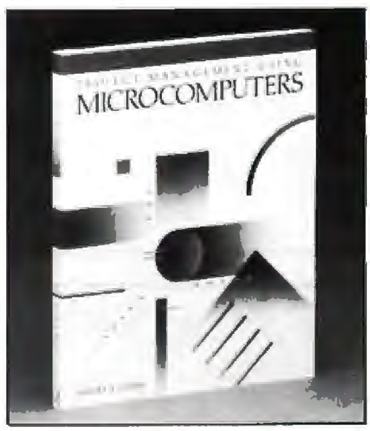

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Listing 9: A *procedure for quantizing timing values for track events.*

```
procedure quantize(var tdi,tdo:track_data_block;
                       quantum:integer);
var
  in_time : real;              { Actual elapsed time,      }
                               { input track data block    }
  out_time : real;             { Actual elapsed time,      }
                               { output track data block   }
  etime : integer;             { Temporary storage for     }
                               { adjustment of event time  }
  qround : integer;            { Rounding term             }
begin
reset_track_data(tdi);
reset_track_data(tdo);
qround:=quantum div 2;
in_time:=0.0;
out_time:=0.0;
while not(tdi.edat) do
  begin
  next_track_event(tdi);
  with tdi.curr do
    begin
    etime:=event.time;
    { Adjust in/out time variance }
    etime:=etime - trunc(out_time-in_time);
    { quantize }
    etime:=trunc(quantum * ((etime + qround) div quantum));
    in_time:=in_time+event.time;
    out_time:=out_time+etime;
    event.time:=etime;
    while event.time > MAX_TIMING_COUNT do
      begin
      store_track_event(tdo,OVFL_EVENT);
      event.time:=event.time-MAX_TIMING_COUNT;
      end;
    store_track_event(tdo,tdi.curr);
    end;
  end;
end;
```

Listing 10: A *sample program using several of the* MIDI *processing routines discussed.*

```
var
  tdt1,tdt2 : track_data_block;

begin { main }
load_track_data(tdt1);
disp_track_data(tdt1);
readln;

writeln('Transposing pitch for channel 0');
transpose_pitch(tdt1,tdt2,0,6);
dump_track_data(tdt2);
save_track_data(tdt2);

writeln('extracting channel 0');
extract_chan(tdt1,tdt2,0);
disp_track_data(tdt2);
save_track_data(tdt2);

writeln('filtering channel 0');
filter_chan(tdt1,tdt2,0);
disp_track_data(tdt2);
save_track_data(tdt2);

end. { main }
```

Procedure quantize (listing 9) maintains running totals (in_time, out_time) of the elapsed time in the input track data stream and the output track data stream, respectively. The procedure uses these totals to adjust the relative time of an output event before actually quantizing the event to the nearest multiple of the quantum value. If the quantization results in a relative time for the new event that exceeds the maximum possible timing count, timing overflow (null) events are placed in the output stream to represent the excess timing value before the track event in question is actually stored.

While the most accurate means of quantizing timing values would be to convert all the relative event times to actual event times before the quantization is applied, the algorithm presented here yields acceptable results.

MIDI PROCESSING EXAMPLE

Listing 10 illustrates the use of several of the MIDI processing functions in an actual program. In each case, a track data block is read from an MS-DOS file, the MIDI processing action is applied, and the resulting track data block is written to a new file for further usage. The routines dump_track_data and disp_track_data are used to display the results of the various processing actions.

CONCLUSION

While ambitious readers will surely find room for improvement and expansion on the ideas I have presented here, these Pascal routines provide a solid basis for understanding the requirements of MIDI data processing in the MPU-401 environment. I hope this introduction will serve as a useful stimulus to further MIDI programming activities. [*Editor's note: The programs described in this article are available for downloading from* BYTEnet *Listings at* (617) 861-9764 *or from* BIX (BYTE *Information Exchange). The programs are* LIST1.PAS, LIST2.PAS *(etc.), through* LIST10.PAS, *written in Turbo Pascal for the* IBM PC, *and* MPU401.PCF, *written in* PC/FORTH. *You will need Turbo Pascal and* PC/FORTH *to run them. The listings in this article are also available on disk. See page 445 for details.*] ■

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Warranty	1 Year	90 Days

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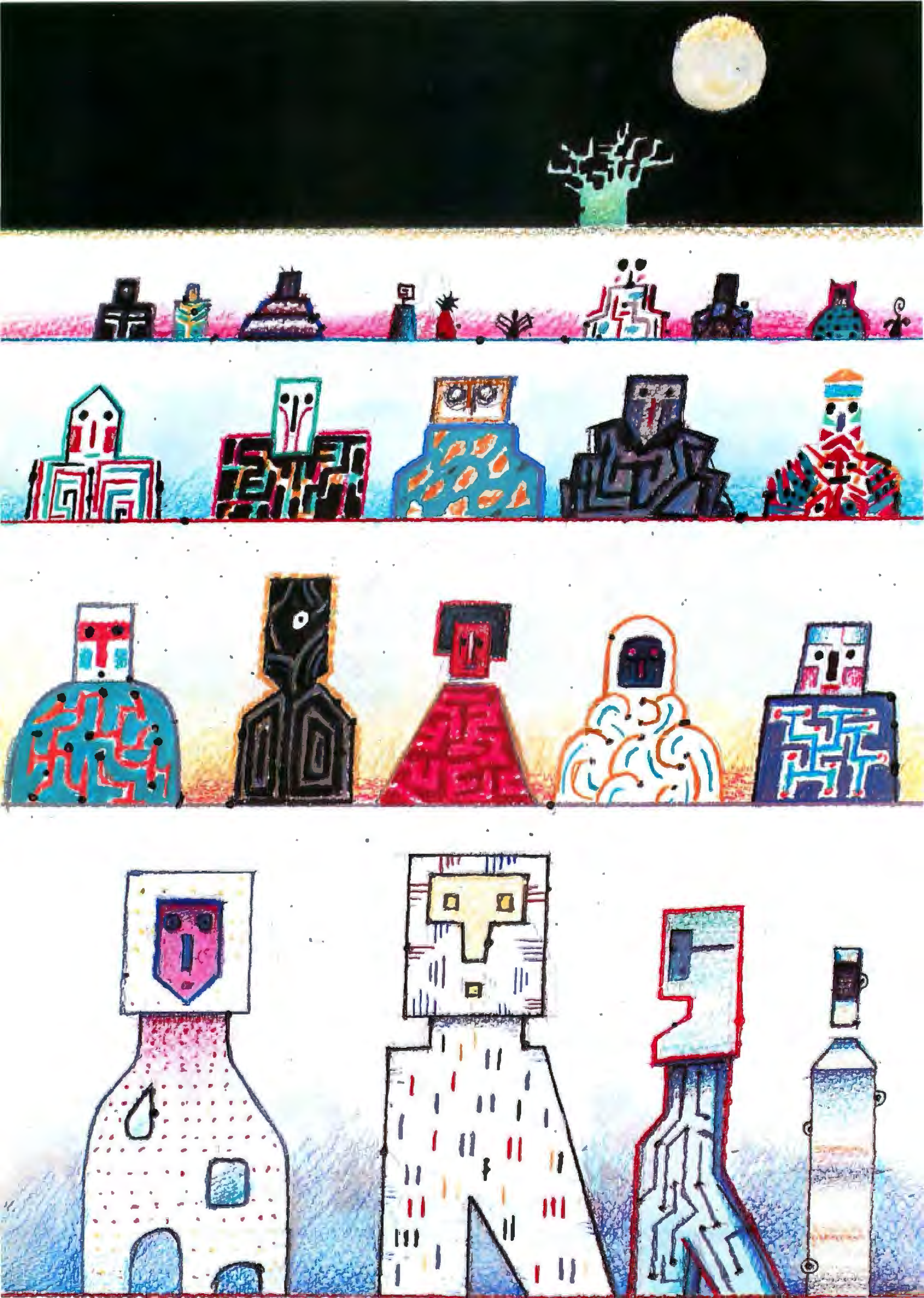

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ACCORDING TO ERIC JENSEN, the Atari 520ST is a very appealing machine and may well become popular. His praises and concerns are similar to those voiced in BYTE's product preview (January, page 84), but Eric also adds some special insight. And while he concludes that he would not be comfortable with the 520ST as his primary machine, the newly released Atari 1040ST does address many of his concerns.

The Compaq Deskpro 286 resembles the IBM PC–compatible Deskpro but has many more options. Stan Miastkowski reviewed the Model 1, whose basic configuration includes 256K bytes of RAM, a 1.2-megabyte floppy disk drive, and five expansion slots.

Wayne Rash reviews the TeleVideo Tele-286, an IBM PC AT compatible that runs at 8 MHz and comes with a standard 44-megabyte hard disk drive. He enjoyed working with the clone, although he found the documentation wanting.

The price of the Mix C compiler seemed too good to be true, so Richard Grehan, a BYTE technical editor, took a long hard look. He discovered that the product was full-featured and that the documentation alone was worth much of the cost. We should note also that Mix now provides a utility that clears up one of Richard's main reservations. Using their $10 MASM utility, you can now link object files created by Microsoft's MASM or M80 assemblers into your Mix C programs.

We have three reviews in support of the music theme. Roger Powell and Richard Grehan have investigated four MIDI interfaces that will allow you to use powerful MIDI-equipped keyboards and hardware with your Commodore 64, IBM PC, Apple II, or Macintosh.

Mario Bernardo examines two music software packages for the Macintosh. As a musician, he recommends Concertware+ as a fine tool for music composition but has serious reservations about SongPainter.

Finally, Christopher Morgan presents the Kurzweil 250 Digital Synthesizer, an impressive, sophisticated machine with 3.6 to 6 megabytes of ROM, 68000-based hardware, and a grand-piano sound. The price is high, but the technology providing the state-of-the-art music-development environment has lasting implications.

R·E·V·I·E·W·E·R'S N·O·T·E·B·O·O·K

There were many interesting products at the West Coast Computer Faire in San Francisco. Without a doubt, the most intriguing was David Small's MacCartridge, a cartridge-disk combination that allows 1-megabyte Atari STs to run Macintosh software faster, without modification, and using Atari's excellent and larger monochrome monitor. The product is real, but it may never be marketed, because Apple must approve its use of the Macintosh ROM. Still, I had to suppress a chuckle at the thought of using MacCartridge to run Meacom's Apple II emulator.

Speaking of which, I was also impressed with Mimic Inc.'s Spartan, an Apple II+ emulator for the Commodore 64. The $299 unit includes eight standard Apple-compatible peripheral slots, and it runs DOS 3.3, Applesoft, Integer BASIC, Apple Pascal, and CP/M (with a Z80 card). A DOS card allows your 1541 drive to read both Apple and Commodore disks and, because the emulators have their own CPU and two video outlets, you can run both Commodore and Apple software at the same time (to different monitors, of course).

There are yet more peripherals for both the Amiga and the ST. Micro Forge showed a seven-slot expansion box for the Amiga. The system can hold two 10- to 40-megabyte hard disk drives and comes with a 130-watt power supply. Developers in need of RAM disks and workspaces for use with audio and video digitizers may also appreciate Comspec's $1079 2-megabyte memory board, which comes with a pre-installed RAM test.

For the ST, Supra is now supplying 10- and 20-megabyte hard drives, the latter at the Faire for $799. The display unit at the Faire impressively flashed 32K-byte Neochrome images on a color monitor. Finally, LogiKhron has perhaps the first cartridge utility for the ST, a $50 clock card with an internal battery that automatically loads the date and time into the ST when you boot.

Two applications stand out. For the Amiga, there is Aegis's Animator, which is bundled with their Images. The Animator, a color animation tool, allows you to create 32-color objects, animate them, and create storyboards with backdrops from Images. You can alter the position, shape, size, and color of objects and rotate them or plot their path around the screen.

For the ST, there is Migraph's Easy Draw, a "professional drawing program" that requires TOS in ROM. The list of features is very impressive. In addition to conventional capabilities, you can adjust the size of the drawing surface, add shadows, and use wedges and arcs. The software can support many professional needs, from the creation of floor plans to the presentation of intricate three-dimensional shapes.

There were yet more IBM PC AT clones and at ever-decreasing prices. The Ceptre PC-galaxy is a $1995 AT compatible with eight slots (three of which are PC-compatible), a 6-MHz clock upgradable to 8 MHz, a 1.2-megabyte drive, and a 195-watt power supply. The Cranium 286/10 AT clone costs $3050, which includes a 235-watt power supply, 12 slots, 6-MHz or 10-MHz clock speed, and a 31-megabyte hard disk drive.

For IBM users, there is Software Carousel from SoftLogic Solutions, a $50 utility that accesses extended memory, allowing you to run up to 10 programs, each at the touch of a key. Every program can use all available system RAM because the software employs a virtual memory manager that can use lower RAM, AT extended RAM, "above board" RAM, or even disk space as a reservoir. And by establishing the amount of RAM each program will use, you can switch immediately among applications, pausing one while running the next.

And, for the PC, there is Finally!, a subroutine library for compiled BASIC from Komputerwerk that contains over 100 utilities that you can include in your souce code or link to your object code at run time. The utilities include a variety of general and geometrical mathematical functions, file and directory control, medium- and high-resolution graphics, hardware interfacing, number conversions, keyboard, printer and screen control, string handling, and sorting routines.

Lest Macintosh users feel slighted, I have enjoyed Affinity's Tempo, version 1.1, a macro facility that allows you to record and later replay keystrokes and mouse clicks. There are some special features. For example, you can make the playback of a macro conditional upon text in a document or the value of a spreadsheet cell. Macros are indispensable for carrying out repetitive tasks, but you will also enjoy automatically opening applications from the Finder and including dialog boxes within your macros. Unlike many macro facilities on the IBM PC, macros will only play back within the application in which you created them. You can suspend them by simply holding down the mouse button and even edit them during the pause.

And the reviews business goes on. We are organizing a joint review of new Modula-2 compilers for the Atari ST, Macintosh, and IBM PC. A Laser 128 is en route to a reviewer, and we are preparing in-house the formal review of the Amiga.

—*Jon Edwards*
Technical Editor, Reviews

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THE ATARI 520ST

BY ERIC JENSEN

The Atari 520ST is a very appealing machine. It is a good engine for bit-mapped graphics, with a good user interface and an attractive price. Still, the review machine had too many rough edges to serve as my primary machine. It is far from portable. A two-drive system put seven boxes on my tabletop and required four wall outlets.

The processor and each disk drive have separate power supplies and the four power switches are inconvenient. I don't like leaving the power supply plugged in while its output is turned off. It draws some power, and I worry that the system will be susceptible to power-line glitches even while turned off. The practical solution seems to be to use a switched outlet box.

A good engine for bit-mapped graphics at an attractive price

The 512K bytes of RAM is enough for most programming, although the operating system for the reviewed machine used more than 200K. [*Editor's note: The latest production units for the* 520ST *and* 1040ST *have* TOS *in* ROM.] In addition, the screen uses at least 32K more.

The displays are very crisp and clean, with enough resolution to draw pictures of good quality. The 12-inch screens provide almost twice the area of the 9-inch Macintosh screen. The SM124 monochrome monitor provides a 640- by 400-pixel display. This allows 22 lines of 110 characters in the directory font, or 20 lines of 77 in the standard font used in BASIC windows (allowing window borders), which is enough to do a fair job of emulating a dumb terminal. There are about 77 dots to the inch horizontally by 65 vertically, which is fine enough resolution to make the jagged edges of diagonal lines fairly unobtrusive.

You can run the SC1224 color monitor in two modes (640 by 200 pixels with 4 colors or 320 by 200 pixels with 16 colors). The lower resolution mode is the operating system's initial choice. This keeps the aspect ratio of icons the same as on the monochrome monitor and simply doubles their sizes. The jagged edges are noticeable here but not particularly offensive. I was very impressed by the lack of colored "shadow" edges on

(continued)

HARDWARE

The hardware appears clean. The 8-MHz clock rate (a bit faster than either Macintosh's or Amiga's) probably translates to about half a million typical instructions per second. There is no other special display support hardware, and none is needed for windowing applications. The display appears to be properly interleaved with the processor so that they do not have to wait for each other. The display generator is an interesting compromise. For the monochrome display, it fetches a word of data and shifts it out a bit at a time to determine the color for 16 successive pixels. For the color displays, it fetches either two or four words in sequence and shifts out a bit of each to develop a color lookup-table index. Again, there are 16 shift cycles before the next words must be fetched. Thus you have neither the situation in which all the bits describing one pixel are in one word, nor that in which the most significant bits for all pixels are contiguous in memory.

As long as this arrangement is hidden under GEM—as it should be for almost all users—this is fine, but there are a couple of cases in which it could be inconvenient. If you were to use multiple planes of memory (with a degenerate color map) to represent multiple overlayed images, then the images would be inconveniently intertwined. If you have to mask out an irregular region in a picture, then you have to know not only the number of words in a scan line but also the spacing between words, which may not be the same in the image and the mask.

Eric Jensen (50 *Carriage Lane, Bedford,* NH 03102) *is a programmer for Hastech Inc. His interests include artificial intelligence, math and logic, and displays.*

Windows are not erased as neatly as they might be—you often see that every underlying window gets a "please clean up" signal.

window borders and characters. Another plus is that you can work in black and white on this color monitor without eyestrain.

The disk drives use 356K-byte 3½-inch floppy disks. They seem reliable, but I had several problems. First, the cables are so short that most users will choose to put the drives to the left of the keyboard. If you try to put them on the right, they will block the mouse connector or sit at an uncomfortable angle. Second, you can press the eject button to remove disks, but the manuals do not explain whether it is safe to reset the machine or power down without first ejecting the disk. The eject button was also a bit inconsistent—crisp one time and mushy the next. Finally, the documentation does not explain that, in a two-drive system, the drive closer to the processor automatically becomes drive A. There are no switches to set or jumpers to connect. There is also no comment indicating that you cannot daisy-chain a third drive.

The two-button mouse has a good feel. You can remove the ball for cleaning, which is a nice feature not present on some professional workstations. However, I had one problem: I found double-clicking the buttons to be very difficult, even after adjusting the delay with the control panel. Perhaps Atari should be measuring up-to-down transition time rather than down-to-down. Perhaps button debouncing logic gets in the way.

Finally, the keyboard has about the same key feel (and exactly the same key spacing) as the Digital keyboard I use every day, so I like it. The oddest feature of the keyboard is the rhomboid shape of the function keys, which are almost impossible to hit without hitting their neighbors.

GEM

GEM appears to be a solid product, with a few excesses and inconveniences, but pretty well on target for anything short of animation. It includes calls equivalent to most of the Graphics Kernel System (GKS) used in many standard graphics programs, but it may be weak in the area of partially redrawn pictures.

Windows are not erased as neatly as they might be—you can often see that every underlying window gets a "please clean up" signal. And after clicking the mouse on any of the window-change bars, the cursor was not redisplayed until the mouse was moved. One of the few bugs I encountered here was a requirement that a window be retitled after it is moved. It seemed to acquire a new name on its first movement but not thereafter.

Atari's TOS, on the other hand, has a number of holes. I haven't documented any crashes. (It appears that memory may not completely recover when you change disks, leading to eventually running out of storage, but I haven't proved it. If so, it takes quite a few disk changes to run out of space.) I have, however, stumbled over a fairly steady stream of minor nuisances and cosmetic inconveniences. Exiting from a program back to the operating system, for example, does not reinitialize the color map; if, therefore, a program changes the colors to black and white, you might get back to the desktop and not see anything. Selecting textual instead of icon directory displays and then changing from low resolution to medium resolution leaves both icon and textual formats selected for the next directory display (and picks icon).

As a whole, though, TOS is a reasonable operating system. It provides a file system that looks almost identical to that in MS-DOS, with directories and subdirectories (called "folders" in the desktop idiom) and files with date and time stamp. (This latter feature is less useful than it should be because the clock resets with the processor, and it is easy to forget about it.)

The desktop command interface does a pretty good job of providing most of the commands possible with MS-DOS. My MS-DOS manual lists 31 commands. Fourteen translate directly, eight are simply calls to standard utility programs (two of which are provided here), six make no sense in translation (such as setting the prompt on the command line), and the last three are more difficult. Renaming a file requires selecting the file, getting a menu of "File Info," and overtyping the filename in the menu. Defining environment variables and creating batch jobs seem impossible, and commands that take arguments are a bit inconvenient. (The developer's package includes most of the missing utilities and a textual command interface that looks a lot like MS-DOS.)

The desktop is clearly much simpler than that provided with the Macintosh. Most of the basics are there, but, for example, there is no choice of font or type size from the main menu bar.

ATARI BASIC

The only languages that come bundled with the machine are Logo and BASIC. The BASIC on the review machine is modern, flashy, and huge. It will be more usable with the operating system in ROM, but with TOS in RAM, I had to disable graphics buffering and dimension the array as an integer array in order to use an array of 7000 elements. Still, Atari BASIC was considerably more than the minimal textbook language. It performed the BYTE computational benchmarks about twice as fast as an IBM PC, while apparently accumulating fewer floating-point errors, and it moved files about a third as fast.

The most obvious feature of the BASIC is its use of four windows—a command window at the bottom, a listing window at the upper left, an output window at the upper right, and an edit window pushed behind all of the above. Atari BASIC is smart enough to fill the screen on either the monochrome or the color monitor—a feature missing on the TOS desktop. There is an inconvenience here.

(continued)

AT A GLANCE

Name
Atari 520ST

Company
Atari Corp.
1196 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2000

Components
Processor: Motorola 68000
Memory: 512K bytes of dynamic RAM
Display: 12-inch monochrome or color
Graphics: Three modes, 640-by 400-pixel monochrome, 320 by 200 with 16 colors, and 640 by 200 with 4 colors
Keyboard: 94-key Selectric-style QWERTY keyboard with numeric keypad, cursor controls, and rhomboid function keys
Sound: Three independent sound channels from 30 Hz to 125 kHz
Floppy disk drive: Bundled, external 3½-inch single-sided double-density drive with capacity of 360K bytes; system supports maximum of two floppy disk drives

Interfaces
MIDI-in and MIDI-out ports
Monitor port (supports RGB analog, high-resolution monochrome)
Centronics parallel printer port (supports Epson-compatible printers)
RS-232C serial port
Floppy disk port
Hard disk port (10-megabit-per-second DMA transfer rate)
128K-byte ROM cartridge port
Ports for mouse or two joysticks

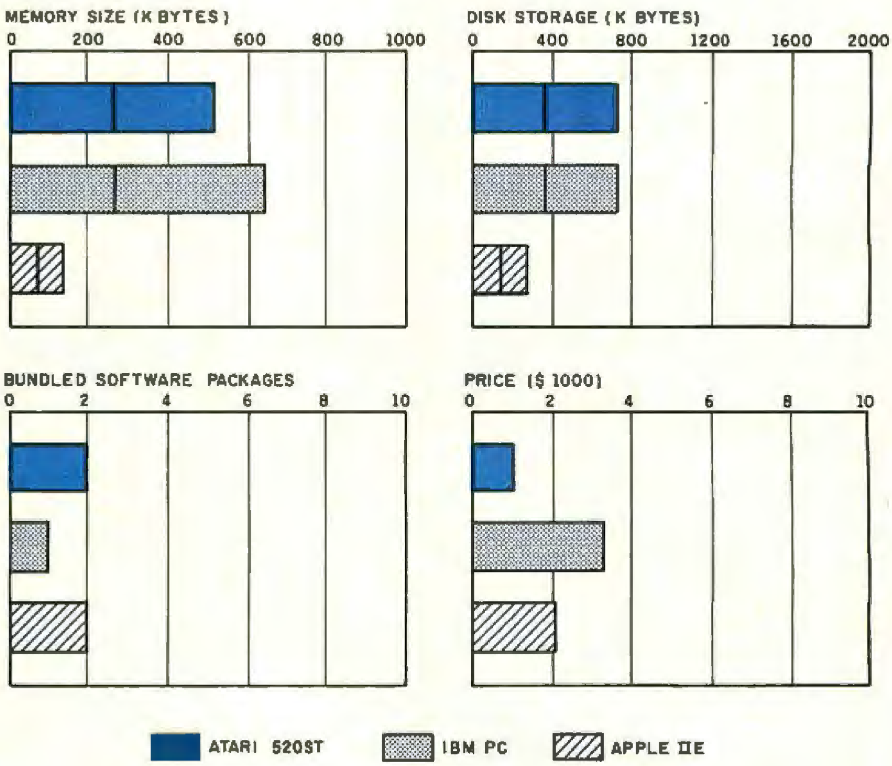
Bundled Software
Atari Logo, Atari BASIC

Optional Peripherals

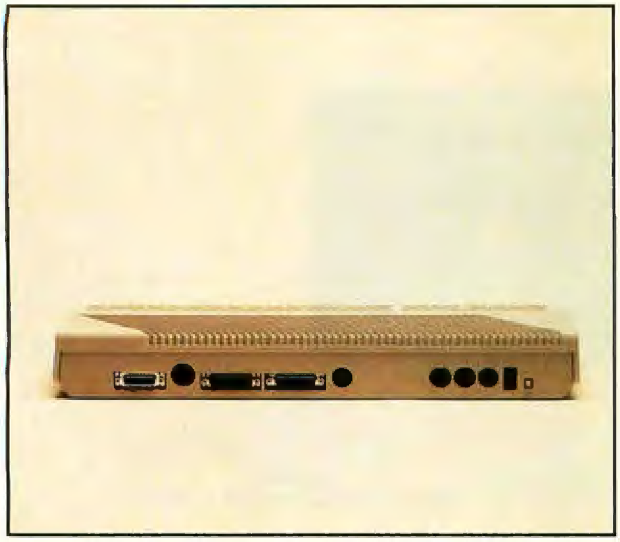
SF354 single-sided drive	$199
SF314 double-sided drive	$299

Price

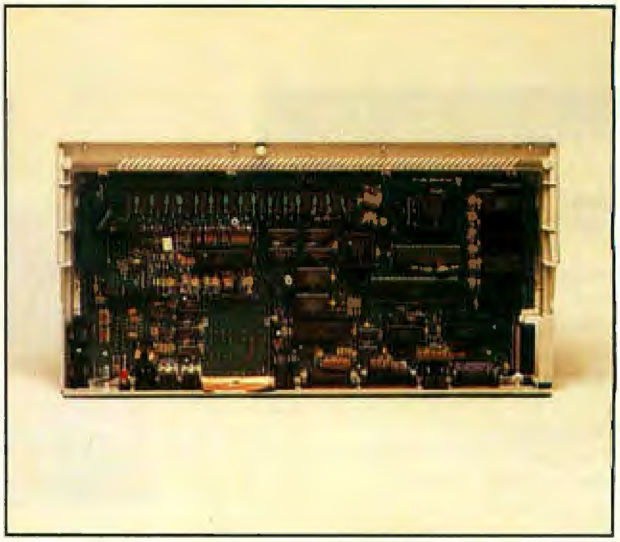
Monochrome system	$799
Color system	$999



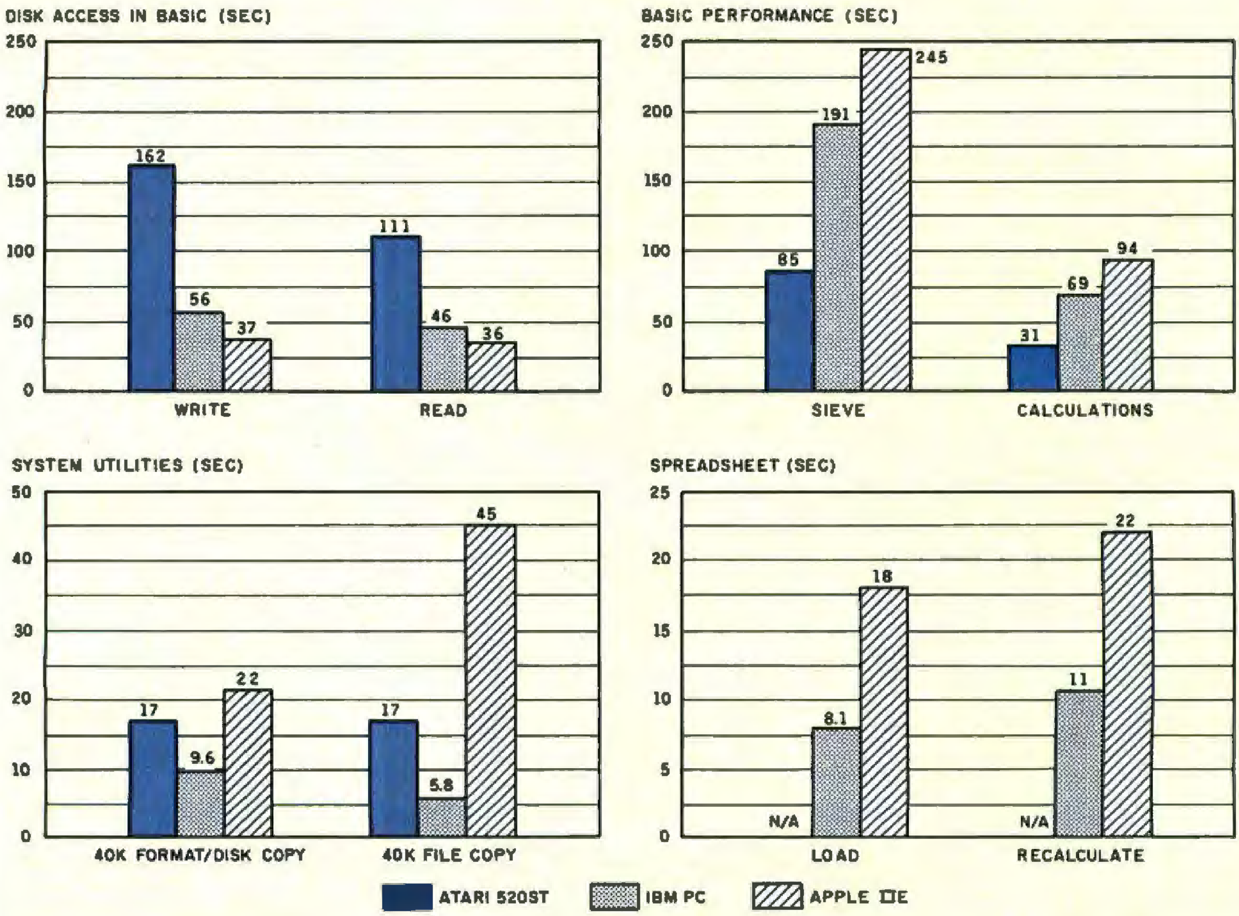
The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single floppy disk drive and the maximum standard capacity for each system. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of a system configured with two disk drives, a monochrome monitor with connection apparatus, a printer port and serial port, 256K bytes of memory (64K bytes for 8-bit systems), the standard operating system for the computers under comparison, and the standard BASIC interpreter. Note that the price of the Atari 520ST includes 512K bytes of memory and a second single-sided drive.



The ST ports include MIDI in and MIDI out, a Centronics parallel printer port, an RS-232C serial port, and a DMA port.



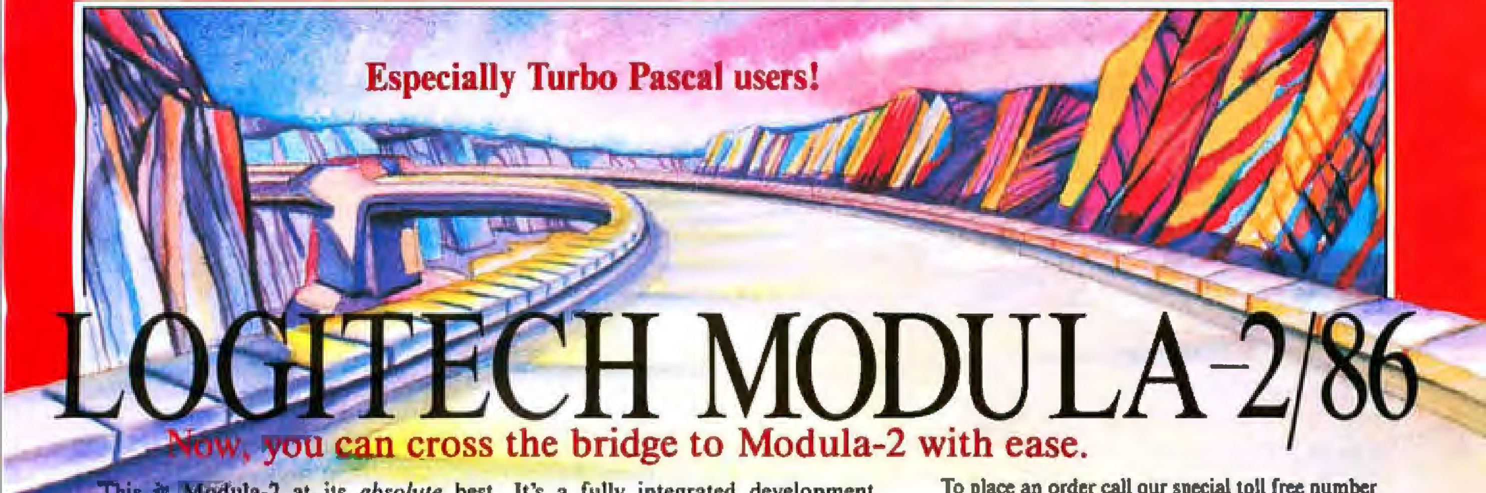
Inside the Atari 520ST.



The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers.

The System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. Tests for the Atari 520ST were done using TOS and Atari BASIC. Running the Sieve on the Atari required that we dimension the array as an integer array.

This is the Modula-2 compiler *everybody's* been waiting for...



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☐ Logitech Modula-2/86 Plus $189	☐ Utilities Package $49
Please add $6.50 for shipping and handling.	☐ Make Utility $29
	☐ Library Sources $99

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The developer's package includes a C compiler, linker, and debugger, and the glue to hold them together.

though. The BASIC automatically wraps text to the next line after 80 characters, but a color window line holds only 38, and monochrome 77, so you can never see all of a long line without panning. All the normal window controls are available, so each window can be repositioned, resized, or even closed. You will soon discover the convenience of being able to keep an old listing on the screen in one window while you type modifications into another.

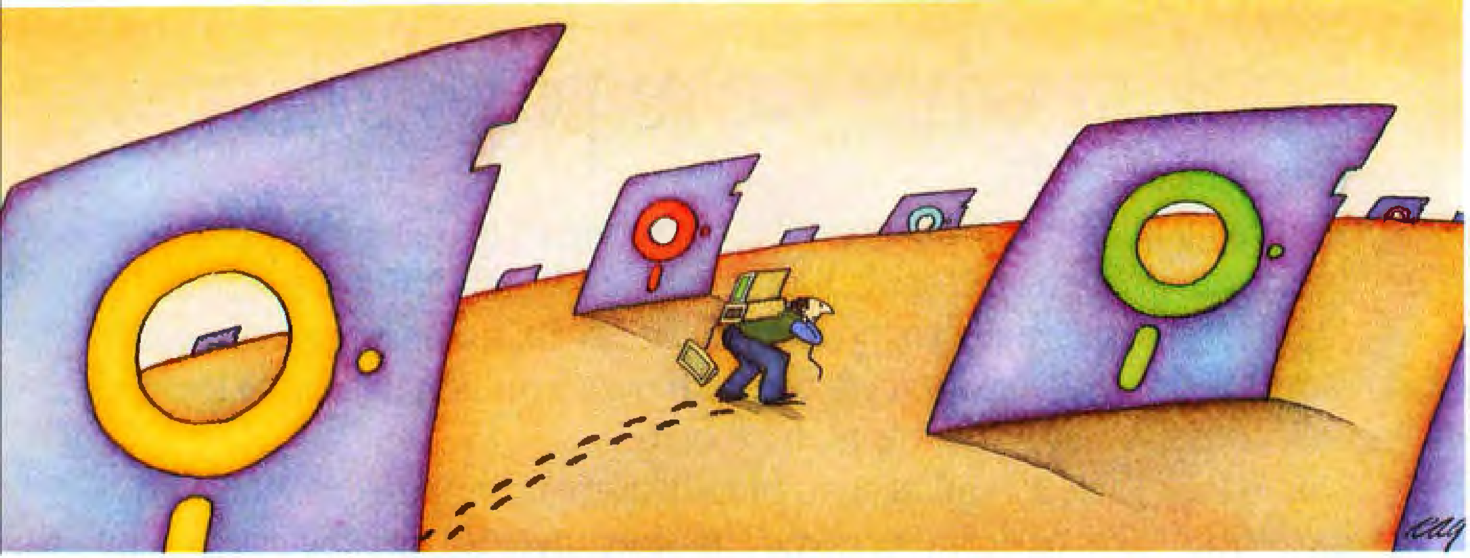
The editing features are woefully short of general word processing. You can move the cursor (with the cursor keys but not the mouse) and overtype characters fairly easily, but inserting new characters requires cursor positioning with the cursor keys, menu selection with the mouse, and finally the insert from the keyboard.

Perhaps the most useful extension of this BASIC is its ability to call a large number of the standard GEM display functions. For example, you can draw graphs and pictures from BASIC without resorting to obscure hieroglyphics or pokes. Other modern constructs include named subroutines and WHILE.

The developer's package includes a C compiler, linker, and debugger, and the glue to hold them together. There is an adequate editor. It took me about 8 minutes to get around the edit-compile-link-run loop, with a surprisingly large portion of that time spent in the linker searching the extensive GEM libraries. The compiler used the standard three passes and passed its output to an assembler, resulting in at least four trips through files. The linker took almost as long. Note in the benchmark graphs that disk I/O is about three times as slow as on the IBM PC; a hard disk would help considerably.

CONCLUSION

The Atari 520ST is a very appealing system in need of some further software development. The user interface is easy to learn and use, and the system is powerful enough for serious work. The developer's package appears to offer enough tools and access to the system internals to suggest that software will get written. The computer brings the convenience and naturalness of the "desktop metaphor" down to a lower price bracket, and thus a larger audience. It has a good chance of becoming a very popular machine. ■



PROBLEM: There's just no easy way to move from one software program to another.

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Now you can keep up to 10 programs loaded and ready to run.

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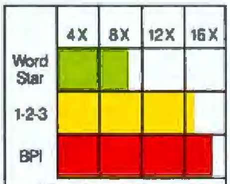

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With up to ten different programs at your fingertips, you'll have instant access to your database, communications, spelling checker, spreadsheet, word processor, RAM resident utilities, languages, anything you like.

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This could be the best reason ever for owning an expanded memory card, like the Intel Above Board, AST RAMpage, or any card compatible with the L/I/M Extended Memory Standard.

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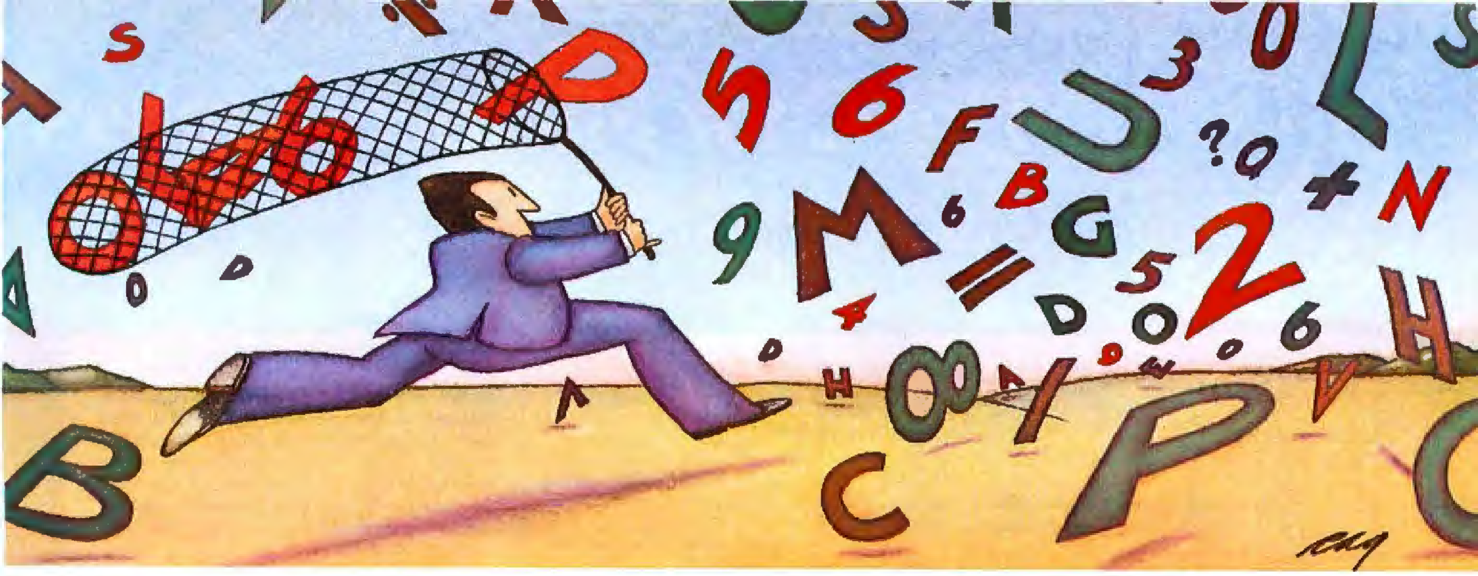

PROBLEM: The more experience your hard disk has, the harder it has to work.

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Your hard disk will run faster when it's not chasing around after files.

Remember the old days when your hard drive was new? Remember that smooth, fast, slick performance? Those quick retrievals, rapid saves, lightning-like database sorts?

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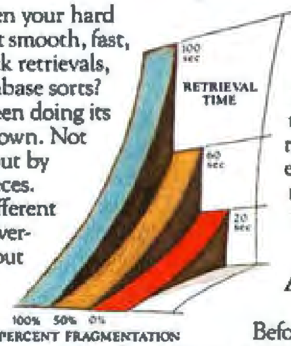

The more fragmented your files get, the longer they take to retrieve.

Loading is slower.
Sorting is slower.
Retrieving, backing-up.
Everything takes longer because your disk has to work harder.

Problem is, it's something that happens so gradually you may not notice the difference. At least, not until you see the dramatic improvement after using Disk Optimizer.

File fragmentation—It's a problem you can see.

Watch your hard drive the next time it reads or writes a file. Each "blip" of the LED means the drive-head is moving to another place on the disk—either to pick up or lay down another chunk of data.

And the truth is, head movement takes time. Far more time than actual reading and writing. What's worse, all this head movement causes extra wear and tear that can shorten the life of your drive.

Disk Optimizer—Tunes up your disk by cleaning up your files.

Disk Optimizer works by finding all the scattered pieces of your files and putting them back together where they belong. Next time your drive reads it, there's just one place to look.

And the results are often dramatic. Reading and writing times may be cut by as much as two thirds. Database sorts that used to take hundreds of head moves now proceed quickly and efficiently. And since head movement is now at an absolute minimum, your disk drive will lead a longer, more productive life.

Analyze, scrutinize, optimize.

Before you optimize, you'll probably want to analyze. So Disk Optimizer shows you, in percentages, how much fragmentation has taken place—on the entire disk, in individual directories, or for groups of files you specify using global or wildcard names.

Plus, there's built-in data security that lets you assign passwords to as many files or file groups as you want.

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AZTEC C

The C for Microcomputers

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

Manx Aztec C86

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

Computer Language review, February 1985

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

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

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

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

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

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

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

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

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

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

Manx Aztec C68k

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

Computer Language review, April 1985

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

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

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

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

Apple II, Commodore, 65xx, 65C02 ROM

Manx Aztec C65

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

NIBBLE review, July 1984

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

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

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

Distribution of Manx Aztec C

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

Manx Cross Development Systems

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

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

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

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

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

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

Manx Aztec CII

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

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

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

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

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

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COMPAQ DESKPRO 286

BY STAN MIASTKOWSKI

An IBM PC AT compatible with a switchable 6-MHz/8-MHz clock speed

The Compaq Deskpro 286 comes in two standard configurations. The Model 1 comes with 256K bytes of RAM, a single 1.2-megabyte floppy disk drive, and five expansion slots. It retails for $4499 with a dual-mode (green or amber) monochrome monitor that supports graphics. The Model 2 has 512K bytes of RAM, a single 1.2-megabyte floppy disk drive, a 30-megabyte hard disk drive, and four expansion slots. It retails for $6254 with a monitor.

Externally, the Deskpro 286 bears a more-than-passing resemblance to the company's PC-compatible Deskpro. It has a large 19.8- by 16.5-inch footprint, and heavy-duty construction is evident throughout.

THE KEYBOARD

The Deskpro 286 keyboard's 84-key layout is virtually identical to the Selectric-style keyboard on the IBM PC AT. Unlike the AT's keyboard, which has LED indicators for the Caps Lock, Num Lock, and Scroll Lock keys located on a panel above the main keyboard, the Deskpro 286 has LEDs for these functions physically located on the key caps. The keyboard weighs 3 pounds, 6 ounces and has a slightly spongy feel that I don't like. The sharp-edged "ears" used to tilt the keyboard upward left a series of marks on the furniture. Unlike the loud "clacks" that come from the IBM PC keyboard, the Deskpro 286 uses soft tones to let you know that you've successfully pressed a key. You can adjust the volume of the key tones by pressing a combination of three keys. The partially coiled keyboard cable was a bother; it kept getting in the way and made it nearly impossible to push the keyboard flush to the system unit.

BASIC OPTIONS

The unit I reviewed came with a single 1.2-megabyte floppy disk drive, a 30-megabyte full-height hard disk drive, and a tape backup unit for the hard disk. If you're interested in customizing your system peripherals, Compaq has a wide range of options (see the "At a Glance" box for details). There are three hard disk drives available (20, 30, and 70 megabytes), and all are full-height, which generally have faster access times and greater reliability than half-height hard disk drives. You can fill the remaining two spaces with any combination of half-height 1.2-megabyte drives, 360K-byte drives, or the magnetic tape backup.

Like the IBM PC AT, the Deskpro 286 has a key lock on the front panel, which, when locked, disables the keyboard and prevents the system unit cover from being removed. For most users, it's probably more trouble than it's worth. It won't prevent the unit from being carted away; but since it's good standard operating procedure to keep a hard disk unit running full time to minimize disk damage on power-down, the key will enable you to leave the office at the end of the day and keep unauthorized (though not malicious) hands off your data. But woe be unto you if you loose the keys; they're not duplicatable and you'd need to order a new set from an address supplied in the manual. All these precautions with the lock and keys are probably necessary so that Compaq dealers bidding for corporate or government business can match the specifications of the IBM PC AT.

INSIDE THE SYSTEM UNIT

The cover of the system unit slides forward after you remove three screws on the rear of the Deskpro 286. The screws, which are a strange combination of slotted and Torx head, are also used to hold in the option cards. If you purchase the Deskpro 286 with a hard disk, you'll need to remove the

(continued)

Stan Miastkowski is a freelance writer, northeast bureau chief for Newsbytes, *and editor in chief of the* McGraw-Hill Microcomputer Handbook. *He can be reached at* POB 548, *Peterborough*, NH 03458.

The system runs IBM PC software so fast, it's hard to imagine what the speed gain would be with the 80287 coprocessor.

cover, unlatch the hard disk shipping lock, and then plug in the hard disk power connector. This is a sensible precaution for making sure that the drive isn't powered on before the lock is disengaged. It's a bit difficult for the large-fingered to connect the hard drive power, but it can be done.

The top of the massive power supply (165 watts) is sloped slightly to allow easier (though not easy) access to the rear connectors of the disk drives. The high-capacity fan is extremely quiet, and the Deskpro 286 never became warm to the touch even after extended periods of use.

The processor board has the 68-pin 80286 microprocessor and the peripheral circuitry. Sitting next to the processor is an empty slot for the optional 80287 numeric coprocessor. Since the system runs IBM PC software so fast, it's hard to imagine the speed gain using the coprocessor with software designed to work with it.

CIRCUIT CARDS AND MEMORY

There are eight slots in the system bus, six of which have the additional 36-pin connectors for AT-type cards that contain extended address lines for additional memory. One of the two 62-pin connectors is located behind the floppy disk drive and can only hold a half-length card. Compaq claims that most PC-type I/O boards will work in the Deskpro 286, although the high clock speed and different timing can cause problems with some. Memory-expansion cards designed for the IBM PC also won't work. The same goes for multifunction cards. These limitations shouldn't be a problem, however, since most of the functions those cards would handle are already performed by cards included with the Deskpro 286.

The unit I reviewed came with four cards installed: an RGB/composite/monochrome video graphics board, floppy controller with parallel and serial interface, hard disk controller, and the basic system memory board. The Deskpro 286 will handle a maximum of 8.2 megabytes of RAM. The memory board must be fully populated with 2176K bytes before you can add more memory-expansion boards. You can have up to three memory-expansion boards, each holding a maximum of 2048K bytes in 512K-byte increments.

Since PC-DOS currently supports a maximum of 640K bytes of RAM, the VDISK utility is included with PC-DOS, which enables you to use the extra memory as a virtual disk. VDISK lets you specify the virtual disk size, sector size, and the number of entries. Memory size in excess of 1 megabyte must be accessed by using a /E option. The usual precautions about copying data from virtual disk to floppy or hard disk applies. If power is lost or you turn the machine off, the data on the virtual disk will be lost. With a system like this, a backup or uninterruptible power supply is an important accessory.

THE DISPLAY

The Deskpro 286 comes with a 12-inch green or amber monochrome monitor. Compaq calls it "dual mode"—when used in combination with the Deskpro 286's monochrome/color graphics board (which is standard in the 286), it will also display graphics as shades of amber (or green). You can change display modes by keyboard commands. Compaq eliminated a great deal of confusion about display boards by putting all the features on one board.

SPEED

The Deskpro 286 runs with a primary clock speed of 8 MHz. Toggling between the primary and the secondary speed of 6 MHz is a simple matter of pressing three keys simultaneously. You hear one beep when you're at 6 MHz, two beeps for 8 MHz. I ran a large variety of IBM PC software (WordStar, MultiMate, R:base 5000, and Lotus 1-2-3) at the primary speed with no problems whatsoever.

IBM's recent decision to change the ROM BIOS on 30-megabyte versions of the PC AT to prevent the installation of "speedup" kits (the PC AT runs at 6 MHz) makes the Deskpro 286 an even more attractive alternative to the IBM AT. Though most users can get along fine with a 6-MHz machine, the extra speed afforded by the Deskpro 286's 8-MHz primary speed is something that you get used to quickly.

DISK DRIVES

The IBM PC AT-style 1.2-megabyte floppy disk drive is handy for storing large amounts of data, although with the Deskpro 286's optional hard disk drive, the floppy is not really needed. The 1.2-megabyte floppy disk drive is capable of reading and writing either 1.2-megabyte floppy disks or 360K-byte floppies. The disk-access light glows green when the drive is writing the high-density format and red when it's writing a 360K-byte floppy. The 1.2-megabyte drive has no problems reading 360K-byte format disks; but occasionally when it was writing data to a 360K-byte disk, the disk was unreadable by the 360K-byte drive on another machine. If you intend to swap data with another machine, you should purchase a Compaq 360K-byte drive.

My review unit came with a tape backup unit for the hard disk. This unit uses 3M DC 1000 tapes and each tape holds 10 megabytes of data. Compaq claims it takes about 16 minutes to fill the tape, and it takes 8 minutes to restore the data to the hard disk. The MS-DOS version 3.0 included with the unit has several tape commands for formatting and using backup tapes. For all the operations, the tape command prints a bar across the top of the screen to indicate how much longer the tape operation has to go. The most time-consuming part of the process is formatting a blank tape, which takes about 40 minutes. I was slightly annoyed the first time I formatted a tape because I had not noticed that the tape's write-protect switch was on and it was 20 minutes

(continued)

AT A GLANCE

Name
Compaq Deskpro 286, Models 1 and 2

Company
Compaq Computer Corp.
20555 FM 149
Houston, TX 77070
(713) 370-0670

Size
6.4 by 19.8 by 16.5 inches

Components
Processor: 80286, 6 MHz or 8 MHz (switchable)
Memory: 256K or 512K bytes, maximum 2176K bytes on system board; up to 8.2 megabytes available
Mass storage: Model 1: One half-height 1.2-megabyte 5¼-inch floppy disk drive; Model 2: One 1.2-megabyte floppy disk drive and a 30-megabyte full-height hard disk drive
Display: 12-inch amber or green monochrome display; dual-mode display adapter monochrome/color, text/graphics (switchable)
Keyboard: IBM PC AT-compatible

Optional Hardware

360K-byte disk drive	$350
1.2-megabyte disk drive	$650
20-megabyte disk drive	$2095
30-megabyte disk drive	$2595
70-megabyte disk drive	$5195
Tape backup system for hard disk	$899
80287 numeric coprocessor	$195
128K RAM upgrade	$150
512K RAM upgrade	$695
Monitor tilt-and-swivel adapter	$50

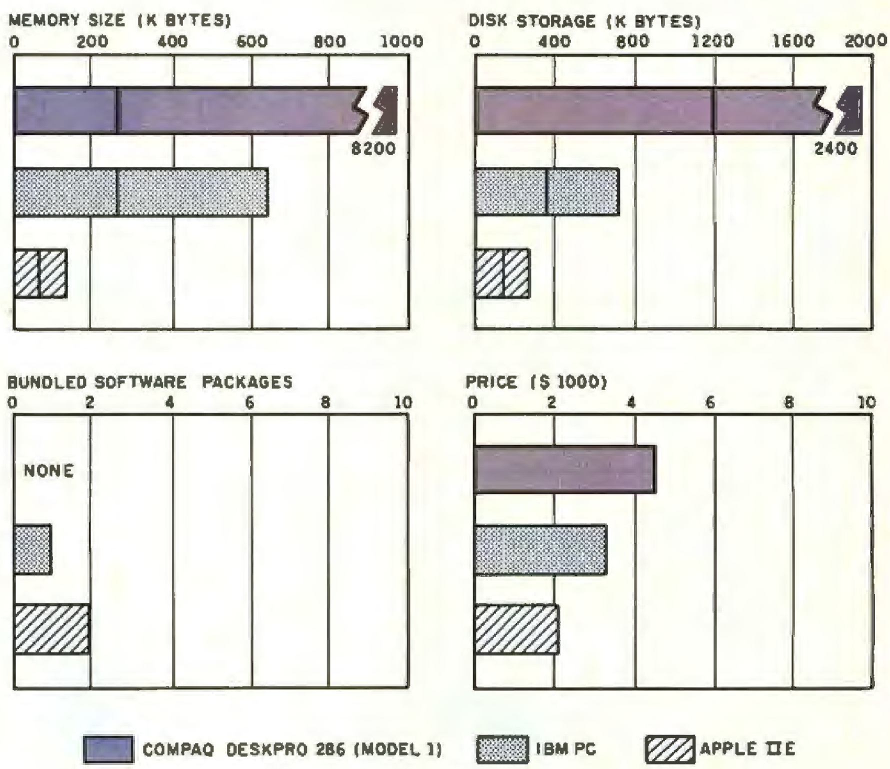
Optional Software

MS-DOS/BASIC version 3.0 or 3.1	$65

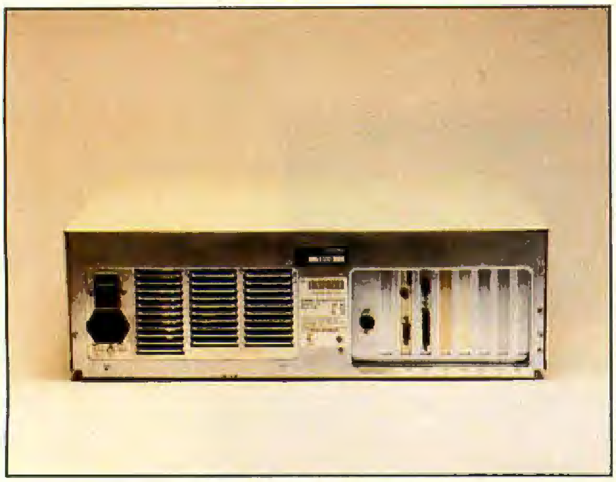
Documentation
Operations guide

Price
(standard configuration with monitor)

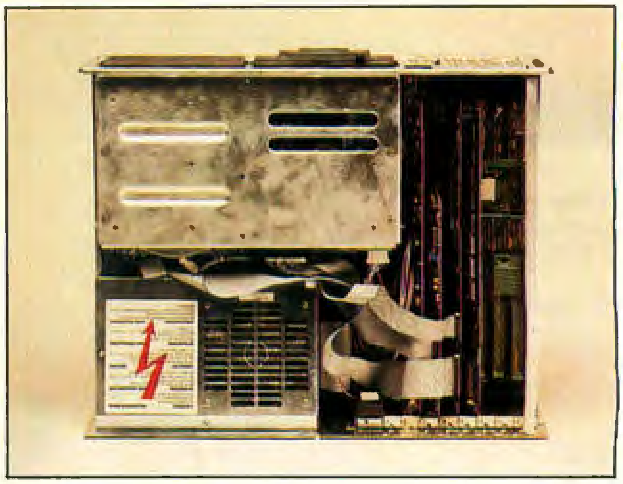
Model 1	$4499
Model 2	$6254



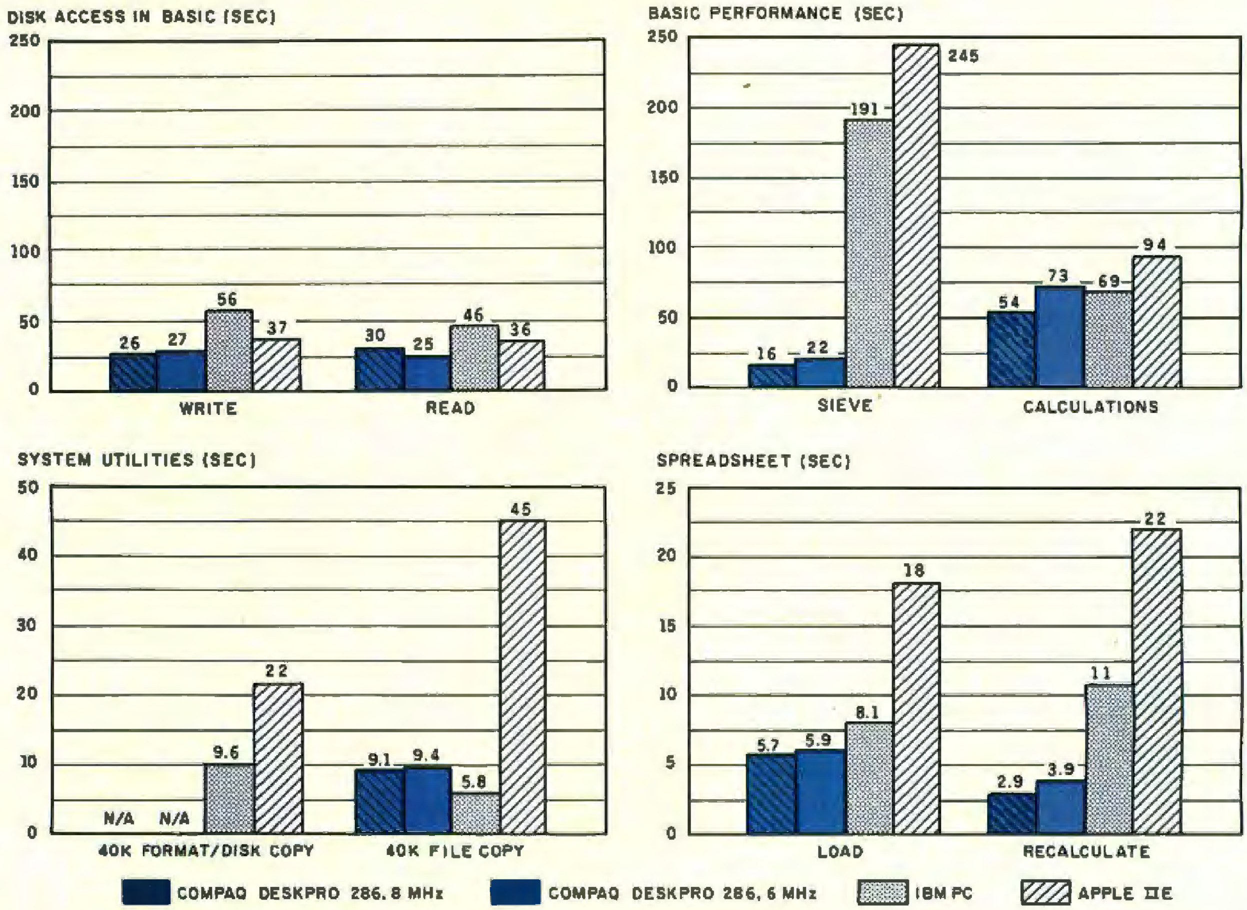
The Memory Size graph shows the standard and optional memory available. The Deskpro 286 Model 1 was used in this comparison. The Disk Storage graph shows the highest capacity for a single floppy disk drive and the maximum standard capacity for each system. The Bundled Software Packages graph shows the number of packages included with each system. The Price graph shows the list price of a system configured with two drives (one 1.2-megabyte floppy disk drive for the Deskpro 286 Model 1), a monochrome monitor, graphics and color display capability, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), and the standard operating system for the computers under comparison.



The back pannel of the Compag Deskpro 286. Note the 3-pin DIN power connector for the Compaq monitor.



Inside the Compaq Deskpro 286.



The graphs for Disk Access in BASIC show how long it takes to write and read a 64K-byte sequential text file to a blank floppy disk. (For the program listings, see "Benchmarking the Clones" by Jon R. Edwards and Glenn Hartwig, BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted time for 40K bytes of disk data) and to transfer a 40K-byte file using the system utilities. The Kaypro was tested using the drives in double-density mode. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. The spreadsheet used was Microsoft's Multiplan. A 360K-byte disk was used in the Deskpro's 1.2-megabyte floppy disk drive.

into the formatting before the operation failed. It would have been nice if the write-protect status of the tape could have been sensed earlier.

SOFTWARE

The only software that comes standard with the Deskpro 286 is a self-booting User Programs disk that contains both demonstration and diagnostic programs. Included on the disk are graphics, word processing, and music demos, as well as an arcade-type game and biorhythm chart. All are impressive examples of how fast the Deskpro 286 runs. The diagnostic program is a complete system test, though the status messages leave more than a little to be desired. Instead of telling you which test is being performed, you're told to refer to a number, which you'll find in the operations guide. Tests that take a great deal of time (such as the memory test) display a cryptic message that says, "This test may take an extended period of time. Please stand by." There are no messages to indicate the status of the test.

Compaq sells their customized DOS version 3.0 for $65. Version 3.1 is also available for the same price. Included are BASICA and the usual contingent of utilities and sample programs.

DOCUMENTATION

Documentation is one area where the Deskpro 286 doesn't shine. The only manual that comes with the unit is an 80-page operations manual that is grossly inadequate. It contains a bare minimum of information designed for the naive. Numerous pages are involved with showing how to hook up the system. After that, you're pretty much left on your own. Gorgeous color photographs show you what wonderful add-ons you can spend your money on, but there's no additional information. The only useful part of the manual is a section on keystrokes needed to change processor speed, key-click volume, etc. It could have been better covered on a reference card, and one isn't included.

The MS-DOS manuals (included with the purchase of the operating system) are much better. Three

(continued)

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The Deskpro 286 has nearly all the features that a serious user needs.

manuals are included: a 527-page MS-DOS version 3.0 reference guide, a 182-page BASIC reference guide, and a 311-page BASIC guide to statements, functions, commands, and variables. All three are well written and organized so that information is easy to find. The examples used are a far cry from the head-scratching ones in early PC documentation.

All Compaq manuals are in a spiral-bound 7½- by 9-inch horizontal format, which is handy for use on a crowded desk. A technical reference manual is available for $60.

SUMMARY

The Compaq Deskpro 286 is a high-powered professional-quality computer that has nearly all the features that a serious business or scientific user needs. In keeping with Compaq's reputation, it's extremely well thought out and built to withstand full-time heavy use. Its speed advantage alone recommends it over its closest competitor—the IBM PC AT. The price of the Deskpro 286 is slightly higher than a comparably equipped PC AT, and unlike the AT, the Deskpro 286 is unlikely to be available at anything other than list price.

If you buy a Deskpro 286, the usual caveat applies about choosing your dealer carefully. (Compaq has over 2500 in the United States alone.) Compaq has been very successful and has acquired some of the arrogance that often comes with success. They've continued to be secretive about technical matters, and getting information over the telephone is often difficult. A knowledgeable dealer can help Compaq Deskpro 286 users deal with any problems or questions. Despite its high price, the Deskpro 286 is an outstanding personal computer. It's a system whose technology will not quickly become obsolete. ■

TELE-286

BY WAYNE RASH JR.

An IBM PC AT compatible with a standard 44-megabyte hard disk drive

The TeleVideo Tele-286 is designed to be compatible with the IBM PC AT. Like the IBM, the Tele-286 is large and heavy, and its hard disk is hidden within the cabinet, with space for two floppy disk drives in the upper right of the front panel. Also like the IBM machine, the Tele-286 is based on the Intel 80286 microprocessor, and it accepts an 80287 math coprocessor. However, both processors in the Tele-286 run at a clock speed of 8 MHz—about one-third better than the IBM PC AT.

For this review I used the Tele-286 Model 2 ($5395), which is roughly equivalent to the enhanced IBM PC AT. The Model 2 system includes one high-capacity floppy disk drive that holds 1.2 megabytes, a 44-megabyte hard disk, and 512K bytes of RAM, which can be expanded to 15 megabytes. The monitor I tested was TeleVideo's optional HRM-100, a high-resolution monochrome graphics monitor.

EXAMINING THE HARDWARE

The system unit measures a whopping 21 by 16 by 6.5 inches, and it will dominate any regular-size desk. You can open the case by removing four screws at the rear of the machine and sliding the cover forward. Inside, you will find eight expansion slots, two of which accept standard IBM PC boards. The other six are designed to accept boards made for the 16-bit bus of the IBM PC AT. The disk drive controller board is already installed in a slot.

To the right of the expansion-card area is the power supply. In front of the power supply are the disk drives. The primary hard disk is mounted in the front center and does not show when the cover is in place. To the right of the hard disk drive, the system can accommodate two half-height floppy disk drives placed one above the other. Below the floppy disk drive locations is room enough for a concealed half-height hard disk. The system provides sufficient cables to support two floppy and two hard disk drives.

The high-capacity floppy disk drive is similar to that of the IBM PC AT's—it can read from and write to a standard double-density (360K-byte) MS-DOS disk. Some other computers may have trouble reading data written by the Tele-286 to 360K-byte disks, however, since the tracks created by the high-capacity disk drive are more narrow than those used by double-density disk drives. TeleVideo also warns that floppy disks formatted on the high-capacity drive will not work on other machines, although they worked fine on my Zenith Z-100. To ensure disk compatibility, TeleVideo offers a standard double-density disk drive.

The front of the machine is unremarkable except for the lack of the key-operated power switch that the IBM PC AT and most other compatibles have. With the Tele-286, you have to be content with a rocker switch on the rear of the machine.

On the rear, next to the power switch, is the power cord and an additional AC power outlet, which is the same kind used by the IBM monochrome monitor. Also on the back panel are connectors for the serial and parallel ports and the keyboard. Like the IBM PC AT, the Tele-286's RS-232C serial port uses a 9-pin connector, and the parallel port is Centronics-compatible.

The keyboard connects to the computer via a six-foot coiled cord and is much like that of the IBM PC AT. The only difference worth noting is that the LEDs indicating the position of the Caps Lock, Num Lock, and Scroll Lock keys are on the keys themselves rather than the keyboard bezel. Like the IBM PC AT, the Tele-286's keyboard is somewhat larger than that of

(continued)

Wayne Rash Jr. (10431 Collingham Dr., Fairfax, VA 22032) is a member of the professional staff of American Management Systems Inc., where he consults with the federal government on microcomputers.

the IBM PC—meaning, of course, that some keyboard templates designed for the PC may not fit.

TeleVideo's HRM-100 monitor sells for $595 and comes with its own display adapter, which provides power and video signals to the monitor through one 9-pin connector, freeing your computer table of one more cable. You may want to check the pin assignments before you attach a monitor from another manufacturer. Another nice feature is its attached stand that allows the monitor to tilt and swivel. The display adapter allows the monitor to display color images as shades of green with a resolution of 640 by 400 pixels. Its character set is crisp and much easier to read than that of the IBM. In fact, the clear characters coupled with the 14-inch diagonal measurement of the screen make for one of the best monitors I have used.

SLOW STARTING

The hardest part about using the Tele-286 is setting up the system and formatting the hard disk—tasks that can be made simpler with clear instructions. Unfortunately, the instructions provided with the Tele-286 are no help.

The problem is letting the operating system know the system configuration—specifically, what kind of disk drives are installed in the unit. A special setup program stores that information in a section of memory that is kept alive by a lithium battery, which also powers the clock. Without the proper configuration data, the hard disk cannot be formatted or used.

First, I had to hook up the battery. The battery is attached to the side of the power supply with Velcro, and it has a connector that you attach to some pins on the motherboard—a job that requires a pair of long-nose pliers and a great deal of patience.

When you connect the battery, you have to be particularly careful to choose the correct set of pins. The directions in the manual are less than explicit, and you might accidentally connect the battery to what appears to be a set of jumper pins on the disk controller only an inch away. The battery connector will indeed fit onto the disk controller, and it would be an easy mistake to make. While I didn't want to find out what happens when a battery is connected to the disk controller, I suspect it's not good.

Then I had to run the setup program. On the face of it, the process seems simple: you simply indicate to the setup program which disk drives are installed. But the setup program does not provide a menu of choices. And although the manual depicts a menu, the choices listed do not include a 44-megabyte hard disk, which is standard equipment on a Model 2.

To make matters worse, the drive selections are listed by the number of cylinders and the number of heads on the disk—information that's not readily available. It's not even clear whether the disk drive capacities that are listed are formatted or unformatted capacities. (The 44-megabyte hard disk in my review unit has an unformatted capacity of 53 megabytes.) After two weeks of frustration and telephone calls to TeleVideo, I managed to partition and format the hard disk, which took about an hour with the proper instructions.

SOFTWARE COMPATIBILITY

The Tele-286 comes with MS-DOS 3.1 and GW-BASIC 3.1. Both of these are versions of the software offered for the IBM PC AT. Unfortunately, the version of MS-DOS I received could not access all 44 megabytes on the hard disk—it was limited to only 32 megabytes, which makes disk partitions necessary. TeleVideo says it has a modified version of MS-DOS 3.1 that will support all 44 megabytes, but none was available for this review.

Like the IBM PC AT, the Tele-286 is not fully compatible with the IBM PC. For example, some versions of Microsoft's Flight Simulator will not run on the Tele-286, nor will some games and educational programs. However, the most serious compatibility problem is the Tele-286's failure to run Digital Research's Concurrent PC-DOS. However, every other IBM business program that I tried did run.

This deficiency suggests there might be compatibility problems with other

(continued)

AT A GLANCE

Name
Tele-286 Model 2

Company
TeleVideo Systems Inc.
550 East Brokaw Rd.
San Jose, CA 95150-6602
(800) 521-4897
(800) 821-3774 (California)

System Unit Size
21 by 16 by 6.5 inches
45 pounds

Components
Display: Text 80 columns by 25 lines; graphics resolution 640 by 400 pixels with shades of green using optional TeleVideo HRM-100
Keyboard: Detached 84-key IBM PC AT-style QWERTY keyboard with 10 function keys; numeric/cursor-control keypad; LEDs in Caps Lock, Num Lock, and Scroll Lock keys
Processor: 8-MHz Intel 80286
Memory: 512K bytes expandable to 15 megabytes

Mass Storage
44-megabyte hard disk drive
1.2-megabyte floppy disk drive

Expansion
Six IBM PC AT-compatible plug-in board slots, two IBM PC-compatible plug-in board

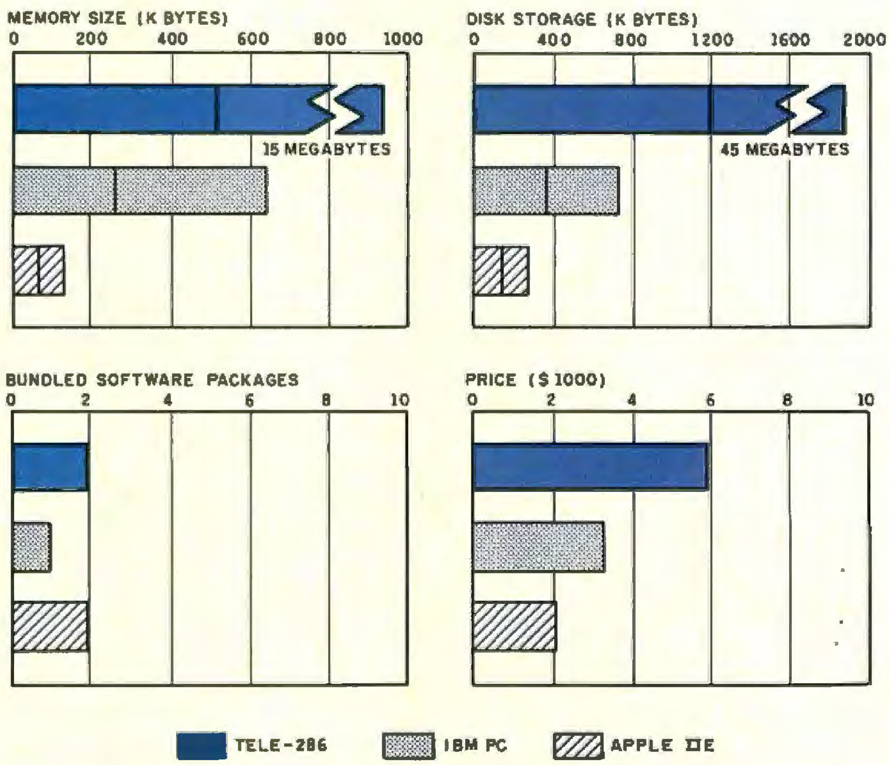
Software
MS-DOS 3.1
GW-BASIC 3.1

Options
Memory expansion
360K-byte floppy disk drive
Additional hard disk
Color monitor

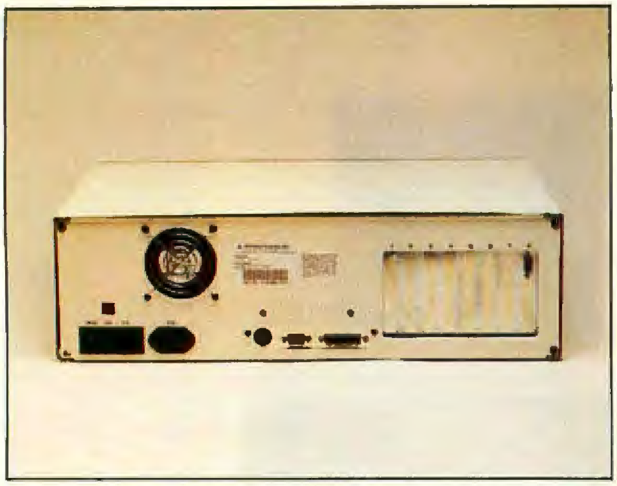
Documentation
Owner's manual
MS-DOS 3.1 manual
GW-BASIC manual

Price

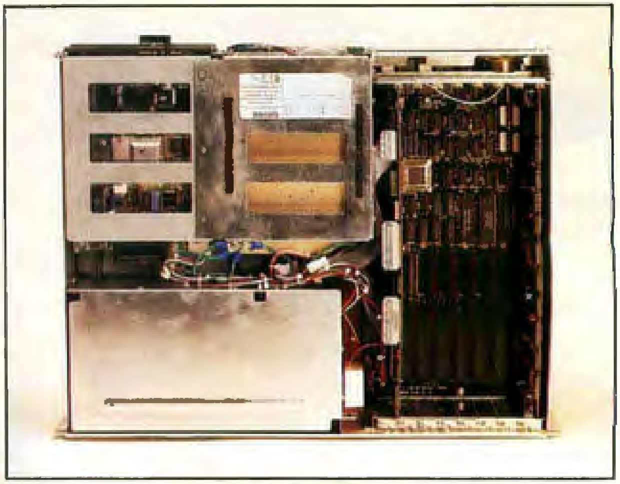
Model 2	$5395
HRM-100	$595



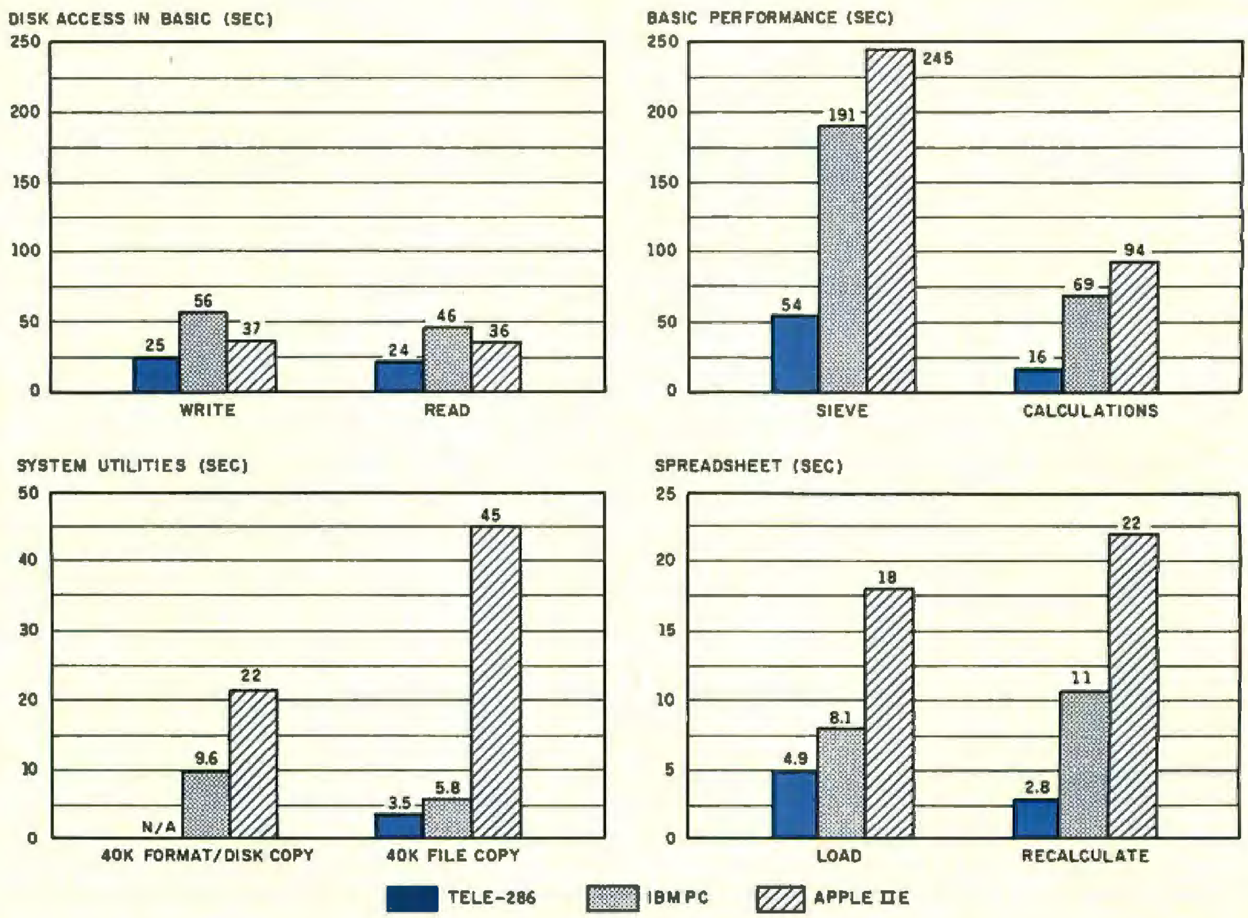
The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single floppy disk drive and the maximum standard capacity for each system. The Bundled Software graph shows the number of software packages included with each system. The Price graph shows the list price of a system with two disk drives, a monochrome monitor with connection apparatus and graphics capability, a printer port and serial port, 256K bytes of memory (64K bytes for 8-bit systems), the standard operating system for the computers under comparison, and the standard BASIC interpreter. Note that the Tele-286 Model 2 comes with 512K bytes of RAM and one of its two disks is a 44-megabyte hard disk drive.



The rear of the Tele-286 showing the power cord receptacle, monitor power cord socket, serial and parallel ports, and access slots for expansion boards with the TeleVideo HRM-100 monitor adapter installed.



The inside of the Tele-286 showing the floppy and hard disk drives, power supply, and main circuit board with expansion slots.



The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graphs show how long it takes to copy a 40K-byte file using the system utilities. (The Disk Copy test was not run because our review unit had only one floppy disk drive.) The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The spreadsheet used was Microsoft's Multiplan. Tests on the Tele-286 were done using MS-DOS 3.1 and GW-BASIC 3.1. Our review system had 512K bytes of RAM, a 44-megabyte hard disk drive, and a 1.2-megabyte floppy disk drive.

programs. You should have your dealer demonstrate any software you are considering using on a Tele-286.

THE BENCHMARKS

The machine's speed is noticeably good with programs such as WordStar 2000, which is sluggish on the IBM PC. The benchmark tests support that feeling of speed. Memory-resident programs execute in one-third to one-fourth the time required on an IBM PC. Operations requiring floppy disk access execute in about half the time.

Some of the benchmark times depend heavily on the type or format of the disk drive being used. For example, the load time for Multiplan took only about one second from the hard disk. (Of course, timing accuracy is limited at such short intervals because of the time it takes to actually start and stop the stopwatch.)

Format and file-transfer times vary with the format in use. Naturally, formatting the 1.2-megabyte high-capacity disk takes longer than the 360K-byte double-density disk. Also, file transfers took slightly less time with the high-capacity disk.

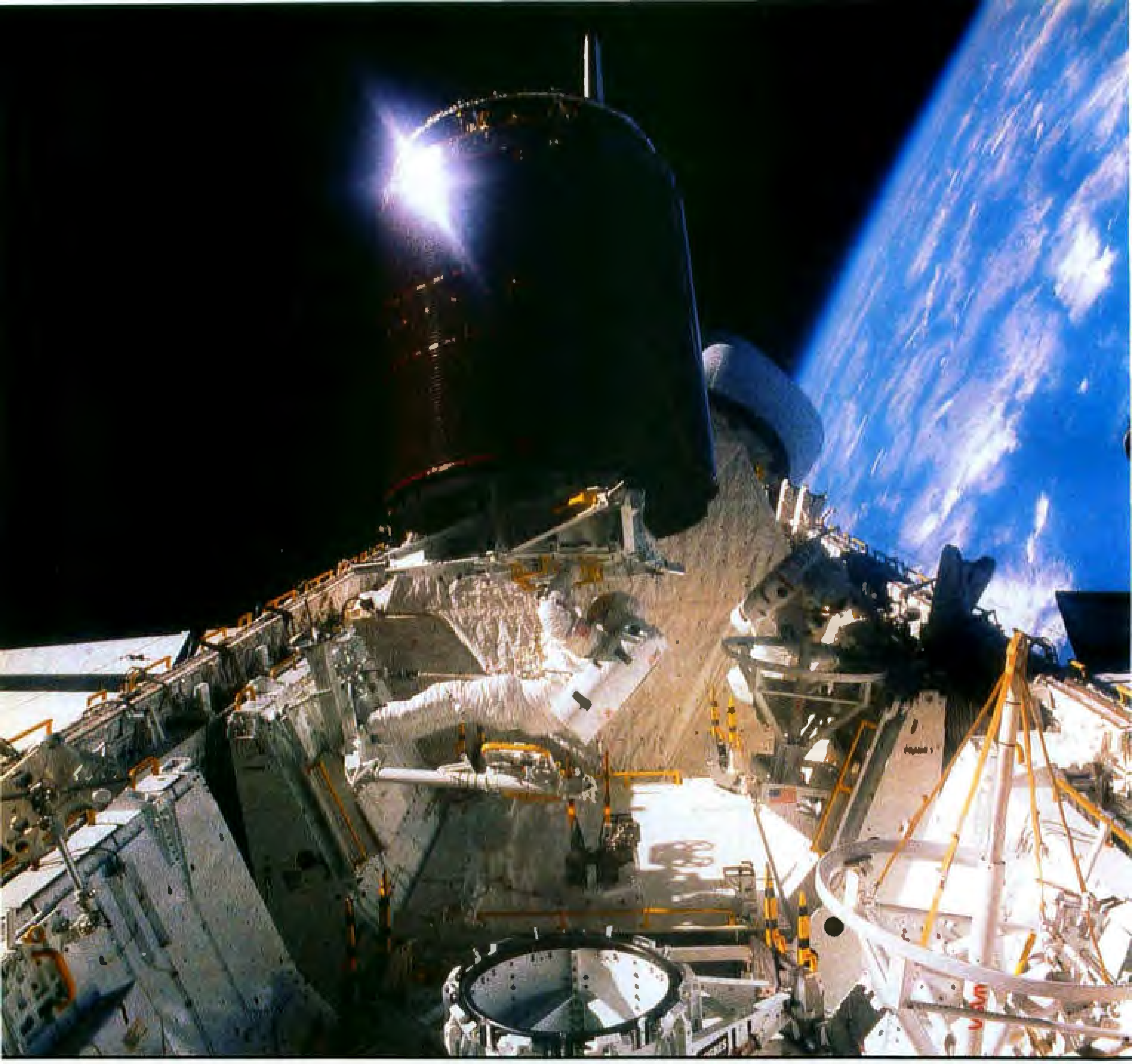
CONCLUSIONS

The Tele-286's most glaring weak point is its documentation. The problems I had in getting the machine running were entirely due to an inadequate owner's manual, and the same problems await any user who tries the do-it-yourself route. Once you get past the problems with setting up the system, the owner's manual improves some. The book is well illustrated and covers most routine activities adequately. There is also very complete coverage for such activities as adding additional disk drives and memory.

The manuals for MS-DOS and for GW-BASIC are also adequate. It appears that TeleVideo has simply reprinted the standard Microsoft manuals and has made no effort to expand or clarify them or to give additional instructions. As a result, new users will find the manual tough to understand at first, but experienced users will be disappointed by the lack of advanced programming support.

Still, the Tele-286 performed most of the tasks I tried, endured frequent moves between my home and office, and persisted through days of constant disk-drive activity while I developed a diagnostics program that exercises the disk drives.

There are a number of good reasons to consider the Tele-286. The standard hard disk is considerably larger than that supplied with the IBM PC AT. The machine operates faster than the IBM, the monitor is easier to read, and it costs less. Cost may well be the major factor, since TeleVideo equipment is frequently sold at a considerable discount. While there are a number of IBM PC AT compatibles available, and more are on the way, it's difficult to find one much better than the Tele-286. ■



MIX C

BY RICHARD GREHAN

A C *compiler* *for the* IBM PC *that costs* *less than* $50

Not long ago I was perusing BYTE and discovered an advertisement for a $39.95 C compiler. I was struck by the potential value of a standard Kernighan and Ritchie C compiler for the IBM PC for less than $50. Of course, it's wise to be wary about a software product that promises so much at such a value, so I ran both versions of Mix C down the guantlet. (They also make a version for Z80 CP/M machines—I got the Kaypro version and ran the CP/M benchmarks on a Kaypro 10.)

WHAT YOU DO AND DON'T GET

What arrived were two shrink-wrapped large blue-covered manuals of over 400 8½- by 11-inch pages. Stuck within the pages of one of the manuals were two Kaypro-readable floppies, and within the other was one IBM PC–compatible floppy. The disks are not copy-protected, so you can make backups or copy the contents onto a hard disk (which I did for the Kaypro 10). It isn't possible to get all the files plus boot information onto a single floppy disk, even for the MS-DOS version. Fortunately, the manual saved me from having to experiment with the distribution of files onto multiple disks; there is a section in chapter 1 that gives a file-by-file list of the recommended disk arrangement.

Many C compilers extend the compiler across several programs that are executed in succession. Mix C's compiler is an all-in-one file for the MS-DOS version and two for the CP/M version, a root file and an overlay. The disks also contain the Linker program and RUNTIME.OVY (both described below), as well as Mix C's library file, CLIB.MIX, and the standard I/O header and library files: STDIO and STDLIB.H, respectively..

Other files present on the MS-DOS disk (and on the second of the two CP/M floppies) consist of programs used for code optimization—both speed and size—and source files. STDLIB.C, PRINTF.C, and SCANF.C contain most of the source code for the standard C system; you can actually add or modify routines to these files and use them to create your own CLIB.MIX library file.

What you don't get with Mix C is any assembly source code output from the compiler that might aid you in debugging programs. Nor do you get the ability to link object files written in assembly language with Mix C functions. Additionally, as you may have guessed, you don't get a separate assembler program with Mix C, as you do with some of the other popular C compilers.

A peculiar program, CONVERT.COM, can be used, according to the manual, to convert object files to ASCII and back. I assumed that by this the manual meant CONVERT.COM could transform unreadable object code to text that was more or less understandable and from which I could glean the machine code generated by the compiler. However, what comes out of CONVERT.COM is a file consisting of streams of ASCII digits with function names sprinkled throughout. The only apparent use of an ASCII object file—as outlined in the manual—was that it provided a means for you to actually use a text editor to cut and paste functions from one object file to another. This seems to me to be at best an abstruse exercise, and it certainly gets you no closer to the generation of machine code that would be useful for debugging.

COMPILING

Producing an executable program from a source code file is typically an easy two-step process with Mix C; you simply execute the CC program to generate an object file, then execute Linker to create the final .COM file. There are, however, a variety of options available that enable you to optimize the resultant code for either space or speed.

Executable files created as described above do not contain low-level run-time routines (system I/O, for example) and as such they require the presence of a run-time support file called RUNTIME.OVY. The obvious advantage of this arrangement is that the resultant .COM files are smaller; a disk with numerous program files will show a real space savings due to the factoring out of common system routines. You can, however, request Linker to include run-time support in the resulting .COM file and so eliminate the necessity of moving RUNTIME.OVY about with all your C programs. Any gain in execution time is almost negligible, as demonstrated in the benchmarks, but the ability to create programs not requiring the presence of RUNTIME.OVY is certainly a necessity for anyone considering marketing products developed with Mix C.

If you are really cramped for space, you can optionally replace RUNTIME.OVY with SMALLCOM.OVY. This is a file identical to RUN-

(continued)

Richard Grehan is a BYTE *technical editor. He can be reached at One Phoenix Mill Lane, Peterborough,* NH 03458.

AT A GLANCE

Name
Mix C

Type
Language

Company
Mix Software
2116 East Arapaho
Suite 363
Richardson, TX 75081
(214) 783-6001

Computer
PC-DOS and MS-DOS machines (DOS version 2.0 or later) and CP/M 80 (version 2.2 or later)

Documentation
Mix C reference manual, bound, 400+ pages

Price
$39.95

TIME.OVY except that it is missing routines for long and floating-point data types.

Two programs provided with Mix C, Shrink and Speedup, allow you to optimize an object file for size or speed, respectively. The documentation is mysterious about the internal goings-on of Shrink, and I wasn't very impressed with its results. Speedup, however, improved execution times remarkably and at a small expense of space. The manual indicates that Speedup will have its most dramatic effects on integer arithmetic.

I ran the benchmarks with Speedup and Shrink files; you should note for these particular benchmarks I did include run-time support in the final executable files and that I did not speed up or shrink the system library code.

I was curious about the effects of speeding up *and* shrinking a file, so I tried running both programs on the Sieve object code on the IBM PC. After shrinking and then speeding up, Sieve weighed in at 13,058 bytes and ran in 20 seconds; after speeding up and then shrinking, Sieve was 13,064 bytes and ran in 21 seconds. I won't even begin to try to explain the significance of the figures, but I would like to know what those 6 bytes are.

LINKER

Not only does the Linker program operate similarly to other object code linking programs of its kind (Microsoft's Link, for example), but if you simply execute Linker with no filenames as arguments, it enters a special menu-driven mode. Commands from Linker's menu allow you to selectively load object files, specify libraries to search for unsatisfied references, and build executable files.

There is even a timesaving Find All command that will search and research a library file until all references have been satisfied. (The necessity for

(continued)

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this is as follows: Suppose the Linker is searching a library file for routine A. It locates routine A and links it into the final run-time code. However, routine A calls routine B, which is defined in the same library, but appears before routine A. Linker will have to make another pass through the library to find routine B. The Find All command tells Linker to make multiple passes through the library file as required.)

Linker's Build command offers additional options: You can specify how much stack space the execution file will be allotted and whether or not it will include run-time support.

A special section in the manual describes the mechanics behind overlays and how you command Linker to create overlay files. This is a tricky process and requires that you give some forethought to how your program will juggle overlay modules in memory, but the instructions are laid out in a step-by-step fashion and I had no trouble building several programs with overlays.

MACHINE LANGUAGE INTERFACE

Arising out of the fact that Mix C operates with its own peculiar format for object files are the difficulties you face when you try to interface a C program to an external routine. Specifically, the object file of an assembly language program processed through, for example, the MS-DOS MASM assembler (an equivalent example for CP/M would be the M-80 assembler) cannot be linked to the object file of a C program created by the Mix C compiler. Also, the Mix C compiler provides no #asm directive found on many other C compilers for in-line assembly source code.

This means that if you have some module that requires coding in assembly language, you are faced with either hand-assembling your code into an array or explicitly poking it into memory from some external file.

However you manage to get a machine language routine into memory, at least Mix C provides functions for transferring control to your routine. You call your machine language subroutine using functions asm() and asmx(), and these functions accept arguments used to transfer the contents of the CPU registers to and from the routine.

Mix C also includes functions for calling the operating system's BDOS directly from C. The MS-DOS version of Mix C has functions for calling the BIOS (specifically, the IBM PC's BIOS, though most compatibles have identical BIOS entry points) in addition to functions for controlling system firmware such as the cursor and sound channels on the IBM PC.

DOCUMENTATION

The Mix C manual is a large bound volume that actually consists of five manuals in one. It begins with "Getting Started," a 19-page guide to the basics of using the Mix C package. This section touches on some of Mix C's optimization abilities and how to manipulate heap and stack space.

The "Tutorial" section follows, and it is an admirable 120 pages including an index. I was especially impressed by the range of topics covered; these include pointers, dynamic memory allocation, and structures. The level of presentation seems aimed for intermediate programmers.

Next is a 178-page reference manual that also contains an index. It is a robust guide to the use of C in general, dealing primarily with the standard function calls. "Functions," the 99-page section that follows, includes descriptions of the other functions that Mix C supports: UNIX functions,

(continued)

Table 1: *Benchmarks for Mix C run on a Kaypro 10. The benchmarks were run on the Kaypro's hard disk. Also, the benchmarks using Speedup and Shrink did include run-time support. Note that no compile times were given in the last three sections, as these compilations required considerable operator intervention. The benchmark programs are available on* BYTEnet Listings, (617) 861-9764.

Mix C Benchmarks — Kaypro 10
Without Run Time Support Included

Benchmark	Compile time (seconds)	Execute time (minutes:seconds)	File size (bytes)
Sieve	:39	3:22	13056
Fib	:41	16:09	4864
Intmath	:51	2:28	5120
Sort	:56	5:31	9216
Fileio	:58	9:02	6016

With Run Time Support Included

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	3:22	31232
Fib	16:09	23040
Intmath	2:28	23296
Sort	5:31	27392
Fileio	9:02	24192

Using Speedup

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	:41	31488
Fib	13:23	23168
Intmath	1:14	24320
Sort	3:42	28160
Fileio	8:46	24960

Using Shrink

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	3:31	31232
Fib	15:57	22912
Intmath	2:33	23168
Sort	5:34	27392
Fileio	9:04	24192

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Table 2: *The same benchmarks run on a dual-floppy* IBM PC *using* PC-DOS *version* 2.0.

Mix C Benchmarks — IBM PC Version
Without Run Time Support Included

Benchmark	Compile time (seconds)	Execute time (minutes:seconds)	File size (bytes)
Sieve	:38	3:20	12921
Fib	:40	12:14	4682
Intmath	:51	1:46	5017
Sort	:55	4:56	9122
Fileio	:58	8:54	5922

With Run Time Support Included

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	3:23	31628
Fib	12:12	23389
Intmath	1:45	23724
Sort	4:55	27829
Fileio	8:48	24629

Speedup

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	:20	31771
Fib	3:51	23675
Intmath	:11	24002
Sort	1:07	28489
Fileio	7:55	25406

Shrink

Benchmark	Execute time (minutes:seconds)	File size (bytes)
Sieve	3:28	31571
Fib	12:00	23355
Intmath	1:47	23581
Sort	4:58	27770
Fileio	8:49	24569

functions specific to the operating system (MS-DOS or CP/M-80), and a special chapter on functions for direct communication to the IBM PC BIOS.

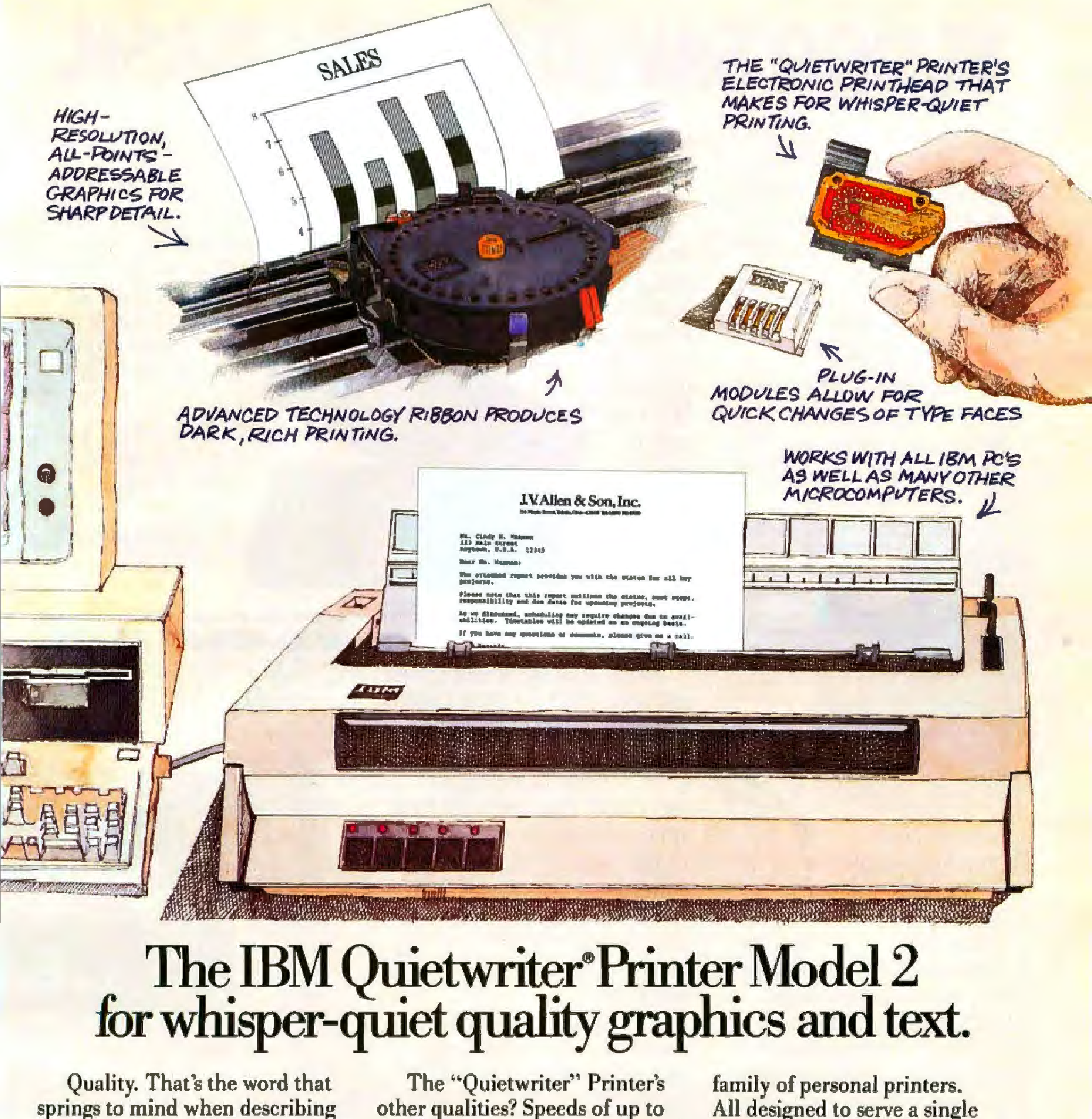
Finally, the 17-page "Tools" section is a close look at the Mix C's software components. It is really an extension of the first section, with the addition of a description of the overlay mechanisms provided with Mix C.

CONCLUSION

I ran the benchmarks on a Kaypro (see table 1) and an IBM PC dual-floppy system with 512K bytes of memory (see table 2). For the Kaypro, I ran all the benchmarks on the computer's internal 10-megabyte hard disk. There was no 8087 math coprocessor in the IBM PC; in fact, if Mix C provides 8087 support, it isn't mentioned anywhere in the documentation.

Compared with other C compilers I have seen, Mix C doesn't break any speed records. Devoted programmers will be unhappy with its inability to generate machine source code, the lack of a compiler directive for in-line assembly code, and the fact that object files created by other compilers or assemblers cannot be linked with Mix C object files.

Still, the compiler supports the K & R standard, it works, and it is certainly affordable. Therefore, I am willing to overlook its inadequacies. ■



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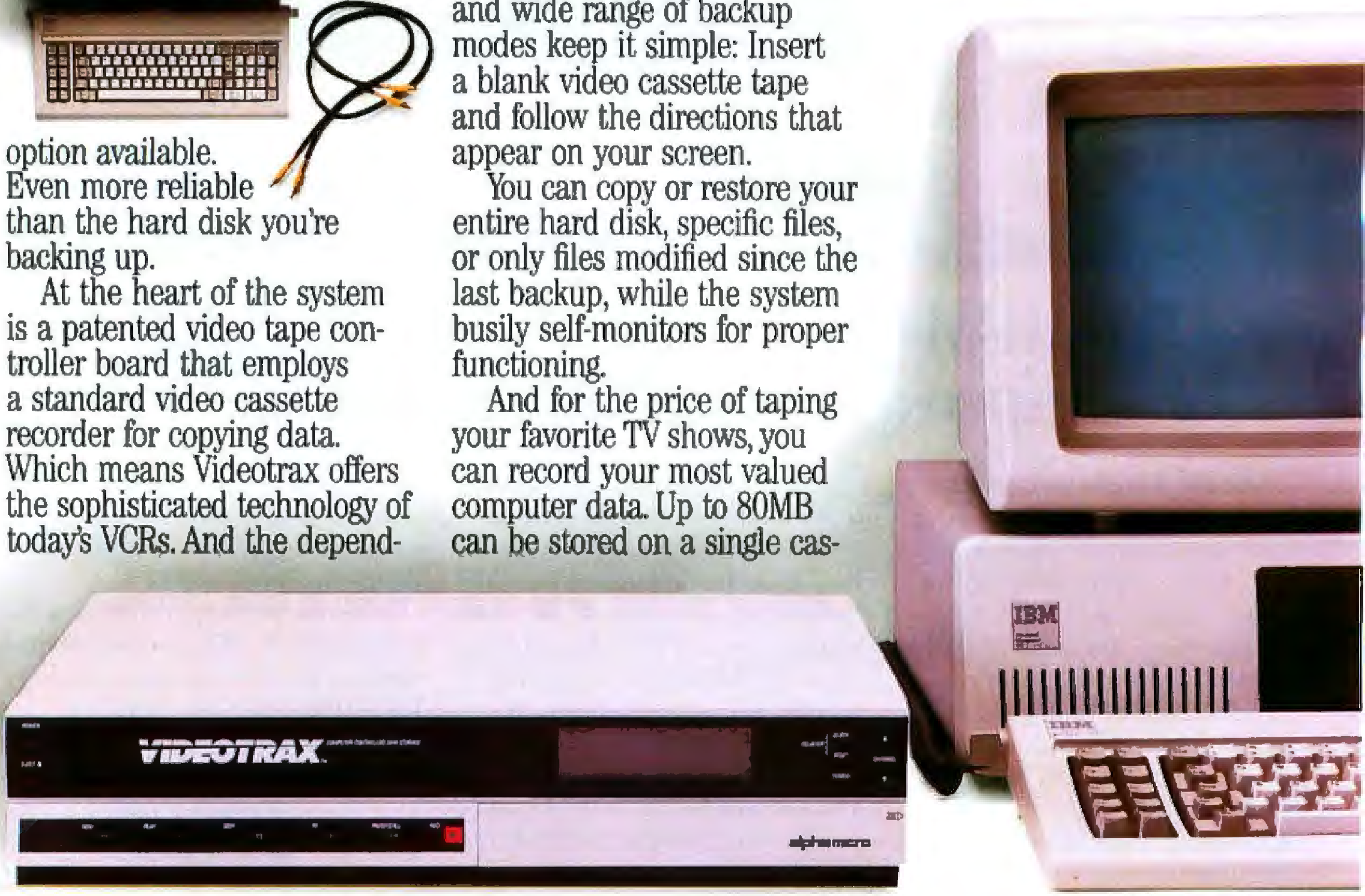

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Inquiry 15

FOUR MIDI INTERFACES

BY ROGER POWELL AND RICHARD GREHAN

MIDI interfaces for the Commodore 64, IBM PC, Macintosh, and Apple II family

Let's assume you have a personal computer and you want to connect it to a MIDI-equipped keyboard or other instrument. One of the first things you will need is interface hardware to send your MIDI signals through your computer. The MIDI specification requires a current-loop serial interface operating at 31,250 bits per second, so it is going to take something more than just retrofitting an RS-232C port.

In this article, we will look at four MIDI interfaces currently available for some of the most popular microcomputers. The TDS-AP for the Apple II+/IIe and the TDSC-64 for the Commodore 64 are from Syntech Corporation. The MPU-401 for either the IBM PC or the Apple II machines is from RolandCorp. The MIDIMAC for the Macintosh or Mac Plus is from Opcode Systems. The interfaces all include at least a high-speed UART with some sort of clock-generation circuitry, a buffered output stage, and an optoisolated input stage. (The MIDIMAC is an exception; it requires no special UART, since the Macintosh's serial ports can operate well above the speed required by MIDI.) However, most of the interfaces we'll look at in this article add extra features such as drum machine trigger signal outputs and tape synchronization inputs and outputs.

Of course, if you are an Atari ST owner, you are probably reading this with a bit of smugness, because the Atari ST has built-in MIDI ports.

TDS-AP

Syntech Corporation's TDS-AP is a MIDI interface on a board that plugs into the Apple II+/IIe. It includes a pair of DIN jacks—one for MIDI in and one for MIDI out—as well as five mini phone jacks: tape in, tape out, footswitch, clock out, and start/stop.

The tape-in and tape-out jacks allow for synchronization with a tape deck. If you have a multitrack tape recorder, you connect the tape-out signal to a line-in signal on a track of your tape machine; this track will become the *click track*. You then program whatever MIDI software you're running to output a sync tone and record this on the click track. Now connect the line-out signal from the click track to the tape-in port on the MIDI interface, and the sync tone that you have just recorded becomes the master clock for the system when you begin to record onto the other tracks of your tape recorder.

You can opt for some *hands-off* event control by attaching a footswitch to the TDS-AP's footswitch jack. For example, we tested the interface with multitrack recording and sequencer software that enabled us to halt the recording process by pressing the space bar or footswitch. If you have both hands busy on a synthesizer's keyboard, it's much easier to operate a footswitch than an Apple II's space bar.

The clock-out and start/stop lines of the interface can be used to drive a drum machine. The clock-out line connects to the clock-in line of the drum machine, and pulses on this line control the machine's tempo. The start/stop line—just as its name implies—provides trigger signals to begin and halt whatever sequence you have programmed into your drum machine. Of course, you could also use the clock-out and start/stop lines to control a sequencer.

The clock-out and start/stop lines add features that may not be immediately apparent. Not only do they permit you to control drum machines that are not equipped with a MIDI interface, but they provide a direct control path to a drum machine that might otherwise be at the end of a line of daisy-chained MIDI devices (and would therefore suffer from signal-transmission delays). They also alleviate the problem that arises if you don't have enough MIDI-thru connectors available and are unable to hook the drum machine into the MIDI circuit at all.

The TDS-AP's documentation is a small 10-page pamphlet filled mainly with simplistic diagrams showing how to connect the interface to a tape deck, a drum machine, and a sequencer (they presume you already know how to connect the MIDI ports to whatever musical instrument you're using). We were happy to find an elaborate description of the procedure you must go through to create a click track. We rate the documentation as adequate: It provides you with

(continued)

Roger Powell (Magnetic Music, POB 328, Rhinebeck, NY 12572) is a professional musician and computer programmer. He has been involved with music synthesis as a consultant for the Moog Synthesizer Company and Bell Laboratories, where he was introduced to computer music. A long-standing member of Todd Rundgren's band Utopia, Roger has also played keyboards for David Bowie and Meat Loaf and has released two solo synthesizer albums. Roger has been producing his own line of MIDI-related software tools for music, including Texture, a 24-track MIDI sequencer for the IBM PC. Richard Grehan (One Phoenix Mill Lane, Peterborough, NH 03458) is a technical editor at BYTE.

AT A GLANCE

Name	TDS-AP DS-AP TDSC-64 DSC-64	MPU-401	MIDIMAC
Type	TDS-AP: for Apple II+/IIe, with tape and drum sync DS-AP: for Apple II+/IIe, with drum sync only TDSC-64: for Commodore 64, with tape and drum sync DSC-64: for Commodore 64, with drum sync only	MPU-401: External processing unit, requires interface card for attachment to host computer MIF-IPC: Interface card for the IBM PC MIF-APL: Interface card for the Apple II	MIDIMAC: one in, three out MIDI interface for Macintosh
Company	Syntech Corporation 23958 Craftsman Rd. Calabasas, CA 91302 (818) 704-8509	RolandCorp U.S. 7200 Dominion Circle Los Angeles, CA 90040 (213) 685-5141	Opcode Systems 707 Urban Lane Palo Alto, CA 94301 (415) 321-8977
Documentation	10-page pamphlet included Technical documentation for any of Syntech's interfaces $5		
Prices	TDS-AP $199.95 DS-AP $129.95 TDSC-64 $199.95 DSC-64 $129.95	MPU-401 $200 MIF-IPC $110 MIF-APL $110	MIDIMAC $125 MIDIMAC version for Mac Plus $175 MIDIMAC upgrade for Mac Plus $50

just enough to get going. If you are a programmer anxious to do some MIDI application software of your own, Syntech will send you the TDS-AP's technical documentation for an additional $5.

TDSC-64

The TDSC-64 MIDI interface for the Commodore 64, also from Syntech Corporation, is functionally almost equivalent to the TDS-AP interface (in fact, the same manual is packaged with both devices); the only major difference is that the Commodore version does not have a footswitch jack.

The TDSC-64 is about the size of a deck of playing cards and plugs into the Commodore 64's cartridge expansion slot. It has three DIN jacks and two mini jacks. One DIN jack is MIDI in, another is MIDI out, and the third carries the clock-out and start/stop signals. The phone jacks provide connections for tape in and tape out.

The third DIN connector mentioned above is compatible with Roland drum machines, but with some minor cable building you should be able to adapt the TDSC-64 for use with other brands of drum machines. You have to bring out the clock-out and start/stop signals to a pair of phone plugs. Fortunately, the pin assignments for the DIN connector, along with a brief construction guide, are provided in the manual.

MPU-401

Roland has been manufacturing the MPU-401 MIDI interface in versions for both the Apple and IBM PC for about three years. The package consists of an internal interface card that is specific to the host computer bus (called the MIF card), a multiwire cable with DB-25 connectors, and an external box (the MPU or MIDI processing unit) containing the actual MIDI serial hardware and custom support circuitry. [*Editor's note: For more information on the* MPU-401, *see* "A MIDI Recorder" *by Donald Swearingen in* BYTE's Inside the IBM PCs, *Fall* 1985.] The MPU-401 was designed to offload timing and synchronizing operations from the computer and is, therefore, known as an intelligent interface as contrasted with other passive, UART-only devices used for MIDI communication between synthesizers and computers. However, the MPU-401 may also be used in UART mode for applications that do not require the additional intelligence that the custom ROM and timers provide. Straightforward jobs like sending and receiving bulk voice data to and from synthesizers can easily be accomplished using only the basic UART.

For applications such as recording and playing MIDI data sequences back, the MPU-401 provides eight programmable timers and circuitry for interrupting the host computer to initiate data transfers. Normally, each timer is associated with a single track of MIDI data to be sent from the host to the MIDI receiving channel of an external synthesizer. As data is consumed by the receiver, the timer for that track will interrupt the host computer and request new information. This information packet starts with a timing byte to indicate an entry delay for the MIDI event that follows. The timer is armed with a countdown and will not send the MIDI packet until the count reaches zero. Thus, the MPU-401 acts as an event scheduler and allows the host computer to do other tasks in the foreground, such as dis-

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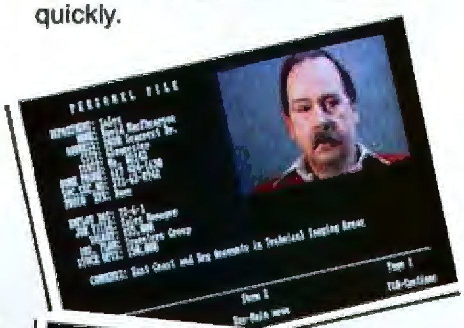

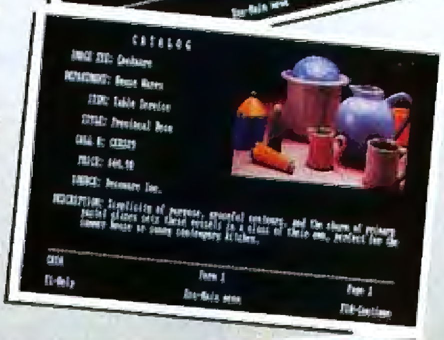

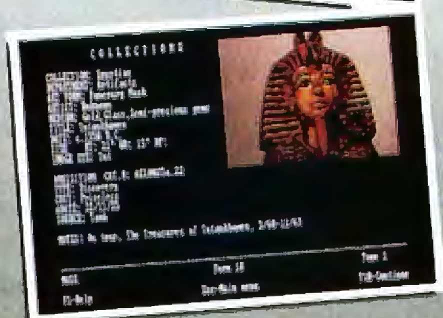

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Inquiry 63 **CHORUS Data Systems, Inc.,** 6 Continental Blvd., P.O. Box 370, Merrimack, New Hampshire 03054 playing a musical score or loading disk files, while the playback progresses in the background via interrupts.

In actuality, a ninth timer exists for what Roland calls a conductor track. This counter operates similarly to the other timer tracks, but it is suggested in the MPU-401 reference manual that tempo changes or other events outside the data streams of the individual music tracks be scheduled using this timer.

The MPU external box is outfitted with one MIDI-in jack, two MIDI-out jacks, tape-sync-in and -out connectors, Roland DIN-sync output jack, and a metronome audio-out connector. The functions of the MPU-401 may be controlled by sending one of a number of specific commands to it. These commands break down into several categories, which are described below.

Start/Stop, Record, and Playback: After the host has initialized MIDI event data pointers for each track, sending a START command will commence playback of the MIDI data streams. You restart playback after a STOP command by sending CONTINUE, which does not reset any timers or status registers before beginning to play again. By sending a RECORD command, the MPU-401 will interrupt the host whenever data has been received from the MPU-401's MIDI-in port, typically coming from a MIDI keyboard device. The host must save the incoming event data in a buffer in order to have it available for further processing.

Enable/Disable MIDI Thru: Since the MPU-401 is connected between the host computer and MIDI-equipped synthesizers, there is a choice of whether or not data received from MIDI in is to be echoed to MIDI out. If, for example, a remote keyboard controller is being used—one which contains no sound-generating circuitry of its own—then you want the data sent from the keyboard to be passed on to the synthesizer receiving on the proper channel. On the other hand, if the control keyboard is also a sound synthesizer, you do not want the data sent from the keyboard to be returned, which would create double-triggering of notes.

MIDI-format system-exclusive messages dealing with synthesizer voice-parameter data may also be echoed through to instruments that are connected to the MPU-401 MIDI-out port.

Timebase: The internal counting functions of MPU-401 must be based on a standard timing interval, and there are seven selections ranging from 48 pulses per beat to 192, graduating by increments of 24. A whole beat is thus subdivided for rhythmic accuracy into timebase units. Roland recommends a setting of 120 pulses per beat in order to provide high enough resolution for real-time sequencing operations.

(continued)

Tempo and Metronome Functions: One of the most significant features of the MPU-401 is its ability to control the speed of playback automatically by sending simple tempo-setting commands from the host. Not only can you set tempo from an absolute range of 8 to 240 beats per minute, but you can specify relative tempos using signed offsets. Additionally, you can control the rate of the new relative tempo, producing gradual speedups or slowdowns (accelerando or decelerando) in the music.

The MPU-401 has an internal, audible metronome with an external output jack for connecting to a mixing console. The metronome has several programmable modes for modifying the number of beeps per beat and placement of metric accents by alternating metronome pitches.

Internal Parameters: A variety of commands, such as read, set, and clear, are provided for altering the contents of the parameters internal to the MPU-401. Reference tables are kept for keeping track of notes-on for certain MIDI channels as well as buffers for the play timers. Note-on tables are necessary for producing notes-off in the event of stopping play while notes are locked on.

Synchronizing Functions: The MPU-401 may be used as the source of all timing signals in a multi-instrument MIDI system, or it may be slaved to the timing output of an external device. For using the unit as a master timing source, you may opt for MIDI timing clocks, which are transmitted over the standard MIDI-out port; FSK (frequency shift key) tape sync coming from the tape-out jack; or Roland DIN sync coming from the DIN-sync output jack. External sync signals may be derived from either MIDI timing clocks received at the MIDI-in port, or FSK tape sync coming into the tape-sync input jack from an audiotape track. (DIN sync refers to a voltage-pulse output signal at a rate of 24 pulses per quarter note [beat] and conforms to the standard that is used in many drum machines.)

By using tape sync, you may drive the computer sequencing software to play back along with the tape-recorded tracks, which has been synchronized via the click track. Likewise, MIDI timing-clock sync may be employed to lock the computer sequencer to the clock of another sequencing device. SMPTE time code, which is used throughout the film industry, can be translated to MIDI timing clocks through an additional piece of hardware (such as a Roland SBX-80) and sent to the MPU-401, thus linking the computer sequencer to any other SMPTE-oriented device.

MIDI Data Filtering: The MPU-401 can be set so that the generous amounts of data created by continuous controller devices (including pitch-bend wheels, modulation

(continued)

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wheels, keyboard pressure sensors) will not be transmitted to the host. In certain cases, the sequencing software does not want to receive all this data in order to conserve memory for higher-priority note data.

Another type of filtering, called channelizing, may also be enabled. By telling the MPU-401 which channels are acceptable to receive from, it's possible to reject or reassign signals emanating from particular source channels.

MIDIMAC

Opcode System's MIDIMAC interface is the ultimate in simplicity. It is a narrow metallic box measuring 1½ by 6½ by 1 inch that attaches to either the Mac's modem or serial printer port. Just plug it in and tighten it with a couple of large thumbscrews. The MIDIMAC box houses four MIDI jacks—one MIDI in and three MIDI out.

There isn't much we can say about this device: You plug it in and it works. Since the Macintosh is equipped with serial ports that can operate well beyond MIDI's 31.25 kHz, the only hardware required for a MIDI interface will be clock circuitry and optoisolators, hence MIDIMAC's compact design. There are no extra features on the MIDIMAC beyond the two extra *MIDI*-out ports; we were particularly unhappy to find no drum machine and tape-sync signal jacks available.

Also, if you have purchased the MIDIMAC interface and decide to upgrade to a Mac Plus, you will discover that not only has Apple made the Plus's new serial ports' mini DIN-8 jacks incompatible with *MIDIMAC's* connector, but even if you could make an adapter cable, the Mac Plus does not provide 5 volts on any of the new ports' pins. (The Macintosh does, and this is where the MIDIMAC gets its power.) Opcode Systems will upgrade a MIDIMAC to function with the Mac Plus for $50, and since this requires modifications to the MIDIMAC's circuit board, you have *to mail it in to* have it "fixed." (You can purchase the MIDIMAC in a Mac Plus–compatible form to begin with for $50 more than the Macintosh version.)

CONCLUSION

Since we purposefully selected devices for different machines, it would not be fair to perform head-to-head comparisons; an interface's capabilities depend largely on the machine for which it is designed. For example, although we mentioned our displeasure with MIDIMAC's lack of anything beyond MIDI ports, it's obvious that MIDIMAC's limitation is due to the fact that the only kind of ports Macintosh provides are serial ports. (If you're going to have a foot-switch connector, a clock out, and a start/stop trigger as on the TDS-AP, you're either going to have to use a parallel port or a very high-speed serial port with some serial-to-parallel conversion hardware.)

Still, we hope that we have given you an idea of some of the interfaces available for your computer. ■

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CONCERTWARE+ AND SONGPAINTER

BY MARIO SERGIO BERNARDO

Two software packages for making music on the Macintosh

The ConcertWare+ and SongPainter software packages for the Apple Macintosh allow you to experiment with sound and learn more about composing music. ConcertWare+, which includes a complete sound-manipulation toolkit for experimentation, can be educational for both experienced and novice users. The SongPainter software package, on the other hand, has serious limitations.

CONCERTWARE+

ConcertWare+ includes three integrated music utilities, Music Player, Music Writer, and InstrumentMaker, as well as 22 demonstration selections and 40 preset instrument sounds.

MUSIC PLAYER

Music Player is a separate song-playing file with over one hour of demonstration musical selections. Short sentences identify each selection and its composer. Also, the sound quality is very good. You cannot edit the music from the player mode, but you can select demonstration songs, repeat them, and combine the songs in any order. You can change the tempo and choose any four instruments for playback. Unfortunately, the Music Player's "scrolling display" does not display real music notation; it displays only dots and dashes.

One other annoyance with Music Player is the lack of a volume control on the play-mode screen; you have to exit to the Apple control panel in order to modify volume. If you connect the audio output in the back of the Macintosh to your stereo unit, you can control the volume from the stereo as well as produce better sound quality.

MUSIC WRITER

With the Music Writer utility, you can input traditional music notation using the complete 88-key piano range. You can use all note and rest values from sixteenth to whole notes (including dotted notes and triplets), dynamic (volume) markings, all major and minor key signatures, as well as any individual pitch or accidental (sharp, flat, or natural). There is also a mode for quick vertical chord entry. You can play every possible combination of four-voice parts for any of the demonstration or user-created musical selections.

Music Writer's display supports real music notation with a large staff format appropriate for those unfamiliar with music notation. An additional, smaller split-screen format above the score displays the voice part currently being edited. Unfortunately, the display does not scroll the music as it's being played. You hear the entire selection, but you are left looking at the first few measures of the written score.

The creators of Music Writer took care to use terms and procedures that let you edit music without great difficulty. There are shortcuts for experienced users, including keyboard entry for note and rest durations, accidentals, and octave shifts, and a very useful sound-with-entry mode that uses the bottom two rows of the Macintosh keyboard as piano keys. You can use this feature to review changes you make to an instrument's vibrato, to a waveform, or to an attack-decay-sustain-release (ADSR) envelope. Another welcome feature for experienced users is a basic form of real-time input of note values using the keyboard or mouse. However, you must insert rest values manually, and you can only input one voice at a time.

In entry mode, a rhythmic auto-correction feature will correct notes to valid values. The program supports time signatures from 1 to 16 beats per measure and the choice of half, quarter, eighth, or sixteenth notes as the beat unit. Tempo control in ConcertWare+ could be improved. The program has 14 stepped values with gaps between values. Since there are 34 traditional metronome markings, many of these fall between ConcertWare+'s values and are not available.

The editing features in ConcertWare+ are easy to use and include cut and paste, transpose, delete, slurred and tied notes, and a quick way to change multiple note durations simultaneously. You can change instrument sounds and dynamic markings anywhere in the score. You can also edit and manipulate Music Writer scores with MacPaint, perhaps to in-

(continued)

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sert lyrics, note beams, and so on. [*Editor's note: Beaming is a new feature in the latest release of* Music Writer.]

ConcertWare+ has excellent printing options. It allows full use of margins and varied paper and type sizes (see figure 1). It also lets you print individual voices or any combination of voice parts, providing a basic version of instrumental-part extraction. This is useful for chamber ensembles, quartets, or four-part vocal scores. You can print entire scores or just specific pages.

INSTRUMENTMAKER

InstrumentMaker lets you manipulate the sound parameters of the Macintosh sound chip. You can create new or edit existing instrument waveforms, ADSR envelopes, harmonic-overtone envelopes, and vibrato, all by drawing the desired contour on the screen. You can combine different parameters of existing preset instruments into a new sound and get instant sound feedback on your changes by using the keyboard.

You can draw waveforms with the mouse on screen or create them from their individual harmonic content, starting with the fundamental tone and adding the next 19 harmonic overtones in any mix you desire. Similarly, you can draw the ADSR envelope directly on screen, without getting directly involved with numeric values or parameters as on professional music synthesizers.

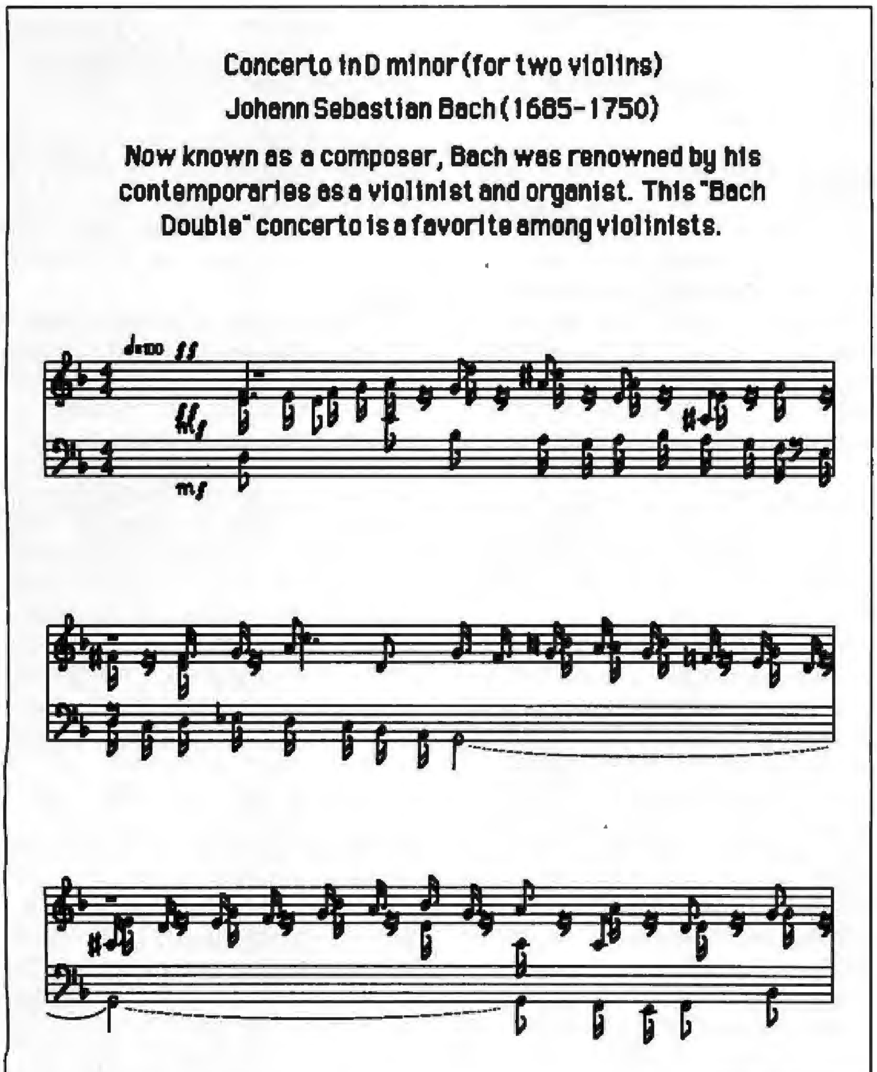

Figure 1: *An example of a printout using ConcertWare+'s printing options, which allow full use of margins and varied paper and type sizes.*

The vibrato controls are equally flexible. You can change width, modulation midpoint, length, and sustain.

Concertware+'s documentation is generally excellent, although it would be helpful to first-time users to include more detailed backup procedures and directions for the organization of working disks. This information is found in an appendix, not at the beginning of the manual.

SONGPAINTER

SongPainter has very attractive screen graphics, packaging, and an impressive manual, but it is a disappointing program. The SongPainter manual cover claims that you will be able to write from "simple songs to software symphonies." The maximum composition length, however, is 48 measures in 4/4 time. At the slowest of tempos, 48 measures generally accounts for only a few minutes of music. Traditional symphonic form ranges from 20 minutes on up in duration and includes hundreds or thousands of measures and complexities in harmony, rhythm, and orchestration, beyond the very rudimentary capabilities of SongPainter.

SongPainter is an icon-driven music package that represents instrument sounds and note lengths on the screen with icons rather than traditional music notation. The instrument icons are placed in "frames" along four horizontal "tracks," each representing an available voice part. You select notes by their names (C, C#, D, etc.). When selected, each note sounds so that you can determine its appropriateness. There are also help menus with descriptions of the various options available. The many demonstration selections are grouped by category.

DEFAULT VALUE

A control window lets you select note volume levels and durations. However, SongPainter's default duration value of one frame equaling a sixteenth note can be rather awkward, since

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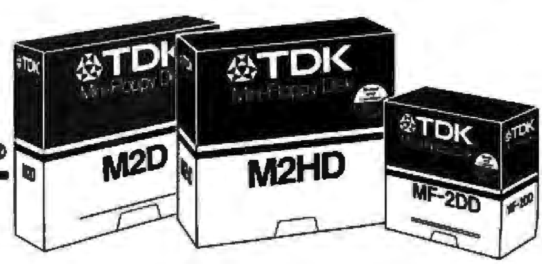

AT A GLANCE

Name	ConcertWare+	SongPainter
Type	Music processor	Music processor
Company	Great Wave Software POB 5847 Stanford, CA 94305 (415) 325-2202	Rubicon Publishing 6300 La Calma, Suite 123 Austin, TX 78752 (512) 454-5004
Disk Format	one 3½-inch disk	one 3½-inch disk
Computer	128K Apple Macintosh	128K Apple Macintosh
Features	40 preset instrument sounds, custom instrument sounds, 23 demonstration songs, keypad play and real-time input, playback of individual parts, visual metronome, 64 meters, 14 tempos, all major and minor keys available, output as MacPaint document, and traditional music notation including ornaments and special markings	32 preset instrument sounds, 37 demonstration songs, playback of individual parts, 3 meters, 7 tempos, all minor keys available, and miniature dictionary definitions
Documentation	Manual	Manual, help function
Price	$69.95	$39.95

music usually uses both longer and shorter note values than a composition's basic beat. It would have been more practical for the default value to equal a quarter note (four SongPainter frames), a more usual beat in popular music. As it stands, if you decide toward the end of a composition that you need a faster note value than the present one-frame value, you have to first convert the entire song by doubling all the note durations and the tempo, followed by your new quicker note values. If the quarter note were the default value, you would have two faster values to fall back on.

WRITING A SONG

To write a song, you first select an instrument (perhaps a clarinet) from the voice window. To enter a sixteenth-note D for the first voice, you would choose the note name D from the tone window and the desired volume and duration (in this case one frame) from the control window. Finally, click the mouse over frame 1, track 1 of the song window (the grid of four horizontal tracks upon which you place the instrument-, duration-, and pitch-icon information). For an eighth note, you would select a duration of two (frames) from the control window. A playback window allows you listen to, pause during, or repeat your song.

The height of each instrument icon corresponds to the individual note volume; a blank frame indicates silence or rest. SongPainter remembers the last combination of selected values, allowing you to enter repeated note characteristics very quickly. In addition, you edit on the same song window used for writing. You can see the names of the notes you have chosen, but this does not, in my view, serve as a satisfactory substitute for real music notation.

Some basic elements of music, such as measure and beat, have been stretched to accommodate SongPainter's bizarre method of music notation. The frames used in SongPainter's notation do not correspond to beats. They are subdivisions of the beat, usually one real musical beat equal to four of SongPainter's frames. In addition, the completed song, often with dozens of different icon blocks on the screen, makes it impossible to detect music elements such as pitch, duration, and rhythm. The tapestry of icon shapes is a nice effect but has little or no value musically.

There are many other problems. There are only seven tempos available, with wide gaps between them. The only time signatures available are 4/4, 3/4, and 2/4. Therefore, you cannot set such important and often used time signatures as 6/8 and 2/2. Similarly, there are only nine preset changes available to modify the timbre envelope. Also, the only four-part harmonies allowed are major, minor, augmented, diminished, and seventh chords. More disturbing still, the chords labeled as major seventh sound like dominant seventh chords and vice versa, a very serious mistake since both serve different musical functions.

Unlike ConcertWare+'s musical dynamic markings (pp, p, mp, mf, etc.), SongPainter's volume markings are labeled quiet, medium, and loud. With accenting on, you can emphasize any sixteenth division of a measure, one of SongPainter's nicer features.

CONCLUSION

In conclusion, I would highly recommend ConcertWare+ for educational and musical exploration. Its strengths are the InstrumentMaker section and MusicWriter's ease of editing and entry of music. In addition, ConcertWare+ is also compatible with professional music synthesizers that have MIDI-to-Macintosh interface capability.

I find SongPainter restrictive and confusing, and I cannot recommend it, especially not for educational purposes. Those with the slightest musical knowledge will find themselves bored and frustrated by this music package, and novices will erroneously believe they are learning correct musical concepts. ■

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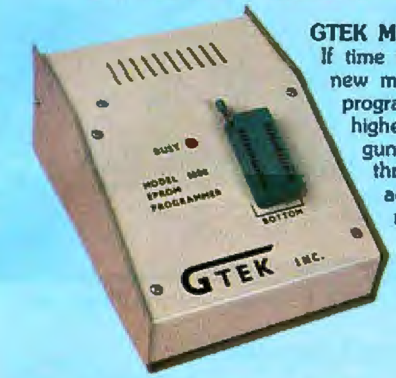

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- For sound engineers and musicians, the 250 has an excellent sequencer program for digital recording and mixing of tracks. You can easily record your own sounds and add them to the synthesizer.
- The Kurzweil 250 gives would-be musicians the chance to sound like virtuosos by using tricks like speeding up the music without raising its pitch, quantizing sequences of notes to clean up the rhythm, and so on.
- The 250 is a first-class MIDI machine that can drive or be driven by dozens of other MIDI devices, including scores of MIDI software programs for the Mac and other computers.
- For programmers, composers, and students, the 250 offers a complete music development language.

DESIGN METHODOLOGY

Designer Raymond Kurzweil wanted to develop a machine capable of reproducing the subtle tonal complexity of a piano or other instrument and also allowing you to create, edit, and perform new sounds with complete artistic freedom and control. The Kurzweil design team has succeeded on virtually every count.

The main problem with digitally sampling and reproducing a complex sound like the piano is that the tone changes dramatically when the notes get louder and louder. The ratios of the overtones and the quality of the attack change, so that a loud piano-tone waveform is not a linear extension of the same note struck softly. If you have access to a piano, try hitting one key progressively harder and harder. Note that even the hammer hitting the string becomes a factor in the overall sound as volume changes, particularly in the treble notes.

Such complexity poses a dilemma to the digital designer: How do you capture the sound of the piano without digitizing the entire range of dynamics for each note—a process that would require huge amounts of ROM storage (30 *billion* bits according to Kurzweil)? The 250 solves this problem with novel data-compression techniques that use proprietary algorithms.

The technique is briefly described in "The Kurzweil 250 Digital Synthesizer" by Donald Byrd and Christopher Yavelow (*Computer Music Journal*, September 1985). "The K250 stores samples in a modified floating-point format with 18-bit words. In effect, the fractions contain the waveform with its dynamic range compressed as much as possible; most of the

(continued)

Christopher Morgan is a part-time professional musician and a former editor in chief of BYTE. *He is currently the editorial director of Lotus Publishing. He can be reached at* POB 829, Brookline, MA 02146.

AT A GLANCE

Name
Kurzweil 250 Digital Synthesizer

Company
Kurzweil Music Systems Inc.
411 Waverly Oaks Rd.
Waltham, MA 02154
(617) 893-5900

Size
Keyboard, 57 by 27 by 9 inches; pedal pod, 17¾ by 11⅛ by 4⅛ inches

Components
Keyboard: 88 notes, velocity-sensitive
Channels: 12
Power: AC 110 volts, 50/60 Hz, 380 watts (220-volt option available)
MIDI (in, out, thru): 16 channels, user-assignable; each sequencer track can be assigned to a separate MIDI channel; special MIDI mode slaves one Kurzweil 250 to another

Price
Basic Kurzweil 250, $12,970; sound-modeling program, $1995; Sound Block Module A, $1995; MacAttach software and interface, $195; stand, $195; plexiglass music rack, $75
An expander system is also available and comprises a Kurzweil 250 without the keyboard unit. Three versions can be supplied: a basic system ($9980); base system plus enhanced instrument voices ($11,975); and a base system plus voices, sampling, sound modeling, and Macintosh software ($13,970)

dynamic information is in the exponents. For typical musical sounds, the K250's separation of the original sound into compressed waveform and exponent uses the sample bits much more efficiently than would be possible through uniform compression systems such as those of dbx or similar compandors."

Besides its data-compression capability, the 250 offers new levels of performance in sound quality, user sampling, sequencing, transposition, and MIDI utilization.

OVERALL DESIGN

The Kurzweil 250 is a true digital instrument. That is, it contains millions of digital samples of musical-instrument sounds (called "soundfiles" in Kurzweil nomenclature) stored in ROM. Pressing a musical key on the 250 causes the processor to extract digital samples from ROM. The samples are converted to analog signals in the channel board.

The basic instrument contains 40 soundfiles in ROM—including the grand piano. Also built into ROM is a series of factory-generated "instruments," Kurzweil's term for the effects (envelope, tremolo, vibrato, etc.) used to alter a soundfile that affects its sound.

To hear sound on the Kurzweil, you assign a keyboard setup to the physical keyboard. The keyboard setup contains one or more instruments, each of which is a modified soundfile. A keyboard setup can be simple (the grand-piano soundfile by itself, for instance), moderately complex (piano on the right side of the keyboard, string bass on the left), or quite complex (clarinet, oboe, stereo vibes, and bass on one layer, and organ on the other, with the restriction that the organ will sound only if you press the velocity-sensitive keys with sufficient force). It's easy to edit keyboard setups with the keyboard editor.

HARDWARE

The Kurzweil 250 Digital Synthesizer comes in a compact case that looks like an electric piano or an organ at first glance. It is quite a handful to transport and requires two people to lift it. Beneath the main unit is a separate module, or pod, containing the power supply and two footpedals that normally control sustain and mute. The functions of these two pedals, like virtually every other knob and slider on the 250, are user-assignable. By isolating the power supply in the pod, the designers have helped to reduce possible hum in the system.

The action of the 88-note, velocity-sensitive wooden keyboard is strikingly similar to that of a grand piano. Directly above the keyboard is the control panel containing 38 buttons and sliders and, in the center, a 24-character-per-line, two-line LCD that serves as the main user interface. (A close-up of the 250's keyboard and control panel is shown in photo 4 of "Digital Music Synthesis" by Robert Moog on page 165 of this issue.) A standard calculator-style keypad is used to maneuver through command menus.

At the far left of the control panel are four sliders used to tune the instrument, to pan sounds between the two stereo output channels, and to adjust overall volume. To the right of these sliders is a group of six buttons and three more sliders used to control chorusing (a whole set of pseudo-reverberation and echo effects to enrich the sound of the synthesizer), to assign alphanumeric names to files and keyboards, and to adjust brightness, detuning, etc. Buttons in the center of the panel control transposition, the footpedals, and so on.

To the right are the controls for the sequencer, the sound-modeling program (digitizer), the various editors, the MIDI interface, and the interface to the optional Macintosh computer (via Kurzweil's MacAttach software). The interface is used to store custom soundfiles, keyboards, and keyboard setups on Macintosh disks, enabling you to build up a library of custom sounds and to trade sounds with other users via disk or modem.

There are three main microcomputer boards inside the Kurzweil 250: the central processor, the channel-group processor, and the channel board (see figure 1). The central processor is a Motorola 68000 running at 10 MHz. It has 128K bytes of ROM

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Inquiry 141

Pitches can be changed on each channel independent of the other channels.

and 128K bytes of battery-backed RAM for sequences, keyboard setups, instrument definitions, and general use. The system is extremely fast: Switching from one instrument sound to another is virtually instantaneous. By comparison, the MacAttach program plods along, taking from 2 to 4 minutes to load a custom soundfile.

The conversion to analog sound takes place in the channel board, which contains 12 channels, each with its own digital-to-analog converter, low-pass filter, and voltage-controlled amplifier. A mixer combines the 12 tracks down to 2 stereo outputs. For studio sound work, the Kurzweil offers balanced XLR inputs and outputs as well as unbalanced high- and low-level connections. The Kurzweil 250 samples at a variable rate, meaning that pitches can be changed on each channel independent of the other channels.

The entire main chassis slides out of the unit at the rear for easy access. The engineers obviously put a lot of thought into the design of the boards and connectors. They are particularly easy to remove for servicing or upgrading.

To augment the sounds described for the basic 250, you can add the optional Sound Block A or B modules, which contain a set of 15 additional voices and 84 new factory-defined keyboard setups. The new keyboard setups also combine several of the new and old sounds. Further sound blocks are planned for the 250, including the recently introduced Sound Block C, which features several new pipe-organ sounds.

SOFTWARE

The possibilities for sound control on the Kurzweil 250 are virtually limitless. You control it by selecting commands from a large menu tree. The commands appear in the two-line LCD. The simplest way to move around the menu is to use the four cursor-control arrows. Pressing the left and right arrows moves you back and forth within a given level of the tree; pressing the up and down arrows shifts you up and down the various levels of the tree.

You can also access any function directly by punching its code number into the numeric keypad or by using "shortcut" keys, a technique similar to that used in the Apple Macintosh when you want to avoid using the mouse to click on menu items. You can then access commands without having to step through the menus. However, you need to remember that certain Kurzweil keys get reassigned when you're using the various software editors.

KEYBOARD-SETUP AND INSTRUMENT EDITORS

The keyboard-setup editor lets you create your own keyboard setups out of combinations of instruments and soundfiles. Up to 40 such keyboards can be stored in the keyboard library, which is in battery-backed RAM, or on

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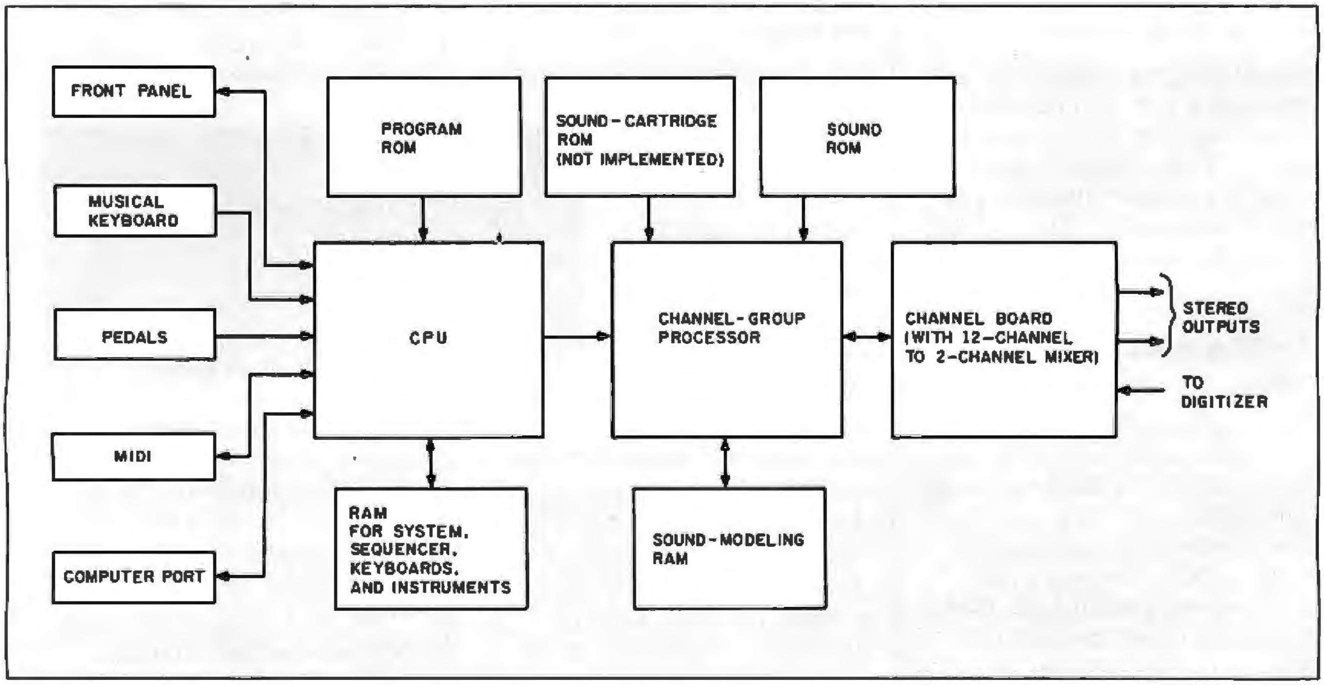

Figure 1. *Block diagram of the Kurzweil 250 Digital Synthesizer, showing the three main microcomputer boards: the central processor, with its on-board Motorola 68000 microprocessor; the channel-group processor, used to extract and combine soundfiles; and the channel output board, which mixes as many as 12 channels of information into 2 and also serves as the input section for the digitizer.*

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The degree of freedom you have in creating keyboard setups is almost frightening. You can create your own sounds, musical or otherwise, and assign them to keyboards.

The instrument editor lets you control the chorusing, vibrato, tremolo, voicing, global parameters, and, via the envelope editor, the shape of the envelope waveform. The latter can consist of up to 255 separate segments, each of which can be a logarithmic-attack, exponential-growth, exponential-decay, or delay segment. Throughout, you have precise control of how quickly segments change in amplitude, what their absolute limits are, and so on.

Global Parameters

There are 10 user-controllable functions that affect the Kurzweil 250 globally. They are sustain, brightness, keyboard dynamics, tremolo, vibrato, pitch-bend, channel stealing, maintenance, chorus, and transposition. Some are straightforward, such as tremolo and vibrato. Others, such as chorus, are complex and can have a profound effect on the 250's sound.

Chorusing, as defined on the 250, involves combining a sound with altered versions of itself that are delayed in time or changed in pitch or volume. Chorusing can create the impressive illusion that an entire group of instruments is being played instead of just one.

Chorusing should always be applied judiciously, since certain keyboard setups used in the chorus mode quickly use up the available 12 channels. At that point the software must "steal" channels by selectively silencing some of the notes currently being played in order to play the newly struck keys. You have control over what algorithm the software uses to choose the notes to be "abandoned." Channel stealing is helpful in some situations but cannot get around the absolute hardware limitations of the basic system. (Still, compared to the monophonic, or one-note-at-a-time, synthesizers of the 1960s, today's polyphonic synthesizers are a plea-

(continued)

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sure.) One way to get around the limitation of 12 channels is to use the 250's MIDI capability to drive external slave synthesizers such as Kurzweil's expander (which is essentially another 250, but without the keyboard).

TRANSPOSITION

The 250's transposition feature is a particularly successful design. Let's say you learned a piece of music in the key of C, but you need to accompany someone in the key of B-flat. Simply hit the transpose-down key twice, and the synthesizer will play in B-flat. There's no need to learn a new arrangement of the piece. Then if you hit two more keystrokes on the transpose-up key, you're back in the key of C. There are five modes of transposition: octave-pitch shift, chromatic-pitch shift, octave transpose, chromatic transpose, and timbre shift.

SEQUENCER

The 250 comes with a sequencing program that lets you store note sequences in much the same way as you would with a tape recorder, although the process is entirely digital. The sequencer does not record actual tones. Instead, it records which keys are struck on the keyboard and how hard they are struck. It also preserves the effects associated with each voice being played. You can play a piece of music, then replay it to edit mistakes or change effects. The sequencer is extremely easy to use; it even lets you store a sequence on a Macintosh disk using the MacAttach interface program. You can control every parameter of a sequence with great precision.

With the 250 sequencer, you don't need a separate drum machine, since you can quickly create your own "loops." A loop is a sequence of music that repeats continuously. You create the first loop, then instruct the sequencer to play it over and over. Also, since the sequencer is recording keystroke events rather than actual musical pitches, you can speed up or slow down a sequence with a few keystrokes. This enables you to record difficult passages at a slow tempo and then speed them up to Vladimir Horowitz specifications. Another practical application is the so-called "time-compression/expansion" technique used to create commercials that are exactly one minute long. The sequencer lets you lengthen a piece of music that is, for example, 58 seconds long to exactly 60 seconds.

THE SOUND-MODELING PROGRAM

The sound-modeling program, or digitizer, lets you create your own soundfiles from tape recordings, records, or even a live microphone plugged into the 250. The user interface for the digitizer is cleverly designed and particularly easy to use. I found I could create an entirely new keyboard of sounds in just a few minutes. You can have someone speak or sing into a microphone, then digitize that voice into the 250 to create an Uncle Harry voice, or whatever. The 250 automatically calculates the pitches of adjacent notes. The process is the culmination of the venerable practice of composing with "musique concrete," or modified sounds taken from nature.

You can store user-created soundfiles on disk (through MacAttach) and modify them just like you can the factory-installed files, and you can combine them with the factory-installed files to create striking effects.

Several features are worth pointing out in the digitizer. One is the high fidelity that is possible with the highest sampling rate of 50 kHz. The other is the ease with which you can edit the sampled sound. Once sampled, a sound can be "trimmed" to remove unwanted material at the beginning or end of the sample.

You can trade soundfiles, instruments, and keyboard setups with other Kurzweil users via disk or modem. I belong to PAN (the Performing Artists' Network), a database bulletin board for electronic musicians and audio engineers. The Synthesizer and MIDI Development Network keeps several soundfiles in the library, which members can download. I recommend PAN to anyone seriously interested in computer music synthesis. For more information, call (215) 489-4640.

MIDI INTERFACE

MIDI is the ubiquitous communications scheme for digital music devices that has become a de facto standard in the music industry.

The Kurzweil 250 offers a particularly full implementation of the MIDI specification and allows the synthesizer to control or be controlled by a variety of other synthesizers, hardware devices, or computers. The 250 has MIDI-in, MIDI-out, and MIDI-thru jacks on the back panel.

DOCUMENTATION

Considering the complexity of the machine, the 250's documentation is surprisingly good, although there were gaps in the earlier versions—no comprehensive diagrams of the software command trees, for instance.

(continued)

The biggest bottleneck to using the 250 is the MacAttach program.

This situation has since been alleviated by the excellent diagrams in the Byrd and Yavelow paper, copies of which have been sent to all Kurzweil owners.

One drawback to the documentation is that it's hard to find things when you need them. However, those sections describing the sequencer and the sound-modeling programs are particularly well written.

New Developments and Miscellaneous Notes

The biggest bottleneck I found to using the 250 is the MacAttach program. At 56,700 bps, MacAttach version 2.0 (which I used for this review) is far too slow, taking from 2 to 4 minutes to load one custom soundfile. This would be prohibitively slow for the live performer. To compound things, MacAttach makes no use of the Macintosh's graphics, and its functions are restricted to loading files to and from the synthesizer's memory and making disk copies. However, this past winter the Kurzweil people told me that they plan to announce Fastlink, an interface card for the Kurzweil that will increase MacAttach data transmission tenfold, making it possible to load a file in 5 to 10 seconds instead of 2 to 4 minutes.

They are also optimizing the Kurzweil 250 for use with a Macintosh equipped with a hard disk drive, and in particular, to work more efficiently with sophisticated MIDI-based music software such as Mark of the Unicorn's Performer and Southworth's Total Music.

In response to criticism that the piano voice has some weaknesses (slight pitch aberrations, certain tubbiness in the midrange, and slight discontinuities from one keyboard region to the next), the company has remasked the ROMs containing the piano voice (and several others). It is now much smoother and more accurate. The new harpsichord voice is also excellent, as are several other new voices in the upgraded software. The approximate charge for retrofitting to the new voicings is $2500.

Redoing the ROMs gave the designers the chance to convert from 256K-byte chips to 1-megabyte chips, freeing up several slots on the motherboard for more sound blocks. Announcements of new sound blocks should be forthcoming.

The currently available Sound Block B features 10 new rock-drum sounds, all recorded in New York with the help of such musicians as Phil Collins and the Thomson Twins. It also includes an electric piano, electric guitar, and other voices.

I have a library of about 20 custom sounds for the 250 that I obtained from the company and from users groups. Most of them are adequate; a few are standouts. It's great fun to create your own.

Conclusions

For a variety of reasons, I feel the Kurzweil 250 Digital Synthesizer is the most important advance in the art of computer music synthesis in the past 10 years. Other approaches may have their particular advantages, but nowhere else have I found a machine that can do all the things the 250 can do for the price.

The 250 is not cheap, but combined with a good analog or digital multitrack tape recorder, it's just about all you need to create a high-powered electronic music studio. The design innovations contained in the 250 will undoubtedly be copied by others, and it's only a matter of time before the Japanese begin to upgrade their designs. (Kurzweil is in fact working with a Japanese company to create a new, lower-priced design.) When the next wave of machines arrives, the state of the art will really take off. ■

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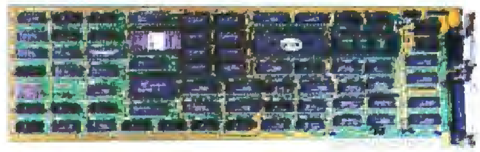

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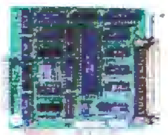

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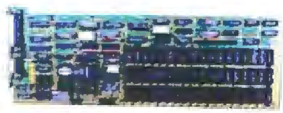

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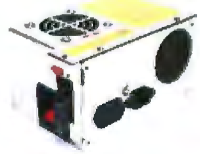

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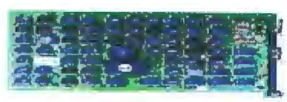

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POCKET APL

In response to the review of STSC Inc.'s Pocket APL (March, page 237), I think Eric Johnson should have made the following two points: One, the program does take advantage of the 8087, if installed. There is a section in the supplied manual that shows the user how to change the program to software floating-point math if the 8087 default is not installed.

Two, APL's strength is in array processing, and the Calculations benchmark, as written, is not the best test of the calculating power of the program. For example:

```
      ∇CALC2
[1]   A←1000⍴*1
[2]   B←1000⍴○1
[3]   C←1000⍴1
[4]   N←5
[5]   I←1
[6]   C←C×A
[7]   C←C×B
[8]   C←C÷A
[9]   C←C÷B
[10]  I←I+1
[11]  →6×⍳I<N
[12]  'DONE'∇
```

This function performs 10,000 multiplication and 10,000 division operations in 64-bit double-precision numbers in 12 seconds. Compare this with the 7:18 time (see table 1, page 238) in the review. Also, with an 8087 installed, the correct figure for the Calculations benchmark as written in the review is 6:16, which illustrates how much time is spent calculating.

KEVIN DOWNING
Evanston, IL

The review gives examples of APL's use of arrays. The benchmark was structured to compare APL's mathematical abilities with BASIC's.

JON EDWARDS
Technical Editor, Reviews

COLOR FOX

We would like to correct one minor misconception and point out one major (and almost universally overlooked) virtue in John D. Unger's review of the Color Fox (January, page 301).

He states that the machine without the video board is slower for screen operations because it uses BIOS scrolling routines. It is definitely slower, but that's not the reason. The unaugmented Sanyo actually has to draw the dot configuration for each character on the screen using the main CPU.

A unique capability is buried in the Sanyo equipped with a video board, however. If you have two monitors available you can configure it as a two-screen system (e.g., text in monochrome using the video board and high-resolution color graphics using the Sanyo video circuitry; that's 640 by 200 pixels by 8 colors). We have recently sent some notes and software to SanPic Users Group (1967 Defiance Avenue, Las Cruces, NM 88001) showing how to use this capability for 320 by 200 pixels by 27 colors. We are not aware of other available software that exploits this capability.

KURT RUDAHL
SALLY GOLDIN
Bangkok, Thailand

ECO-C88 C COMPILER

In the review of the Eco-C88 C compiler (January, page 307), David D. Clark uses a popular factoring algorithm—the Pollard rho method—as a benchmark (listing 3) to test the implementation of long integers. While the program may have dubious usefulness as a benchmark, it is not a correct implementation of this algorithm. The problem arises in the line

```
x = (x*x + 2) %p;
```

and in the two subsequent similar lines. The variable *x* may take any value less than *p*; therefore, the multiplication x*x will eventually cause an overflow if p^2 is much greater than $2^{31} - 1$, the greatest positive number that can be represented in 32 bits. This is true for the number given, and indeed for most larger numbers of interest. Most C compilers do not incorporate the code necessary for overflow checking, so no error is reported.

For the number used, 1394761, and using the program given, the factor 1181 is found after 871 iterations. A correct implementation takes only 38 iterations. It is a credit to the robust nature of this algorithm that it still works at all! A correct implementation can be obtained by declaring a double variable *d*, and by replacing the above line (and the two subsequent lines analogously) by

```
d = (double) x*x + 2;
x = d/p;
x = d - (double) x*p;
```

This is awkward and will not work for the largest values of *p*, but it works correctly for the given number.

Since the way in which a program reacts to an overflow situation may vary from compiler to compiler (and certainly will for different sizes of long int), I think it is dangerous to use this program as a benchmark.

MICHAEL SCOTT
Dublin, Ireland

The changes you suggest do correct the overflow problem and cause the program to operate as it should. Of course, they also destroy the utility of the program as a long integer benchmark. Also, if an argument in the range appropriate to the program is used, the program runs too fast to be useful as a benchmark. After experimenting with several other arguments, I am also amazed that the program works when overflow occurs. The value in the program is not unique in that respect. Factors of other large numbers can be found even when intermediate calculations overflow. The only difference is the unusually large number of iterations required to find a factor (the number of iterations required should have been a clue that the original program was not functioning as expected). I am not mathematically astute enough to explain why the algorithm still works with a pathological argument.

DAVID D. CLARK ■

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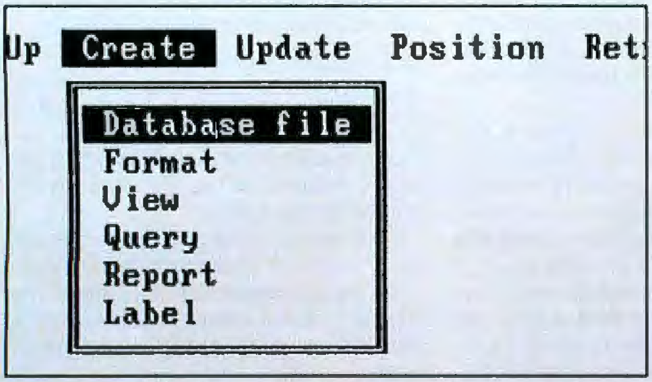

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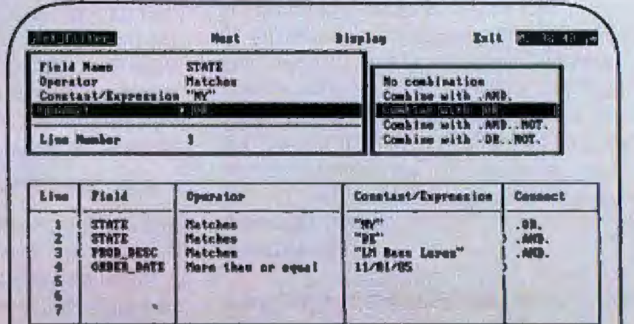

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Kernel

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COLOR AND CP/M ARE the major themes of Computing at Chaos Manor this month. Looking at a new color monitor from NEC, the MultiSync, leads Jerry to the conclusion that the era of color text is here. And wondering whether he should finally retire Zeke, he comes to the conclusion that CP/M isn't dead. There are a lot of CP/M machines out there, they're good at what they do, and there's plenty of CP/M software. Jerry also looks for a macro editor and has the BDS 630/8 laser printer fixed.

In BYTE U.K., Dick tells us what happened when he added a WS3000 multi-standard modem to his computer system. Miracle Technology Ltd.'s new family of WS3000 modems are just about the state of the art in personal computer modems.

In Applications Only, Ezra tells us about four new versions of old, familiar programs: WordStar 2000 Release 2, dBASE III Plus, Volkswriter 3, and Keeptrack Plus.

Our correspondent in Japan also added a modem to his system this month. Bill describes his experiences with his new Hayes Smartmodem and also with the DeSmet C development package, a C compiler.

Bruce Webster takes another pause from the 68000 wars. He begins the article with an industry update, in which he looks at what some of the major computer companies are up to. Bruce then looks at a couple of storage devices: MacBottom and the DASCH external RAM disk. MacBottom proves to be his product of the month. Bruce concludes by making some comparisons of mass storage devices, including a correlation between speed and fragility.

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COLOR AND CP/M

BY JERRY POURNELLE

Jerry looks at the prospects for color and shows that CP/M isn't dead

I've started this four times. There's no easy way. I ended last month's column just before going out to Caltech's Jet Propulsion Laboratories for the *Voyager* encounter with Uranus. It was an absolutely wonderful weekend. Many friends and colleagues came down for the encounter. We had a wild party here at Chaos Manor, and then all got together out at JPL to watch *Voyager* do its stuff. Charley Kohlhase, whose programs control *Voyager*'s flight, joined us—*Voyager* arrived one minute early after more than five years and billions of miles in transit! Marvin Minsky showed up at JPL, found out where the science fiction writers were, and spent the rest of the day with us. We ended up at Burger Continental for dinner. Sunday was similar. A wonderful weekend.

Then came Tuesday morning and *Challenger*, and it wasn't so much fun anymore.

Since then I've received a lot of mail from readers saying the same thing: we've always thought we ought to support the space program, but we never got around to it. What should we do?

I've no room for the long answer. The short answer is, send $30 to join the L-5 Society Promoting Space Development, 1060 East Elm St., Tucson, AZ 85719. Tell 'em Pournelle sent you. They'll tell you the rest.

Meanwhile, I've been busy. The space movement has known for a long time that we'd lose a shuttle one day; but we weren't really prepared when it happened. There's so much to do: press releases; news interviews, some sane and some absurd; and organizing the policies we ought to advocate. You can see what's coming: I didn't do anywhere near as much puttering around with small computers as I would have liked. On the other hand, by making use of BIX, BYTE's electronic conferencing system, I *was* able to put together a national conference bringing together people from the White House staff, the National Commission on Space, the aerospace industry, major universities, and the space advocacy groups. I expect something will come of all that.

MULTISYNC

The official name is the NEC JC-1401P3A MultiSync Monitor. With a name like that, it's got to be good? In any event, it certainly is. NEC calls the MultiSync "the intelligent monitor," and it pretty well lives up to the billing.

The MultiSync isn't very large; I measure 12 inches diagonal of useful area. It comes with a neat swivel stand; when you set it up, it's about 14 inches high by 14 inches wide by some 18 inches deep (if you leave room for the cables). The stand swivels and tilts so that you can partially pack a keyboard under it for storage.

The MultiSync's resolution is 800 horizontal dots by 560 lines. Eighty-column text could have 10 dots horizontal width per column by as many vertical dots as you like. I've no real feel for those numbers. Subjectively, it looks good; more on that later.

The distinguishing feature of the MultiSync is that you can use it with a wide range of color boards. I took mine out of the box and plugged it into Big Kat, the Kaypro 286i IBM PC AT clone that normally drives a 19-inch high-resolution Zenith monitor. No adjustments needed: MultiSync worked fine.

Not only did it *work* fine, but I was tempted to leave it in place. The MultiSync display is crisp and sharp. Text looks good on this monitor. The only problem, for me, is that the text is a little small. I'm farsighted, sufficiently so that I'm most comfortable sitting 30 to 35 inches from an eye-level monitor. The MultiSync is sharp enough that I *can* see and read text at those distances, but it's not really large enough for comfort; and due to the layout of my office, the screen for Big Kat is most conveniently placed 36 inches from my schnozz. I left the MultiSync connected to Big Kat for a day or so, but eventually I went back to my enormous Zenith, which doesn't look as sharp but is certainly large enough.

Next I connected MultiSync to the Golem, our monster CompuPro S-100 286/Z80 SPUZ system. The Golem can drive up to four physical consoles. One of those consoles is Old Reliable, the TeleVideo 950 I bought the first year I did this column. (Incidentally: anyone out there know where I can get some key caps for a 950? The only problem with my Telewidget is that the housekeeper dropped the keyboard last month and lost two key caps.) The other physical console for the Golem isn't exactly a console. It's the CompuPro S-100 PC Video board, which apes the IBM PC color system. With the PC Video board, a properly equipped CompuPro running Concurrent CP/M will also run about 85 per-

(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.

cent of the software developed for the IBM PC, including Lotus 1-2-3 and Flight Simulator.

The MultiSync works splendidly with the PC Video board. Text looks nice—once again, a bit small for people who like to sit as far away as I do; but it's readable, and everything is as steady as if it were painted on.

MultiSync will, without modification, work with the Enhanced Graphics Adapter PC board that is rapidly becoming the business standard; and also, I'm told, with the Professional Graphics Controller. I'm getting a Professional Graphics Controller, and I already have a Princeton Graphic PGC monitor; I'll provide a comparison when the Princeton board comes.

Meanwhile, the MultiSync is trouble-free. The instructions are clear. It works fine with the Perma Power Color Commander gadget (which lets you reprogram the color outputs; see last month's column). MultiSync has a text mode that lets you add color to text or background; not as flexible as the Color Commander, but likely to be all you'd need. Finally, MultiSync runs cool compared to some color monitors I've had here. I do wish it were about two inches larger.

COLOR TEXT?

I'm convinced that the era of color text is here. On the other hand, I've been convinced before. Maybe it's the atmosphere at computer shows—I go to them, see text in color on screens, and come away convinced that it's something I could work with. Then I get it home, and it isn't.

It's likely I'm not trying the right stuff. It has taken me a long time to realize that the problem isn't the monitor, it's the computer hardware that drives the monitor. The standard PC color boards, including CompuPro's PC Video board, just are not good enough; not for me at any rate. Examining them closely shows why. My ancient Processor Technology VDM board—probably one of the last in the world still in operation—has about 11 vertical by 9 horizontal dots in the matrix that forms each letter. (I don't know exactly; I've mislaid the documents, and it's nearly impossible to count them on screen because they run together, which, of course, is what you *want* them to do.)

While the MultiSync monitor could handle that, the IBM PC color and PC Video boards don't have that many dots forming each letter. The edges of the letters are therefore fuzzier. The better the monitor, the less fuzzy it is, but even with the best monitors there's still too much fuzziness. That's something I should have known (and heaven knows enough people tried to tell me); I can only plead that with the construction and other distractions, I wasn't paying attention. Worse: last spring during construction a Hercules color board came in here, but it got separated from its documents, and both got lost in the swim. I've started a search, but it hasn't turned up, and it's deadline time; so I can't even report on how that board looks with MultiSync.

I've more to confess. For months we have had a Princeton Graphic SR-12 color monitor sitting in the storage room. It arrived during hectic construction, when I was hounded from room to room by carpenters tearing down walls faster than I could move computers. At a show, I thought that the Princeton monitor had some of the best color text I'd ever seen; it arrived and wouldn't work with the standard color board in Big Kat. It isn't supposed to, of course. It needs a special color-video board. Somehow that board never arrived, and due to alternate waves of sloth and frantic activity here we forgot to remind anyone. Consequently, the SR-12, which friends assure me is one of the world's great monitors, has blushed unseen like the flower in the crannied wall. That too will be remedied, but not before I turn in this column.

So: it's probably my fault I don't have good color text for a PC AT. On the other hand, when I check with knowledgeable friends, they say they haven't really solved the problem either. On the gripping hand, as the Moties say, I know it *can* be done. By "good" color text I mean letters large enough for me to see and as well formed as those I have on my 1978 VDM board and my even older 14-inch Hitachi monitor; in other words, text that I could stand to look at hour after hour; text that won't distract me when I'm trying to write books. I know it's possible, for two reasons.

First, the standard color output from the Kaypro 286i is *almost* good enough now. It would be good enough for most people, I think. I use Big Kat for my on-line communications, particularly BIX. I spend at least an hour a day at that. It doesn't take the concentration that creative writing demands, but I'd much rather write books on Big Kat than on, say, the original Kaypro II with built-in screen, and I *did* manage a novel on the Kaypro. Not only that, but a number of good writers, including Norman Spinrad and Roland Green, have done the same, and indeed continue to work with the older Kaypro machines to this day.

Second, the color outputs of both the Atari 520ST and the Amiga are *already* good enough to write books on. So far I haven't found a good enough (for me) text editor for either machine, but that's only a matter of time. Not only are there some really good programmers writing editors for both machines, but some of those programmers are in communication with me through BIX. They may not follow all my prejudices, but they're at least aware of them.

LOOKING AHEAD

"*I'm getting old, boss.*"

"Eh?" I woke from dozing. Zeke was nattering.

"*Old. You just said it yourself. My* VDM *board was part of Zeke* I. *That's nine years old! I've got 8-inch disk drives. Noisy. And I'm big, huge, take up a whole corner of your new office. Big Kat there is no bigger than my disk drives! Time to retire. The boys would like to have me.* Or Mrs. Pournelle. Or Notre Dame. *It's silly. All those columns about the future of computers written on an obsolete* CP/M *wreck like me.*"

"You're no wreck, and you're not obsolete," I shouted, and woke up; but it gave me pause to think. Not that Zeke II can't do everything he was bought for. He can. Visitors are generally startled at just how fast he is at handling text and at saving it, if they're used to 5¼-inch floppies;

(continued)

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Zeke's 1.2-megabyte 8-inch drives are just about twice as fast as Big Kat's floppies. I'm used to him.

On the other hand, Zeke has become a dedicated word processor. Not that he *can't* do anything but write. I still have lots of CP/M Z80 programs for accounting, making calendars and keeping my schedule, and all the other things I expect small computers to do for me; but both PC-DOS and Concurrent DOS are so much faster, and it's so much more convenient to have those programs memory-resident and readily available, that I haven't fired up Zeke for anything but writing since we moved upstairs.

In fact, when I finish this column, I'll save it on Zeke's 8-inch disk, then turn around and put that disk in the Golem to check the spelling. I check spelling with The Word Plus, and, frankly, I don't even remember if I have a Z80 version or if it was upgraded to run on the 8086 family. The Golem has both, and they operate invisibly; and he's terribly fast, especially when I run the spelling program from the CompuPro M-Drive/H memory drives. I can then save the corrected column on the Golem's 5¼-inch drive in PC-DOS format, insert the PC floppy into Big Kat, and send it all off to Peterborough through BIX.

That's absurd. *Three* computers to get the column out? Surely one can go—but which?

Probably Zeke. What I should do is start a quest for a really good terminal I can run off the Golem at 38.4 kilobaud (or kilobits per second, as they want you to say now, although I can't guess why). Last time I looked, there weren't any that would scroll text fast enough for me: when I flip a screen page, I want that to happen right *now*. But surely there are new terminals that will do the job. Once I've found one, I'll have to look at the keyboard. Of course, the screen has to be large enough, and bright enough, and the letters properly formed, and—

And if we're going to do that, it can't be long before we have good color boards and monitors and editors for the AT, and—

And at that point I say to heck with

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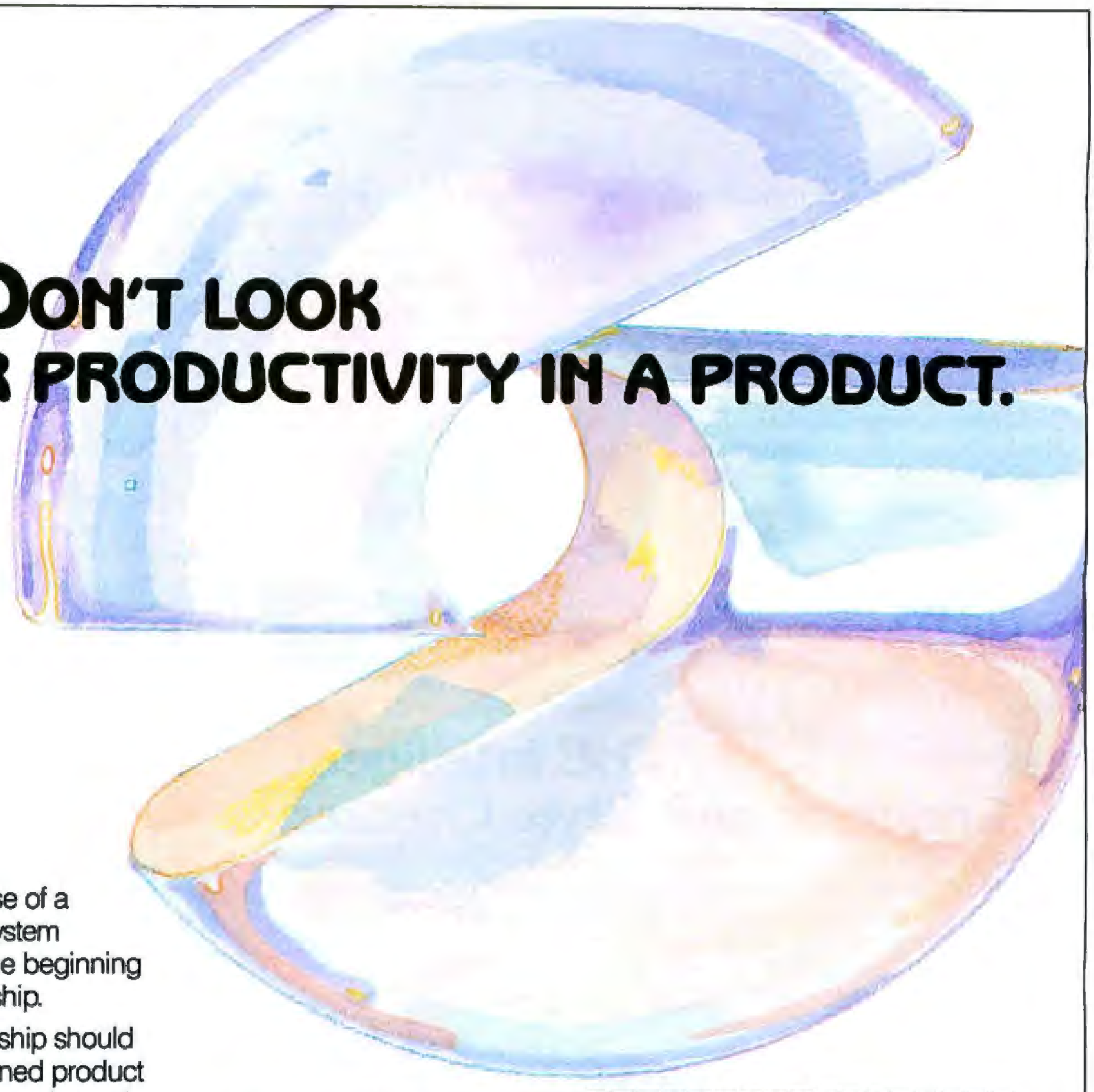

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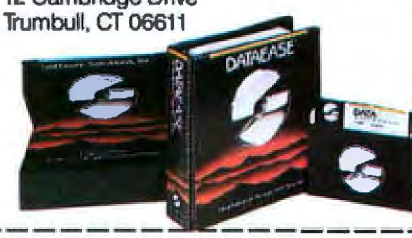

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it and do nothing. Which brings me to the point: CP/M isn't dead.

VERY MUCH ALIVE

Mrs. Pournelle has finished the outline and several chapters of a new book. She's using an Ampex terminal and a CP/M system built out of Ampro Little Boards by Don Castella of Disks Plus in Chicago. For some time, she's had her pick of computers and systems to use as word processors. She has used a Z-150; a Z-160; Adeline the Otrona (about whom more later); a Z-100; Lucy Van Pelt, the IBM PC; and a Macintosh. The system she likes best is the one she has now: CP/M, hard disk, Ampex terminal, and the WRITE text editor. Of course, all she does with that machine is write and edit, so it's hardly a fair test; but it does confirm my impression: given a number of systems to choose from, a good CP/M system with WRITE is still about the best creative writer's word processor around.

Incidentally, her Ampex terminal does run at 38.4 kilobaud. It won't scroll as fast as Zeke does with his memory-mapped video, but then no terminal does. The amber screen is nice, the letter set is pleasing, and the letters are large enough. I could certainly live with it as my major system for writing books. I'm not too happy with where the arrow keys were put on the keyboard, but I'm not too happy with anybody's keyboard arrangement. She likes the terminal a lot, and I'm sure I would once I got used to it. Maybe I ought to get one and hang it on the Golem. But that's for another time. The point is that for writers a CP/M machine is not only good enough, there are ways in which it's superior to more "advanced" equipment; and built up from Little Boards the way Castella built Roberta's machine, a CP/M system certainly costs less than most comparably equipped "advanced" systems.

Don Castella periodically shows me the new stuff they're doing with Ampro Little Boards. There's a Little Board using the Intel 80186 chip; Don built up a system with a hard disk and a Link PC-emulation PC-Term terminal and brought it around. It seems quite nice. Castella and the Ampro people claim they can put together fast multiuser PC-DOS and Concurrent DOS systems at a lower cost per user than anyone else in the business, and I expect that's right. Of course, the Little Board systems are no more than 85 percent compatible with an IBM PC; about like a CompuPro, although the incompatibilities aren't the same.

Some of the incompatibilities may be due to the terminal. The Link PC-Term is supposed to emulate the IBM PC monochrome system, and perhaps it does; I haven't done any extensive tests. In fact, I have a confession: I've done almost nothing with the Little Board/186 system.

It isn't the Little Board's fault. If I don't sound enormously enthusiastic about partial clone systems, it's not because I don't think they have their

(continued)

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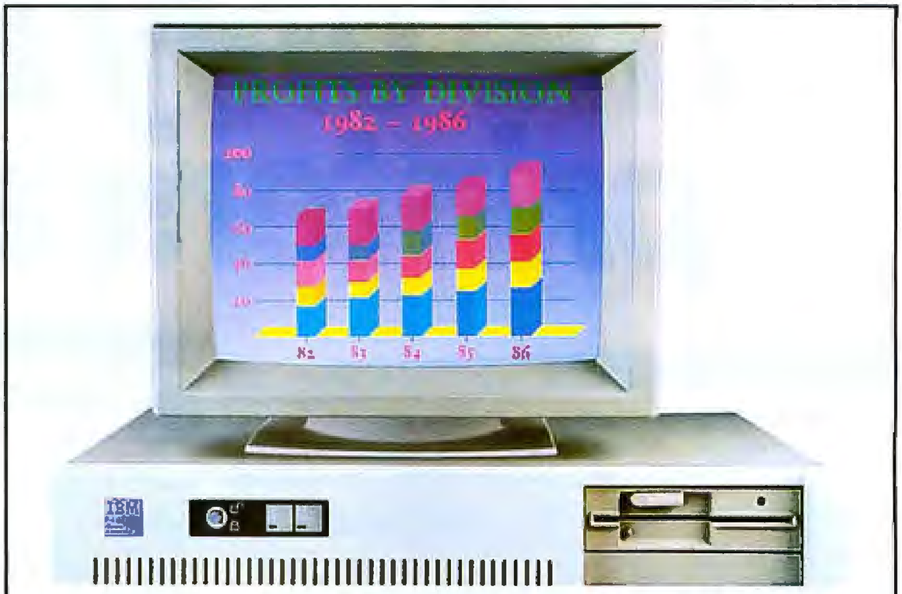

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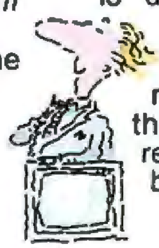

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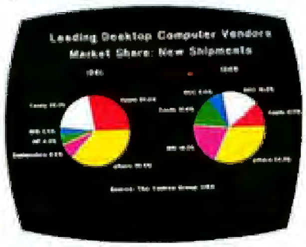

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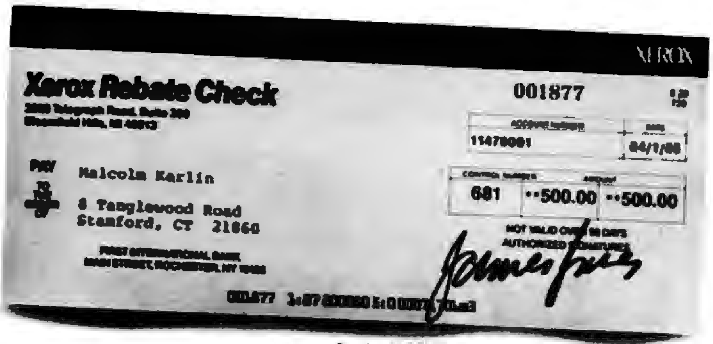

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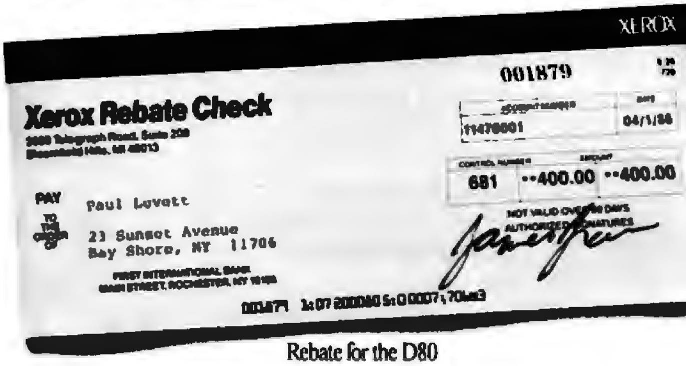

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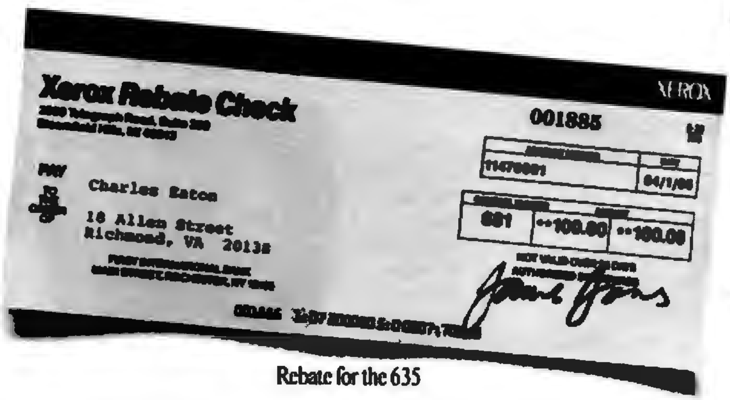

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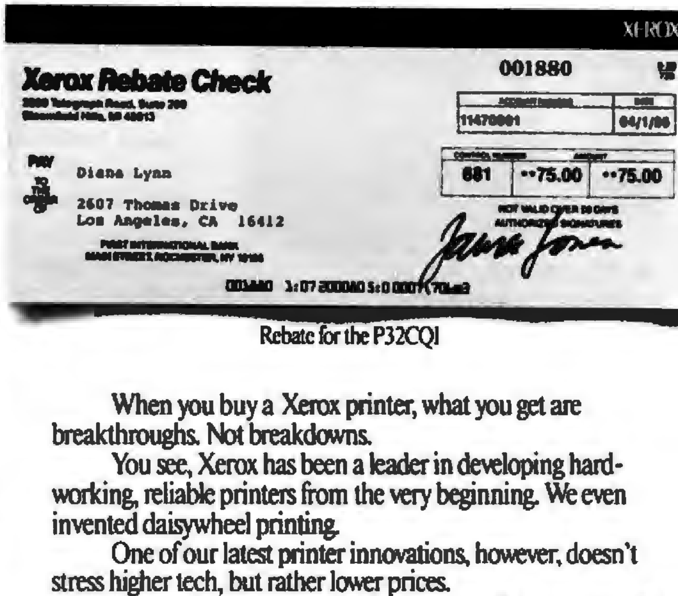

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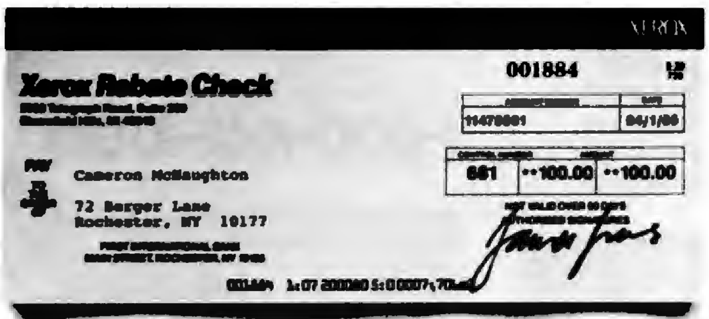

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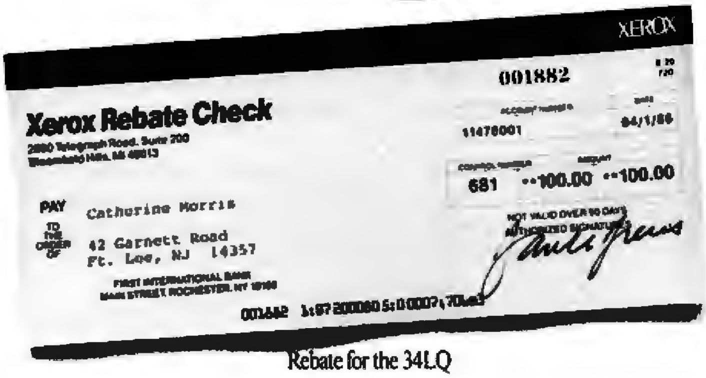

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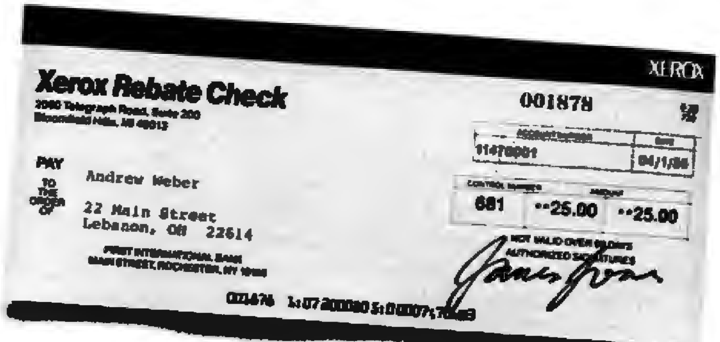

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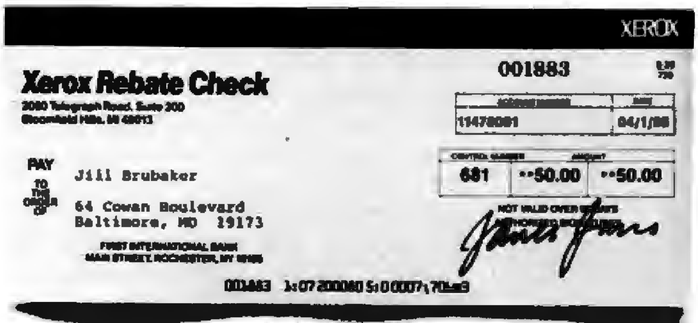

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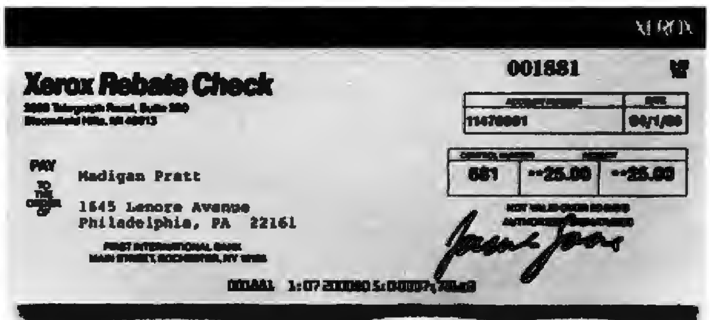

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place. They do: it's just not here. I don't much like multiuser systems (One user, at least one CPU!), but then I don't have to. I operate a small business, but it's not like most: I have a small number of products, not many customers (i.e., publishers), and a very small staff. I don't have inventories to maintain or shared databases to update, nor must I find the lowest-cost computer system to do the job. If I did, I'd look at the situation a lot differently. As it is, though, I'm much more excited about Roberta Pournelle's Little Board Z80, and what I'd like to see would be a Little Board 8/16 that would run both Z80 and 8086/8088 software.

There is, after all, a *lot* of CP/M software out there. You don't see it so much because dealers don't stock it. Dealers don't stock CP/M software because the word is out that CP/M is dead or dying; and as that word spreads, fewer dealers stock CP/M software. The spiral is deadly.

I don't know if the trend can be halted. I do know it's wrong. There are a lot of CP/M machines; they're very good at what they do; and you can get an awful lot of bang for the buck from them.

NOT EXACTLY FREE . . .

There's plenty of CP/M software, too. Much of it is in the public domain: free if you can find it. The trouble with free software is that it's not generally in anyone's interest to tell you about it. Dealers like Don Castella try to provide it with systems they sell. Barry Workman bundles some into packages he calls the Software Anthology Series. There are users groups, too, although fewer than there used to be.

Besides the public domain stuff, there's a mountain of CP/M software that has become what I call "pseudo public domain." I guess I can best explain that by an illustration.

Consider the Scrimshaw Company. Scrimshaw was started in a garage by four guys. One had a CompuPro "boat anchor" S-100 system; they used it to develop a Pascal compiler. The compiler worked and was out there early; if you wanted to do Pascal on your 8080 system, you bought Scrimshaw or you went without. They sold a lot of them.

Eventually competition came along. But by the time better compilers had appeared, the Scrimshaw people had got into another kind of programming entirely. Their new stuff—call it the SuperDuper Accounting System—took off like a rocket. Then came the IBM PC. SuperDuper got ported over to the PC and continued to sell like fury.

For a little while they continued to sell the Scrimshaw compiler, but it wasn't really worth the effort. It cost too much to update and support for the revenue it brought in. They stopped selling it and eventually ceased to support it.

The Scrimshaw compiler is now pseudo public domain. It isn't *really* public domain, because Scrimshaw never officially put it there; but it may as well be, because they don't care how many people pass it around. They'll never give you *permission* to copy it and give it away, because they don't want to *support* it; and if all copies are in theory illegally obtained, they have no obligations toward it whatever. On the other hand, they sure aren't going to waste resources tracking down and suing pirates.

That's one case. Less complex is the case of the FuddyDuddy calendar program. The FuddyDuddy Company consisted of Duane and Arlene Goodhacker working off their kitchen table. They sold 71 copies of FuddyDuddy at $87.50 each (thus doing better than a lot of start-up companies). Nobody was unhappy with the program, but it never took off. Expenses, including advertising, came to 93 percent of what they took in, so their effective remuneration was on the order of 40 cents an hour. Eventually, Arlene went into real estate sales, and Duane became a programmer at the Huge Aircrash Company. The FuddyDuddy Company never exactly went out of business, it just ceased to operate for

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There are a lot of orphan programs out there in the CP/M world.

lack of interest; and FuddyDuddy became an orphan program.

There are a lot of orphan programs out there in the CP/M world. Some are really excellent. The real problem is finding them.

One solution would be for people like Duane and Arlene to turn their programs into shareware and let people who sell CP/M systems know they've done it. The word can be put out on bulletin boards, too. Shareware works this way: you can get a copy of the program from anyone who has it. You can pass it on to anyone you like. If you do like it and use it, send some money to the authors of the program.

Of course, the Scrimshaw people aren't about to make *their* programs shareware. On that one, you just have to let your conscience be your guide. The important thing is that there's a *lot* of CP/M software. Some is not bad, some is very good, and nearly all of it is cheap.

V WEAPONS

Into that complex situation comes the NEC company with its V20 and V30 chips. These chips replace the CPU chip in PClones and do two things: they make the PClone run a bit faster, and they emulate an 8080 so that you can run very nearly all the old CP/M software. The V20 replaces an 8088, and the V30 replaces the 8086. V20 chips work fine in PClones, including the Zenith Z-100, Z-150, and Z-160. They don't work in partial clones, including the DEC Rainbow, TI Professional, and Victor 9000.

Accelerate 8/16, which is CP/M software for using NEC V-series chips, is available from Walt Bilofsky's Software Toolworks. Intersecting Concepts of Moorpark, California, has a cooperative arrangement with Software Toolworks to copublish; the Media Master program lets a V20-equipped PClone handle a wide variety of 5¼- and 8-inch disk formats, including, of course, PC-DOS. About the only major format it can't handle is Osborne single-density. Double-density works fine.

The result is wonderful for owners of CP/M machines: if you want to upgrade to a PClone, send $99.95 to Software Toolworks and you get Accelerate 8/16, which includes the V20 chip, instructions, and Media Master. With that, you can not only transfer all your old CP/M files onto your new Zenith or Compaq or whatever, you can also run all your old CP/M programs. You don't need to go buy all new software.

Now for the bad news: we don't know *precisely* what CP/M software will run on the PClones. We do know that *most* will. If a program doesn't make really tricky BIOS calls, or subroutines embedded in specific locations in CP/M, it should work fine. Barry Workman reports that he has sold a number of copies of FTL Modula-2, his low-cost CP/M Modula-2 compiler with integral editor, to people with V20 PClones. I haven't tried that myself, but so far Barry has heard no complaints.

It's a bit hard to estimate the effect of the V-series chips. They don't cost a lot, and they definitely improve the performance of PClone machines. Reports of 20 to 25 percent speed improvements are probably exaggerated, but certainly WordStar and other I/O-bound programs go 10 to 15 percent faster; a significant upgrade for 20 bucks or so. Walt Bilofsky has done a lot more testing than I have; he reports that nothing runs slower, and most things run somewhat faster.

Thus, it makes sense to upgrade your PClone just for the speed improvement; and it also gives you access to a vast array of CP/M software.

If you have a PClone, you could do a lot worse than to get Accelerate 8/16. Then send for Workman's cata-

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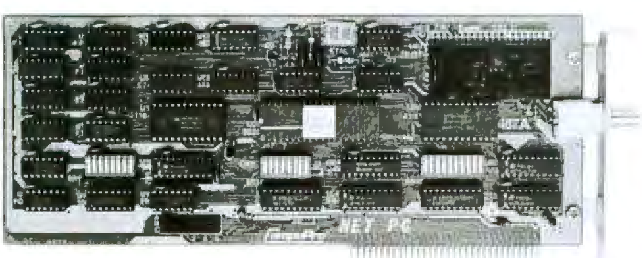

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log of CP/M software: there's an amazing amount of it, much of it packed 20 programs to a disk, and all cheap (Workman and Associates, 112 Marion Ave., Pasadena, CA 91106). Software Toolworks also has a ton of CP/M stuff.

NEC sent me a pile of V20 chips, which we're busily installing in every PClone we have. The *Challenger* disaster interrupted our tests. Full reports another time, but we're very excited.

INTEGRATION?

When IBM brought out the PC with PC-DOS rather than CP/M-86, it splintered the micro community. Nowadays, it's no big deal to transform files from CP/M to PC-DOS (although not everyone can do it), but for a while it was. PC-DOS, warts and all, became the mainstream. CP/M didn't vanish, but it sure got a lot less attention.

The V-series chips can bring those streams back together. There may even be a sort of renaissance through hybrid vigor. More: I'm told that NEC is working on a chip that can run everything from Z80 through 80386 software. And someone will bring out a chip that has 68000 capabilities.

Integration of the micro community means larger customer bases for software. A larger market base means lower prices. Lower-priced, powerful software interests more people in small computers.

The only real question is, why did it take the Japanese to bring us together?

THE GREAT EDITOR HUNT

It all started when I was talking with Don Castella about what I might do with the Little Board/186 machine.

"I do have an idea," I said. "I've collected some enormous files of stuff off BIX. I'd like to go through and edit them down. Delete blocks of nonsense. What I really need is a good macro editor, like WordMaster. What do we have?"

It turns out that I don't have anything. I might be able to tailor Borland's Turbo Editor Toolbox; although it won't hold files larger than memory, that's not such a severe limitation for PC-DOS as it was for CP/M. Alas, I haven't time to do the tailoring. I want something I can use *now*. WordStar in nondocument mode doesn't have proper macros. VEDIT would probably work—I recall I was pretty happy with it under CP/M-86—but I don't have a PC version.

Don suggested Pmate, which apparently is quite popular with programmers; but, alas, that's one of the few editors I don't have, and I'm not convinced it has the command processing I want.

Connie Kageyama brought over an editor called KEDIT, which looks all right; but in reading the manual I can't find out how the macro system works and whether search-and-replace mode lets you match control characters and delimiters and suchlike. I'm told that you can, but the documents don't explain it very well. I'll try again.

One problem is that I've been spoiled by WordMaster. (My mad friend MacLean dubbed it Word Masher long ago, and to this day I invoke it under the command MASH file.ext.) WordMaster not only lets you search and replace for carriage returns and linefeeds and other control characters, but it also has a way to insert any character you like into the text stream. (Well, there is one exception: if you try to insert a Control-Z, which is the CP/M "end-of-file" mark, WordMaster not only won't do it, but the screen flashes "Turkey!") There is a small buffer in which you can set up quite complicated commands, including conditionals. Finally, WordMaster lets you edit as long a file as your disk can hold. It was an early CP/M version of TECO and is, in a word, one of the best programming editors ever written.

There's only one problem. WordMaster was the first CP/M program published by MicroPro. When WordStar took off, MicroPro abandoned WordMaster. Not only is there no PC-DOS WordMaster, you can't get anyone at MicroPro to admit they ever

(continued)

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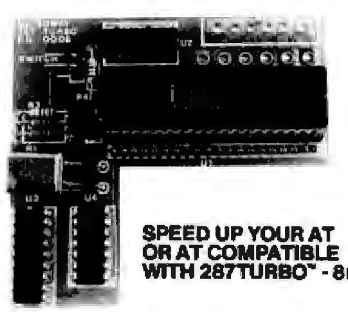

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Fifth Generation FASTBACK 150

published Word Masher in the first place. It has become pseudo public domain.

The Golem lets me edit PC-DOS files: which is what I finally ended up doing. I capture the file on Big Kat's hard disk: write to a PC-DOS floppy: take the floppy out of Big Kat and insert into the Golem: copy the file into RAM disk (because I sure don't want to scroll back and forth through long files on 5¼-inch floppies!): use WordMaster to do the edit: copy back to floppy: put floppy in Big Kat: copy back to hard disk . . .

It all works, but I keep thinking there has *got* to be a good macro programming editor for a PC AT. I do wish MicroPro had ported WordMaster to PC-DOS. I wonder—what editor do they use for programming? I'm *sure* it's not WordStar. Oh well.

GET IT FIXED!

We dearly love the BDS Model 630/8 laser printer. Some of you may recall that we temporarily connected it to my wife's system. The idea was that we'd later set her up with a good dot-matrix printer and move the 630/8 in for the staff. I suppose you can guess what happened next. Just as jewelry is never really an investment—you can't ever sell it ("You want to sell *my* diamonds?")—there is no such thing as "temporarily" connecting a really first-class bit of machinery to your wife's computer.

However, compromise is possible. The BDS 630/8 has both serial and parallel input ports, and both can be active. Given a long enough shielded cable, we can connect the staff's PC up to Roberta's BDS machine when she isn't using it. A better solution is to network the printer using Applied Creative Technology's Systemizers. These are wonderful little boxes that let you connect up to 15 computers to a number of different printers so that you can choose whether to get fast, low-quality dot-matrix listings or high-quality stuff from the laser printer. The Systemizers have their own memory, too. You'll hear a lot more about the Systemizers in a future report; meanwhile, if you've got printer network problems, you could

(continued)

do a lot worse than call Tim Wylde's people at Applied Creative Technology.

All very well; but the bottom line is that Roberta has become dependent on the laser printer. The other night she was using it to do the final submission copy for her book outline when it unaccountably stopped working. It would print a couple of pages of text, then rapidly go through a series of error messages and shut itself down in the middle of the third page. Turning it off and back on naturally got a "paper jam" error. When we cleared that it would work again, but only if we sent it fewer than two pages of text.

Roberta thought something was wrong with her file and tried fixing that, but the problem persisted, so she called me. It took me about five minutes to deduce that the problem had to be the printer: it simply wasn't doing the hardware handshaking with her computer. The result was her computer kept pumping text out; the BDS printer's buffer would overflow; something within the BDS would detect that; and wham, it would shut itself off.

We solved the immediate problem by taking her text upstairs and printing it on my Hewlett-Packard LaserJet. (I've offered to swap with her: I get the BDS and she gets the HP. She isn't interested.) The next morning I called BDS. I described my problem to the telephone receptionist; a minute later, I had someone from technical support. Two minutes after that, they not only understood the problem but knew what to do about it. So far, no one at BDS had the remotest idea of who I was.

I had two choices. They'd send me a kit I could use to fix the machine myself, or they'd send a local technician out. I was ready to choose the do-it-myself route, but when they found out who I was they insisted on sending the technician.

They needn't have bothered. All, or nearly all, the electronics in the BDS laser printer is contained in the "lid." This two-inch-thick lid sits on top of the machine and is connected with eight screws. Remove the screws and the lid lifts off. There are some cables, well marked, that you must disconnect. You then put the new lid on, connect the cables, and replace the eight screws. It took the technician nine minutes. It would have taken either me or Roberta no more than double that.

The BDS 630/8 is built around the Canon laser-printer engine. Most of that is in a cartridge. With 85 percent of the electronics in the lid, fixing the BDS is a breeze. Their normal policy is to send you a new lid; you replace yours and send them the old one in their box. They fix the lid at their shop and recycle it. Fascinating. I wish more computer companies had a system like that.

Except for that incident—which was covered by warranty—the BDS 630/8 has been in heavy use for five months with nary a glitch. We've even discovered the secret of making it feed envelopes, which it does very well.

The BDS laser printer is terrific. It's quiet and fast, and it turns out good-quality work. As I noted in a previous column, the computer thinks it's a Diablo 630, meaning that almost everyone has software that can drive it; it took us about five minutes to hook it up. I can now testify that it's both reliable and easy to fix. If you need a good printer, be sure to consider the BDS.

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ADA

It was a Sunday morning. I was watering my lawn. Up pulls a rented Buick.

(continued)

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Which could leave you with no economically viable alternative but to visit your authorized General Computer dealer. Or call (800) 634-9737. (In Illinois, call (800) 854-9737.)*

GENERAL COMPUTER
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It was Randy Brukardt, one of the R's of RR Software, the company that produces the best—darned near the only—Ada compiler for PCompatibles. Randy lives in the land of ice and snow, which is probably why he spends nearly all his time writing compilers. He was in town for the Ada Faire.

Randy had a bone to pick: when I mention low-cost Modula-2 compilers, I generally haven't mentioned RR's Janus/Ada Compiler C-Pak. It's also low-cost. Randy says, "The real war isn't between Ada and Modula-2, it's between modular languages and everything else. Ada and Modula-2 have much more in common than they have differences."

Niklaus Wirth, inventor of both Pascal and Modula-2, would disagree. To him, Ada is a language designed by a committee and, horror of horrors, includes exception handling. Wirth's opinion of exception handling is somewhat lower than my opinion of Boy Scouts who put live frogs in my sleeping bag.

On reflection, though, I think Randy is right. There really is more in common than in contention between Modula-2 and Ada. They have many of the same strengths and weaknesses. In both cases, the weaknesses are generally solved with faster machines and more memory—modular programs sacrifice both speed and memory to ease of comprehension and maintenance. Both languages are worth knowing, and if you have to write a very large program and coordinate the work of many programmers, either is better than any other language that I know of.

If you want to know more about Ada, you could do a lot worse than to buy the RR Janus starter package. (They no longer sell the CP/M version, but you can get it through Workman and Associates.) The Janus package has good introductory materials and is more than enough to let you learn quite a bit about the language. Since the Department of Defense has mandated Ada for many of its programs, and the Janus/Ada package is now used as the teaching program in many military programming schools, it might be a good investment in job security as well.

SPIN AND POP?

The Otrona Attache was one of the nicest small computers ever made. When it first came out I called it the "BMW of the portables," and I've had no real reason to change that view. It really was the best small CP/M machine ever made. If Otrona had just stuck to developing portables, they'd have come up with a laptop machine compatible with the Attache and gone on from there, and they'd have owned the portable market. Alas, the company abandoned its safe niche and tried to swim out in the big ocean with the other IBM PC compatibles—and is no more.

Unlike those who bought other orphans, Otrona owners are in luck. Jim Pope and his partners have acquired the manuals, spare parts, and partially completed machines dumped when Otrona's assets were liquidated. Jim tells me it was a real horror story: mounds of unsorted manuals, circuit diagrams, component boards, all in a heap in a warehouse, all sold by the pound. The result was good, though: they founded Spin and Pop Enterprises (POB 6458, Denver, CO 80206). I have mixed emotions about the name.

Spin and Pop can service, refurbish, and upgrade your Otrona. They even have a few Attaches to sell. Do understand: buying an Otrona Attache nowadays is a little like buying an old Duesenberg. It looks great and it will work fine, but it won't have a stereo tape player or fuel injection. I wouldn't give up my Attache for anything, and, indeed, we often carry her along on trips.

If you have or want an Otrona, you simply must make contact with Spin and Pop. Get your Otrona upgraded and use it! That machine is far too nice to be left languishing in a closet.

BEAUTIFUL DREAMER

Are you tired of trying to remember WordStar commands? Are you weary of asking Lotus 1-2-3 for help? Does the IBM PC keyboard drive you nuts? Are you often in Num Lock when you shouldn't be, and vice versa? Is that your trouble, Bucky?

If so, help is at hand.

T. S. Microtech's Dreamer for the IBM PC is a neat little 7- by 10-inch box that plugs between your PC keyboard and the PC. It has a numeric keypad, plus arrow keys and 30 more keys. These do about 70 WordStar and Lotus 1-2-3 functions.

There are things about the Dreamer that I'd have done differently, but if I were running a data-entry shop, I'd certainly look into this gadget. It takes up room, and you'd want to think about the design of workstation furniture; but properly used, it could save a lot of time. TSM keeps upgrading to make other business programs easy to learn and easy to use. Definitely worth looking into. You'll hear more about this in the future.

WINDING DOWN

As usual, there's a huge mess of stuff I ought to look at and won't be able to get to. Real Soon Now.

The book of the month is John McPhee's *La Place de la Concorde Suisse*, which isn't in French; it's about the Swiss military defense system. With a population no larger than New Jersey's, the Swiss can put a fully equipped army of 650,000 in the field in less than 48 hours.

Addison-Wesley has a bunch of new computer books, all excellent. There's a new edition of *Programming in Ada* by J. G. P. Barnes ($21.95), the book for experienced programmers who want to learn what Ada is all about; and a new release of Peter Grogono's *Programming in Pascal* ($24.95), one of the best introductions to that language you'll ever find, and certainly the best explanation of pointers and event rings I've seen. Finally, Grogono, with Sharon Nelson, has written *Problem Solving and Computer Programming* ($18.95). Carefully read that as well as Niklaus Wirth's *Algorithms + Data Structures = Programs* (from Prentice-Hall), and you'll have a better computer science education than many university graduates.

Today's mail disclosed another V20 chip and CP/M program from Micro Solutions, another outfit that I know produces good stuff. Their UniForm program enables Kaypros (and other machines) to read and write foreign disk formats, and it was nearly unique when it first came out; I thought it a real boon at the time, and I would probably still use it if the Golem didn't have the ability to read a variety of disk formats. Now they have UniDOS, which they claim will run unchanged CP/M programs on an IBM PC. You don't even have to copy the data to PC format; Micro Solutions' new UniForm can run CP/M programs from about 200 different disk formats as if they were native to the PC. The Micro Solutions package can also run Z80 CP/M programs on an AT (no V20 there, but the program checks for the presence of a V20 or an 80286, as well as whether or not your program expects a Z80). It does this in software, of course, and slows things down, but actually, a fast PC AT can emulate a 3-megahertz Z80 pretty well. More on that next month, and now I'm really out of time.

Do write the L-5 Society. What if we lose *another* shuttle? The nation must always have access to the frontier. I don't expect I have to explain that to micro people. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, *One Phoenix Mill Lane, Peterborough,* NH 03458. *Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.*

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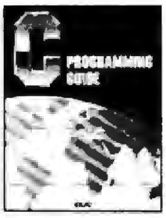

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MODEM MYSTERIES REVEALED

BY DICK POUNTAIN

Our U.K. *correspondent struggles into the electronic age with the* WS3000 *modem*

BYTE U.K. has finally been dragged kicking and screaming into the electronic age. This is the second column to be wholly transmitted to the U.S. over the telephone, using a 1200-bits-per-second modem, British Telecom's International Packet Switching Service, and a BIX (BYTE Information Exchange) mailbox. The changeover was relatively painless despite a certain initial apprehension on my part. Nevertheless, it did uncover one of those wonderfully obscure hitches that seem to accompany serial communications the way that black cats used to accompany witches.

I have owned a 300-bps acoustic coupler for several years now, but I've never really used it much. One reason is that until recently there has been little worthwhile to access in the U.K. The bulletin boards that do exist seem to be filled either with information relevant only to various computers that I do not own, or with trivia and a puerile form of humor that might have escaped from the pages of a school magazine.

But another reason is that the U.K. has a lot of catching up to do in communications. Until two years ago the state-owned telephone authorities forbade private citizens to connect any apparatus directly to the telephone network. As a result, the 300-bps acoustic coupler represented the state of the art in hardware for quite a while, unless you were a corporate user with a leased line. In addition, the low-cost home computers that have dominated the market here are seldom equipped with serial ports as standard features, and this also hindered the growth of communications.

Since the privatization and subsequent liberalization of the telephone network, some progress has been made. Direct-connect modems are now becoming available at reasonable prices, and we are even starting to see speeds of 1200 and 2400 bps full duplex in the latest models. British modem manufacturers still complain that the approval procedure required by British Telecom takes too long and hinders their competitive efforts, but movement is visible nevertheless.

Also complicating the matter is the fact that the U.K. has a wider variety of communications standards to support than the U.S. does. Moreover, even when our standards appear to use the same speed as yours, ours are in fact based on different carrier frequencies than yours. Ours are based on CCITT standards rather than Bell; for example, our 300-bps standard is CCITT V21, whereas yours is Bell 103.

Although our bulletin board systems are mainly 300 bps, we have a major public teletext network called Prestel that uses the CCITT V23 standard, which operates at the split rate of 1200/75 (that is, 1200 bps receive and 75 bps transmit). This curious standard was chosen because Prestel was not designed to be a fully interactive system. It is mainly an information source for business data, weather reports, and the like. The 1200-bps receive speed gives reasonably quick screen updating, while the 75-bps transmit rate is adequate for sending short command sequences to turn to the required page.

With the advent of home computers, several vendors rented space on Prestel for electronic computer magazines and encouraged home computer owners to use the service. So for several years one was faced with a choice of buying either a 300-bps or a 1200-/75-bps modem. The split tended to be 1200-/75-bps modems for home computers such as the Sinclair Spectrum and Commodore 64, and 300-bps modems for CP/M users who were probably using U.S. telecommunications software.

In 1984 the British firm Miracle Technology Ltd. produced a multistandard (i.e., 300 and 1200/75 bps) modem called the Minor Miracle at what was then a very competitive price of just over £100. In 1985 the firm followed up on the success of this model with a new family of WS3000 modems that, in their various configurations, are just about state of the art in personal computer modems.

STRANGE INTERACTIONS

The basic model in the WS3000 series operates with the V21 (300 bps full duplex) and V23 (1200/75 bps) standards as well as the equivalent Bell standards, at a price of £250. It comes with auto-dial and auto-answer facilities, uses the widely accepted Hayes protocols, and is highly intelligent. It also has internal storage for 60 telephone numbers.

The two more expensive models are identical to this model, except that they add 1200 full duplex (the V22 model) and 2400 full duplex (the V22bis model). Both lower-priced models can be upgraded to higher specifications after purchase.

I decided to purchase the V22

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, *One Phoenix Mill Lane, Peterborough,* NH 03458.

model, at a cost of £495, because I anticipate using BIX a lot, and uploading large text files at 1200 bps rather than 300 bps will save money in the long run. And to be honest, using BIX at 300 bps with my old acoustic coupler is a real pain. Most of the system's interactivity evaporates when you have to sit drumming your fingers waiting for the text to unfold on the screen.

My purchase decision was slightly complicated by the fact that Hayes launched a U.K. version of their best-selling Smartmodem 1200 just about the time I decided to buy, priced almost exactly the same as Miracle Technology's V22 model. However, a couple of factors (patriotism apart) made up my mind. The U.K. version of the Hayes operates only at 1200 bps full duplex, whereas the WS3000 operates at every standard you can think of, including Prestel's split rate. At a more trivial level, the WS3000 comes with a built-in phone jack to connect the telephone handset, whereas the Hayes doesn't and so forces you to buy a doubling adapter.

I received my WS3000 V22 in the last week of 1985, after a lengthy wait due to production delays with the plastic cases. It's a smart-looking unit and, like the Hayes, slim enough to sit under the telephone. It has no mechanical controls, just a set of red lights that reveal the current status of the lines and operation modes.

I quickly got the unit set up and working faultlessly at 300 bps and spent a couple of days playing around on BIX and various U.K. bulletin boards. But try as I may, I simply could not make it work at 1200 bps. It took a while to discover this fact because a lot of commands and various registers can be altered on the device, and I had to play around for several days to be convinced that I was using the modem correctly. It is, in fact, very easy to use, and most of the stuff I was doing was quite irrelevant, but I discovered that only later.

The symptoms were simply that at any speed involving 1200 bps (including 1200/75 and 1200 full and half duplex) only garbage appeared on the screen, even though it was clear that the modem was dialing correctly and logging on successfully to the various services (including BIX). The obvious conclusion to draw was that the 1200-bps chip in the modem was faulty, but some hunch told me that this wasn't so. If that were the case, how could the modem dial and log on correctly? A painful process of detective work began, which involved several phone calls to Miracle Technology's patient and helpful customer service department.

The first two things to suspect when faced with an RS-232C–related problem are always communications parameters and cabling. It was easy enough to try all the possible combinations of parameters, and the

(continued)

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cable had been specially made to fit my serial port. Both checked out OK.

Next I presumed that my communications software was at fault. Trying several different packages, including the communications module of Symphony, convinced me that this was not the case.

Then a clue appeared. After a benchmarking session one evening, while the stopwatch was still in my hand, it occurred to me to time the rate at which the garbage emerged from the modem. A convenient standard text source was at hand in the shape of the modem's internal telephone directory. This can be listed by sending the command ATN? to the WS3000, and it worked fine at 300 bps but produced garbage at 1200 bps. The stopwatch revealed that the garbage was indeed being transmitted at 1200 bps, and a character count of the directory revealed that only one character in four was getting through properly, hence the garbage. This suggested that my serial port might not be receiving properly at 1200 bps. Discussions with Miracle Technology further encouraged this theory.

My workhorse computer is an IBM PC with a serial port provided by a Microsoft Systemcard multifunction board. A friend lent me a brand-new serial card, and I replaced mine with it. It displayed exactly the same symptoms. At this point, having put my own board back in place, I gave up rational thought and howled at the moon for a while.

Eventually, my courage returning, I decided that since the top of my computer was still off, I would take the whole darned thing apart bit by bit until I made it work. One by one, I removed boards from slots and tested the modem by logging on to BIX. When I removed the Microsoft Mouse card, the modem worked like a charm.

Those of you who have the bus version of the Microsoft Mouse know that the interface card has a jumper on it with four positions that let you choose which hardware interrupt the mouse will operate with. My mouse is an early version, and the jumper is not documented in the manual (it was mentioned on a piece of loose paper in the box, which I lost within a week). The jumper had actually been moved once, when I tried out Digital Research's GEM, because the GEM manual clearly tells you to set the mouse on interrupt 3. I had, though, subsequently moved it back to 4. Moving it onto interrupt 3 again solved my problem, and both mouse and modem now work just fine.

There must be a moral to this story, but I don't know what it is. Perhaps you could say it's a warning that these open-architecture machines, of which we are all so much in favor nowadays, are not an altogether unmixed blessing. Maybe the ideal would be a closed machine that got everything right the first time.

Items Discussed

WS3000 V22 Professional Modem £495
Miracle Technology (U.K.) Ltd.
St. Peters St.
Ipswich IP1 1XB
England
Tel: (0473) 216141

British Telecom Packet SwitchStream
British Telecom
Customer Service Group
G07 Lutyens House
1-6 Finsbury Circus
London EC2M 7LY
England
Tel: (01) 920 0661

The WS3000

The phantom bug having been defeated, I am now very happy with my choice of modem. The WS3000 is a very smart modem indeed, and the days of wrestling with an acoustic coupler (the handset popping out of the cup halfway through a call) seem like the dark ages.

The modem responds to commands that for the most part are the same as those of the Hayes Smartmodem. All such commands are prefixed by the letters AT (for attention), and the modem squeaks through its loudspeaker to acknowledge that its attention has been gained. A set of 32 nonvolatile internal registers holds all the modem's parameters, and most of them can be read and written by the user. After you've messed them up so badly that the modem no longer works, the command ATZ will restore the original factory settings from ROM, for which I have been truly grateful several times.

The WS3000 differs from the Hayes Smartmodem in that it supports many more communications modes. There are 21 in all, when CCITT and Bell, half and full duplex, originate and answer, equalized and unequalized are taken into account. The six registers S25–30 hold codes that determine what settings will be used for each of the speeds: 75, 150, 300, 600, 1200, and 2400 bps. When the modem receives its first AT command during a session, it senses the speed being used and copies the appropriate code from one of these registers into S18, the current-mode register. So the user can fill registers S25–30 with the codes to be used as default settings. If visiting America, for example, I would load the appropriate Bell standard set.

In auto-answer mode the WS3000 is speed-sensing; in other words it tries to determine what speed the caller is using by comparing the carrier tone with all the ones it knows about, starting with the fastest. I haven't yet been able to test this facility as I don't get many calls from other modems.

One very powerful feature is the provision of a parallel control port. This port is brought out on the back panel of the case as a 26-pin connector and can be configured by software to emulate a Centronics printer port or a variety of other 8-bit ports. By writing suitable software (which can be put in ROM and added to the command set), you can use the port for remote control of machinery and instruments. It's possible for an instrument hooked up to the port to auto-dial a number and send its readings, or for a machine to auto-dial engineers and make a fault report. Those who are enthusiastic about the home of the future could use it to alter the central heating, for example, or reset

(continued)

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the burglar alarm while on vacation.

I have found the WS3000 to be as transparent as a modem can be. I use a simple dumb-terminal program, configured to 1200 bps full duplex; the WS3000 then sets itself to this speed automatically. My keyboard enhancer program, Software Research Technologies' SmartKey, assigns modem command strings (e.g., ATDN1 for "dial stored phone number 1") and log-on strings to single keys, so I can get onto BIX with just two keystrokes, one to get a PSS (Packet SwitchStream) line and the other to do all the logging on. Borland's SideKick serves as an editor and, with its Paste facility, a means of transferring documents.

A nice bonus is that SideKick lets me use the WS3000 as an auto-dialer for both voice and data calls. By keeping all my phone numbers in SideKick's PHONE.DIR file, I can search the directory for a number and dial it by hitting a carriage return. This is a pretty good test of the WS3000's Hayes compatibility, since SideKick is designed to work with the latter.

This string-and-sealing-wax setup works just as well as any of the expensive blockbusting communications programs I've seen. The only feature I miss is the ability to call the terminal program, SideKick-style, from inside another application, and I understand that there are now products in the U.S. that will do this.

COMMUNICATING IN THE U.K.

Before I finish, a little elaboration on British Telecom's Packet SwitchStream network would be useful, especially for British readers who are contemplating joining BIX.

The British Telecom services are called Packet SwitchStream (PSS) and International Packet SwitchStream (IPSS), and both can be obtained merely by opening an account, just like a regular telephone account. The cost of opening such an account is very reasonable indeed—a one-time connection charge of £25 and a quarterly rental charge of £6.25. For this you receive a password called your NUI, or network user identity, which will be recognized at one of the Packet Switching Exchanges that are situated in all the U.K.'s major cities. You also get an NUA, or network user address, by which other modem users can reach you.

By dialing the number of your Packet Switching Exchange (a local phone call) and giving your NUI, you will be connected to a computer called the PAD (packet assembler/disassembler). Once connected to the PAD you can gain access to other users or networks in the U.K., or abroad by entering their NUA just like a telephone number. For example, BIX can be accessed via the U.S. Tymnet network, whose NUA is 31069.

With packet switching, your message is chopped up into small packets (usually 128 bytes), and these packets are then mixed in with packets from other users and sent over a high-speed data link. Each packet contains an address that enables your whole message to be reassembled again at the other end. By this means the data rate of the system can be kept very high, and so the cost to you is low.

For example, if you dial the U.S. directly by public telephone it costs about £45 per hour; most of the time is wasted, too, since the gaps between words (or typed characters in a data call) are much longer than the actual information. With packet switching there is no such waste, and the cost is much less. Tymnet, for example, costs £4.80 per hour and £3 per kilosegment (1000 packets) transmitted. To that you add the cost of the local phone call to your PAD, which goes on your ordinary phone bill. Inland calls on PSS and European calls are much cheaper still.

Assuming you have an IPSS account, the complete sequence to access BIX from the U.K. is as follows:

<your own NUI>	
A9 31069	to get onto Tymnet
BYTENET1	at the Tymnet prompt
MGH	password
BIX	to log onto BIX

To go through the registration procedure, type new when BIX asks for your user name. You'll need a MasterCard or Visa (Barclaycard) credit-card number to pay the registration fee, so have it on hand before you start. Any BIX users who want to reach me can send mail to dickp.

[*Editor's note: Starting with last month's column,* BYTE U.K. *is available on* BIX *in the Byte.uk conference. Dick encourages readers to add comments and queries about his columns to the conference.*] ■

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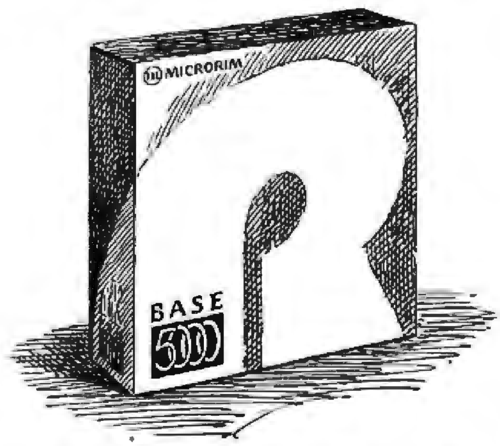

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UPGRADE FEVER

BY EZRA SHAPIRO

WordStar 2000 Release 2, dBASE III Plus, Volkswriter 3, and KeepTrack Plus

Writing this month's column has not been fun. None of the products is new; you and I have seen them all before. So I've been faced with a tough question: Should I base my evaluations on how the products have changed, or should I treat them as if they were brand new? Well, I've taken the dumb way out and tried to do both.

IN THE CENTER RING

Imagine you're at the circus. It's time for the moment you've been waiting for—the elephant act. The elephants come marching out. They dance. They wave their trunks in the air. They roll giant colored balls across the ring. And then—the grand finale! The overhead lights dim. A spotlight shines on a curtain at the far side of the ring, which opens to reveal *an elephant on roller skates*! Fantastic! The crowd cheers! The elephant raises his trunk and slowly, majestically, skates around the ring. He's not very steady, but he manages to maintain his balance. You notice the expression on his face; he looks sad. Everyone applauds; you go home thinking about that poor, sad elephant.

A year later the circus comes to town again. You've been reading reports in the local paper about how the elephant act has been improved (or "enhanced," as we say in the computer biz). You go to the performance. You watch the elephants; strangely, nothing seems very different from last year. On schedule, the lights dim, the curtain opens, and out comes that same forlorn elephant on roller skates, *only this year the roller skates are motorized*! The sad elephant buzzes around the ring (steadier than last year because he doesn't have to pump his legs). The crowd cheers. You feel cheated. You shake your head in disbelief, and...

...and you put WordStar 2000 Release 2 back on the shelf, that's what.

Yes, friends, WordStar 2000 Release 2 (MicroPro, $495) is with us at last, with all the charm of an elephant on motorized skates. It's faster than last year, to be sure, although it's still so ungainly and hungry for disk space that I wouldn't recommend running it on anything less than an IBM PC AT with a fast hard disk. The fact that MicroPro is so concerned about speed that it's offering a RAM version for users with 512K bytes or more (sent as a premium when you mail in your registration card) is a signal to me that the program still has problems.

After several weeks with the product, I find it clumsy, overdesigned, and uninviting, although the list of features looks terrific on paper. The program isn't absolutely ghastly, but I can't come up with a reason why I'd want to use it.

In all fairness, the program *does* give you everything you need for professional word processing, plus a number of bonuses. The documentation is clean, and the tutorials on disk are helpful. CorrectStar is still an excellent—and possibly the best—integrated spelling checker. The database-like mail-merge feature is very nice, as is the ability to store layout formats. You get great macro/abbreviation facilities. Two new features, arithmetic functions and multicolumn layouts, are welcome additions. And MicroPro supports just about every printer ever made.

Yet I remain unsatisfied. Part of the problem is the interface, loosely (very loosely) based on original WordStar's use of Control-character prefixes. The prefixes have been changed to be more mnemonic; block operations are triggered with Ctrl-B, exit options with Ctrl-Q. This makes more sense than the original, which used Ctrl-K for both. As a result, a veteran WordStar user like myself finds the landscape of WordStar 2000 familiar but unsettling. MicroPro contends that the transition is easy; I argue that if I'm going to have to learn a new system, I might as well learn something entirely new.

Menus or submenus fill nine lines at the top of the screen. Add the status and ruler lines, and nearly half the display is gone. This was ugly when WordStar did it; why not change with the times? I'd vastly prefer almost any other system—pull-down menus, pop-up menus, a command line, or anything that doesn't cause as much visual clutter.

I suspect that what I'm encountering is part of a master plan to make the program easily grasped by the computer-uninitiated in the business environment. After they become adept, the theory goes, they can turn off all the visual noise and get on with life. Well, I'm what is known as a "power user"—I don't need all the help—but I'm learning, too, and every time I have to ask a question I'm forced to confront all this stuff. There's no way around it.

Drawing another analogy, I expect a top-of-the-line word processor to

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behave like a luxury sports sedan. I want good handling, quick response, fast acceleration to cruising speed, a sense of security and comfort, and I don't want convenience features to distract me from driving. The parallels to word processing are obvious. If WordStar 2000 were a car, it would be a limousine with tail fins.

With Release 2, WordStar 2000 has become an acceptable word processor at last, but there are at least half a dozen word processors on the market I rank as outstanding, including WordPerfect, XyWrite, MultiMate, Framework, Volkswriter, and even lowly, original WordStar (which you can get with CorrectStar). If you want to settle for "acceptable," be my guest. But think about that elephant.

An Important Product

Make no mistake, when you buy **dBASE III Plus** (Ashton-Tate, $695), you're not just purchasing a database management program—you're joining an institution. Over the years, the dBASE phenomenon has grown from a small cult happening to a massive superstructure. Although Ashton-Tate has built strong customer loyalty by providing excellent support for the product, you don't need it. Just look at the number of dBASE books, dBASE users groups, dBASE bulletin boards, dBASE consultants, dBASE utilities, dBASE program generators, dBASE compilers, dBASE . . . you get the idea. I often find myself recommending the program not because it's particularly suited to a given use, but because of all the support. There's a snowball effect, too. As dBASE becomes increasingly dominant, fewer competitors have the guts (or the budget) to challenge it head on, so they attempt to chip away at the edges of Ashton-Tate's market. As a result, I could probably pick out products that beat dBASE in any specific category (this one has a better query language, that one is more portable to minicomputers and mainframes, the other one is easier for a novice, and so forth), but nobody beats dBASE overall.

Each upgrade to the original dBASE product has broadened its scope. The current move, from dBASE III to dBASE III Plus, adds the regular performance improvements (has a database manager ever been enhanced *without* an announcement of faster sorting and indexing?), networking capabilities, a few new programming commands, rewritten documentation, and a mild sprucing up of the user interface.

The networking will further solidify the product's position in the business community. You have file and record locking, eight levels of password protection, and encryption/decryption on any network that runs with PC-DOS 3.1, including networks from 3Com, Novell, AT&T, and IBM. Since I didn't have access to anything but a few single-user computers, I have no idea whether any of this works, but it sure sounds impressive.

As to the other stuff, I have mixed reactions. I've never found dBASE all that difficult to use in its rawest form, the infamous "dot prompt" interface. At that level, the program works like a language, and you can accomplish a lot with a limited number of commands. It's a bit confusing at first, but you can build a pretty straightforward card file without too much effort. Things get trickier as your needs become more complex, but if you can take the time to learn gradually it's no big deal.

However, software companies seem to feel that they have to prove that their products can be operated by the subaverage dunderhead, so Ashton-Tate has bolted on a "Framework-like" menu system, a query aid, a view mode, a Screen Painter, and an Applications Generator. It's here that dBASE III Plus lacks punch.

The menu system is okay, but database manipulations are rather arcane, and the menus will not save you from yourself if you don't have a clear idea of what you're trying to accomplish and how the program works. They do save a little time when you're building

(continued)

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You can't learn to program in C without a good book and a good compiler. You can buy other C books but they don't include a compiler. You can buy other C compilers but they don't include a book. Either way you spend a lot of bucks and the compiler might not do what the book says it should. With MIX C you don't have to worry. You get both a good book and a good comiler for just a few bucks. And we guarantee that the compiler does what the book says it should.

Language Features

- Data Types: char, short, int, unsigned, long, float, double, void
- Data Classes: auto, extern, static, register
- Typedef, Struct, Union, Bit Fields, Enumerations
- Structure Assignment, Passing/Returning Structures

Functions

abs	conbuf	feof	getcseg	isascii	movmem	replace	strcat
asm	conc	ferror	getdseg	iscntrl	open	repmem	strcmp
asmx	cos	fflush	getd	isdigit	outp	rewind	strcpy
atan	cpystr	fgets	putd	islower	peek	right$	strlen
atof	creat	fileno	getdate	isprint	perror	rindex	strncat
atoi	cursblk	filetrap	gettime	ispunct	poke	rmdir	strncmp
atol	curslin	find	geti	isspace	poscurs	scanf	strncpy
bdos	curscol	floor	puti	isupper	pow	setbuf	strsave
bdosx	cursrow	fopen	getkey	itoa	printf	setbufsiz	system
bios	cursoff	fprintf	getmode	keypress	putc	setcolor	tolower
biosx	curson	fputs	setmode	left$	putchar	setdate	toupper
calloc	delete	fread	gets	len	puts	settime	ungetc
ceil	drand	free	getw	log	putw	setjmp	ungetch
cfree	exec	freopen	heapsiz	log10	rand	setmem	unlink
chain	execl	fscanf	heaptrap	longjmp	read	sin	write
character	execv	fseek	hypot	lseek	readattr	sound	writechs
chdir	exit	ftell	index	malloc	reach	sprintf	xmembeg
chmod	exitmsg	fwrite	inp	alloc	writech	sqrt	xmemend
clearerr	exp	getc	insert	mathtrap	readdot	srand	xmemget
close	fabs	getch	iofilter	mid$	writedot	sscanf	xmemput
clrscrn	fclose	putch	isalnum	mkdir	realloc	stacksiz	xmovmem
cmpstr	fdopen	getchar	isalpha	modf	rename	str$	_exit

MIX Editor $29.95

When you're programming in a high level language you need a high powered editor. That's why we created the MIX Editor. It's a powerful split screen text processor that works great with any language. It has auto indent for structured languages like Pascal or C. It has automatic line numbering for BASIC. It even has fill and justify for English.

You can split the screen horizontally or vertically and edit two files at once. You can move text back and forth between the two windows. You can also create your own macro commands from an assortment of over 100 predefined commands. It comes configured like WordStar but you can customize it to work like other editors or word processors.

The editor works terrific with our C compiler. The MSDOS/PCDOS version has a macro for compiling direct from memory. If your program has an error the editor positions the cursor to the error and displays an error message. You can also run other programs and execute DOS commands. Because the editor works so well with our C compiler we want to make sure you have both. For a limited time we're offering the editor for only $15 when purchased with the C compiler.

ASM Utility $10

The ASM utility allows you to create your own assembly language function libraries. It works with Microsoft's MASM or M80 assemblers. It provides macros for function entry and exit so you don't have to worry about environment details. It also provides a macro for calling C functions from assembly language. Lots of useful assembly language functions are included as examples.

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- ☐ Kaypro II
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or editing a simple database, but if you want a full accounting system you have to read all the documentation anyhow.

The query thing (is "structurer" a real word?) is a good shortcut. You get to select fields and filter criteria, and you can get your results *much* faster using it than you could if you had to type out queries in the dBASE language.

The view mode is merely a euphemism for file-join capabilities. You can build new tables from as many as 10 open files. I do not see this as helping the dunderhead; again, you have to know what you're doing.

The Screen Painter is a full-screen report/entry form editor. It's useful and self-explanatory.

The Applications Generator is a development tool aimed at helping people who don't know what they're developing. That's a snide remark, but this add-on is not going to construct a project that requires any real sophistication with no assistance from the operator. It's helpful for quick and dirty development, and I suppose you can use it to generate some blocks of code that would be boring to write out, but I still see the heavy-duty stuff as requiring programming expertise.

So, conclusions.

One: Database management is not an arena for idiots. It takes planning and intelligence.

Two: dBASE III Plus is not a program for idiots either. It comes with tools that make it simpler to build a baby accounting system or an automated address book, but if that's all you're up to, there are cheaper, friendlier products on the market.

Three: If you use the tools as shortcuts while developing something, you're pretty smart. I salute you.

Four: The main point (to me) of this upgrade is the network support. If you need those capabilities, or want to buy into the dBASE culture, check this one out.

A Solid Performer

Volkswriter 3 (Lifetree, $295) is one of the great forgotten programs. People don't seem to get excited about it, probably because it doesn't do anything flashy. But I don't know if you want fireworks in your everyday word processor; Volkswriter 3 gets the work done and lets you move on to the next job. It's a good product that shouldn't be neglected, particularly considering the price tag.

Basic features: Function-key command set. Uncluttered screen. Decent mail merge. Remapping of ASCII keys. Import and export. Support for a wide variety of printers. TopView-compatible.

New features in this version: Automatic paragraph reformatting. Quick spelling checker with large dictionary. Ability to store multiple layouts, either within individual documents or as templates. Columnar math functions that make it possible to create a small spreadsheet within a document.

Liabilities: There are three things about the program that I don't like. First, I wish it were possible to remap the command keys. I have a tough time with more than a couple of levels of function keys; Volkswriter 3 uses all four levels. Even though punching F1 gives me a diagram of the layout across the top of the screen, I still have trouble remembering the difference between Alt-something and Ctrl-something. Second, if the spelling checker decides that what you've typed is a botched abbreviation, it will demand that you repunctuate it. If the mistake is just a typo, you can't ask Volkswriter 3 to suggest alternatives. Finally, it's another one of those programs that lets you put a character anywhere on the screen. You position the cursor, type a character, and Volkswriter 3 fills the intervening area with spaces or returns as necessary. I'm willing to accept this as a mode, but in general I prefer having to put in the spaces myself so I can use the right arrow key to get from one line to the next.

Overall reaction: Volkswriter 3 is a solid workhorse of a word processor. If you demand lots of zippy features like windows and outlining and such, look elsewhere. But if you're on a tight budget (and who isn't?) and you need a businesslike editor, Volkswriter 3 is worth a long look.

Cute and Handy

There are dozens of hard disk management utilities for MS-DOS machines. As a rule, these programs are designed to simplify file handling and directory organization, and they all look pretty much alike. You can usually show the tree structure of your directories in some sort of graphics representation (useful!) and move from one directory to another by cursoring around the branches of the tree. Individual directories can be displayed when sorted by any reasonable criterion (name, size, age, attributes, etc.). Specific files can be viewed on screen, sent to your printer, copied, moved, deleted, renamed, tagged for mass operations (copying a selected group of files to a floppy disk, for example), and so on, and so on, and so on. In practice, the novice

(continued)

Items Discussed

WordStar 2000 Release 2 ... $495
(MS-DOS)
MicroPro International Corp.
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200

dBASE III Plus ... $695
(MS-DOS)
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502-1319
(213) 329-8000

Volkswriter 3 ... $295
(MS-DOS)
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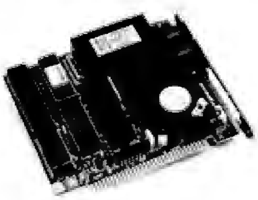

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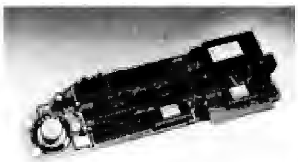

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user is insulated from the cryptic world of the DOS command line, and the expert is given a shortcut through tedious disk-maintenance tasks.

I usually don't recommend paying money for any of these programs for two reasons. First, a lot of good public-domain and shareware utilities do exactly what the commercial ones do. Why pay for a commercial product when most of your money is going for packaging and promotional costs? You sure aren't buying originality or brilliant programming. The second reason is a matter of personal honor—I don't recommend products when I can't keep their names straight.

At first glance, **KeepTrack Plus** (The Finot Group, $79) is yet another program of this type. It does *all* the expected things, and does them *well*, and who cares?

However, buried somewhere off on a submenu is a nice file-by-file backup-and-restore system that I haven't seen anywhere else yet. You select a branch of your directory tree (or your whole disk) for backup, and KeepTrack Plus duplicates your disk structure on the backup medium. That is, it will create the necessary directories so that the file C:\COMM\TALK\BIX.DOC will be copied to A:\COMM\TALK\BIX.DOC. KeepTrack Plus creates a master index in your root directory that shows where the backup of each file has gone and another index file on your target medium that shows what it contains. Both indexes are in plain ASCII, and they can be edited or viewed with no hassle. If you want to exempt certain files from the backup process, you create an ASCII file in your root directory that lists exceptions. The system is ideal for backing up on sequentially numbered floppies but will work with streaming tape, cartridge hard disks, and so on. I am far more comfortable with this file-by-file arrangement than with the standard DOS process that does not let you get at individual files.

The original KeepTrack is still available at $39, but it lacks the backup system, and I won't recommend it for the reasons stated previously. For convenience software, KeepTrack Plus is pricey, but it makes life easier. ■

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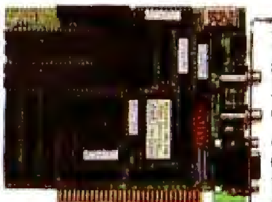

IBM sets the standards for Monochrome, Color/Graphics and the Enhanced Graphics Adapter. Hercules sets the Monochrome Graphics standard. And the MegraGraph-Plus simply redefines the standard for what the Graphics Adapter is supposed to be: Monochrome text, Hercules graphics, color graphics, enhanced graphics. And most importantly . . . No software driver patches required.

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List Price	$549	$599	$624	$595

(1) Needs software driver patches.
(2) Compatible only to the BIOS level, but not the hardware level. Will not be compatible with most games software.

ATI

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Inquiry 34

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Step 1: Set your computer's telecommunications program for full duplex using 8-bit words, no parity, and 1 stop bit, or 7-bit words, even parity, and 1 stop bit. You may call at either 300 or 1200 baud.

Step 2: To reach BIX via Tymnet.*

* *BIX is accessible from anywhere in the country through local Tymnet numbers. If you don't know the Tymnet numbers for your area, contact the BIX Customer Service Line (see below). At other times, numbers can be obtained by calling Tymnet at 800-336-0149.*

- Call your local Tymnet number and log on.
- Depending on your baud rate, Tymnet will respond with "garble" or request a terminal identifier. Enter the letter "a". (Ignore quotation marks in this and succeeding entries.)
- Tymnet will ask you to log on. Enter "byteneti" and a carriage return (CR).
- Tymnet will ask you for a password. Enter "mgh" and (CR). You will then be at the door to the BIX computer.

Step 3: (If there is no prompt requesting a login at this point, hit a (CR) which should produce it.) When you see a phrase ending in "login:", enter "bix". (Echoing of this response is normal.)

You should now see the BIX logo scroll onto the screen and a prompt asking you to enter your name. Since this will be your first time on the system, enter "new" and a carriage return. This will take you to a special section where you enter the information we need to register you as a BIX user. Follow the on-line prompts and supply the information requested. BIX lets you re-enter data if you make a mistake.

When you've completed your registration, BIX will automatically take you to a special "Learn" conference where you'll get a quick tutorial on how to use the system. (Typing "help" or "?" at any prompt while you are on BIX will give you an immediate review of available commands.)

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To reach BIX from other countries, you need an account with your local Postal Telephone & Telegraph (PTT) company. From your PTT, enter 310600157878. Then follow instructions starting at Step 3. A list of PTT addresses and contacts for most foreign countries is available by calling or writing BIX.

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If you follow these instructions but still are unable to log on to BIX, call the BIX Customer Service Line for assistance at 800-227-2983, 8:30 a.m.–11 p.m. eastern time weekdays. In New Hampshire and outside the U.S., call (603) 924-7681.

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Inquiry 411

NEW TOOLS, NEW CHALLENGES

BY WILLIAM M. RAIKE

Bill's conversion process continues as he adds a C compiler and a modem to his system

Last month I went into detail about EM/3+, the "operating-system unification adapter" from Megasoft that lets me run both MS-DOS and CP/M-86 software and handles disks recorded under either operating system in more than two dozen formats. After living with it for another month, I'm even more enthusiastic than before: I've gained all the benefits of MS-DOS while retaining the use of much of my CP/M-86 software library. And I've had time to get used to two new acquisitions—a C compiler and a modem. But converting to a different operating system hasn't been all peaches and cream...

THE DESMET C DEVELOPMENT PACKAGE

Almost all of my CP/M-86 software now runs under the combination of MS-DOS and EM/3+ on my computer (see May BYTE Japan, page 329) except for the Digital Research C compiler. It had been cumbersome to use, yielding bloated object code, so I welcomed the excuse to switch to a more suitable compiler. I finally decided to order the latest version (version 2.5) of the DeSmet C development package from CWare (POB C, Sunnyvale, CA 94087, (408) 720-9696). It includes a full C compiler, assembler, linker, and library files; I added the optional D88 symbolic debugger. Considering the compilation and linking speed, the small size of the compiled object programs, the exceptionally clear documentation, and especially the tremendously useful symbolic debugger, the whole package is a terrific bargain at $159.

This column is definitely not intended as a full-scale product review, but I can't pass up the chance to give the DeSmet C compiler/debugger combination a pat on the back. If you've ever gritted your teeth in exasperation because of your C compiler and linker while tracking down some elusive bug in a C program, you'll greet the D88 symbolic debugger with a huge sigh of relief. When you run your C program under the debugger, you can set breakpoints; list the C source code; display the contents of variables, registers, and memory; calculate the values of C expressions; and stop your program at crucial points to see what it's actually doing instead of what you think it's supposed to be doing.

Although the DeSmet C package is really designed for use with the IBM PC and compatibles, the compiler and linker ran with no modifications at all on my Fujitsu FM-16β computer, which makes no pretensions at all toward IBM PC compatibility. To use the D88 symbolic debugger, I had to make some minor modifications to the CONFIG.C file that's supplied on the distribution disk. Although the standard library has console functions that are specific to the IBM PC, the distribution disk includes easily understandable assembly language source code you can modify for any machine. And my Fujitsu, now running under the combination of MS-DOS and EM/3+, had no trouble reading CWare's IBM PC-formatted disks. The package even has a full-screen editor, but I prefer to stick with my usual editor.

I haven't run extensive benchmarks, but some statistics follow to give you a rough idea of the DeSmet C compiler's performance. One of my small text post-processor utility programs, XPAG.C, contains 167 lines of C code. The DeSmet C compiler and linker took 5.36 and 2.95 seconds, respectively, or a total of 8.31 seconds, to produce an executable program file. The size of the executable file was 12,288 bytes, compared to 22,528 bytes under Digital Research C. (Digital Research C produces over 10K bytes of code even for the smallest possible C program: main( ){ }. DeSmet C produces 1536 bytes for the same program, partly because the compiled program doesn't need to keep track of I/O redirection, which is handled automatically by MS-DOS.) I never did run Digital Research C on the well-known Sieve of Eratosthenes benchmark, but DeSmet C produced an executable program file only 7168 bytes long; it took 2.24 seconds to compile and 2.44 seconds to link. The printf( ) function accounts for over 5000 bytes of the final program size; it also represents about half of the compilation time. The execution time (to find 1899 primes 10 times) was 4.46 seconds. The times I've just quoted were measured on my Fujitsu FM-16β, which has an 80186 main processor running at 8 MHz, with all files residing in a RAM disk.

A NEW MODEM AND ITS DOCUMENTATION

During a recent trip back to the U.S., I bought the Hayes Smartmodem 2400, and I'm already spoiled. After

(continued)

William M. Raike, who has a Ph.D. in applied mathematics from Northwestern University, went to Japan in 1980 looking for 64K-bit RAMs. He has been there ever since as a technical translator and a software developer.

using my old Epson 300-bits-per-second acoustic coupler, it's a real joy to be able to sit down at the computer, let the Smartmodem dial the number for me, and then communicate at 1200 bps, four times faster than before. I wonder how I ever put up with waiting for characters to plod across the screen at 300 bps.

Since the Smartmodem supports both the U.S. and international CCITT modem standards at 1200 bps and the CCITT standards at 2400 bps, I have no problem using it over here. Although there are still few chances to use the 2400-bps rate here in Japan, I now routinely use 1200 bps when communicating with BIX and other information utilities. It looks as if this modem will meet my communication needs for the foreseeable future.

Not only is the Smartmodem 2400 a well thought out, flexible, and powerful device, but it has the best hardware documentation I've ever seen, bar none. In addition to the sections that provide clear descriptions of the operation of each of the common commands used for ordinary communication tasks, the manual contains detailed technical sections and appendixes that explain how to make the modem do practically anything imaginable. There's even a technical appendix that gives connection diagrams for modular telephone jacks (which I found essential to make the two-wire connection to my telephone junction box, since modular jacks aren't yet in widespread use in Japan). I also found specifications for pulse dialing, tables of touch-tone frequencies, and detailed descriptions of the RS-232C signals and how the modem uses them.

The descriptions of the RS-232C signals turned out to be indispensable for me. After rewriting my communications program in Turbo Pascal under MS-DOS, I discovered that I could communicate readily with my laptop computer, but not with the Hayes modem. I eventually deduced that the RS-232C driver under Fujitsu's MS-DOS, unlike the CP/M-86 driver, won't output a character unless it senses that the DSR (data set ready) line (pin 6) is active. Since the Smartmodem holds pin 5 (the CTS, or clear to send line) active at all times but only activates the DSR line when a valid phone connection has been established, I surmised that everything would work just fine if I cut the DSR line (pin 6) in the cable and shorted pins 5 and 6 together at the computer side. This would fool the computer into thinking it had a valid DSR signal. It was a satisfying, if minor, bit of detective work. Sure enough, after minor surgery on the ribbon cable, I was able to communicate just as well under MS-DOS (and EM/3+) as I had before making the conversion from CP/M-86. I had a kludge that worked!

SOME KLUDGES WORK BETTER THAN OTHERS

But it turned out that I had congratulated myself just a wee bit early. The next problem that emerged was a direct result of what is, in my opinion, poor software design.

It seems obvious to me that device-driver routines ought to be "quiet" programs. That means that they shouldn't do anything that isn't absolutely necessary, and in particular they shouldn't produce any console output and shouldn't interfere with the execution of an application program, except in the event of an absolute catastrophe. The serial port driver under Fujitsu's version of MS-DOS displays a message on the console, in ever-so-polite Japanese, any time I turn the modem power on or off. Not content to foul up the screen, any application program that happens to be running is interrupted and control returns to the operating system command processor. I was not amused one day when I flipped the modem power switch to "off" and my word processor immediately bombed out, returning me to the operating system minus the text I had created.

The solution seemed easy: Instead of using a modem signal line (pin 5) to pull up the DSR line, make a cable adapter that shorts pin 4 to pin 6 on the computer side. The computer always holds pin 4 (RTS, or request to send) high, so this second solution accomplishes the same thing, regardless of the state of the modem. But so much for theory; the problem persists, and I may just have to learn to live with it.

But I'm still annoyed by the software design process that allows such "error" handling in the first place. The same kind of problem crops up in other places. For example, if I try to write a block of text to a disk file from within my word processor and make a typing mistake that indicates I'm trying to access a nonexistent disk drive, the operating system (again, politely) informs me of that fact and aborts the word processor without saying so much as "Excuse me." The sensible way to handle such errors would have been to have the operating system (or the BIOS) return from the I/O service request with an error indication and let the application program (word processor, communications program, or whatever) handle the error gracefully. There's no need for gratuitous messages on the screen, and certainly no excuse for aborting a program.

FUNCTION KEYS DON'T

It seems to me, for Japanese computer companies to compete successfully in the world software arena, they

(continued)

Inquiry 300

should pay more attention to design criteria that avoid such problems. Another criticism I have concerns the keyboard driver for my machine under MS-DOS. My Fujitsu has 10 programmable function keys. Under CP/M-86, I used them frequently and effectively at both the level of the operating system and the level of applications programs. Fujitsu chose, under MS-DOS, to dedicate all 10 function keys for use with a "feature" that lets you edit the command lines you enter for the operating system. But Fujitsu's documentation doesn't mention any way to redefine them, either.

Under CP/M-86, it was possible to make BIOS system calls to have complete control over the console coprocessor (an MBL68B09) that manages the keyboard and the screen in the FM-16β. You'd load some registers, execute software interrupt 220, and the function keys get set to whatever you want. Obviously, Fujitsu must use some kind of BIOS interface to the coprocessor to accomplish the same functions under MS-DOS, but the documentation should say something about how it's done. I'll find out eventually, but in the meantime, no one I've been able to reach seems to know anything about it. And now, because the tricks you can use with the IBM PC to redefine keys using ANSI escape sequences don't work on the Fujitsu (see Best of BIX, February BYTE, page 386), I've got a computer with 10 useless function keys.

This kind of shortsighted design, combined with poor or nonexistent documentation and technical support from the factory, is a real problem. Hopefully, computer manufacturers will realize that foresight, good technical documentation, and support for software developers sells more computers.

NEXT MONTH

I'll discuss a couple of new computers from NEC that retain their compatibility with earlier models, and I'll tell you about a new laptop from Oki that has a built-in modem. I'll also share a quick overview of my reactions to the COMDEX show in Japan. ■

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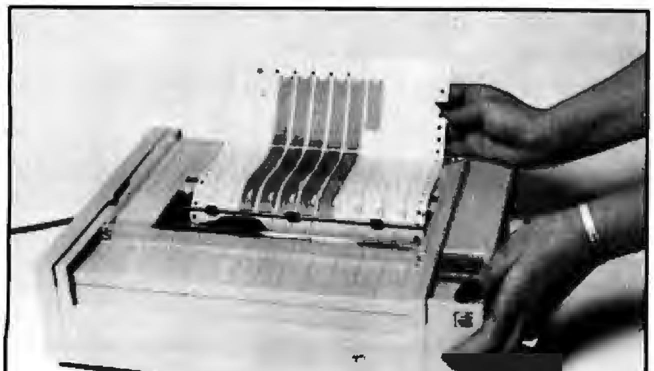

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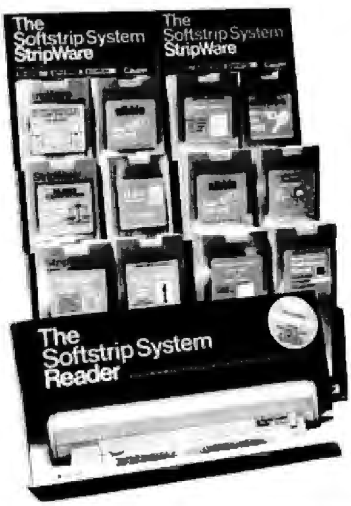

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STORAGE FOR THE MASSES

BY BRUCE WEBSTER

An industry update, and Bruce also looks at some storage devices

I'm writing this column in the last half of February, and the industry seems to be largely catching its breath after the Christmas season and the January trade shows. I'm doing a little breath-catching myself, after juggling different languages, compilers, and machines for last month's column. Once again, it's time to pause from the 68000 wars and look at a few of the products that have shown up over the past few months.

INDUSTRY UPDATE

Apple, much to its dealers' surprise and delight, has wasted little time shipping the Macintosh Plus in significant numbers. No indication yet as to how the Mac Plus is selling with its hefty $2600 price tag; I would suspect that dealers are having little trouble selling what they can get, though. In the meantime, some interesting rumors about the Apple IIx (next generation of the Apple II line) continue to surface. Over on BIX, one alleged description was posted that made the IIx appear to leapfrog the Amiga and the Atari ST machines: 4-megahertz 65C816 processor (which has a 16-megabyte address space and a 6502 emulation mode), Mac-equivalent ROMs, 4096 colors, high-resolution display, 32-voice sound synthesizer, 1 megabyte of RAM (expandable to multiple megabytes), Apple II and Macintosh emulation modes, and an affordable price tag (less than $1500).

That rumor is wild enough to just possibly be true, especially if Steve Wozniak is indeed involved in the machine's design. Woz knows what hackers and developers want and—more important—knows that hackers and developers are the ones who write all the software that sells the machines. Rather than deliver a closed, crippled machine like the original 128K-byte Macintosh, which has gone through two generations in two years, Woz and Apple together just might have the brains and vision to put together a machine that can survive through the next ten years, just as the original Apple II has survived the last ten.

Atari, in the meantime, is having delays in shipping the 1040ST and the new 520ST. The word from Atari is "any minute now," and I suspect its people are working very hard to meet that, lest they fall victim to the famed Osborne syndrome. For those of you unfamiliar with microcomputer history, the Osborne 1 was a marketing innovation: a cheap, portable CP/M computer with lots of bundled software. Unfortunately, it had a number of limitations, like a tiny screen (5 inches) that displayed only 52 characters on a line and disk drives that didn't hold a whole lot (90K bytes). Osborne, feeling the heat of competition from Kaypro (which had entered the market with a similar but better system), announced the Osborne Executive, which corrected most of the problems of the Osborne 1. Unfortunately, production problems prevented Osborne from shipping the Executive for a few months, and sales of the Osborne 1 dropped to almost zero as dealers and customers waited for the new, improved version. Osborne was already on shaky financial ground, and that turned out to be the coup de grace, pushing Osborne into Chapter 11 financial reorganization (i.e., bankruptcy). Osborne emerged from bankruptcy a year or two ago but hasn't been able to make any significant market penetration.

So why would the people at Atari announce the 1040ST and the new 520ST before they could ship them? A combination of reasons, probably. Conflicting reports continue to come in on how the Amiga and the 520ST did during the Christmas season, but most sources indicate that the Amiga outsold the 520ST. Whatever the actual numbers, the 520ST was not the runaway success that many (including myself) thought it would be. That, combined with Apple's pending announcement of the Mac Plus and the lack of a good trade show forum during the spring, probably enticed Atari to make the announcement at the Winter Consumer Electronics Show in early January, even though they weren't ready to ship yet. At that time, they were saying "end of January," which was a reasonable and acceptable delay. Unfortunately, it's now late February, significant editorial coverage of the 1040ST has been appearing for a month now—with more to come—and the machines still haven't been shipped. I'll wager that 520ST sales have dropped off sharply, partly because of the announcements and partly because inventories of the "old" 520ST have been exhausted and Atari is (very understandably) unwilling or unable to produce more "old" units.

It would be a shame to see Atari hurt by this delay, especially since the 1040ST and the revised 520ST possibly represent the best price/performance deals in the history of microcomputers. Atari is probably better able to sur-

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vive the sudden drop in sales than Osborne was, but they need to get those machines out the door soon; no company can survive dramatically reduced sales for long . . . except, possibly, IBM, which reputedly has a few billion dollars in the bank.

Commodore, in the meantime, seems to keep dodging the bullet that everyone thought would have been fatal by now. The bankers are apparently convinced that a live but ailing Commodore stands a better chance of paying off its debts than a dead one and that sales of the C-64, C-128, and Amiga are sufficient to keep Commodore alive for now. Smart folks, those bankers. The two big problems still appear to be lack of software and Commodore itself. Little new software has shown up in the past month, though a number of companies (like Aegis) claim to be on the verge of shipping several titles, and I still don't know if a decent word processor is available for the Amiga—especially critical because of Commodore's attempts to position the Amiga as a business machine.

Commodore seems to be hurting its own cause by throwing up roadblocks for developers. The latest obstacle: Commodore apparently wants software firms to pay $500/product/year for the privilege of putting the Workbench (desktop interface) on their product disks. This strikes me as unnecessary and counterproductive, since every Amiga owner already has the Workbench. Developers can, of course, not put that stuff on their disks and just have the users make working copies, like most CP/M and MS-DOS software, but it is in both Commodore's and the developers' interest to make things as easy as possible.

IBM, as always, goes right along being IBM, comfortable in its view of the marketplace and its position therein. The question is how closely that view corresponds to reality, since the clone makers continue to eat away at IBM's market share. On the other hand, the real question might be whether or not it matters, since for large sections of the computer market, IBM has the apparent power to define just what reality is, with hordes of analysts and MIS managers following in its wake. Still, it was Zenith's portable, not the much-rumored (and still unannounced) IBM laptop computer, that won the key IRS contract. And the large inventories of unsold IBM PCs and XTs appear to be keeping IBM from introducing any new PC systems. Big Blue may just have painted itself into a corner.

Product of the Month: MacBottom

To be honest, I was hesitant about picking the MacBottom 20-megabyte hard disk as product of the month. I'm sure there are Macintosh hard disks that are newer, or cheaper, or faster, or have more sophisticated system software. And there isn't much about it that's flashy or exciting. In fact, in the few months I've had it, I've given very little thought to it. Ironically, that's exactly why I did pick it as product of the month: because, day after day, week after week, it has quietly, unobtrusively done its job and done it very well. No crashes. No bugs. No lost files. No lost desk space. No power switches to fiddle with. Easy boot-up. Nice utilities. Fast performance. In short, just

(continued)

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ZBasic™	13.7 sec.	ZBasic™	30 sec.
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about everything I want out of a hard disk, and all done so well that I take it for granted . . . or, at least, I will until I have to send it back and suddenly do without.

The MacBottom (built by Personal Computer Peripherals Corporation) sits underneath the Macintosh. It has the same "footprint" as the Mac; that is, it takes up the same amount of desk space. It's about two inches high, which—by adding that much height to the Mac—only serves to make the screen easier to see. It plugs into either the printer or modem port. If the printer port is used, the MacBottom will act as a printer buffer. You never have to turn the MacBottom on or off; instead, it senses (through the RS-422 port) whether or not the Mac is on and turns itself on or off accordingly. As most (all?) hard disks do, it makes some noise, but not an objectionable amount. It has a small, pleasantly green LED on the front that blinks during disk access (just so that you know it's doing something). The unit I have holds 20 megabytes; a 10-megabyte version has been available but is being phased out.

Since there is no way (at least none I know of) to boot off a hard disk connected to one of the serial ports, you do have to use a special boot disk to start things up. However, the boot-up program is smart enough to make a user-defined volume on the hard disk the default (start-up) volume and to eject the boot disk, leaving you with a hard disk–based system and no dreary floppy disks lying about.

MacBottom comes with MB Utilities. The boot-up program installs an important utility, the MacBottom Panel, as a desk accessory. You'll use this utility most often. As such, it is the easiest to access. It lets you "insert" (mount) or "eject" (dismount) volumes at will. It also shows any print buffering in progress and allows you to flush the buffer if desired. Three other MacBottom utilities let you create and delete volumes, change their size, change (without rebooting) the default volume, change the size of the printer buffer, and modify the boot sequence (which volumes are to be mounted, which one is the default, which port to use). Volumes do not automatically grow

(continued)

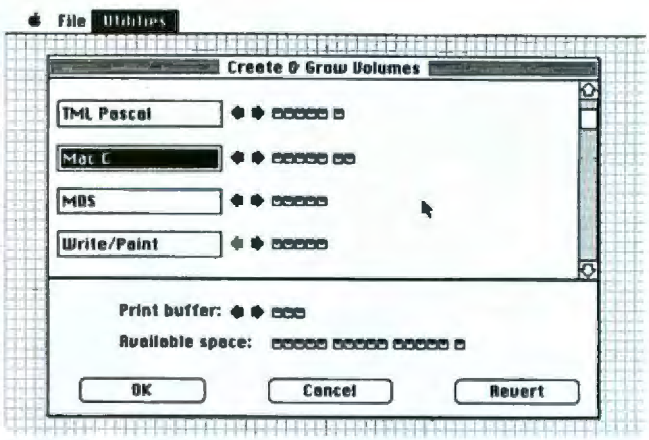
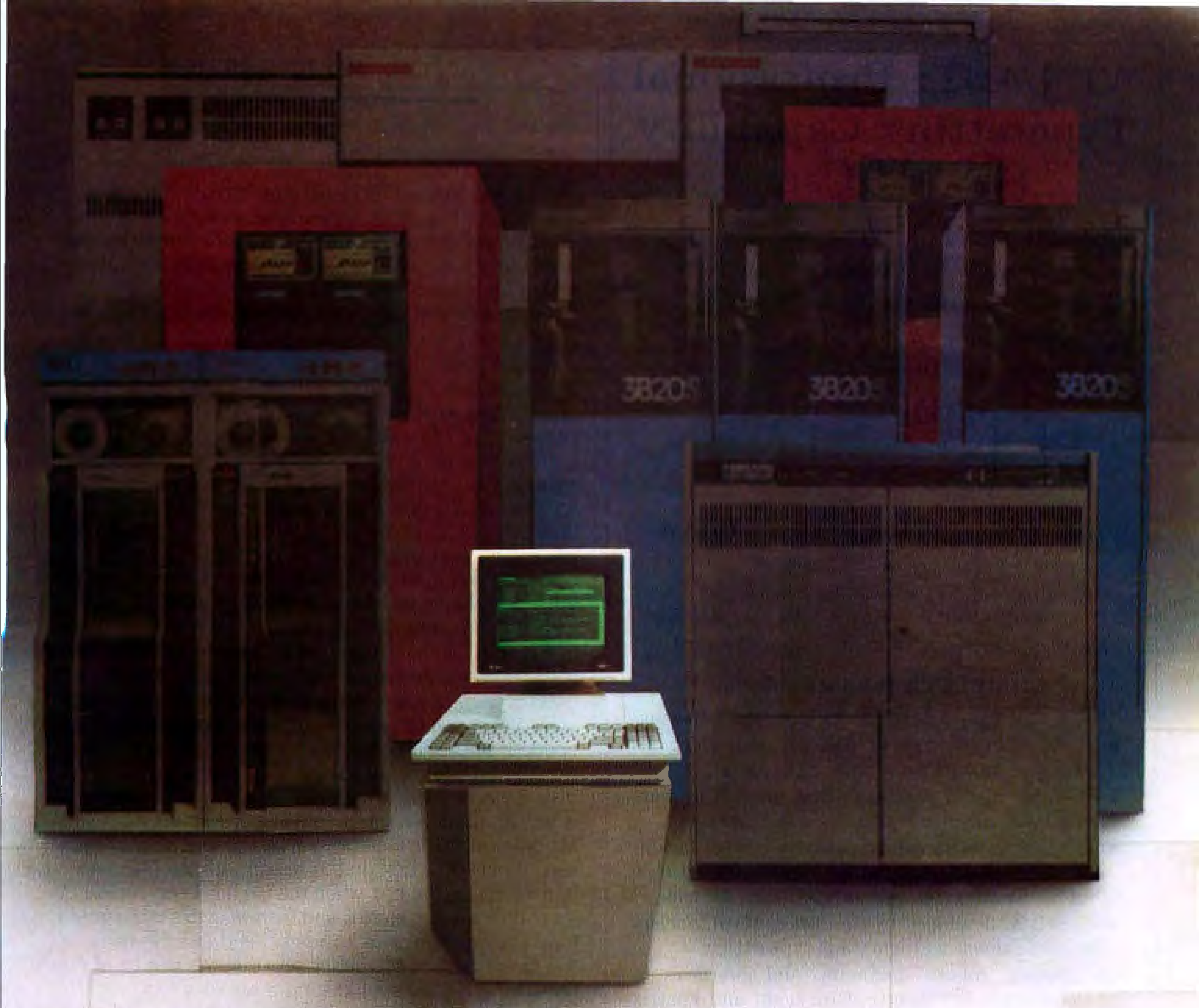


Figure 1: *The Create & Grow Volumes Utility of MB Utilities. You can allocate and deallocate space for a volume 400K-byte chunks at a time. These chunks are shown as little floppy disks.*



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and shrink; instead, you allocate space in 400K-byte chunks, shown as little floppy disks (see figure 1). Also, shrinking a volume will cause the files thereon to be lost, since there is no clean way of "compacting" the volume before lopping off chunks of it.

This isn't as convenient as systems that handle all this automatically, but I've had no directory or file problems—nothing lost—so I can't complain. Besides, you can increase the size of a volume without affecting the files, and that's usually what you want to do anyway. One other function of the utilities: You can lock or unlock the Finder on a given volume. If you lock the Finder on the default volume, it will remain the default volume, even if you use applications on other volumes and those volumes have their own copies of system files. If you unlock the Finder, when you run an application on another volume, the Mac operating system will select that volume as the new default (provided the system files are there as well).

The backup program, MB Backup, is intelligent and easy to use. You can back up an entire volume, just files that have been changed since the last backup, or files of your own choosing. If you select the entire volume option, Backup prompts you to put in and label as many disks as are needed, since the contents of a given volume probably won't fit on a single 400K-byte disk. As Backup fills each disk, it ejects the disk and asks for a new one. If the disk is unformatted, Backup automatically formats it for you. My only quibble is that for each file it copies to the floppy disk, it puts up a box on the screen with the filename in it, then erases the box when the file has been copied. A lot of time is spent erasing and redrawing this box. I would have preferred the box to remain and just the name of the file to change or—better yet—that the names of the files being copied should form a scrolling list.

The changed files option lets you update the disks that form a complete volume backup by saving out (to the appropriate disk) just those files changed since the last backup. The selected files option, as you might guess, lets you scroll through a list of all the files on that volume and select which ones are to be saved onto the disk.

Backup has three restore options. If a file being restored already exists, a dialog box prompts for an overwrite/skip/cancel decision; if the file is in use, the options are just skip and cancel. This lets you restore to the volume in use, that is, the default volume. One important fact to be aware of: The files backed up on a floppy disk are special "MB Backup documents" and can be restored to normal format and use only by the restore options.

Another utility included with the MacBottom is Floppy Copy, which uses available disk space to speed duplication of floppy disks. This is intended primarily for single-drive systems and does a single-pass copy in around 1 minute 45 seconds. It does this by copying the source disk onto the hard disk itself, then writing the disk "image" onto the destination floppy disk, doing any initialization or formatting necessary. Having done that once, it asks if you want to make another copy of that same disk and will format and write a new copy of the disk in a little more than a minute.

 Inquiry 262

I am pleased with the MacBottom hard disk. It does what I want it to, and it does it well and (to date) with no failures, problems, or glitches. The folks at PCPC assure me that it works fine on the Mac Plus and that they have a new system software release to support Apple's Hierarchical File System; I may have a follow-up on that in a month or so. At $1595, MacBottom is a bit pricey, but if you're interested in worry-free, thought-free hard disk usage, it's worth it.

DASCH RAM DISK

If, on the other hand, you're more interested in speed than in storage space, you might want to look at the DASCH (disk acceleration/storage control hardware) external RAM disk from Western Automation Laboratories Inc. Now, RAM disk software for the Macintosh is nothing new, but this is an actual external box that—like the MacBottom—connects to the printer or modem port and looks to the system like an extra disk drive. Also, like the MacBottom, it can double as a printer buffer. It has its own external power supply, so you can crash or turn off the Mac without affecting what's being stored on the DASCH. Unlike MacBottom, the DASCH is not made to fit under the Mac. Its dimensions are 7½ inches wide by 9 inches long by 2 inches high, and it must be placed either on top of or to the side of the Mac. It comes in three versions: 500K, 1000K, and 2000K bytes (the prices are $495, $795, and $995); the smaller versions are upgradable to the larger versions for the difference in price plus 10 percent of that difference.

The start-up program, Start, will automatically copy files from the boot disk (or any other disk) to the DASCH, afterward selecting the DASCH as the default volume and ejecting whatever disk is in the drive. Again, like the MacBottom, this makes the start-up process relatively painless. Even more interesting is that the DASCH remembers what disks its files came from. If you then run the Backup utility that comes with the DASCH, you'll be prompted for each disk, and the appropriate files will be copied out. Another program, Configure, lets you modify Start in all sorts of ways: which port to use, whether or not disks other than the start-up disk are to be copied, whether or not existing files on the DASCH should be overwritten by their counterparts, and so on.

The DASCH is fast, easy to use, and can save lots of time. While my experience with it hasn't been quite as flawless as with the MacBottom, the few problems I've experienced have been minor and were easily dealt with. My only real criticism is the lack of a battery backup to protect against power drops and outages. Aside from that, I really like the DASCH.

One interesting problem I've had with both the DASCH and the MacBottom deals with restoring files previously backed up (or, in the case of the DASCH, copying files onto a "blank" RAM disk). If those files were originally in folders, they end up in folders on the destination volume. Unfortunately, those folders are unnamed (literally: "Unnamed #1," etc.), and they overlap with icons of

(continued)

Benchmarks that I ran on different mass storage devices showed an interesting correlation between speed and fragility.

files already on the volume. Furthermore, when you open the folders on the DASCH, the icons inside are widely scattered, requiring (at least) a "Clean Up" command to get things straightened out. The clue seems to be in how the desktop file is created or restored. If you're doing a Restore command on the MacBottom, answer "yes" when it asks you if you want to update the desktop file. Of course, if you have folders already sitting on that volume, they'll end up being unnamed, and special icons may be lost. All in all, it points to some inadequacy in the utilities, the Mac operating system, or both.

Mass Storage Comparisons

Just to compare the relative speeds of different mass storage devices, I ran a set of "benchmarks" consisting of performing typical user actions: copying a file, duplicating a file, opening an application, opening a document (by double-clicking it), and exiting back to the desktop. I used Microsoft Word (version 1.00), which fits the bill nicely because of its size and popularity. Note that all tests were run after having opened Word a few times, so that it no longer checked for the master disk.

The tests were run on a standard 512K-byte Mac, except for the internal RAM disk, which was run on a Levco Monster Mac (2 megabytes) using Assimilation Process's Mac Memory Disk software. For that test, I sized the RAM disk so that only 512K bytes of application memory was left, so that there would not be an "unfair" advantage in copying files. All tests were run under Finder 4.1; both Macs had the old (64K-byte) ROMs and single-sided (400K-byte) drives. The hard disk was the 20-megabyte MacBottom, and the external RAM disk was the 1-megabyte DASCH.

Part of what made the timings so difficult was their variability. Generally, times tended to get better when they were repeated with few or no actions in between. For example, repeatedly opening a document, then exiting back to the desktop, tended to yield the best time for both actions. However, the times didn't always keep going down; they would occasionally jump back up by a second or two (or more).

A few interesting features of Word showed up as well. For example, the time to open Word on a two-drive floppy disk–based system is shown as 12.4 seconds. That was with disks in both drives. If I removed the disk from the

(continued)

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Table 1: *Some comparative times indicating relative performance of different types of mass storage on the Macintosh. The file used is Microsoft Word (version 1.00) and is 125K bytes. The document is the Memo file included on Word's master disk. The figures in parentheses are normalized times that tell you how much faster the internal RAM disk is than the other means of storage.*

	Floppy Disk (single-sided)	Hard Disk (MacBottom)	External RAM Disk (DASCH)	Internal RAM Disk (Assimilation Process)
Copy File from Floppy	35.0	23.6	13.2	7.9
Duplicate File	16.9	9.2	4.3	0.7
Open File (application)	12.4	7.9	5.2	5.0
Open File (document)	23.6	10.6	6.8	6.4
Exit to Desktop	29.0	11.6	6.8	4.7
Combined Time (copy, open doc, exit)	87.6 (4.6)	45.8 (2.4)	26.8 (1.4)	19.0 (1.0)

external drive but left the drive connected, the time *increased* to 20.6 seconds. If I then disconnected the external drive, the time remained about the same (i.e., around 20.5 seconds). However, no such variation occurred with the other configurations, except that the time to open Word increased somewhat the first few times it was opened with disks in the drives. Strange.

The timings, found in table 1, confirm what you'd suspect: Internal RAM disks are faster than external RAM disks (though not by much), which are faster than hard disks, which are faster than regular floppies. The last row in the table—Combined Time—adds together the first, fourth, and fifth rows to give you a feeling for just how these time differences can accumulate.

The interesting correlation here is between speed and fragility. An internal RAM disk is the fastest form of mass storage, but it's also the most vulnerable. Files can be irreparably lost or damaged by power glitches, system crashes, or even programs that run amok. And, of course, if you turn the machine off without saving all your files to more permanent storage, they're gone for good. Some firms are developing software to preserve the contents of RAM in case of a system crash, allowing you to do a "warm" boot and still find the RAM disk and your files there, but that's no help against the other dangers.

External RAM disks shouldn't be affected by system crashes, rogue programs, or turning the computer off. Power glitches and outages can still cause a problem, though, unless the RAM disk has some sort of battery backup. As mentioned, the DASCH unit I have has no battery backup, though the folks at Western Automation claim to be working on one.

Hard disks shouldn't be affected by much of anything, but, unfortunately, they are. Power glitches at the wrong time (e.g., during a write operation) can cause problems, as can turning off the computer at the wrong moment. Physical shocks or movement can also affect them, causing the dreaded head crash, where the read/write head of the disk drive actually touches the surface of the disk itself. The MacBottom has some protection against both problems. The desktop Special menu has a Shut Down option that moves the heads off the disk, then reboots the system; you should select this before turning the Mac off. I would be happier with a design that didn't require this shutdown step, but the MacBottom has survived power glitches and many power-downs without the Shut Down, so it doesn't appear to be overly sensitive in this area. As for shocks or movements, the under-the-Mac location does a great job of preventing accidental bumping or jostling.

Floppy disk drives are the heartiest form of mass storage (except, of course, for cassette tape, which we can safely ignore), least affected by crashes and other physical events. What few floppy disk problems I've had are related primarily to software (usually operating system) errors during reads and writes—and those will affect all forms of mass storage equally. Of course, the floppy disks themselves can be physically damaged, but the advent of the 3½-inch not-so-floppy disk has done much to eliminate those dangers. (A friend of mine, Matt Yuen, once put an address label and a stamp on a 3½-inch disk and dropped it in a mailbox. It arrived at its destination in working condition, with all data intact.)

So which is best for you? Well, that depends upon what you want and how much money you have to spend. These four options are not mutually exclusive; as I type this, the Mac at my left shows on its desktop three hard disk volumes, a floppy disk volume, and two RAM disk volumes, one internal and one external. My personal preference would be a 1- to 4-megabyte Mac with a 20-megabyte hard disk and running an internal RAM disk. On the other hand, if you have a lot of Macs in a network sharing a hard disk, giving each Mac an external RAM disk would improve performance of each workstation while reducing susceptibility to crashes and (with battery backup) power glitches or failures.

WRAP-UP

Next month, I will continue my attempt to catch up with the backlog of new products. I may also start a follow-up on last month's 68000 benchmarks, giving timings comparing different compilers on the same machine. But no promises. Until then, I'll see you on the bit stream. ■

(continued from page 24)

Let me describe some of the specific problems, such as the one with overlapping windows. This occurred specifically with small windows that had completely disappeared behind larger windows. There is an "under" menu selection to bring out hidden windows, but the mouse must be positioned over the hidden window, which is hard to do and rather frustrating. There are much better ways to do this. Overlapping windows represent sheets of paper lying on top of each other. The way one looks for hidden papers is to move the top papers. This suggests a simple solution: Move the top window to the bottom and thus uncover the hidden windows.

The window-frame moving algorithm follows the mouse while continuously flashing or painting the entire frame in white, which presents another problem. Since it takes a noticeable length of time to paint the frame, it is impossible for the system to follow the mouse with acceptable speed. The flashing effect is unpleasant, and in larger windows it deteriorates into nauseating waves of white. A simple rectangular outline is fast and adequate, as demonstrated by the Macintosh and a number of other systems.

The Smalltalk-80 documentation is far from adequate. The system is not self-explanatory. Despite heavy use of the "explain" tools and the various books and manuals, figuring out what classes and their methods actually did was a frustrating experience.

On the other hand, the power and elegance of the documentation tools is quite impressive. Perhaps someone mistakenly thought that automatic documentation might make up for a lack of standard documentation. The fact is, Smalltalk requires documentation every bit as much as any other large system, and perhaps even more so because Smalltalk is dynamic. The Smalltalk books are excellent, but the nature of the system demands far more internal reference material.

I find it surprising that graphics are so little used for documentation. Smalltalk-80 suffers from a lack of graphics tools in general and is desperately in need of painting and drawing facilities along the lines of MacPaint and MacDraw. The existing paint facility is too slow and cumbersome for any significant work. With basic graphics tools, it would be possible to add graphic documentation tools, which in turn would make high-quality internal documentation possible.

After years of work with various low- and high-level systems, I am quite used to working with poorly documented ones. There is no doubt that much of Smalltalk-80 is better documented than the average system. What is different, though, is the dramatic contrast in relative quality of various parts of the system. The text-oriented documentation tools are outstanding, but the documentation itself is poor. Smalltalk is a graphic system, but graphics are used only minimally for documentation. When a system has so many fine components, any flaws stand out. Smalltalk-80 did make me more productive; possibilities were opened that I would not have considered otherwise. Yet, I should have been even more productive. The flaws were so much in evidence that using Smalltalk was not the enjoyable experience it should have been. Such a system is unlikely to enjoy any significant success with a wider audience.

I. GANAPATHY
Vancouver, British Columbia, Canada ■

Conducted by Jerry Pournelle

CREATIVITY OR STRUCTURE?

Dear Jerry,

I couldn't help writing after reading the letter to you in the March BYTE ("Language," page 293). As best I can tell, David Suits and you share the view that the balance between creativity and structure in programming leans more toward creativity than structure. Both of you seem to find that structure is at least as much of a burden as it is an aid. Truly, with no offense intended, this makes no sense to me—and I suspect at least a few others feel the same. After some thought, I think I have the real answer to the creativity/structure debate.

When I read the letter, I considered how I might make the light of reason dawn on both of you. Now I am sure that I cannot. I am convinced that my best arguments in favor of structure (as embodied in my favorite language, Modula-2) would make only a little sense to you. It could not make sense because I claim that structured programming provides exactly those benefits Mr. Suits claims for his approach.

There must be at least two different kinds of programmers in the world. I don't mean good ones and bad ones. The difference is not one of skill, but of approach. Some prefer a structured approach, and some prefer a fluid approach. Since I find the structured approach the only reasonable way to program, I cannot imagine why anyone would willingly suffer under the anarchy of fluid programming. No doubt, I seem to Mr. Suits to be willing to go through my programming life wearing the straitjacket of structure. (I refer to David Suits because I have his letter before me, although I also remember your article ("Come to the Faire," July 1985).

I think I see this difference between our two camps most strongly in Mr. Suits's use of the term *uncreative* to describe those of us who thrive on the structure of Pascal and Modula-2. I resented the use of such a pejorative term when I first read it, but I suddenly realized that I was thinking of equally pejorative terms to describe the approach to programming that Mr. Suits advocates. I think we're dealing with a relative issue here.

I'm not alone in thinking the only *real* way to program requires structure. I work with people who love Modula-2. To us, the

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TOSHIBA

TOSHIBA AMERICA, INC., Information Systems Division structure built into Modula-2 lets us express our creative ideas more quickly, make modifications more easily, and avoid details that detract from the problem at hand. David Suits (and the people who feel as he does) expresses exactly the opposite experience when working in a highly structured language.

I'm almost sure that this is a never-the-twain-shall-meet issue. The only remaining question is to decide whether it's a matter of nature or nurture. (This could take a few hundred years!)

I want to go on record as coming down on the nature side: I think preferences in approach to programming are due to temperament more than to whatever traditions are passed down to us or the long-term consequences of first experiences. I first learned BASIC and then dabbled in FORTRAN. My first experience with ALGOL was a great relief: I had found the language I'd been wanting all along without knowing it. Now, although I get along all right in Pascal, I like Modula-2 best.

It is possible that appreciating structure is an acquired taste and that enough experience with it might change the mind of some of Mr. Suits's camp. This is the common assumption of people in the structure camp, but I suspect they may be dead wrong. Proponents of both camps may be speaking only to those who already agree with them.

For instance, in the March issue you say you still use BASIC for much of your work in spite of expressing an affinity for Modula-2. I have a friend who may be a more extreme case, he programs in BASIC and then converts to Pascal. BASIC is his working language, but he likes the speed of Pascal. My friend also finds Modula-2 attractive, but he plans to continue developing in BASIC and then translating into some other language.

I simply could not function that way. I would not dream of using BASIC for more than 25 or 30 lines of code (and would prefer to never be stuck with using it). I just can't follow BASIC. Unlike you, I would never choose BASIC over Modula-2. Although I am willing to allow that other factors are involved, part of that difference in the way you and I operate seems to be a matter of temperament. You and I both profess a liking for Modula-2, but that liking means quite different things to the two of us.

By the way, I think the analogy to the writing process that you presented in July 1985 ("How Do We Really Do It?" page 322) was quite apt. I didn't agree with the conclusions you drew with regard to programming; now that I think about it, I don't approach writing in the way you described either. (Writing is my profession, too.)

It seems clear to me that different approaches to programming can be attributed (at least in part) to temperament. This suggests that particular programming languages are best suited to particular *programmers*, not to programming per se.

JOHN M. CRAIG
Technical Support Specialist
Modula Corporation
Provo, UT

You've misunderstood, which is probably my fault. First: I don't do much programming any longer. I'd very much like to, and now that I'm not fleeing carpenters every couple of days, I may have time to; but until then, any programs I do are very much in the quick-and-dirty category. Often they can be tacked onto a structure I've already written; and since

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those are mostly in CBASIC. I can either take time off to convert everything to Modula-2 or continue with CBASIC. I haven't time to make the conversions. I very much wish I did.

Second: It's only recently that there have been implementations of Modula-2 that provided an endurable programming environment. When I had the Lilith here—alas, your company has reclaimed it—it was a snap to do programming in Modula-2. Given that kind of environment where the machine manages all the gory details, you can be quite creative; but, alas, most people in the micro world find that structured programming requires that we keep track of some pretty onerous details by hand.

Lately I find myself more a moderator than a participant in language debates. Programming is fun, and I try to keep track of what's going on. But until I have more time, I'm likely to remain a moderator. Alas.—Jerry

CAVEAT EMPTOR

Dear Jerry,

The trouble with Pournelle's law (February Chaos Manor Mail, "Know Your Dealer," page 315) is the assumption that the average home computer buyer can *find* a vendor whose staff knows anything about computers, much less a vendor with more expertise than the purchaser. The industry may have been started by hobbyists who understood every solder joint, but it has long since been taken over by business types whose idea of "long term" is 90 days and whose idea of "technical" is the copious use of buzzwords (note that I said use, not understanding!). The industry is now dominated by mass merchandising operators, many of whom are snake oil salesmen. So even if you find a store with knowledgeable personnel, you may have serious problems.

My advice to a new buyer is to adopt an attitude of caveat emptor. More concretely, do all the following:

Learn about the hardware and software before you do anything rash.

If you somehow find an honest and competent dealer, stick with that dealer; it's cheaper than mail order in the long run.

Pay by credit card (*not* debit card); this will give you certain legal rights you will not have if you pay by check or cash. If you can arrange for the purchase to be legally considered a mail-order transaction, you can get the USPS to help you if you are sold a lemon.

If you don't have a trustworthy dealer, order from the cheapest source you can find: You probably won't get any meaningful support anyway. The well-known and high-priced manufacturer will swindle you on service as cold-bloodedly as anyone else. But forget the Brand X product that is not serviced by any independents.

Read the instructions. Follow them, even if you know "shortcuts." You can always burn out your motherboard later, if the need arises.

Order all available documentation. Yes, I know it's expensive; so is not having it when you need it!

If a dealer proposes a package, ask for a demonstration that will show if all the pieces work together. If the dealer starts to tell you that the "ABC 666" monitor is "just the same" as the "XYZ 456," that "I don't have this but do have that," that a certain printer is equivalent to another, or tries any other substitution, walk out. If you don't, you will learn more than you ever wanted to know about the Tower of Babel.

Ask somebody who owns one, especially if that person is dissatisfied. Get into a BBS and ask about skeletons in the closet.

Find out what the vendor means by "compatible"; it may not be what you mean.

Get it in writing. Make sure that you include all representations made by the dealer and that you specify both a full refund and a penalty for delay. But don't expect the dealer to stand behind claims made by the manufacturer: The dealer can't afford to and has no control over the manufacturer's flackery anyway.

Don't buy any copy-protected software. It will interfere with backup; it will cause you problems if you go to a faster machine, a faster disk, or a faster clock on the same machine. It may even give you grief just for installing a new version of your operating system.

Beware of terms like "high-res": They are just so much snake oil. In practice, "high-res" means "the resolution offered by what I am pitching." Metz's law states: "If it's really high-res, the manufacturer will tell you what the resolution is; if numbers aren't given, the manufacturer is ashamed of them." Practically, anything less than 640 by 200 in color or 720 by 350 in monochrome is suitable only for masochists.

Consider your intended use, then evaluate the trade-offs of resolution versus number of colors versus speed. Also consider the relative importance of horizontal and vertical resolution for your application.

Don't equate a requirement with a proposed solution. For instance, you do not require a mouse, but you may require the ability to point at data and to drag it around the screen. A mouse is a solution, but so are other methods. Identify all solutions, then select the one that best fits your needs and budget. The first solution proposed by a vendor will be the one that best achieves the vendor's objectives.

(continued)

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which may not be compatible with yours.

Once you have your system, get in the habit of backing up disks.

SEYMOUR J. METZ
Annandale, VA

Well—there are still some dealers who understand what they're doing; as you say, if you find one, it's worth a lot to keep that dealer. But recall that Pournelle's law says: "If you don't know what you're doing, deal only with people who do." It doesn't condemn you to perpetual ignorance.

It's still a good idea to learn something about these little machines. It's fun, too. —Jerry

p-SYSTEM

Dear Jerry,

I've read BYTE for years and love it; I've read your column since it started and loved it. Yes, *loved* it, because today I read that the p-System is "the original user-hostile operating system." Never! It may be unconventional—after all, a prompt line that shows you all the possible options at any stage is not like CP/M's or MS-DOS's wonderfully user-friendly A> prompt. After all, the standard p-System screen editor isn't at all like those with 574 different keystrokes, and it does work well with both free text and programs, and it does leave the cursor at a syntax error (optionally, not compulsorily). Different—yes; user-hostile—never! You praise MOSYS, but its editor is reported to have many shortcomings.

Finally, at $79.95 (available from Pecan), the UCSD p-System with compiler, editor, and native code generator (with 8087 and BCD support) should have been named product of the month.

STUART A. BELL
Cambridge, United Kingdom

Surely you are not so fickle as to abandon me after all this time? I do agree: with the new price and, more important, the new support provided by Pecan, p-System is quite a bargain.

As to its hostility, I remain unrepentant. The problem with p-System is that it's thoroughly menu-driven; and while that does give you lots of on-screen prompts, it also makes you go around red robin's barn to get anything so simple as a directory. Indeed: it's the problems I have getting a directory (call the filer; specify devices by number, and the device number is never intuitive) that caused me to neglect p-System. You will note, though, that I always try to point out that a lot of people do love it, and they're not all masochists.—Jerry ■

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Inquiry 209

THE BEST OF BIX is a selection of the most interesting messages from BIX, the BYTE Information Exchange conferencing system. The conferences covered for this month include those for the Commodore Amiga, Atari 520ST and 1040ST, the IBM PC family and compatibles, and the Macintosh computers. These pages represent only a small fraction of the material discussed in these conferences.

For information on joining BIX, see the instructions on page 336.

AMIGA

The highlights of the Amiga conference this month include a benchmark comparison of two popular C compilers for the Amiga, 68020 upgrade VMEbus adapters, and GenLock and LIVE! digitizers.

Bugs and Fixes includes discussion of Amiga ABasiC speech functions, Alink linker improvements, disk "hashchain" tables, and more about the terminal program MaxiComm. Bugs and Fixes concludes with a short tutorial on Tymnet log-on procedures and file chopping, and the author of the Aegis Animator describes a minor glitch.

COMPILER BENCHMARKS

amiga/product.dcsn #706, from ricks [Rick Schaeffer]

Benchmarks for Aztec C versus Lattice C Compilers

Well, I finally got my Aztec C compiler! Of course, the first thing I did was run a whole series of benchmarks to compare it with my Lattice C compiler. Since there's been so much interest in Lattice vs. Aztec, I ran all the benchmarks I could get my hands on and made up the table below for anyone else who is interested.

The rules under which the benchmarks were run were as follows: First, I used the default selections of both compilers as far as compile-time options go, since I wanted to compare "apples to apples" as much as possible. The Aztec compiler comes set up to take advantage of RAM disk during compiles, so I used the "cc2" program with Lattice (which I've modified to, likewise, take advantage of RAM disk for temporary files).

The Aztec C compiler automatically runs all passes of its compiler; cc2 does the same thing except it costs time to load cc2 itself, so I ran cc2 from RAM disk, again attempting to compare apples to apples. Compile times and link times were timed with a stopwatch, and time was measured from hitting Return after typing the command line to seeing the CLI prompt after the compile completed.

Run time was obtained by calls to the AmigaDos Current_Time function. The source code for all the programs except the Dhrystone program was obtained from the November 1985 BYTE. The source code for the Dhrystone program was obtained from the CompuServe Amiga Forum database. A large comment header was removed from the Dhrystone program. Other than that, the programs were entered verbatim as published in BYTE except for the timing routines, which were for the Macintosh. I modified these to work with the Amiga.

The Aztec compiler, by default, generates code that uses 16-bit integers, and the Lattice compiler uses 32-bit integers. However, the Aztec compiler has a compile-time switch that causes it to use 32-bit integers, and there is a set of 32-bit libraries supplied with which to link such a program.

(continued)

Benchmark Results (seconds):

	Frame	Intmath	Pointer	Qsort	Sieve	Float	Fib	Dhrystone
Compile								
Aztec(16)	21.44	26.58	23.29	27.07	24.70	26.07	23.67	36.26
Lattice	44.16	61.42	45.00	70.74	76.60	48.03	45.49	68.46
Aztec(32)	23.48	26.19	23.96	26.78	26.01	25.23	23.74	35.14
Link								
Aztec(16)	33.95	33.47	33.97	43.79	39.11	38.92	31.52	42.64
Lattice	112.34	109.79	111.73	112.00	116.49	114.34	115.35	112.64
Aztec(32)	35.52	30.64	33.64	41.86	40.49	38.42	32.99	39.47
Executable Module Size (no register variables)								
Aztec(16)	5012	5532	4996	9504	13432	5428	5124	6488
Lattice	13470	14108	13712	18224	22216	14336	13876	16040
Aztec(32)	5212	5772	5196	9684	13640	5628	5328	6812
Executable Module Size (with register variables)								
Aztec(16)	5012	5252	4988	9448	13380	N/A	N/A	6328
Lattice	13744	14088	13704	18204	22184	N/A	N/A	15996
Aztec(32)	5208	5488	5184	9628	13588	N/A	N/A	6644
Run Time (no register variables)						(Dhrystone in Dhrystones/second)		
Aztec(16)	0.00	4.34	19.77	55.23	4.80	15.90	19.55	1000
Lattice	0.10	21.77	16.85	56.40	5.96	118.32	22.70	454
Aztec(32)	0.10	9.82	19.88	61.55	5.87	15.90	22.59	704
Run Time (with register variables)						(Dhrystone in Dhrystones/second)		
Aztec(16)	0.00	2.70	10.54	42.00	2.68	N/A	N/A	1041
Lattice	0.00	21.40	10.53	44.60	3.98	N/A	N/A	462
Aztec(32)	0.00	7.38	10.51	42.95	3.28	N/A	N/A	769

Therefore, I ran the benchmarks twice for the Aztec compiler: once with the default of 16-bit integers and again with the 32-bit option and libraries selected. All timings are in seconds and hundredths except the run time for the Dhrystone benchmark, which is in Dhrystones per second. I did not include timings for compile and link of the register variables versions of the benchmarks. They were insignificantly different from the times shown, which are for the nonregister versions.

A couple of notes about these timings:

First, the run times are shown to the hundredth of a second, but I doubt the accuracy of the Amiga's clock at that resolution. I *am* confident, however, that the timings are accurate to the tenth of a second.

Second, the Aztec compiler supports and uses the Motorola Fast Floating Point (FFP) library, whereas the Lattice compiler uses Lattice's own IEEE-compatible floating-point library. The Lattice compiler can be linked with the FFP libraries, but it doesn't use them by default (you have to do the function calls yourself). That is the reason there is such a large difference in the floating-point benchmark for run time. It is my understanding that the FFP library will be supported by the Lattice compiler in a future release.

The Lattice compiler version I used for these benchmarks was 3.02. I understand that Lattice is now shipping version 3.03, but I have not, at the writing of this message, received my upgrade. The Aztec version used for the benchmarks was 3.20a.

amiga/product.dcsn #708, from duck [Dale Luck, Commodore-Amiga]
a comment to 706

The Green Hills C compiler, running on a 14.4-MHz CSA board gives 2100 Dhrystones per second. I just found this out yesterday. For those who do not have the source code, a VAX-11/785 pumps them out at about 2050 per second.

amiga/product.dcsn #709, from ricks
a comment to 708

You might be interested to know that a Convergent Technologies Mightyframe (12-MHz 68020) running their flavor of UNIX (called CTIX) checked in at 2931 Dhrystones per second.

TENFOLD PERFORMANCE BOOST

amiga/tech.talk #407, from theo [Ted Inoue, Universal Imaging Corp.]

Anybody know of a Multibus adapter for the Amiga? Our company is looking into making the Amiga the front end to an image-processing system, but the boards come in Multibus format.

We'd like to use the Amiga to talk to our set of Multibus image-processing boards, and it would allow a really nice system for a reasonable price (reasonable being relative; in this market, $25,000 to $35,000 is very reasonable). So, if anybody knows of some way to adapt the output from the Amiga to talk to a Multibus system, I'd like to hear about it. Also, if there is any info on VMEbus capability, that would be nice. However, VME has a full 32-bit data and address path, so things might have to be hacked very hard to squeeze the Amiga to talk to VME boards.

amiga/tech.talk #410, from sassenrath [Carl Sassenrath]
a comment to 407

Commodore-Amiga in Los Gatos, California, makes boards that interface the Amiga to Multibus. This is how the Amiga talks to the Sun hosts. Send mail to "duck" for more info.

amiga/tech.talk #411, from jdow [Joanne Dow]
a comment to 410

Better yet—please, Dale, post the info in Amiga/hardware if this can be used as a special-purpose product. There are many, many here who'd like to do such a thing. I can see multiprocessing on the horizon.

amiga/tech.talk #413, from duck
a comment to 407

Maybe this would be another application for our "BillBoards": they are boards that we hacked together. One plugs into the Amiga and the other board plugs into our Sun-2's Multibus. We run "wack" remote on the Sun-2, peering into the Amiga's memory. Call Bill Kolb at Amiga, (408) 395-6616. Maybe he'd be willing to let out the design or schematics. The Amiga board does not run with anything else *except* our kludge-o RAM cards.

amiga/tech.talk #415, from sparta [Gary Bonham, Sparta Inc.]
a comment to 407

You might try CSA (Computer System Associates) in San Diego, (619) 566-3911. They make the 14.4-MHz 68020/68881 board that I have in my Amiga. They have been working on coming off of their piggyback board with a full 32-bit VMEbus (they already have a 32-bit-wide RAM board up there). They may repackage the entire system in a larger box to accommodate it.

amiga/tech.talk #416, from sparta

68020

Yesterday I took my friend (Amiga) to CSA in San Diego for open heart surgery. It had already had a transplant a while ago resulting in a 68020/68881 running at the usual 7 MHz. Now, all operations up on the 68020 board occur at 14.4 MHz. At this rate there are not many computers out there that can keep up (in the price range). The Mandelbrot timing (in P3 mode) I have quoted before is now down to a shade over 3 minutes (versus about 37 minutes on a normal Amiga).

GENLOCK AND AMIGA-LIVE!

amiga/product.dcsn #710, from duck

There seems to be a little confusion regarding these two separate peripherals. They are each complete peripherals in their own right. Neither depends on the other being on the Amiga. You can GenLock Amiga graphics to external video without doing frame-grabbing. Conversely, you can do video digitizing with Amiga-LIVE! without the GenLocker. They each have their own synchronizing circuitry. These two peripherals can also be coupled to achieve certain effects not possible when using either of them separately.

BUGS AND FIXES

SOUND ADVICE

amiga/softw.devlpmt #1067, from duck

Audio Response, from a conversation with Sam Dicker, Commodore-Amiga

QUESTION: Why can't I SAY "JAH4"? When I TRANSLATE$ "ja", it prints "JAH4"; but when I SAY "JAH4", I get an illegal function call message.
ANSWER: You have found a bug in the SAY command which will be fixed in the next release. It looks like SAY can't handle strings ending in a number (the 4 in "JAH4"). I recommend, as a work-around, that you append a space to all strings that you SAY. The TRANSLATE$( ) function does this for you, which is why the bug was never reported.

QUESTION: Can WAVE be used to get *very* different sounds?
ANSWER: All square, sawtooth, and random waves sound alike.

QUESTION: Please excuse the following waveform ignorance, but

(continued)

could I get a piano sound out of BASIC?

ANSWER: AmigaBASIC has very limited sound capabilities. It is designed to play fixed sine or custom waveforms at a fixed volume and fixed frequency. Fixed, that is, during the duration of the musical note. The sine or custom waveform represents one cycle of the "fundamental." This severely limits how interesting you can make your sounds.

The WAVE command defines the waveform before the SOUND command starts it playing. This makes it impossible to modify the waveform while the sound is playing. The SOUND command sets a constant volume for the entire duration of the sound. You cannot define an envelope (i.e., attack-decay-sustain-release). This gives all sounds an organlike quality.

The SOUND command also sets a constant frequency for the entire duration of the sound. You cannot add vibrato or bend the pitch of a note. AmigaBASIC is really designed to support only one synthesis technique: using the waveform to represent one cycle of the fundamental. This turns out to be the most serious restriction. A custom waveform (nonsinusoidal) can produce any set of harmonics. But they are fixed frequencies and exact harmonics, and not very interesting to the ear.

These are, by no means, limitations of the Amiga hardware and ROM kernel software. Dedicated music programs and even high-level languages can provide much better access to the hardware. For example, ABasiC, the BASIC that was shipped with the first machines had none of these limitations. Simply adding the ability to play a large waveform, either recorded digitally or synthesized, as the entire sound can produce just about any sound, including a piano sound.

Despite my criticisms of the design of AmigaBASIC's sound support, there are ways of "tricking it" into producing more interesting sounds. This may give you some ideas:

```
DIM waveform%(255)
FOR i%=0 TO 255
waveform%(i%)=127
NEXT
FOR i%=0 TO 255
waveform%(i%)=0
WAVE 0,waveform%
WAVE 1,waveform%
SOUND 60,.5,255-i%,0
SOUND 60,.5,i%,1
NEXT
```

Good luck.

ALINK PROBLEMS

amiga/main #2371, from jriley
a comment to 2367

FFP support is ready. Dropping Alink is in the works, but you gotta realize that you pay a price for playing by AmigaDOS's rules. No library format?

Editor's note: Jriley is the log-on for the Lattice Support Group. Lattice Tech Support can be reached through the Lattice conference, the Lattice BBS [at (312) 858-8087 2400 bps, no parity, 8 data bits, 1 stop bit], and voice [(312) 858-0073]. Jriley is here to answer any questions you may have on Lattice products.

amiga/main #2372, from jdow
a comment to 2371

Even with no library format, Dale let slip that Alink can be sped up materially by allocation tricks. If the hacks that allocate OK but don't deallocate on exit are cleaned up, Alink might not be quite so objectionable.

amiga/main #2376, from jriley
a comment to 2372

The price you pay for that hack can be more than it's worth. With a large link job going, Alink will effectively kill any multitasking due to lack of memory.

We don't need to complain about Alink, we need to *fix* it. After all, we are programmers (I hope).

amiga/main #2377, from jim_kent [Jim Kent]
a comment to 2376

I am not very familiar with linkers. However, I believe that they would not start freeing memory until they started resolving references, after the high point of memory allocation. If this is the case, then they really might as well hang onto everything until the end, in which case a slightly modified hack of the faster option would be OK. I wonder what Aztec's secret is.

amiga/main #2379, from jdow
a comment to 2376

I said the hack had to be cleaned up properly so that things worked correctly. The ideal algorithm might be this: Allocate in 128K hunks until they don't have room, then try 64K on down until memory is gone.

Keep careful track of the allocations granted and deallocate on the way out. The way I understand things, Alink wastes an excessive amount of time allocating and deallocating small pieces of memory. Done slightly differently this could be made faster without significantly altering the operation of Alink.

Of course, an even faster linker has its advantages as well. The fix to Alink could proceed very quickly. The other, maybe and maybe not.

REHASHING DISKS

amiga/main #2351, from gsipko [Gord Sipko]

I am the not-so-proud owner of a "corrupt" sys: disk. I've been using DiskEd to repair the pointers and have been having great success. I almost have the disk usable again—only the :c directory to finish.

Now, here's the problem: When I recalculate the hash numbers for each of the commands in :c, I end up with 11 pairs of commands that hash to the same number and three other commands that have the same number. What gives?

Presumably the hash number must be unique! Does DiskEd have a problem? I'm stuck! Is there anyone out there that will own up to DiskEd?

amiga/main #2352, from mmorris [Martin Morris, Computer Toolsmith]
a comment to 2351

The hash numbers are not unique; those files with the same hash code are chained together. The "hashed" entry points to the first file with that hash code. The "hashchain" field in the first file header points to the next, and so on. "Hashchain" is word 124/128 in the file header block, described on pages 1-4 and 1-5 of the Amiga technical reference manual.

MORE ABOUT MAXI

amiga/main #2375, from jdow
a comment to 1435

Here's a reposting of 1434 and a couple of notes to help people doing Amiga downloads (thanks again to Willie):

amiga/main #1434, from langeveld [Willem Langeveld]

```
' this version is for MaxiComm format uploads
a$=INPUT$(128,1)      ' discard these 128
FOR I=1 TO n          ' n is determined by the file size
  a$=INPUT$(10000,1)  ' 10000 seems like a good number
  PRINT# 2,a$;        ' Don't forget the ";"—it will insert a space
                        otherwise
NEXT I
a$=INPUT$(<nnn>,1)    ' <nnn> is the number of leftover bytes to be
                        copied
PRINT# 2,a$;          ' Seems to work also without ";"; you get one
                        byte extra
CLOSE etc.

' this version is for normal XMODEM uploads with no MaxiComm
  header block
FOR I=1 TO n          ' n is determined by the file size
  a$=INPUT$(10000,1)  ' 10000 seems like a good number
  PRINT# 2,a$;        ' Don't forget the ";"—it will insert a space
                        otherwise
NEXT I
a$=INPUT$(<nnn>,1)    ' <nnn> is the number of leftover bytes to be
                        copied
PRINT# 2,a$;          ' Seems to work also without ";"; you get one
                        byte extra
CLOSE etc.
```

Hope this helps. The version of TxEd currently in Listings needs the second version (above) with the length mentioned in the txed.doc file.

CHOPPING FILES

amiga/main #2339, from efreedus [Eric Freedus]

Running TxEd
I ran TxEd through the AmigaBASIC program listed to trim off the end. Apparently I had to allocate enough memory first. In any event, now I can't get it to run. I'm getting an "Unable to load TxEd: file is not an object module."

Second, when logging in through Tymnet, if I use the Backspace key to correct a typo, all console output is shut down thereafter. I'm sending, but I don't see my own keystrokes. Is there a key sequence to correct that during the Login procedure? The shutdown carries right through to when I'm on-line with BIX.

amiga/main #2340, from tom_thompson [Tom Thompson, Technical Editor, BYTE]
a comment to 2339

A backspace entered on the Tymnet log-on sequence kicks the system (for you) into half-duplex mode. Solution: Either abort the log-on if you make an error, or put your terminal program into half-duplex mode.

As for the chop problem, what was the file size of the output file versus the input file? The error message you're getting indicates that the chop failed (this is also the same error message you get with the unchopped file, that's why I suspect chop).

Also, TxEd may be one of those files where some of the code looks like an end-of-file character, so BASIC quits prematurely. Suspect this as the problem if your output file is a lot smaller than the input file.

amiga/main #2342, from jdow
a comment to 2340

Make sure the chop number is the same as the chop number in Charlie Heath's message re TxEdDemo. He has uploaded two versions, and the BASIC program trimmed the "old" TED version to working size, not the new TxEd version.

amiga/main #2343, from jdow
a comment to 2340

Also re Tymnet Log-on
^H sets Tymnet into a mode where you must generate a local echo of characters you send. If your terminal program can do this, I highly recommend it for good typists (or even mediocre typists). A ^X and ^R enables XON/XOF (^Q/^S) flow control through the Tymnet node.

The only way to abort the ^H mode is to hang up and redial Tymnet for a fresh start.

ANIMATOR

amiga/product.dcsn #685, from jim_kent

My First Bug
Actually, this is just my first documented bug. When running Animator

(continued)

or Images from the Workbench, if you change directory, you must change directory back to "sys:" or the Workbench will crash when you exit. CLI is fine. I'm not sure if I will be able to fix this bug as it appears to be in the Workbench. See topics "software" and "flames" for more discussion of this problem.

In the meantime I would really suggest for this and *many* other reasons that you get rid of the Workbench and run things from the not-as-pretty but *far* more reliable CLI. There is a batch file "noworkbench" included on the Animator disk that when run should keep Workbench from appearing when you reboot.

amiga/product.dcsn #686, from jdow
a comment to 685

Rather than having the program automagically relog to "sys:" the more proper route is to note where it is when your program starts and relog to that. Somehow, I agree with you. A well-behaved program should not have any effect on the underlying system parameters after it exits unless it is something like CD, which must have that effect because of its function.

(CP/M is something like that—a program can log new "drives" and "users" all it wants. The only way it affects the CLI environment is to change the value at location 4. Well-behaved programs leave this alone unless appropriate.)

amiga/product.dcsn #687, from jim_kent
a comment to 686

Well, anyway, got my CD back to work. Bug fixed in 1.10 release of Animator.

ATARI ST

This month's discussions include answers concerning Atari ST graphics and programming languages. Once again, the problem of resolution switching is addressed, and several conference members have made considerable progress in solving the problem. Also, a few helpful hints in graphics programming are offered. But the debate over which language to use rages on, as conference members discuss the pros and cons of Modula-2, C, and Pascal.

GRAPHICS COPROCESSOR

atari.st/main #28, from dbetz [David Betz, Senior Editor, BIX]

Are the 1040STs being delivered with the sockets for the enhanced graphics chip?

atari.st/main #29, from neilharris [Neil Harris, Atari Corp.]
a comment to 28

According to Sam Tramiel, the graphics chip is not intended for the 1040ST. It will go into a future product in the ST line, at a higher price point than the current model. However, the graphics coprocessor will be available as an upgrade board for the current models.

atari.st/main #30, from jruley [John Ruley, University of Dayton]
a comment to 29

Whoa! That is directly opposed to what we've been hearing here and in the BYTE article [March 1986]—are you sure you mean that?

If it is a board-level operation, then is there going to be an upgrade for the 520ST as well? You could make a lot of friends that way!

atari.st/main #36, from neilharris
a comment to 30

Coprocessor Upgrade
If you read the BYTE article carefully, you will see that the interview *[with Shiraz Shivji]* mentions a possible socket, not a definite one. There is no socket in the production 1040ST. The official Atari response on the coprocessor upgrade board is that it will be available for the 1040ST.

atari.st/main #40, from cheath [Charlie Heath, MicroSmiths Inc.]
a comment to 36

How does one access the coprocessor? Is it a switch in ROMs, and do the ROM calls use the coprocessor instead of the CPU? Is the software ready? Does the coprocessor give any new video output modes, or is it just a fast memory mover and line drawer?

atari.st/main #41, from neilharris
a comment to 40

The coprocessor requires a new set of ROMs, currently under development. All system calls are identical, but some work faster. The extra functions will be accessible through the BIOS. In addition to the blit functions, the chip will handle halftoning and horizontal and vertical line drawing.

atari.st/main #43, from jim__kent [Jim Kent]
a comment to 41

So it looks like no lines and much less fills. I assumed the blitter would pick up on the unused instruction trap that now calls the a-line. Oh well. We are still going to get some blazing graphics on this beast if we have to code it in 68000 ourselves.

atari.st/main #59, from philemon [Philip Lemmons, Editor in Chief, BYTE]
a comment to 29

In Hannover, I spoke to Shiraz Shivji, the principal 1040 designer. He said future 1040s will have the socket for the graphics coprocessor. He also promised us an article on how the coprocessor works.

atari.st/questions #15, from dnorton [Duane Norton]

Could someone in the know give us all some hard information on the capabilities of the graphics coprocessor which may or may not be on the 1040ST? Is it just a boundary-oriented blitter, capable of moving arbitrary blocks of memory from here to there, or will it be more like a NEC 7220, with line-drawing primitives and its own op codes?

atari.st/questions #19, from neilharris
a comment to 15

The graphics coprocessor is primarily a blitter, with the usual complement of move functions with Boolean operators. It is also capable of halftoning during the blit. Horizontal and vertical line drawing are included (actually, these are subsets of a blit anyway—rectangles with a width or height of 1). Graphics operations are between two and ten times faster with this chip. We expect this to be most noticeable in the day-to-day text operations (including scrolling) as well as graphics animation.

atari.st/questions #20, from dnorton
a comment to 19

Many thanks for the information, Neil. Hmmm...so is this new chip a truly general memory-to-memory DMA device? On a bit, not word, boundary? Sounds like it could be used for more than graphics, such

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as quick structure assignment in languages and operating system jobs such as garbage collection and memory reorganization. Oh joy!

RESOLUTION SWITCHING

atari.st/tech #23, from swestrup [Stirling Westrup, Xuclid Research]

According to previous messages in the technical section of the old Atari conference (see April BYTE, page 367), you can change from low to medium resolution without rebooting if you poke the desired screen resolution into the hardware register ShiftMd. What is the address of this register? The only reference I could find to it was in the *Hitchhiker's Guide to the BIOS*, where they say that it is shadowed by SShiftMd at location $44C.

atari.st/tech #25, from jtuermer [Joerg Tuermer]
a comment to 23

The address of ShiftMd is $FF8260. I have no color monitor, so I can make no tests, but the XBIOS function 5 (_SetScreen) also mentioned in the *Hitchhikers Guide* should do the changing without booting. Changing by direct setting of ShiftMd may leave the machine with some problems concerning cursor, fonts, etc.

atari.st/tech #55, from swestrup
a comment to 25

Of course _SetScreen *should* change resolution without rebooting, but it doesn't! And here I am wanting to change resolution while booting. That's so programs in the Auto directory come up in the right resolution.

atari.st/main #39, from cheath

We asked Digital Research Inc. if it was possible under software control to even switch from 320- by 200-pixel, 16-color resolution to 640 by 200 resolution so we could present 80-column text and then switch to a multicolor graphics display. The folks at DRI told us we'd have to reboot.

atari.st/main #44, from swestrup
a comment to 39

I have now successfully switched the Atari from low to medium resolution and back again without crashing the system or rebooting. My current problem is that GEM still thinks it's in the wrong mode and all of the fonts and windows are garbled. I tried poking the correct resolution into SShiftMd, but that didn't work.

atari.st/tech #70, from swestrup

I am uploading a listing of a 68000 assembler program that switches the Atari ST into medium-resolution mode without going through BIOS or XBIOS. It can be assembled and linked with the standard DRI assembler and linker that come with the developer's package. I have no idea what this program will do to a monochrome monitor. Are there any brave souls out there?

atari.st/listings #5, from swestrup

FIXSCR.S
I wrote this test program to change the screen resolution from low to medium without having to reboot the system. This program has to operate in supervisor mode so that the hardware register ShiftMd ($FF8260) can be set. The value $F9 corresponds to Medium Res, while $F8 is Low Res. Unfortunately, GEM does not recognize the change and behaves as if the old resolution is still in effect. In addition, this program will occasionally cause a few bombs to appear on the screen. I don't know why.

```
.TEXT
MOVE.L   #0,-(A7)          * PUSH A REQUEST FOR
MOVE.W   #$20,-(A7)        * SUPERVISOR STATUS
TRAP     #1                * AND TRAP FOR IT
ADDQ.L   #6,A7             * THEN FIX UP THE STACK

MOVE     SR,D0             * READ THE STATUS REGISTER
MOVE.B   #$F9,$FF8260      * GO TO MEDIUM RES MODE

AND      #$DFFF,D0         * CLEAR THE SUPERVISOR BIT
MOVE     D0,SR             * AND SET US BACK IN USER
                           * MODE
RTS
```

atari.st/tech #71, from jtuermer
a comment to 70

My documentation says that a return from supervisor mode should be made with another call to Super (BDOS $20). After the first trap you should save D0 and push it on the stack before the second one. This is the old value of the supervisor stack pointer (SSP). The present program leaves the SSP at the same value as the User SP before the RTS. Maybe this is producing the bombs.

I have looked carefully through a BIOS listing and cannot find where the _SetScreen routine could possibly reboot. But if you try to set to a resolution not supported by your monitor, the next Vertical Blank Interrupt will branch through the routine pointed at by swv_vec ($46E), which is initially pointing to the system reset handler.

This is in fact what happens to the "brave souls." The system reboots and they are back in monochrome.

atari.st/tech #77, from sak [Sal Magnone, CIA Software]

I read the messages about changing screen resolution without rebooting or other troubles and thought I'd mention a new program. I just got a demo of a game called Pawn that's got some really great low-resolution pictures. The significance is that the game operates in medium resolution. It pulls the low-resolution 16-color picture down from almost the top of the screen, waits, then slides the picture back up, revealing the medium-resolution text that it covered coming down. My guess is raster interrupts. Can an ST do that? When you try and dump the pictures, they get scrambled as though the interrupt got turned off. The dump routine probably does kill video interrupts, because the picture looks like someone just switched modes on it. Then it goes back to normal after the dump stops.

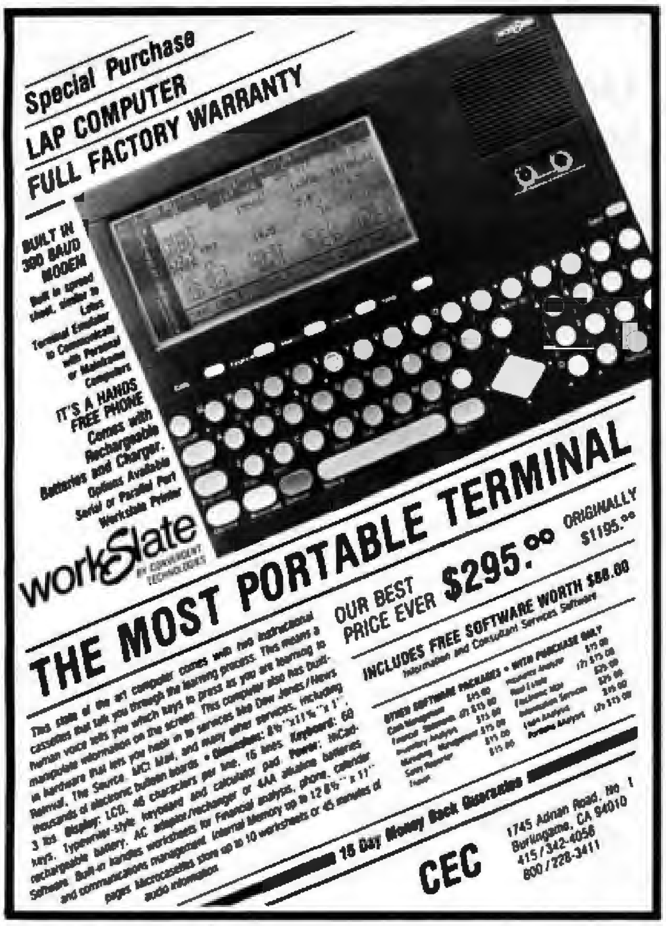
atari.st/tech #78, from jtuermer
a comment to 77

You can enable the HBLANK (autovector level 2) interrupt. This will give you an interrupt on every scan line. If you revector it to your own handler, you can decrement a counter set at VBL interrupt to the number of the scan line you want to change resolution, color, and so forth. If your counter reaches zero, make your changes. You may have to revector the other interrupts. This is described in the *Hitchhiker's Guide to the BIOS* (August 26, 1985, page 30).

atari.st/questions #22, from jruley

Do you still have to turn the machine off to switch between the high-resolution monitor and the modulator output? That is, can you have a black-and-white monitor and the RF modulator on at the same time? I know that would mean you'd have garbage on one or the other—but you'd be able to switch from the desktop.

(continued)



atari.st/questions #24, from neilharris
a comment to 22

Since the video shifter puts out a 60-Hz signal for color and a 71-Hz signal for monochrome, the two modes are not at all compatible. If you fed the wrong signal into a monitor, you would be likely not only to get garbage on the screen but also to damage the flyback transformer.

atari.st/questions #26, from al [Alastair J. W. Mayer, author of BIX's CoSy software]
a comment to 24

That's no worse than feeding a 50-Hz PAL signal into an NTSC monitor (or vice versa), something I've done more than once. Garbage, yes—like a severe case of out-of-adjustment horizontal and vertical hold—but my monitor still works fine. (Mind you, I don't make a habit of it and only did it for a few minutes at a time.)

atari.st/questions #27, from jim_kent
a comment to 26

What sort of plans does Atari have for a standard video output? As it is, video-types are the only people left I can in good conscience recommend an Amiga to. (I'm a concerned animation programmer with a VCR.)

atari.st/questions #28, from neilharris
a comment to 27

The latest model of the 520ST has both RF and composite video outputs.

LANGUAGES
atari.st/main #52, from swestrup

Modula-2
Where can I get a good book on Modula-2? I'd like to decide whether I like the language before I go out and buy a copy of it.

atari.st/main #53, from jruley
a comment to 52

As to a book—it sounds corny, but I recommend *Modula-2: A Seafarer's Guide and Shipboard Manual* by Edward Joyce (Addison-Wesley, 1985). Not only is it a fairly complete reference on Modula-2 with a good index, it is actually fun to read!

atari.st/main #54, from neilharris
a comment to 53

Personally, I found the [Niklaus] Wirth book, *Programming in Modula-2*, 2nd edition, indispensable as a reference, and the Knepley and Pratt book, *Modula-2 Programming*, a good tutorial textbook. I will try to upload the sample program that comes with TDI's Modula-2/ST, which they have permitted to be passed around. It does use the GEM features.

atari.st/tech #33, from wbaker [Bill Baker]

Just started playing with Lattice C from Metacomco. My overall first impressions are that the language implementation is good, but I think the linker is a dog. A small hello-world program took five minutes to link. (I use double-sided drives.) There is a full AES and VDI library implementation with source in assembler but no real documentation other than function names and arguments.

Having tried Hippo C, Megamax C, and now Lattice, [I find] none of the C implementations anywhere near as good as TDI's Modula-2/ST. Looks like I may have to learn a new language if I want to have development tools anywhere near as good as others I am used to (IBM PC family, Microsoft C, Brief editor, Make, and PLINK86).

atari.st/tech #34, from dmenconi [Dave Menconi]
a comment to 33

Everyone is raving about Modula-2. My problem is that I will have to learn a new language. I will probably go for it because I really like developing in Ada, and I understand that Modula-2 is like Ada. Until I get around to it, I plan to develop in Personal Pascal by OSS. This Pascal is out for the ST and is coming out for the Mac RSN. They say that something that runs on the ST can be compiled and run with no modification on the Mac (of course it will need to be tweaked to be aesthetic and efficient). If true, OSS is really going to clean up!

atari.st/tech #49, from bwebster [Bruce Webster, Consulting Editor, BYTE]
a comment to 34

No, no, no. Modula-2 is not like Ada, though both are derived from Pascal. In fact, Modula-2 and Ada represent diametrically opposed trends. Modula-2 is a very minimal language; just about everything beyond the basic language syntax is a user-defined library, though most Modula-2 implementations come with a set of standard libraries to save you the hassle of writing them yourself. Ada is a "kitchen sink" language, as in having everything but the kitchen sink. Modula-2 really resembles a hybrid of Pascal and C.

atari.st/tech #52, from wmiller [William Miller, Stratus Computer]
a comment to 49

The similarity is in the concept of modules (Ada "packages") with separate definition and implementation sections. Other similarities exist due to the fact that both have Pascal as an immediate predecessor. But, as Bruce said, there is a major difference in the design philosophy.

atari.st/tech #54, from bwebster
a comment to 52

Thanks. Couldn't have said it better myself. I haven't done any actual Ada programming, though I was almost on the industry review board (read: "enormous group") back in '79 when I was leaving General Dynamics and they were offering that as an incentive to stay. (Almost worked.) I have gone through a few books on Ada, though, and have carefully read Tony Hoare's talk, "The Emperor's Old Clothes," in which he describes his horror at the thought of ICBMs guided by programs written in Ada. There is a definite dichotomy of design, despite the resemblances.

atari.st/tech #61, from jerryp [Jerry Pournelle, Consulting Editor, BYTE]
a comment to 52

There are great similarities between Ada and Modula in that they are both highly structured and programs can conveniently be written in small independent packages or modules.

The difference is that Ada was designed by a committee of bright people, and Modula was designed by a single genius.

atari.st/tech #38, from jruley
a comment to 33

Looks like it's Modula or nothing. That really gripes me—is there no decent C for the machine short of the $300 Alcyon in the developer's kit?

I'd appreciate any comments—I am trying to replace Hippo C on my

(continued)

520ST. If I dont get any kind of good news on a C by next weekend, I'm going to get Modula and chuck C for good.

atari.st/tech #46, from dmenconi
a comment to 38

I am going to do my first project on the ST in Personal Pascal. I think it is a strong alternative to Modula-2 because it has a nice library for the ST and I understand it will soon be implemented on the Mac. As far as I know, Modula-2 isn't out on the Mac yet, and when it is, there will still be the question of portability.

The questions that remain are: How optimized is the code generated by these two languages? Personal Pascal has an optimizer, and from the manual it looks like they did some intelligent things. How soon will compilers for other machines be out?

So far I have rooted for this Pascal for a couple of reasons: coming soon on the Mac, nice ST interface, most people know Pascal better than Modula-2, and Pascal's been around longer, so its compilers are better understood. But Modula-2 has some nice features, too. First, it is likely to be more portable on future machines because there is one complete language definition instead of several (the original Pascal definitions had neither strings nor good I/O). Second, Modula is, I believe, more structured than Pascal. For instance, it has packages that allow a programmer to divide a program into modules and really keep track of which packages use which routines. This is a tremendous aid in avoiding spaghetti code.

A disadvantage that awaits the unsuspecting C programmer who would use either of these languages is that they're designed to protect the programmer from himself. For example, consider the strong typing; characters are type "char"—not integer or "char" depending on how the programmer feels that day, as in some languages.

So, there you have it, a long-winded dissertation on the other two choices. I highly recommend a careful examination of both languages before a choice is made.

atari.st/tech #48, from jruley
a comment to 34

Well, I went with the Modula—maybe we should compare notes after we've both had some time to work with them. With respect to choosing between the two, I spent today reading a book on Modula-2, and it looks to me like it's possible to do anything in Modula-2 that you can do in C—although the implementations vary, they have all the same features. It's been awhile since I looked at Pascal, but unless yours has a lot of extensions (separate compilation, based variables, coroutines), there are quite a few things that will give you trouble if you try to do low-level stuff.

RAM Disk and C Functions

atari.st/tech #40, from mmanlove [Mike Manlove]

Here are a couple of problems that have been bugging me for a week. I'd sure appreciate any insights that you might have.

First, is there a RAM disk that works with the TOS ROMs? I've got the Hippo RAM disk, which works fine with TOS.IMG but bombs when I boot ROM. Thinking about it, it seems like most RAM disks would perform brain surgery on the BIOS/XBIOS, which is most likely in ROM.

Second, has anybody had any luck with the C library functions Malloc( ) and Calloc( ) which come with the developer's kit? The application I'm working on really wants to play around in the heap, but right now it can't. Even a trivial program can get only a little memory allocated (504 bytes for my Malloc tester), and you dont get a null pointer if there's not enough memory—you get cherry bombs. Do I need to do something magical before using these functions?

Random comments: I'm running a 1-megabyte ST with the ROMs, two double-sided floppy disk drives, and both monitors (I couldn't decide). I've been having a fine old time with the developer's kit, but the compile/link times off floppies are getting out of control, which is why I'm after all the RAM disk I can get. The TDI Modula-2 compiler may be the next step.

Thanks again for any help you can offer. I just got here, and BIX looks great!

atari.st/tech #42, from jim_kent
a comment to 40

I use the Michetron RAM disk with the same hardware configuration (except only a color monitor). Works like a charm. I'm also curious about Malloc problems.

atari.st/tech #56, from swestrup
a comment to 40

As to the Malloc/Calloc problem: I am told that when your C program is loaded by TOS, it gives all of the memory to the program, which doesn't want it. In order to have Malloc have something to allocate, you have to do a Memfree call (I think that's what it's called) so that the memory is given back to TOS. The kicker is that the call requires the address of the last byte of memory that you want to keep. I have yet to figure out how to get this address from either the compiler or the linker.

atari.st/tech #57, from jim_kent
a comment to 56

I read in an addendum to my developer's kit (November 1985 or so) that in fact the start-up routine freed up almost all of memory and doing so was the cause of the problem. In any case I have since switched to the Lattice C compiler. Its start-up leaves your program with all but 4K bytes. Malloc calls seem to function well. I wrote a little C preprocessor (long story, it was a front end to a menu-maker package) just last week using *lots* of dynamically allocated memory with no problem.

Unfortunately, there was a file trashed in all versions of Lattice C that I could get my hands on—clib.bin. This is forcing me to use the "-t" option to produce .o output so I can use link68, the DRI linker. My general impression of Lattice C other than this has been a massive improvement in compile time, error reporting, and symbol size (31 characters) over Alcyon.

atari.st/tech #66, from mmanlove
a comment to 56

This is just a hip-shot (I haven't read the remaining comments yet), but the standard C "sbrk( )" function seems to be implemented. Would this give the end of the program itself or the end of all the memory that TOS handed over to it? I'll do some experiments.

atari.st/tech #67, from cheath
a comment to 66

We had some problems with those memory management functions, too. I'll see if I can get my partner, the ST hack, to tell me what he figured out about them.

atari.st/tech #73, from jtuermer
a comment to 56

If you have the developer's kit, you should look at a file called APSTART.S (if it is included in your version). Or look at the source of whatever module you mention first in your link run. It starts by adding up the length of text, data, and uninitialized data segments. This information comes from the base page. The address of the base page is handed over as 4(A7) to any program. The length of the base page

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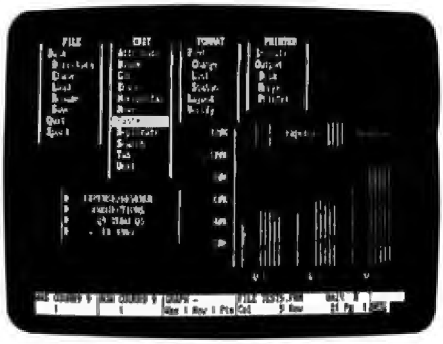

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($100) is also added to the total program length. A SetBlock (BDOS $4A) then reduces the total space allocated for the program to this amount. You can change this start program or make a Malloc in your program to get more room. Someone told me that the DRI C compiler makes its Malloc allocations in the third segment (BSS). But the length of this segment is initially set to zero.

NDC Coordinates

atari.st/tech #74, from jruley

I've just finished a frustrating couple of hours with Hippo C, trying to make my graphics terminal program resolution-independent. The Abacus GEM book lists an option on the open virtual workstation function for NDC instead of RC screen coordinates, but this does not appear to work. Is this a problem with Hippo C or with the ST?

atari.st/tech #75, from neilharris
a comment to 74

NDC coordinates are not supported on the ST version of GEM.

atari.st/tech #83, from timoren [Tim Oren, KnowledgeSet Corp.]
a comment to 74

You can't use NDC with the ST's VDI, because it doesn't have a full GDOS implemented. That also prevents you from opening workstations on other physical devices (other than the screen) and prevents doing loads of new fonts. Atari is supposed to be testing a RAM-resident GDOS which will work by stealing the VDI trap. The MiGraph EasyDraw package uses an early version of the GDOS.

Graphics Programming

atari.st/tech #79, from jruley

Help!
I am still, unfortunately, programming in good ol' Hippo C with the wonderful Abacus documentation. I need to do two things:

1. Read out the currently set color palette values. I can get the RGB representation of these values using one of GEM's inquiry functions, but how can I convert the RGB values to the color numbers (0-511)?
2. Save and restore the screen—specifically, I need a way to avoid the ugly gray blob that appears when the "fsel_input" function's dialog box disappears from the screen. I can do this by getting the screen address using "physbase" and treating the screen as an array, but the documentation led me to believe that I could use the "vro_cpyfm" function to do this.

So far as I can tell, the blasted function does not do anything. Here's how I am trying to use it:

```
static short int handle, screen[8], *sMFDB, *dMFDB;
usual GEM set-up
screen[0] = 0;
screen[1] = 0;
screen[2] = 639;
screen[3] = 399;
screen[4] = 0;
screen[5] = 0;
screen[6] = 639;
screen[7] = 399;
vro_cpyfm(handle,3,screen,sMFDB,dMFDB);
all sorts of stuff, including fsel_input
vro cpyfm(handle,5,screen,sMFDB,dMFDB);
```

My understanding from the documentation is that the first call to vro_cpyfm should save the screen to a memory area and that the second call should restore it. This is not happening—in fact, I've tried several variations, and so far as I can tell, the function simply does not work! Any suggestions?

atari.st/tech #80, from jim_kent
a comment to 79

Well, I can maybe help you some with the first problem. Presumably, the 0-511 value is a 16-bit word divided into four 4-bit nibbles: 0 red green blue.
Personally I don't use GEM much, but try this:

```
atari_color_reg = gem_color_reg->r*(1<<8) +
  gem_color_reg->g*(1<<4) +
  gem_color_reg->b;
```

Or maybe the same thing with the r, g, b reversed. You also might need to scale down (probably divide by 16) the GEM component values before you fold them into the register value.

atari.st/tech #84, from jtittsler [Jim Tittsler, Atari Corp.]
a comment to 79

I don't know how you get there from Hippo C, but if you can do an extended BIOS call, you can also get the value of each palette register. The extended BIOS call 7, setColor(colornum, color), sets the color register colornum to the given color. The old color is returned (and if "color" is negative, the hardware register is not changed, so there is a nondestructive way of inquiring the value of each of the palette registers).
From Hippo C, can you do something along the lines of: for(i=0; i<16; ++i) colorreg[i]=xbios(7, i, -1);?

atari.st/tech #85, from jruley
a comment to 84

No, you can't using Hippo. But as I'm writing my own XBIOS, that'll work just fine—thanks!

atari.st/tech #86, from jruley
a comment to 85

Well, I went off and tried it—looks like it'll work!
Anybody else out there still using Hippo? If so, I'll post my XBIOS routines in Listings.

Power Problems

atari.st/questions #2, from dbetz

I have a new Atari 520ST and have been having some problems that seem to be related to the power supply. Whenever the machine is running, the display jitters. I don't think it is related to the power in my house, since I have used many other computers without any similar problems. Also, my ST seems to be very sensitive to static electricity. I have it set up in my living room and whenever I walk across the carpet, I get a burst of "key clicks" from the ST, and if I am in an editor, I get a burst of garbage characters on the screen. I suspect that the problem is related to the power supply. Anybody have any idea what the problem is or what I can do about it?

atari.st/questions #9, from neilharris
a comment to 2

Are you running a monochrome monitor? If so, a color monitor in close proximity will cause some screen jitter due to 60-Hz vs. 71-Hz beating. Just turn off the other monitor.

atari.st/questions #10, from dbetz
a comment to 9

I was running the monochrome monitor and didn't have any other monitors (color or otherwise) anywhere near the one I was using. I tried this in several locations in my house, so I don't think it was because I was too close to some sort of RF source. I have never had any trouble with any of the other computers I've used (including an Atari 520ST that I borrowed for a while). It really seems like this problem is related to the power supply or the main keyboard unit (I tried a different monochrome monitor also). Neil, thanks for your suggestion, but I don't think it's the source of my problem this time.

atari.st/questions #13, from mmanlove
a comment to 10

I had a similar problem with the color monitor at first. Moving the CPU power supply away from the monitor (like, down on the floor) took care of it. Don't know if this could be the problem with the mono monitor, though.

atari.st/questions #14, from dbetz
a comment to 13

Thanks for your suggestion. I didn't think of the possibility of interference from the power supplies. I had all three of them stacked right in back of the monochrome monitor! I don't have the machine anymore, so I can't check your theory, but I'll call the people that I sent it to tomorrow and suggest that they try it.

IBM PC AND COMPATIBLES

The summary of events in the IBM conference this month includes a discussion on the V series of microprocessors, coping with hard disk problems, memory expansion for the PC XT, Trojan Horse programs, and programming the IBM 5550 Japanese PC.

V20 HARD DISK PROBLEM

ibm.pc/pc.hardware #629, from lowellt [Lowell Tuttman]

I thought that I would relate an interesting V20 experience I had in the last week. I got a "General Failure reading drive C:" on my 22-megabyte hard disk (Micro Design) and decided it was time to reformat and reload the disk. At this time I had a V20 in place. I ran a good backup (32 floppies' worth) and then reformatted the disk. All was going well at this point. After restoring the files (many hours later) I found that I got "Parity check 2" at boot time on the hard disk. I was able to boot from a floppy and then go over to the hard disk without problems but definitely no boot. I replaced the 8088, reformatted the disk, reloaded it, and was able to boot OK with the 8088 in place. I then put the V20 back in and all is still fine. The boot process works fine, as does everything else. It is curious that I can format floppies with the V20 in place but not the hard disk.

ibm.pc/pc.hardware #631, from ucivms725 [John Leonard]
a comment to 629

I had the same problem when I reformatted my hard disk. The problem was narrowed down to the RESTORE procedure. When I backed up my hard disk, I also backed up the hidden system files of DOS (a package deal when you back up the entire hard disk). When restored over the top of the newly formatted hard disk, these hidden files overwrite the already existing DOS files from the format. My disk would not boot from the hard drive, but the files were there A-OK if the system was booted from a floopy. I found two solutions: Back up each hard disk subdirectory one at a time (if you can remember them) or unhide the two system files from the first backup disk and delete them.

My V20 is working perfectly, there appears to be no problem with any operation, and I found that when used in conjunction with an 8087 I cut the processing time of a large SPSS-PC (statistical program) run from 63 minutes to 13 minutes! (I would not have believed it had I not had a copy of the printout with the start and end times right in front of me!)

ibm.pc/pc.hardware #633, from naro [Richard Naro, NEC Electronics]
a comment to 631

I would be interested in hearing the details of benchmarks with the V20. While it speeds up its internal operations, the only effect it can have on an 8087 is the time spent computing the effective address.

My guess is that much time is spent doing integer multiply/divide and string operations, which are highly optimized on the V20/V30 microprocessors.

ibm.pc/pc.hardware #634, from naro
a comment to 629

Format routines are notorious for having CPU timing loops. My guess is that the format routine is the cause of the problem, but this is the first time I've heard of it on a hard disk. The 765 floppy disk controller chip is much more susceptible to this problem.

ibm.pc/pc.hardware #635, from conniek [Conrad Kageyama]
a comment to 631

I don't know which DOS you are using, but in 3.x, there is a /P switch to the RESTORE function which will prompt you before replacing any existing files.

ibm.pc/pc.hardware #636, from lowellt
a comment to 634

I think that the problem I had was what was described in message 631. The system files *were* restored over the newly formatted one, and I did get a DOS error message saying "target disk may not be bootable". I was curious about its being a timing loop because my floppies were fine after formats with the V20.

By the way, I ran all the benchmarks in the "V20.arc" files from NEC and I'll be glad to post the benchmark times that I got as soon as I can find the printout.

ibm.pc/pc.hardware #638, from dgookin [Dan Gookin]
a comment to 635

Sometimes, depending on your flavor of MS-DOS, /P prompts *only for* hidden or system files. Very misleading and somewhat pointless.

ibm.pc/pc.hardware #639, from billn [Bill Nichols]
a comment to 638

/P is supposed to prompt for two things: attempting to overwrite a read-only file or attempting to overwrite a file of the same name but a later date. Both cases work (for me) and are valuable. /P is necessary to avoid clobbering the hidden system files. If you skip /P but restore over them, you may not be able to reboot.

ibm.pc/pc.hardware #642, from lowellt

I think I'm a little confused about the V20 and the V20-8. I gather that these are the 4-MHz and 8-MHz versions, respectively. What happens if you put a V20-8 into a regular PC?

(continued)

ibm.pc/pc.hardware #643, from naro
a comment to 642

Early versions of the V20/V30 that were marked with no speed info were 8-MHz devices. Currently, devices are marked as follows: 70108-5 = 5 MHz; 70108-8 = 8 MHz; 70108-10 = 10 MHz.

The latest mask level is M (it is found in the date code). This level is fully compatible with the 8086/8088 it can replace except for the -10 devices. This is because it is difficult for CMOS to use a 33% duty-cycle clock, so the 10-MHz devices still require a 50% duty-cycle clock (although below 9.5 MHz they are OK).

The device speed is only the clock at which the manufacturer will guarantee operation and does not affect the throughput of the microprocessor. The most noticeable impact will be on your wallet since there are price premiums for faster devices.

ibm.pc/pc.hardware #648, from billn
a comment to 643

Do you have access to info on V60 and V70 chips? I'm interested in comparing them with the 80286 and 80386 on a performance basis. Thanks.

ibm.pc/pc.hardware #649, from naro
a comment to 648

Yes, but the information is not in a form easily distributed yet. Send BIX mail with a request to be added to the mailing list, and I will send out information as it is published.

As for performance, the V60 can do 2 to 3 MIPS [million instructions per second]—but remember that a MIPS is not constant from machine to machine—and the V70 can do 4 to 6 MIPS. I prefer elapsed time as a better measure of performance. For example, the V60 floating point can do 32-bit reals in under 5 μs (divide in under 8 μs), and there is no penalty for the MMU [memory-management unit] since it is included in the internal pipeline.

HARD DISK POWER FAILURE

ibm.pc/pc.hardware #667, from asantic [Alexander Asantic]

I have a Rodime 20-megabyte full-height drive in an expansion unit attached to a PC. I've been having a problem lately with the disk drive spontaneously losing power while in use. This has never happened in many months of use but appears to be occurring with greater frequency as time goes by. So far, no damage to the disk or the data on it.

It seems that a circuit breaker is tripping for some reason and probably needs to be replaced. The expansion unit has a very adequate 135-W power supply, and only one slot is filled. This slot contains a modem that has been there from the beginning. No other part of the computer besides the drive itself is affected when this problem occurs, and cycling the system power brings the disk back up.

The longer the system has been running, the more reliable the hard disk appears to be, so I am currently leaving the machine on 24 hours a day to insure that some important work gets done by Thursday. That's Murphy's Law for you! Anyway, any suggestions as to how to go about diagnosing/solving the malfunction would be appreciated.

ibm.pc/pc.hardware #668, from bbrown [Bob Brown]
a comment to 667

Does your disk have a "power delay unit" between the power cable and the disk proper? This is a gizmo which is intended to "sequence" the hard disk on after the rest of the circuitry is stable, primarily to limit the amount of current drawn from the power supply at power-up.

Power sequencing is quite common on "real" computers, and a flaky sequencer can drop the attached device and anything that's "behind" it on the power circuit. I've never seen a power delay on a micro, so I don't know what to tell you to look for to discover if you have one, but I know they exist because my MicroKit HD lists such a thing as an option in the documentation. If you've got one, I suspect it could cause the problems you are seeing, and I'm pretty sure you don't need it with your expansion box almost empty.

Anybody know what one of these jobbies looks like?

ibm.pc/pc.hardware #670, from billn
a comment to 667

Circuit breakers also trip due to overheating and voltage spikes/surges. Are you using unfiltered power? If so, get a spike filter at least to protect your equipment. Breakers also get old and trip for no reason. It should be cheap to replace.

ibm.pc/pc.hardware #676, from asantic
a comment to 668

Interesting suggestion! If there is a sequencer, it doesn't appear to delay power-up for very long, and it would have to be built into the innards of the drive chassis somewhere. I don't see anything likely-looking in plain sight. I still suspect a circuit breaker, but I haven't dismounted the unit yet to look around. I'm not really sure what to look for. There's something that looks like a relay in partial view (small case, clear plastic, metal inside), and I hope that's not the bugger causing the disk to crap out because he's soldered to a board. Thanks for the reply.

ibm.pc/pc.hardware #677, from asantic
a comment to 670

The power is filtered, and there has never been a problem with power quality before. Overheating is unlikely since the drive becomes more reliable after the system has been powered up for a while. The expansion unit has a hefty power supply and lots of room and ventilation. (Sigma DynaFrame—ever meet one? Built like a tank.)

On the circuit-breaker assumption, how would you suggest I proceed?

Oh, by the way, there's a click when the power cuts out, and sometimes a click when the drive powers up.

ibm.pc/pc.hardware #678, from billn
a comment to 677

That click could be most anything. One possibility is that the load in your expansion box is too small. The power supply puts out *x* watts, most of which has to be dissipated as heat. The regulators overheat and automatically cut out to prevent damage. Test: Move a peripheral board into the expansion box (not memory). Second possibility—flaky breaker. Breaker cuts out due to overheating because of high-resistance contacts. Test: Next time the system cuts out, *carefully* put your fingers on the breaker case. If it's more than warm, replace it. Third possibility: Check the grounding. But try the other two first.

ibm.pc/pc.hardware #682, from bbrown
a comment to 676

Sequencers on real computers delay for several seconds, long enough for drive motors to reach 80% of full speed. I'd expect a "delay" on a PC disk to hold power for a second or so, long enough to notice. I'd also expect it to be separate from the drive proper.

ibm.pc/pc.hardware #683, from smack [Steve Mack]
a comment to 677

I have just started using Rodime drives, and while I have not had the specific problem you mentioned, I have noticed a defect in these drives that might cause such a problem. The shock-mounted drive/printed-circuit-board assembly is attached to the mounting frame in such a way that the pins on the underside of the PC board extend to or below the mounting frame at one point. They could easily short to the cabinet's mounting frame, possibly happening due to vibration/head movement or due to the gradual deterioration of the rubber shock mounts and consequent settling.

Who knows what shorting out random drive logic pins might cause? I always insert washers between the drive frame and cabinet frame to keep the PC board pins just enough farther from shorting that I can sleep well. Paranoid but plausible.

P.S.: I should mention, I use 30-megabyte, not 20-megabyte, so the layout may differ.

HARD DISK SINGS THE BODY ELECTRIC

ibm.pc/pc.hardware #672, from mhaas [Mark Haas]

My hard disk has recently started chirping. It's a high-pitched squeaky sound that comes, usually briefly, and then goes. If I press gently on the rear shock mounts (between the drive and its chassis), the chirp stops. The drive is a new Microscience 20-megabyte unit, and so far this seems to have no effect on the drive's performance or reliability.

Anyone have any suspicions about this? Should I be worried or just get out the screwdriver?

ibm.pc/pc.hardware #673, from dondumitru [Donald Dumitru]
a comment to 672

My SysGen 30-megabyte (in an IBM PC) started chirping a couple of months ago. I set it out on a table with a power supply and fiddled until I found what piece was vibrating. Then I took a piece of tape and just taped the annoying part to the drive's frame with a bit of tension. (This assumes the chirper isn't a moving part.) Haven't heard it chirp since!

ibm.pc/pc.hardware #681, from conniek
a comment to 672

I'd suggest checking all the screws first, naturally, but most likely the source of your squeak is the antistatic spring on the bottom of the drive, attached to the spindle. If you just tweak it a tad to change the tension on it, your noise should go away. At least that's the problem on most of the Microsci 20s.

ibm.pc/pc.hardware #688, from jshifrin [Jerry Shifrin]

One suggestion I've heard (but not tried) is to run the drive on its side for a while, presumably to move the lubricant around a bit.

ibm.pc/pc.hardware #689, from mhaas
a comment to 681

I'll check that out as soon as possible. The chirping sound seems to be worst when the machine is dead cold, when it's first turned on. The noise essentially disappears after several minutes and then only occasionally reappears briefly. Is that consistent with the antistatic spring you mentioned?

ibm.pc/pc.hardware #690, from mhaas
a comment to 688

This raises another question I have about hard disks. Are hard disk drives designed specifically to be mounted either horizontally or vertically? Thus, would you have to choose a specially designed drive to add into a Compaq Portable (vertical mount)? Can you have problems if you mount a PC with a hard disk vertically, as with one of those Curtis stands?

ibm.pc/pc.hardware #691, from barryn [Barry Nance]
a comment to 690

I'm embarrassed to say this, but I installed my 20-megabyte disk upside down. Once I found out, I didn't bother to turn it around. It works just fine in that position, and I'm not going to tamper with success.

ibm.pc/pc.hardware #692, from conniek
a comment to 689

I can't say for sure on that one. Now it's beginning to sound more like a bad bearing/bushing, though it could simply be a matter of the frequency of the vibration of the antistatic spring changing with the temperature.

ibm.pc/pc.hardware #695, from conniek
a comment to 690

Well, the drives are supposed to be tested in all planes, but, really, you can do only so much to compensate for gravity. The word that I got was that you should do the low-level FDISK and FORMAT with the drive in its intended position, i.e., if you plan to set the machine on its side on the floor, then do all of the above with the machine in that position. I understand that this was very critical with the earlier CMI drives in the AT.

ibm.pc/pc.hardware #704, from petewhite [Pete White]
a comment to 690

My Seagate has been running in a vertical configuration for over three months without being powered down for more than a few hours. Nary a problem, yet.

ibm.pc/pc.hardware #705, from petewhite
a comment to 689

I have an external drive with a spring that exhibited the same noises, the same way. Drove me bananas! Turned out to be the antistatic spring. (Where were you when I needed you, Connie?)

ibm.pc/pc.hardware #706, from mhaas

Cure found for dreaded chirpies. Yes, a cure has been found for that dreaded disease inflicting thousands of hard disks, the chirpies. Connie was right. I removed the hard disk from the chassis, turned it over, and bent back the small brass spring that contacts the platter spindle. This relieved some of the springiness, just a tad, and cured the chirpies. Thanks, Connie.

For those with similar symptoms, don't bend the spring enough to actually deform it. You just want to reduce the spring's pressure on the spindle a slight amount.

MEMORY MODIFICATION

ibm.pc/xt.hardware #102, from jkilgore [Jerry Kilgore]

I recently acquired a how-to note that had been extracted from a bulletin board somewhere. By adding an LS-158 chip, closing a jumper, and replacing the chips in banks 0 and 1 with 256K chips, I have 640K on the motherboard of my XT. Does any one know (1) why this works and (2) will it harm anything? The XT tech manual shows the empty LS-158 chip socket and the jumper but makes no other comment.

ibm.pc/xt.hardware #106, from dono [Donald Osgood]
a comment to 102

Later-model XTs come with that capability built in. They don't mention it

(continued)

because they want to sell you the memory, I suppose. It certainly is a *normal* capability of recent-vintage XTs.

ibm.pc/xt.hardware #111, from conniek
a comment to 102

We have a number of members using that mod, and the file, I believe, was probably called MB640K or some such. That particular file, if I am correct, involved soldering an additional jumper, which is a little scary to me. There is a later mod that involves simply adding an additional chip to an empty socket, which negates the need for the soldering. Unfortunately, I don't recall the chip number.

ibm.pc/xt.hardware #112, from dondumitru
a comment to 102

I have 640K on the motherboard—exactly as described in that mod. The modification involves (1) soldering a jumper between two solder pads (there just for the purpose of soldering a jumper to); (2) inserting a "decoder/multiplexer chip" into an empty socket (sorry, I don't remember the chip number); and (3) putting 256K chips into banks 0 and 1. Ta, dah! 640K for minibucks. For an XT, this has to be the *best* way to upgrade your memory. For me, memory and the decoder/multiplexer cost around $80. I had it installed in less than 45 minutes.

ibm.pc/xt.hardware #114, from rschnapp [Russell Schnapp]
a comment to 112

I have the text of that mod in my SideKick Notes file. The mux chip is a 74LS158. If you'd like me to repost it (I don't know the original author's name or the message number), I will.

AVOIDING TROJAN HORSES

ibm.pc/pc.software #632, from mwelch [Mark Welch]

I am uploading to the Listings conference a nifty little program called CHK4BOMB (in a file called CHK4BOMB.ARC). This program goes through a program and lists out all ASCII strings and *also* checks the program to see if it is doing any direct disk accesses through the ROM *BIOS*. In other words, it checks to see if a program that shouldn't be going to the disk drive actually does. I just ran it on a nifty-looking disk directory utility, and it came up with the following warning message (after listing out all the ASCII strings in the program):
[clipped from output of CHK4BOMB.COM]

****WARNING****
This program uses the ROM BIOS routines for direct disk access. This program COULD format a disk or write to certain sectors without updating the directory or File Allocation Table. DO NOT RUN this program until checked by an expert, unless you are familiar with the author or company.
****WARNING****
This program writes to absolute sectors. The possibility exists to overwrite important data!

ibm.pc/pc.software #633, from petewhite
a comment to 632

Sounds like a program that should be described in the Sysops conference. I'll have it as soon as it's listed; thanks for bringing it over. Right now I use the utility program ASCII to list and another utility to lock out disk access when testing. This one sounds a bit more simple to use.

ibm.pc/pc.software #635, from barryn
a comment to 632

That does sound nifty. But I bet it would go nuts on Norton's Utilities.

ibm.pc/pc.software #639, from mwelch
a comment to 633

Tell me about (and tell me where to get) the utility to lock out disk access when testing. I've heard that there is a program that tells the system that there is no hard disk; I would like to get that.

ibm.pc/pc.software #647, from conniek
a comment to 632

We've been using it for some time now, and it is definitely handy. However, it's a tad slow, so what I usually do is to redirect its output to a file so that I can start it up and go away. Then a quick LIST of the output file does the trick if anything less than kosher is in there.

ibm.pc/pc.software #653, from petewhite
a comment to 639

It's on the Cul-De-Sac, (617) 429-1784. File named DPROTECT.ARC. It tells you if anything wants to write to disk and locks it out so it can't. I'll have it in Listings as soon as a few problems are addressed. (In the Cul-De-Sac it's in Misc. Utilities #2, File #65—1 minute at 1200 bps.)

IBM 5550 (JAPANESE PC) HELP!

ibm.pc/pc.software #748, from gperfect [George Perfect]

We are currently working on some windowing software for the IBM 5550 (Japanese PC) and have a small problem (apart from not understanding Japanese!).

We would like to display kanji—2-byte—characters on screen without using the BIOS. That is, we would like to place the character codes directly in the screen buffer and avoid the speed penalty incurred when using the BIOS calls.

To date, all attempts to do this have failed miserably. If anybody can assist with information or suggestions on speeding the display of kanji characters, I would be most grateful.

ibm.pc/pc.software #750, from barryn
a comment to 748

George, there's some material in the Pascal conference that's related to direct-screen I/O. The assembler conference (topic cpu8088) has some as well, I believe. Neither set of material talks about kanji in particular, but you may be able to make use of the data anyway.

Two questions: What's the layout of the video memory (screen buffer) for kanji, especially in relation to the usual—English—layout of character/attribute byte pairs? And exactly what happens when you try writing to the screen—what symptoms do you get?

ibm.pc/pc.software #766, from gperfect
a comment to 750

Thanks for the info. I think we understand how to write to a normal screen buffer (we do it all the time on other machines), but the problem with kanji is different. Kanji characters are stored in 16 bits—normally treated as 2 discrete bytes. The first byte (if within certain ranges of high-order ASCII, i.e., > 127 decimal) acts as a lead-in to tell the display software that the next byte will complete a 16-bit kanji code.

With regard to the buffer format, it is basically the same as a standard PC (i.e., first byte for character code, second byte for attribute). The standard procedure for writing characters to an IBM screen buffer works for display of ASCII characters and single-byte Japanese (kana characters mainly), but the process fails with 2-byte codes.

The 5550 has a second display buffer which appears to work in APA graphics mode at all times. It appears that the BIOS fills this buffer with the FONT image of each character—read from disk if necessary (another small problem)—and, so far, we have only succeeded in making this happen by sending kanji characters via the BIOS calls.

Our problem is that we do not understand the operation of the 5550 BIOS (IBM does not publish it) and so cannot fathom the format of the character-display buffer or even if it is used by the BIOS in the display of kanji at all. There is a wealth of technical information available for the 5550 and several good books, but our Japanese partners have fought shy of translating it for us.

In terms of symptoms, our main problems are speed (using the 5550 BIOS is *extremely* slow) and clipping of characters on window boundaries, i.e., if a 2-byte character straddles a window border. The second problem is solved with a little searching (and a few curses at the JIS codes, which could make the process of identifying kanji mixed with single-byte characters much easier), but the first is a real problem to windowing software.

Right now, it would be a great help if someone who really knows the 5550 could tell us that what we want to do is impossible—at least we would save the effort of trying. Ideally, if somebody has worked the machine and knows the literature, we would appreciate a pointer to the answer. Thanks again for your help.

ibm.pc/pc.software #769, from barryn
a comment to 766

I've never seen the Japanese PC, so I'm on thin ice here. All I can tell you is how I'd approach the problem if I were in your shoes.

I think you hit the nail on the head when you say the problem is the mystery of what the BIOS is doing—obviously it *works*, it's just too slow.

What do you think of this idea? Locate the Interrupt 10H vector in lower memory (assuming, as on a regular PC, that it's the one doing video-related functions) and use either DEBUG.COM or a product like ASMGEN (available here on BIX in the IBM section of the Listings conference) to reverse-assemble the BIOS code that's pointed to by the Int 10 vector. Print out the result and go through it, analyzing the code for video-buffer updates and accesses. This process should eliminate the mystery of what the BIOS is doing.

Then you can proceed to use what you've found out to construct your own video-memory-buffer control routines and bypass the BIOS code for the too-slow functions.

MACINTOSH

This month the Mac conference covers questions about hard disks, a debugger, a font, and some hints on using Word. There are also some questions concerning the Mac Plus.

REQUEST FOR SCSI INFORMATION

macintosh/hardware #77, from cfuller [Clayton Fuller]

SCSI Info?
Where can I find more information on the SCSI standard? A source for the published standard would be nice, but if there are any articles describing its use, that would be better.

macintosh/hardware #79, from tcantrell [Tom Cantrell]
a comment to 77

There are two SCSI info sources:

ADSI (Adaptive Data Systems Inc.)
2627 Pomona Blvd.
Pomona, CA 91768
(714) 594-5858
ADSI has a very complete *SCSI Guidebook*.

NCR Microelectronics Division
Logic Products Marketing
1635 Aeroplaza Drive
Colorado Springs, CO 80916
(303) 596-5612
Ask for all info on the NCR 538x SCSI chips

[Editor's note: ADSI's SCSI Guidebook *costs $16.95 plus tax and/or shipping costs.]*

MACAPP, MUSIC DRIVERS, MAC PLUS COMPATIBILITY, AND TMON

macintosh/softw.devlpmt #145, from spmpuyol [Robert Puyol]

About MacApp
I'm a certified developer in France, and I have two questions. What is the latest MacApp version? (Mine is 0.3, a Pascal Workshop alpha release.) Are Macintosh MacApp and Macintosh Smalltalk available?

macintosh/softw.devlpmt #146, from mondrejko [Michael Ondrejko]
a comment to 145

There is a Smalltalk available for the Macintosh from Apple, mostly unsupported, but for $50 definitely worth it. For an order form, contact: Smalltalk Request, c/o Eileen Crombie, Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014.

macintosh/softw.devlpmt #147, from dsharp [Doug Sharp]

Mac Music Driver?
Anyone know of a good way to output good multivoice music from a Mac program? I have heard Jazz Musician-Jam Session and got real excited until I heard what they wanted to license it for. I'd like a driver that could take a MusicWorks or Deluxe Music Construction Set type of file as input so I could use a decent editor to try out the sounds. It can't be purely digitized tunes because of memory-size and processor-use considerations. Any hints or pointers would be accepted.

macintosh/softw.devlpmt #148, from petter [Petter Gustad]

What is the latest version of Megamax C (any after v2.1)? Has anyone seen an updated version of Edit that runs on the Mac Plus?

macintosh/softw.devlpmt #150, from tom_thompson [Tom Thompson, Technical Editor, BYTE]
a comment to 148

I don't know about Megamax C. I *think* the MDS editor works on the Mac Plus, but I haven't used it sufficiently to be sure. Stuff that I've checked so far:

Application or Desk Accessory	Finder version #
MockWrite 3.0, 4.0	4.1
Macintosh Pascal 1.0	1.1g
Consulair Mac C 4.0	4.1

The MDS editor refused to print to the Imagewriter II on the Consulair disk, but that may be due to the super-stripped system file on the disk. MockWrite wrote to the Imagewriter II with no problems.

Oddly enough, TurboControl, with autostart set, didn't cause a crash on the Mac Plus. I can only conclude that it has something to do with the "old" Finder (4.1). It will be interesting to try it with the Mac Plus version to see what happens. I'm trying to do a compatibility study here to see what software will work without upgrades. Any info would be appreciated, as I want to see what impact it will have on the boxes of software I already have.

macintosh/softw.devlpmt #152, from rkaapke [Richard Kaapke]
a comment to 150

I have used Bill Duvall's editor under Finder 5.1 *with HFS*. His editor

(continued)

(MDS Edit) doesn't open files across HFS folders correctly. If you use the HFSOPEN patch program put into the public domain by Andy Hertzfeld, MDS Edit will open files correctly but save them to the "root directory" by using explicit filenames like "HD20:file".

macintosh/softw.devlpmt #153, from kschmucker [Kurt Schmucker]
a comment to 145

I am also a MacApp tester/user. I think it is great. As a small test, I developed a program that uses multiple documents, the standard File and Edit menus, is compatible with multiple desk accessories, prints on the LaserWriter and the Imagewriter, and has all the standard window controls. Only 87 lines of (object) Pascal.

The first MacApp users meeting was held at the MacWorld Expo. About 50 people were there, and there was a high level of enthusiasm among many of the other MacApp users. Several serious applications were also shown: a shipboard navigation package, a re-implementation of MacPaint that supports multiple documents, auto-scrolling, and full-screen windows, and a crossword puzzle program.

Version 0.4 will be out soon. If you want an interim version (0.39) that lacks documentation and a couple of features, you can request it. Personally, I'd wait.

My guess is that after MacApp hits the street, it will be the *only* way to develop *new* end-user applications (end-user applications, not new device drivers or stuff like that) because it cuts your development time down so much (by a factor of 4 usually) and impacts your application (performance and space) so little.

macintosh/softw.devlpmt #155, from ccrawfor [Chris Crawford]
a comment to 153

I'm a little surprised at your assertion that MacApp impacts an application's performance and space so little. This certainly violates common experience with high-level languages. I attended a presentation on MacApp at a Software Entrepreneur's Forum meeting, and the lecturer seemed to acknowledge that MacApp did exact a considerable performance penalty.

macintosh/softw.devlpmt #156, from roberts [Guy Roberts]
a comment to 148

I've been using Megamax C version 2.1b for about three weeks now on both a Mac 512 and a Mac Plus with no problems.

macintosh/softw.devlpmt #159, from ccrawfor

TMON RAM Usage?
I am curious about using the TMON debugger. I have been using MacsBug for the last few months (before I got my Mac fattened I simply didn't debug—that's a tale of discipline). There seems to be a consensus that TMON is one of the best around, but I am curious about its consumption of RAM. How much disk space does it require? How much RAM does its resident portion require? Are there any constraints or gotchas in using it to debug production code?

macintosh/softw.devlpmt #160, from brecher [Steve Brecher]
a comment to 159

TMON can take from 20K to 50K+ of RAM, depending on how you configure it and what "user area" (set of user-customizable routines) you use. Disk consumption is likewise variable depending on what you *include/exclude* (doesn't a guy like you have a hard disk?). I always have TMON loaded—it's my start-up application (I've altered it so that after loading the monitor it launches my "real" start-up application). Last time I used MacsBug was about 1947. Get TMON. Then get Darin Adler's public domain Extended User Area.

macintosh/softw.devlpmt #161, from kschmucker
a comment to 155

Quantification of "little impact" = 10K to 20K in space and between 10% to −20% performance hit. (By that I mean the MacApp version can be from 10% slower than a non-MacApp-written application up to 20% *faster*.) Maybe I'm spoiled, but that seems like a good trade for a *big* reduction in development time.

macintosh/softw.devlpmt #163, from tom_thompson
a comment to 160

I've located the source for the Extended User Area and will upload it for you if you're interested.

macintosh/softw.devlpmt #164, from lloeb [Larry Loeb]
a comment to 160

Darin's EUA fixes some minor TMON bugs as well. Gee, *if it's not in* Listings, I'll put it there.

macintosh/softw.devlpmt #167, from ccrawfor
a comment to 163

Yes, please do so; I just today ordered TMON from ICOM, so I will be very interested in the Extended User Area.

macintosh/softw.devlpmt #171, from hedges [Tom Hedges, Fractal Software]
a comment to 147

Studio Session is supposed to sell for less than $100, not a particularly high figure. It is due out by the end of April and would be your logical first step toward high-quality music output by the Mac.

macintosh/softw.devlpmt #175, from dsharp
a comment to 171

I wasn't talking about a music program but a music driver to use from within a game I'm working on. If Studio Session is the same as the program I saw called Jam Session, then it is indeed a wonderful music machine, but the developers wanted mucho bucks to license a driver for developers. If they drop their prices considerably, I'd jump at it, but meanwhile I'm still looking for a good, reasonably priced Mac music driver.

macintosh/softw.devlpmt #176, from frankb [Frank Boosman]
a comment to 175

I understand that MacroMind is now licensing code for developers to use in their programs. MacroMind produces VideoWorks and MusicWorks, and I seem to remember a sliding scale of royalty charges, up to a max of about 60 cents per unit. What they charge depends on what use you want to make of their code; it's handled on a case-by-case basis. Call the people at MacroMind for a MusicWorks driver.

macintosh/softw.devlpmt #177, from hedges
a comment to 175

Oh, OK, I didn't think their retail price was that high. The music output code (which I have personally worked on) is sort of the "family jewels" of the Studio Session product, so it makes sense they don't want to license for cheap.

You can use a single digitized sound from SoundCap, a product from Fractal and MacNifty, but it would require lots more space if you wanted to output complex melodies. On the other hand, if you are content with sound effects and short bursts of music, the SoundCap digitized sounds might be the way to go. The SoundCap file unpack and output code is in the public domain and is posted in the Listings area.

macintosh/softw.devlpmt #178, from dsharp
a comment to 176

I've talked to Mark Cantor of MacroMind, and they are licensing a VideoWorks driver with very minimal sound abilities for a reasonable sum. I am looking for a four-voice music driver. Sorry.

ANOTHER PROGRAM BUG

macintosh/softw.devlpmt #183, from ccrawfor

Odd Bug
I've got a pretty good programming problem here. I have a call to CautionAlert that causes the system to crash. It always crashes the system, with one exception: *If* I have installed MacsBug and *if* I crash the system once, get thrown into MacsBug, execute an Escape to Shell (ES) command, and then restart the program from that point, the CautionAlert will not subsequently crash. Moreover, I found that the crash occurs only when I set my program as the start-up program on the disk.

The ALRT definition in the resource file is fine and good, I checked it with the resource editor. So is the DITL for the ALRT. I thought that perhaps I wasn't initializing one of the many managers properly, but I am calling InitGraf, InitFonts, InitWindows, InitMenus, and InitDialogs, in that order, so it doesn't seem that I am leaving anything out.

This is not a make-or-break problem; I can leave the Minifinder as the start-up. I am curious, though, as to the cause of this odd little bug. Any ideas?

macintosh/softw.devlpmt #184, from brecher
a comment to 183

You need to call TEInit.

macintosh/softw.devlpmt #185, from ccrawfor
a comment to 184

Are you sure that I need to call TEInit? I am not using any part of the text edit package—at least, I didn't think that Alerts were part of the TE package. Am I wrong?

macintosh/softw.devlpmt #189, from ccrawfor
a comment to 184

Oh, mortification! You were right! That's what I get for trying to save two lousy bytes that I thought were unnecessary because I wasn't directly using the text editor package. A great big OOPS!

INSTALLER TIP

macintosh/news #290, from lloeb

How to Fix the Installer
If you have read the errata to the latest Software Supplement (errata.wrt in Listings), you know the System Installer that Apple supplies wants to install 3.1 instead of 3.1.1. Here's how to rewrite the script to install the correct system file: Open System Installer with ResEd and find the INSC resources. In these resources there is a hex string that represents the date of the system to be installed. You paste here the date you got from the system you *wish* to be installed (by opening the destination system with FEdit and copying it from there). Save your changes (this *is* a backup disk, isn't it?). Open the Imagewriter (and LaserWriter if you have them) system files with ResEd again and paste the correct INSC resource (that hex date string) in those as well. Save your changes and you're done.

APL FOR THE MAC

macintosh/software #170, from jbaker [John Baker]

PortaAPL Version 3.0a
For the last two weeks I have enjoyed the immensely rewarding experience of working (day and night) with what may be the best "power user" problem-solving tool running on the Macintosh today.

I am speaking about version 3.0a of PortaAPL. The first two versions of this product, 2.0 and 2.1, were very satisfying pieces of software. The latest release pushes PortaAPL into the front line of top-quality APL systems. In my opinion PortaAPL is the best APL system buy on the market today. It compares very favorably in all respects to STSC's APL*PLUS, the best MS-DOS APL.

At this point you may wonder who I am and what makes my opinion about APL systems worth anything. I run a small successful APL consulting firm in Edmonton, Alberta, Canada (home of the best hockey team in the NHL). My major clients are large mainframe APL shops in private industry, the Alberta government, and the University of Alberta. I have programmed in APL for over ten years.

Having worked on all of these systems, I can state without hesitation that PortaAPL is a very sound and thorough implementation of standard IBM VS/APL with many STSC extensions. It's the first complete APL system that costs less than $300 and yet delivers the power and capacity required to run many mainframe-developed APL systems. I have ported hundreds of APL functions and one complete database system from VS/APL environments to PortaAPL with no difficulties or incompatibilities. Of course, the Mac cannot keep up with an Amdahl mainframe, but the amazing thing is this little interpreter is fast enough, running mainframe code, to still be useful.

If you want to experience *real power* on the Mac, do yourself a favor and get PortaAPL. You will not regret it. Take it from a very satisfied customer. PortaAPL is produced by Portable Software, 60 Aberdeen Ave., Cambridge, MA 02138, (617) 547-2918.

[Editor's note: PortaAPL costs $275 plus $10 handling charges.]

macintosh/software #175, from kerskine [Keith Erskine]
a comment to 170

What kind of graphics does PortaAPL allow you to do?

macintosh/software #177, from jbaker
a comment to 175

PortaAPL supplies a workspace of cover functions that allow you to access most of QuickDraw from APL. The system comes with a small plot demo that shows one how to set up a simple technical plotting system. I have modified this system to plot engineering graphs, log normal, splines, etc. The performance is quite adequate. It's not as fast as commercial plotting packages; however, the APL environment is more flexible and adaptable than some of the plot packages I have used. If you have a need for "nonstandard" plots, PortaAPL is a good tool to program them in.

BOSTON II FONT INFO

macintosh/software #179, from joeleben [Joe Leben]

For those that don't know about it, acquire the shareware package called the Boston II font. It's a collection of fonts that are *much* better that any I've seen, and I've got a lot of fonts. It's optimized for producing normal-sized text on an Imagewriter printer and has to be seen to be believed. The italics are even more legible than the normal characters. It comes with a well-formatted on-disk manual and other miscellaneous software, including a RAM disk package that can be used to speed up the printing of the heavily formatted manual. Best $10.50 I've spent in a long time. It can probably be found on bulletin boards, but I got mine by mail by sending a blank disk and a check for $10.50 (U.S.) to the following address: Charles E. Maurer, 31 Forsyth Ave. S, Hamilton, Ontario L8S 2A4, Canada.

P.S.: The manual is worth the $10.50 for the typographics *tips and* techniques that it presents.

(continued)

macintosh/software #182, from lloeb
a comment to 179

I heartily concur. Best usable font I have for real correspondence.

macintosh/software #192, from bwebster [Bruce Webster, Consulting Editor, BYTE]
a comment to 179

I'll second the comments about Boston II. I wrote nice things about it in a recent column (February BYTE), for which Charlie sent me a nice letter (as did Paul Rapoport, creator of the International font). Boston is now *the* font I use for word processing on the Mac. (Be sure to get Boston II; there's an older Boston running around.)

macintosh/software #233, from jamurphy [Joe Murphy]

Macintosh Pascal 2.0
Macintosh Pascal 2.0 has been finally released as an update for those of us who have Macintosh Pascal 1.0. The update should be available at any Apple dealer. It comes on two disks, one with the new version of MacPascal and the other with documentation about the update, some new sample programs, an installer to put the program on a hard disk (or to make backup copies), and a shell program. The shell program is a 75K run-time file that allows programs to be executed without running MacPascal.

The notorious copy protection is gone, but there are invisible files on the disks which make it necessary to use Copy II Mac, the utility included with the program or any copy program that copies invisible files to make backups.

They appear to have fixed all the bugs and have added some features. The program comes with Finder 5.2, but if you try to execute a file with the PSHELL (run-time file), it crashes unless you use Finder/System 4.1. I thought it was really amazing when I tried to run a file as an application, and my Mac did a very vicious crash. It was only when I tried the old Finder that I realized the problem. It seems incredible, but the PSHELL is not compatible with the version of the Finder it comes with! Overall, though, it is a free update (you need your master copies to get the update, although my dealer put the copies on two disks I brought because I didn't want to lose version 1.0), and Apple should be commended for that. It is a well worth getting and, aside from the one problem with the run-time file, is a great improvement over 1.0.

SOME TIPS ON UNPRINTABLE CHARACTERS IN WORD

macintosh/software #236, from lloeb

Word Tidbits
It *is* possible to find and change certain unprintable characters in the *Find/Change* dialogs. It requires the following special codes:

^w white space
^s fixed-size nonbreaking space
^t tab
^p paragraph (RETURN character)
^n new line (Linefeed?)
^– optional hyphen
^d Word document division

MAC PLUS PIN-OUTS

macintosh/tech.talk #144, from rkaapke

Mac Plus Peripheral-8 Pin-out
Since checking the connections between a Macintosh Plus and an Imagewriter II, I have found that the pin-outs are identical. For those without an Imagewriter II manual handy (see page 88, appendix C):

```
 8 7 6
5 4   3
 2 1
```

(You should recognize this pattern only in one orientation, which is looking at the pins in the male connector, holding it so that the flat part is pointing up.)

Pin 1:	DTR	Data Terminal Ready Output
2:	CTS	Clear To Send Input
3:	TxD–	Transmit Data– Output
4:	SG	Signal Ground
5:	RxD–	Receive Data– Input
6:	TxD+	Balanced Transmit+ Output
7:	NC	No Connection
8:	RxD+	Balanced Receive+ Input
Shield:	PG	Protective Ground

I have no idea where to get these connectors other than on a Macintosh or Apple II peripheral-8 cable.

If you want to adapt a 9-pin to the peripheral-8, try using the Mac 512K to Imagewriter II cable (which has a 9-pin on one side and a peripheral-8 on the other). Plug the 8-pin connector into the Macintosh Plus port, then get a "gender bender" 9-pin female to 9-pin female straight-through cable. Plug your 9-pin connector into one end of the gender bender and the Imagewriter II cable's 9-pin connector into the other end. Note that the voltages found on the 9-pin connector are not supplied on the peripheral-8, so don't expect this to work with a ThunderScanner or Koala MacVision, or with any other device that requires power from the Macintosh and not from its own source.

This is theoretical—I have not tried it; as soon as my Plus arrives, I'll post any corrections that I needed to make.

Incidentally, I have a ThunderScanner and I will be thinking about the power problem.

All you brave souls who dare to try this out, please leave us a note telling of your success or corrected failures.

macintosh/tech.talk #150, from rkaapke
a comment to 144

When consulting this diagram, reverse the positions of the transmit and receive connections. When I used an Imagewriter II to Macintosh 512K (DB-9 to peripheral-8) cable, I needed to exchange my transmit and receive lines for all the connectors I wanted to mate to the DB-9. The diagram in message 144 is for an Imagewriter II; the Macintosh Plus has the transmit and receive lines (four in all) reversed. (Exchange TxD+ for RxD+, and so on.)

macintosh/tech.talk #151, from tom_thompson
a comment to 150

Your pin-outs are correct. Possibly what's going on is the null modem (transmit-receive pair swap) in the cable. Can you confirm? To recap: pin 3 is TxD–, pin 5 is RxD–, as specified in message 144.

macintosh/tech.talk #152, from rkaapke
a comment to 151

Aha! Yes, of course—it's obvious now that I look at the connections! The Macintosh Plus peripheral-8 pin-out on message 144 is correct; an Imagewriter II to Macintosh DB-9 is a "null modem" cable, and so if you use it with a Macintosh Plus to bring the peripheral-8 out to a male DB-9, the transmit and receive lines are reversed. You have to keep this in mind if your way of making an adapter from the Macintosh Plus peripheral-8 to a DB-9 is using the Imagewriter II cable. Thanks for clearing that up for me. ■

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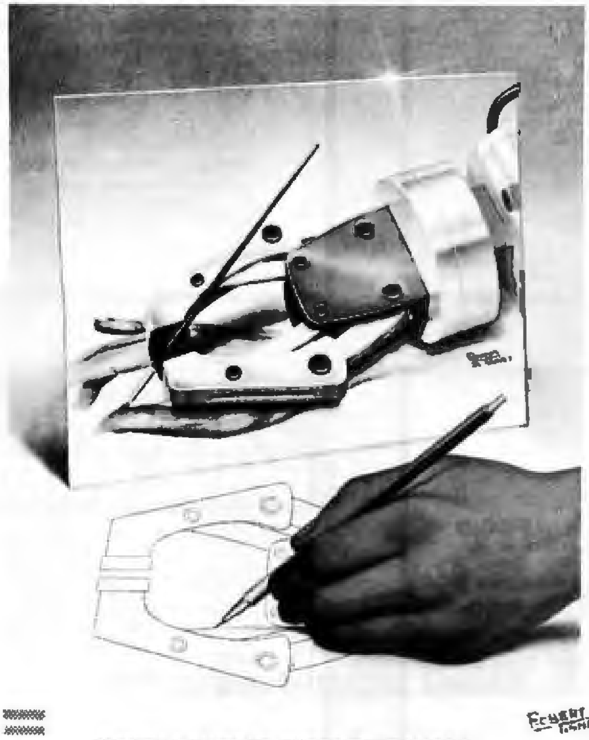

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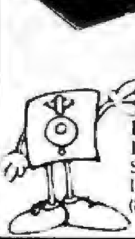

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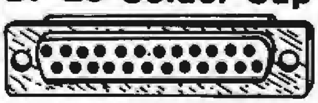

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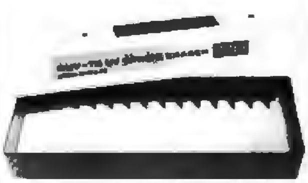

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74LS09	.16	74LS139	.36	74LS290	.86
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74LS12	.18	74LS148	.86	74LS298	.66
74LS13	.36	74LS151	.36	74LS299	1.46
74LS14	.24	74LS153	.36	74LS323	2.46
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74LS27	.20	74LS160	.28	74LS365	.36
74LS28	.24	74LS161	.36	74LS366	.36
74LS30	.18	74LS162	.46	74LS367	.38
74LS32	.16	74LS163	.36	74LS368	.36
74LS33	.28	74LS164	.46	74LS373	.76
74LS37	.24	74LS165	.64	74LS374	.76
74LS38	.24	74LS166	.86	74LS377	.76
74LS40	.18	74LS168	.94	74LS378	1.12
74LS42	.36	74LS169	.94	74LS385	1.84
74LS47	.58	74LS170	.84	74LS386	.42
74LS48	.66	74LS173	.46	74LS390	1.06
74LS49	.66	74LS174	.36	74LS393	.76
74LS51	.18	74LS175	.36	74LS395	1.06
74LS54	.18	74LS181	1.46	74LS399	1.06
74LS55	.20	74LS189	3.86	74LS424	2.86
74LS63	.86	74LS190	.46	74LS447	.92
74LS73	.28	74LS191	.46	74LS490	1.46
74LS74	.22	74LS192	.66	74LS624	1.82
74LS75	.28	74LS193	.66	74LS640	.96
74LS76	.28	74LS194	.56	74LS645	.96
74LS78	.38	74LS195	.56	74LS668	1.46
74LS83	.46	74LS196	.58	74LS669	1.26
74LS85	.46	74LS197	.56	74LS670	.96
74LS86	.20	74LS221	.56	74LS674	9.56
74LS90	.38	74LS240	.66	74LS682	3.14
74LS91	.86	74LS241	.66	74LS683	2.86
74LS92	.46	74LS242	.66	74LS684	2.86
74LS93	.38	74LS243	.66	74LS685	2.86
74LS95	.46	74LS244	.58	74LS688	1.86
74LS96	.46	74LS245	.69	74LS689	2.86
74LS107	.32	74LS247	.88	74LS783	21.96
74LS109	.34	74LS248	.66	81LS95	1.36
74LS112	.26	74LS249	.96	81LS96	1.36
74LS113	.32	74LS251	.46	81LS97	1.36
74LS114	.32	74LS253	.46	81LS98	1.36
74LS122	.44	74LS257	.36		
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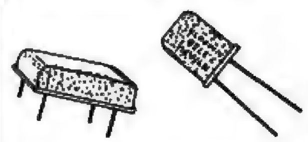

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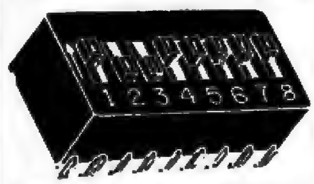

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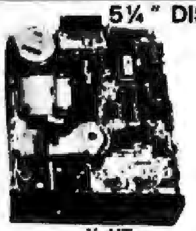

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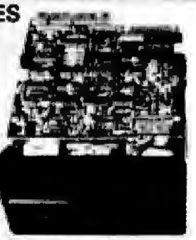

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Mfr. — Torin TA 300
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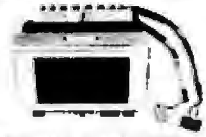

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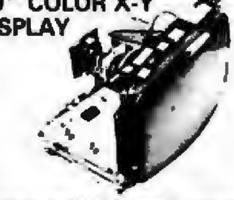

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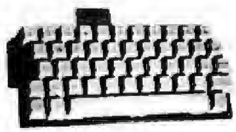

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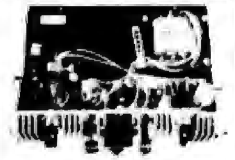

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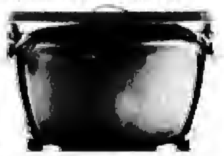

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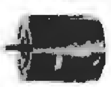
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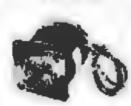

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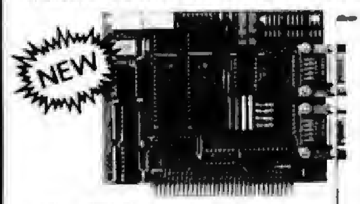

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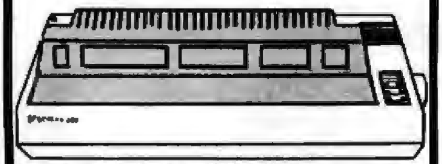

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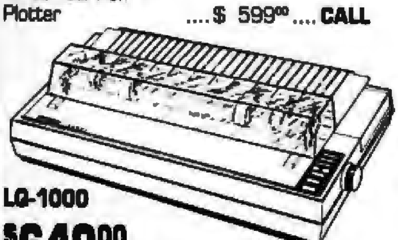

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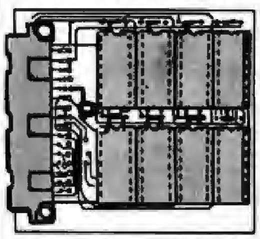

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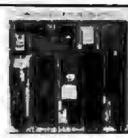

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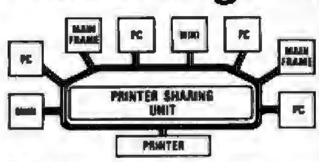

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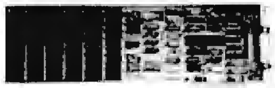

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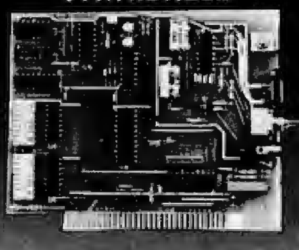

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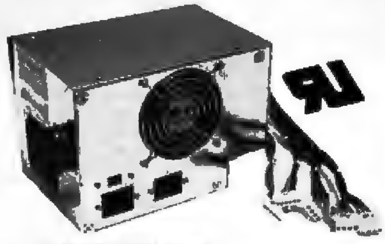

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Now, tens of thousands of businesses, government agencies, schools and individuals have learned that you don't have to pay inflated "brand name" prices to get "brand name" quality.

Just buy Super Star® diskettes.

Quality ...without high price.

We ship almost a million Super Star® diskettes a month and get very few of them back.

Unlike others who offer a "house brand" or "generic" diskettes, Super Star® diskettes are top-of-the-line quality, exceeding ANSI and IBM standards by 50% or more.

They are not cosmetically flawed, duplicator product (where a failure rate of 20% or more is expected) or what we in the diskette industry refer to as "floor sweepings", a term which speaks for itself.

A lifetime warranty.

If you sense pride in our description of Super Star® diskettes, you've got it right.

After all, wouldn't you be proud if you found a way to deliver top-quality diskettes at about half the price of "brand names"?

When every bit counts, it's Super Star®!

Nearly a million Super Star® diskettes a month are being sold to some of the largest and most recognizable names in the nation. They love 'em, because they save money...and they are dependable.

So now is the time for you to re-discover Super Star® diskettes.

And we say "re-discover" for a reason.

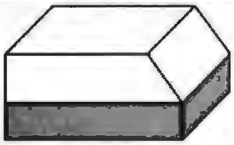
You've already used Super Star!

Super Star® diskettes, as noted, are made by some of America's leading diskette manufacturers...and the odds are that you've already used them more than once as the copy-protected masters on some of the best known software programs around.

So, when you want the best...and the least expensive best...order Super Star®!

SUPER STAR SPECIAL!

Your choice of storage at $ 4.95!



Buy 50 Super Star® diskettes and get a storage case for only $ 4.95 (shipping included)!

These are durable plastic cases with dividers and are very nice units.

The 5.25" unit holds 50 diskettes and the 3.50" unit holds 40 diskettes.

5.25" Storage Case(P/N3100)..$ 4.95 ea.

3.50" Storage Case (P/N 3102).$ 4.95 ea.

What the world needs now is a complete line of high quality, inexpensive diskettes with a LIFETIME WARRANTY!

And DISK WORLD! has them!

Super Star 5.25" Diskettes

5.25" SSDD	(P/N 3800)	.55 ea.
5.25" DSDD	(P/N 3801)	.64 ea.
5.25" SSDD-96TPI	(P/N 3802)	.80 ea.
5.25" DSDD-96TPI	(P/N 3803)	.84 ea.
5.25" DSDD-HD	(P/N 3804)	$ 1.72 ea.

ORDER IN MULTIPLES OF 50 ONLY!

All Super Star 5.25" Diskettes are poly-bagged in lots of 25 with sleeves, write-protect tabs and user ID labels.

QUANTITY DISCOUNTS: 350-500 diskettes, deduct 3%. 500-700 diskettes, deduct 6%. 750-1,000 diskettes, deduct 9%. 1,000+ diskettes, deduct 12%.

Super Star 3.50" Diskettes

3.50" SSDD	(P/N 3805)	$ 1.52 ea.
3.50" DSDD	(P/N 3806)	$ 1.86 ea.

ORDER IN MULTIPLES OF 50 ONLY!

Super Star 3.50" diskettes are packaged in boxes of 50 with user ID labels.

QUANTITY DISCOUNTS: 350-500 diskettes, deduct 1.5%. 500-700 diskettes, deduct 3%. 750-1,000 diskettes, deduct 4.5%. 1,000+ diskettes, deduct 6%.

The Super Star LIFETIME WARRANTY!

Super Star Diskettes are unconditionally warranted against defects in original material so long as owned by the original purchaser. Returns are simple: just send the defective diskettes with proof of purchase, postage-paid by you, with a short explanation of the problem and we'll send you replacements.(Incidentally, coffee stained diskettes or diskettes with staples driven through them or otherwise damaged don't qualify as defective.)

HOURS:
8AM-6PM Central Time
Monday - Friday

WE WILL MEET OR BEAT ANY NATIONALLY ADVERTISED PRICE ON THE SAME PRODUCTS AND QUANTITIES SUBJECT TO THE SAME TERMS AND CONDITIONS.

HOW TO ORDER:

ORDERS ONLY:
1-800-621-6827
(In Illinois: 1-312-256-7140)

INQUIRIES:
1-312-256-7140

FOR FASTEST SERVICE, USE NO -COST MCI MAIL. Our address is DISKORDER. It's a FREE ,MCI MAIL letter. No charge to you. (Situation permitting, we'll ship these orders in 24 hours or less.)

SHIPPING: 5.25" & 3.50" DISKETTES-Add $ 3.00 per each 100 or fewer diskettes. **OTHER ITEMS:** Add shipping charges as shown in addition to other shipping charges. **PAYMENT:** VISA, MASTERCARD and Prepaid orders accepted. **COD ORDERS:** Add $ 5.00 special handling charge. **APO, FPO, AK, HI & PR ORDERS:** Include shipping charges as shown and additional 5% of total order amount to cover PAL and insurance. We ship only to United States addresses, except as shown above. **TAXES:** Illinois residents add 7% sales tax.

MINIMUM ORDER: $ 35.00

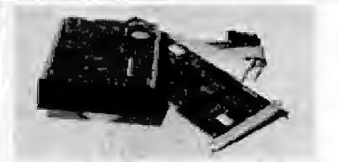
DISK WORLD!, Inc.

629 Green Bay Road
Wilmette, Illinois 60091

TOLL FREE
800-854-8230
CA Residents 714-558-8813

OUR POLICY — Inquiry 9
- Surcharge for VISA or Mastercard.
- Volume purchasing agreements available.
- Orders subject to availablity. • Supply limited on certain items.
- Pricing subject to change without notice.
- ACP Retail Store pricing may vary. Not responsible for typos.

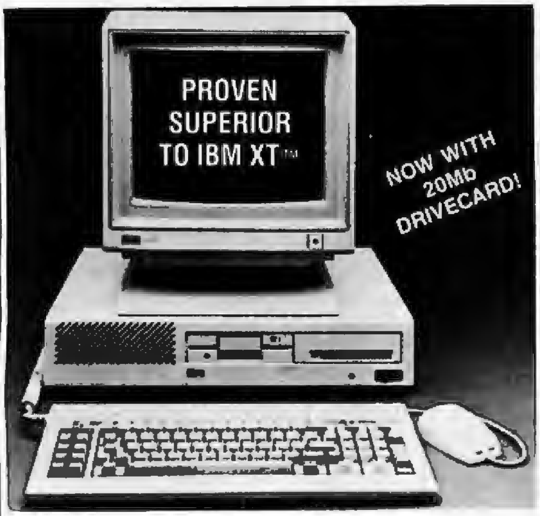
CORPORATE BUYERS CALL BARRY



20 Mb Upgrade Package (1 Yr War) **$449** — 20 Mb Drivecard Plug-In 1 Yr War) **$699**

SEAGATE FOR AT
(Linear Voice Coil Activator)
20 Mb for AT..............$575.00
30Mb for AT..............$695.00
40Mb for AT..............$815.00
(Inc. Cable & Mounting Rails)

IBM Compatible W/20Mb DRIVECARD



Don't miss out on this unbeatable system manufactured by Toshiba for ACP. ACP has sold over 3,000 **ADVANCED XT's** to satisfied customers including "true blue" users like Rockwell, Hughes, and Kodak. Not only is the price affordable but the features and compatibility are unbeatable. For more details call one of our expert consultants. Don't hesitate this will be a sellout!

ACP BASE PRICE **$699.00**

Call for complete Monochrome or Color RGB system prices with 10 or 20 Mb hard disk drives or the **NEW 20Mb Drivecard.**

PC UPGRADE SPECIAL
$14.95 SET OF (9) 64K RAMS
$36.95 SET OF (9) 256K RAMS
$7.95 4128 PIGGYBACK RAM
$120.00 8087-2 Coprocessor

1200 Baud Hayes™ Comp. Modem
Short Card by U.S. Robotics with Telpac I Software.
List $499 ACP..**$149.95**
Buy (6)..........$139.95

AST
Sixpak Plus w/64K..............$235.00
Advantage 128K, AT..............399.00
AST 5251-11..............575.00
AST 3780..............575.00
RAMpage up to 2 Mb..............Call

DCA
Irma..............$785.00
Irmaline..............895.00

DIABLO/XEROX
620 Serial LQP.....was 1495 now $349.00
620 API LQP..............399.00
620 036 (36cps)..............449.00
Tractor..............was 395 now $99.00
F-21 Sheet Feeder.....was 896 now 249.00
Cable for 620 (to IBM)..............29.00
Diablo P-11 100cps..............129.95
Diablo S-11 100cps Serial..............139.95
Diablo P-31 Wide..............249.95
Diablo S-31 Wide..............269.95
Other Diablo Dot Matrix's available.....Call

EPSON
FX85 160cps NLQ..............$375.00
FX185 160cps Wide..............499.00
All Epson Models..............Lowest Price

EVEREX
Graphics Edge or Edge..............$259.00

HAYES
Samrtmodem 1200..............$395.00
Smartmodem1200B..............349.00
Smartmodem 2400..............575.00
Smartcom II 2.1 Software..............88.00
Hayes Comp. 1200 (Int) w/SW......169.95
Hayes Comp. 1200 (Ext)..............199.95

HERCULES
Color Card..............$166.00
Graphics Card w/Software..............295.00

INTEL
Above Board PC or AT.......Lowest Price

IRWIN
310A 10 Mb Tape (Ext)..............$949.00
110D 10 Mb (Int)..............495.00

KEYTRONICS
5151 Deluxe Keyboard..............$169.95
5153 w/Touchpad..............285.00
PC Jr. Numeric Keypad..............39.95

MICROSOFT
Mouse..............$125.00
Mouse (Serial)..............145.00

MOUNTAIN COMPUTER
20Mb Hardcard..............$899.95

MOUSE SYSTEMS
PC Mouse w/Paintbrush..............$136.00
ACP Mouse w/Keyboard..............149.00

★ NEW ★ Advanced AT!
INTRODUCTORY PRICE

- 80286 CPU-8MHz
- 1.2 Mb Floppy Disk Drive
- Hard Disk Controller w/Floppy
- AT Style Keyboard
- 192W Pwr Sup. • 8 Expan. Slots
- MS-DOS 3.1, BIOS

$1495.00

ADVANCED AT CARDS

ADV-320	Hard Disk Controller with Floppy for AT........$229.95
ADV-6020AN	Color/Graphics/Printer ... 89.95
ADV-6050	2Mb Multifunction with RS-232, Game & Cable. 169.95
ADV-6060	3Mb Memory Expansion 129.95
ADV-6120	Printer/RS-232 and RS-232 (Opt.)..........99.95

ADVANCED PC/XT CARDS

ADV-6040	Monochrome/Graphics/ Printer..............$99.95
ADV-6040-3	As Above for 132 Col..139.95
ADV-6050A	Monochrome/Printer Adapter..............85.95
ADV-6050C	384K Multifunction Card RS-232, Printer, Game, Clock ½ Card..........119.95
ADV-7060	Floppy Controller, 2 Floppys..............39.95
ADV-EGA	EGA Short Card........329.95
ADV-6120E	Printer, RS-232 x 2......79.95
ADV-6250A	Multifunction, RS-232, Printer, Game, ½ Card..95.95
6260A	Multifunction, Floppy Cont., RS-232, Printer, Game, ½ Card..............149.95
ADV-6280	640K Memory Card, 0K. 55.95
ADV-6090	Mono/Color/Graphics, Printer 80/132 Columns 179.95

ORCHID
PC Turbo 186 w/256K..............$585.00

PARADISE
Color/Monocard..............$165.00
Modular Graphics Card..............274.00

PERSYST
Mono Board w/Parallel..............$159.00
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PRINCETON GRAPHICS
HX-12 RGB (640x240)..............$449.00
MAX-12E Amber TTL..............175.00
SR-12..............575.00
HX-12E (690x350)..............545.00

PROMETHEUS
ProModem 1200 w/Mite (Int)......$239.00
ProModem 1200B (Hayes Comp.)....289.00
Alpha/Num or Options Proc..............79.95

QUADRAM
Expanded Quadboard (0K)..........$165.00
Gold Quadboard (0K)..............385.00
Silver Quadboard (0K)..............215.00
Quadlink..............399.00

SIGMA
Color 400 Card..............$485.00

SHARP
12" Med-res RGB Monitor..........$269.95
Color Plotter w/Software..............199.00

STAR MICRONICS
Gemini 10X ...reduced TO LOW TO PRINT
Gemini 15X.......sale TO LOW TO PRINT
SG10, SR10, Radix etc...Lowest Price Yet!

TAXAN
415 (640x260) RGB..was 699 now $279.95
Mod. 640 (Ultra Hi-res)..............595.00

TEMPLATES
Lotus, dBase III, etc..........Lowest Price

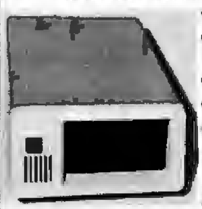
TITAN
Accelerator PC w/256K..............sale Call

TOSHIBA
P321 "3 In 1" LQ Printer.....sale $599.00
P341 24 Pin 136 Col..............869.00
P351 24 Pin w/Serial & Parallel....1099.00
T-1100 MS-DOS Lap Top..............Call

WESTERN DIGITAL
Filecard 10 Mb Plug-in..............Call
Cobra Hard Disk Controller..........$179.95

ZENITH
ZVM-1220/30 12" Grn/Amb TTL...$109.00
ZVM-1240 & ZVM-135 RGB..............Call

SYSGEN 20/20



- 20Mb Hard Disk
- 20Mb Tape Back-up
- New/Factory Box
- PC/XT/AT Comp.
- External Complete

Reg. Retail $3300
ACP Only **$999**

Grid Compass MS-DOS Lap Computer Demo Sale Call for Details. 100's in Stock as Low as **$849.00**

EGA SPECIAL
New Advanced EGA Card for High-res IBM Graphics.
SPECIAL PRICE! Only **$288.88**

UNBELIEVABLE!
Micropro INFOSTAR SYSTEM! includes
Datastar, Reportstar (PC DOS)......$99.95
IBM brand Pascal Compiler..........99.95
IBM Pascal Reference..............49.95
IBM DOS 2.0..............24.95
Visicalc IV IBM..............39.95
Compaq MS DOS/BASIC ver.2.......49.95

Advanced Computer

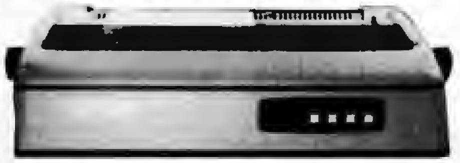
California Digital

17700 Figueroa Street • Carson, California 90248

Letter Quality Printer
F-10 DAISY WHEEL

$429

Quantity Two



Single unit price is $499. But if you have already purchased an F-10 printer from California Digital, we will honor the $429 price on the second printer.

FREE
Accessory Pak
Includes 6 Daisy Wheels & 2 ribbon cartridges
With F-10 Purchase

The F-10 Daisy Wheel printer is the perfect reasonably priced 40 character per second word processing printer. This printer is "extremely" similar to C. Itoh's F-10-40 Starwriter printer, however we have been advised by legal counsel for the C. Itoh Company that we should refrain from referring to the F-10 printer as a Starwriter.

This printer auto installs with Wordstar and Perfect Writer, features extensive built-in word processing functions that allow easy adaptability and reduced software complexity. Industry standard Centronics interface provides instant compatibility with all computers equipped with a parallel printer port. The F-10 accepts paper up to 15 inches in width.

These printers were originally priced to sell at over $1400. Through a special arrangement California Digital has purchased these units from a major computer manu-facturer. We have a limited number of these popular printers left.... while they last we're offering a special Accessory Pak, including six Diablo daisy wheels and two ribbon cartridges, with every F-10 printer already priced at a fraction of their original cost.

Options available: sheetfeeder, tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

SONY 53W Floppy Disk Drive
3 1/2" New IBM portable compatible

$139

5¼" DISK DRIVE
SALE $89

Quantity Two

Your Choice 48 or 96 TPI drive.
QUME MODEL 142 • 48 TPI
MITSUBISHI 4853 • 96 TPI

	One	Two	Ten
TEAC FD55BV half height	119	109	99
TEAC FD55FV 96 TPI, half ht.	119	109	105
TEAC FD55GF for IBM AT	189	179	175
SHUGART SA455 Half Height	119	109	105
SHUGART SA465 ½ Ht. 96TPI	125	119	109
TANDON 100-2 full height	129	125	119
MITSUBISHI 4851 half height	119	109	105
MITSUBISHI 4853 96/TPI½ Ht.	99	89	89
MITSUBISHI 4854 8" elec.	295	285	275
QUME 142 half height	99	89	89
Switching power supply			49
Installation Kit with manual			10
Dual enclosure for 5¼" drives			59
34 pin edge connectors			5
Scotch head cleaning kit			19
Flip & File Storage tubs			15

CP/M 2.2
Operating System

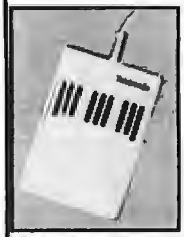
14.95

Complete with manual by Digital Research

Originally $185.00
Now only $14.95

(10+ = 9.95 - - 100+ Call)

TEKTRONIX MOUSE



$79

- 200 dots-per-inch resolution
- Programmable baud rate
- Multiple protocols
- Programmable buttons
- Serial interfaces
- Runs on any surface
- Free of pads or grids
- Microsoft TM compatible driver

Moving your cursor has never been so easy! This mouse combines the best features of optical and mechanical technology into one high performance mouse. The Tektronix mouse was private labeled by LogiTech for Tektronix. The 200 dots-per-inch resolution requires less desk space and gives you precision control. This mouse is fast and precise in the most demanding environments. And it has a programmable baud rate so you can use it with almost any of your favorite software.

BAR CODE READER
For IBM/PC

$529

The DataLogic bar code reader plugs directly between the keyboard and the mainframe of your IBM/PC.

Bar code is suitable for inventory control, freight and invoice records, personal records and other applications limited only by your imagination.

Also available for the Apple II and RS-232 serial.

QUME
$149

Eight Inch Single Sided Drives

QUME 841 single side	159	149	call
SHUGART 801R	359	359	354
SIEMENS FDD 100-8	119	115	109

Eight Inch Double Sided Drives

QUME 842 "QUME TRACK 8"	189	179	call
SHUGART SA851R	495	485	475
OLIVETTI double sided	189	179	159
REMEX RFD-4000	179	169	159
MITSUBISHI M2896-63 ½ Ht.	459	449	409
Dual 8" enclosure with power and fan			259
Switching power supply			89
Installation kit with manual			10

PLOTTER

$179

The Comrex Comscriber I is the ideal solution to make short work of translating financial and numeric data into a graphic presentation. Many ready to run programs such as Lotus 1-2-3, VisiOn and Apple business graphics already support this plotter.

The Comscriber I features programmable paper sizes up to 8" by 120 inches, 6 inch per second plot speed and 0.004" step size. Easy to implement Centronics interface allows the Comscriber I immediate use with the printer port of most personal computers.

The Comscriber I is manufactured for Comrex by the Enter Computer Corporation. The plotter is marketed by Heath Kit and also sold under Enters own "Sweet P" Label. This is your opportunity to purchase a plotter which was originally priced at $795 for only $219.

Also available is a support package which includes demonstration software, interface cable, a multicolor pen assortment and a variety of paper and transparency material.

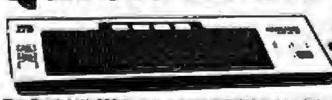
NEC RGB COLOR MONITOR

$219

The NEC JC-1401D is a 13" medium/high resolution RGB monitor suitable for use with the Sanyo MBC-550/555 or the IBM/PC. The monitor features a resolution of 400 dots by 240 lines. Colors available are Red, Green, Blue, Yellow, Cyan, Magenta, Black and White.

The NEC monitor carries the Litton-Monroe label and was originally scheduled for use in their "Office of the Future" equipment. A change in Monroe's marketing strategy has made these units excess inventory which were sold to California Digital. We are offering these "new" RGB monitors at a fraction of their original cost. Sanyo compatible NEC-1401/S, IBM/P/C Computer compatible NEC-1401/PC.

Quick-Link 300



$59

The Quick-Link 300 gives you an instant link to any dial up data base. Such as Dow Jones, Western Union or the Source. The Quick-Link has four user programmable log-on keys, allowing the operator, with only one key stroke, to dial the data base, log-in and give the password. All this information is permanently stored in non-volatile RAM.

Features include video output to television or monitor, auto dial, auto-log, full sized keyboard, 300 baud modem and 1200 baud auxiliary printer port. All this is available for only $59.

MEMORY

4164 DYNAMIC MEMORY 150ns

$.99

Quantity 100

DYNAMIC MEMORY		1–100	100+	1000+
4164 150ns. 128 refresh	ICM–4164150	1.39	1.19	.99
41256 150ns. 256K	ICM–41256150	4.59	3.95	3.29

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. • COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.

VISA

master charge

Inquiry 170

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COMMODORE® COMPATIBLE ACCESSORIES

Now Compatible With C-128!

RS232 Adapter for VIC-20, C-64 and C-128

The JE232CM allows connection of standard serial RS232 printers, modems, etc. to your VIC-20, C-64 (excluding the SX-64 Portable), and C-128. A 4-pole switch allows the inversion of the 4 control lines. Complete installation and operation instructions included.

• Plugs into User Port • Provides Standard RS232 signal levels • Uses 6 signals (Transmit, Receive, Clear to Send, Request to Send, Data Terminal Ready, Data Set Ready).

JE232CM. $39.95

Voice Synthesizer VIC-20 & C-64
Plug-In — Talking in Minutes!
JE520CM. $99.95

300 Baud Auto Modem
Mitey-Mo (For C-64). **$69.95**

Parallel Printer Interface
FREE 10K Buffer Included!
MW350 (For VIC-20, C-64 & C-128). **$69.95**

TRS-80® COMPATIBLE ACCESSORIES

E-X-P-A-N-D TRS-80 MEMORY
All kits come complete with documentation

TRS-80 MODEL I, III
TRS-16K3 200ns (Model III). $5.95
TRS-16K4 250ns (Model I). $5.49

TRS-80 COLOR AND COLOR II
TRS-64K-2. . . . . $11.95
New models only —
TRS-CoCo-Incl. 2-50464's (41464's). . . . $19.95

TRS-80 MODEL 4, 4P
TRS-64K-2. . . . . $11.95
Expands Model 4 from 16K-64K or Model 4P from 64K-128K
TRS-64K-2PAL. $29.95
Expands Model 4 from 64K to 128K

TRS-80 Model 100 • NEC • OLivetti
M1008K. . . . . $29.95 ea. or 3 for $79.95
TRS-80 Model 100 Expansion
NEC8KR. . . . . $29.95 ea. or 3 for $79.95
NEC Model PC-8201A Expansion
OM108K. . . . . $29.95 ea. or 3 for $79.95
Olivetti Model M10 Expansion

TANDY 200
M200R. . . . . $89.95 ea. or 2 for $169.95
Tandy Model 200 Expansion

UV-EPROM ERASER

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.

DE-4 UV-EPROM Eraser. . . . **$74.95**
UVS-11EL Replacement Bulb. . . . **$17.95**

DATA BOOKS

30003	National Linear Data Book (82).	$14.95
30009	Intersil Data Book (85).	$ 9.95
30013	Zilog Data Book (85).	$14.95
30022	Nat'l. Logic Data Book Set (84).	$24.95
210830	Intel Memory Handbook (83/84). . . .	$19.95
230843	Intel Microsystem Hndbk. (83/84). . .	$19.95

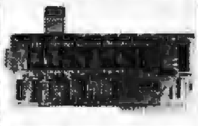
MUFFIN/SPRITE-STYLE FANS

MUF60 (SPN3-18-3462) $9.95
Howard Industries (4.68" sq., 60 cfm)
SU2C7. . . . . $9.95
EG&G Rotron (3.125" square, 20 cfm)

APPLE® COMPATIBLE ACCESSORIES

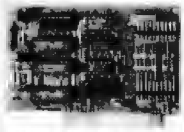
All Apple Cards come complete with instructions. ***MADE IN THE USA!***

16K RAM CARD (Language Card)
For Apple II and II+*



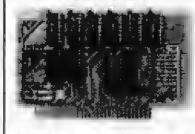
Expand from 48K-64K. Runs AppleSoft, DOS, CP/M and Pascal. (ARC-16K/MEM-1)
JE860 . . $39.95**

CONTROLLER CARD
For Apple II, II+ and IIe*

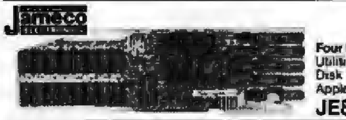


Capable of handling up to two drives. Recommended drives: ADD-514 or ADD-12 (ACC-1)
JE875 . . . . $49.95

EXTENDED 80-COLUMN CARD
For Apple IIe*



JE864 is an extended 80-column/64K RAM Card. Ultra-high resolution capability.
JE864 . . . . $69.95



128K RAM CARD
For Apple II, II+ and IIe*
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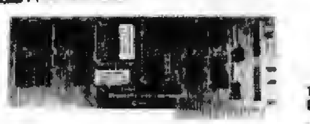

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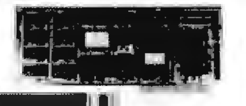

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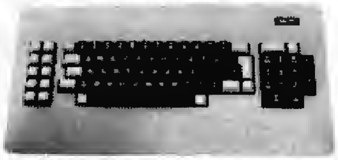

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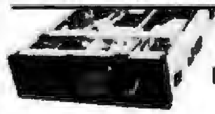

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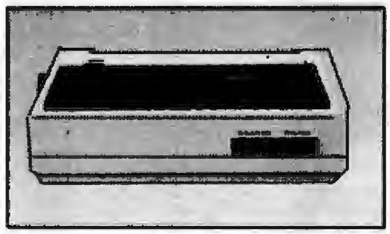

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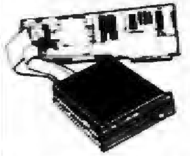

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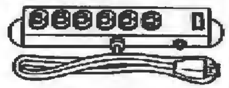

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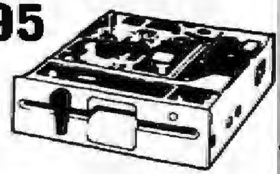

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• 8 slot expansion
• Intel 80286
XT-SBC
• 4.77 & 8 MHz clock
• Serial & Parallel
• 4-layer PCB design
• RTC Calendar
XPC TURBO
• 4.77 & 6.67 MHZ
• 4 layer PCB design
• 8 slot expansion
• up to 640K Memory
• 8088-2 processor
XPC-XT
• Standard 4.77 MHz
• up to 640K memory
• 8 slot expansion
• standard 8088 CPU
• 8087 socket avail
Power Supplys
XT 135 watt
• 135w switching
• Whisper Fan
• Side AC switch
• +5V15A −5V .5A
• +12V4.2A −12V .5A
XT 150 watt
• Whisper fan
• Hi output 150 watt
• 4 DC connectors
• +5V15A −5V .5A
• +12V5.5A −12V .5A
AT 200 watt
• 200 Watt power
• Exterior AC switch
• 4 DC power conn
• +5V 20A −5V .5A
• +12V7.7A −12V .5A
XTC 135
• Rear Mount
• Rear On Off switch
• extra AC outlets
• +5V15A −5V .5A
• +12V4A −12V .5A
Cabinets
The XTjr. cabinet is only 3" x 16.5" x 15" yet it will hold a standard XT compatible motherboard, includes a switching power supply. Front panel cut-out for a half height floppy or hard disk
Our XPC-XT cabinet has an 8-slot back panel with additional cut outs for two RS-232 I/O ports. Features mounting for up to four half height peripherals
The right choice for an external add-on cabinet! Add-on a floppy, tape back-up, or up to 33 meg of hard disk (half height). Switching power supply is included
Keyboards
AT
This Keyboard is standard equipment with all of our XAT systems, but the layout is so well liked, we're offering it here.
XT
Our volume purchases of these IBM style units allows us to lower the price once again
5051
Now a fully selectric unit at an affordable price. Features a 10-key numeric pad & a separate cursor pad
Drives
Archive
Irwin
Maxtor
Memtek
Miniscribe
Panasonic
Seagate
TEAC
Tulin
3 Sub-Systems
This full height cabinet will hold a Tape Back-up with full or ½height Hard Disk inside (or two Hard Disks)
A perfect cabinet for Tape or Hard Disk, a nice addition to your PC
Choose from single ½height, dual ½height, or ½height with full height base. All Sub-systems include controllers, cables, software and manuals
3 Networks
One way to stay ahead of the competition is by using a Multi-User or Network system configuration from Micro Products International. Choose Hi-speed RS-232, XOR-NET, SDLC or Token Ring. Data transfer rates up to 4 megabytes second can be obtained
Cassette Training
What is the Cassette Training concept? Using interactive Audio Training to combine the advantage of classroom and self-teaching methods
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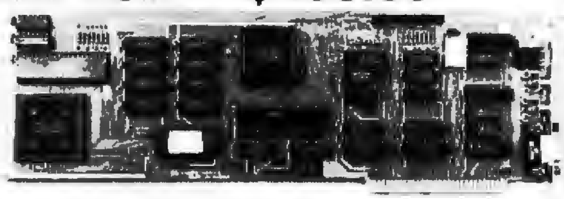

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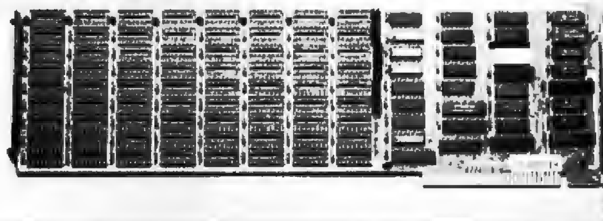

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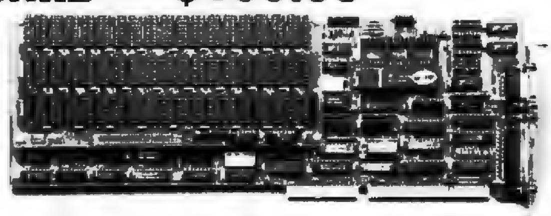

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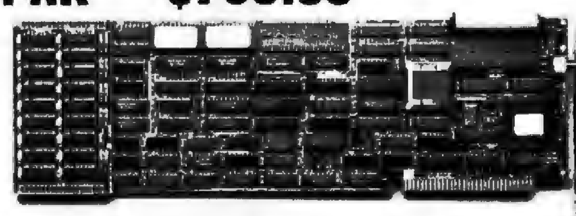

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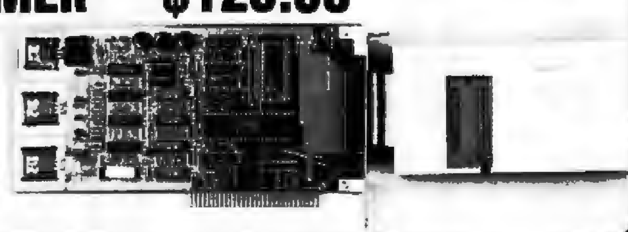

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4164-150	65536x1	(150ns)(5v)	1.29
4164-120	65536x1	(120ns)(5v)	1.95
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2732	4096x8	(450ns)(5V)	3.89
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2732A-2	4096x8	(200ns)(5V)(21V PGM)	4.25
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2764	8192x8	(450ns)(5V)	3.49
2764-250	8192x8	(250ns)(5V)	3.95
2764-200	8192x8	(200ns)(5V)	4.25
MCM68766	8192x8	(350ns)(5V)(24 PIN)	17.95
27128	16384x8	(250ns)(5V)	4.25
27C256	32768x8	(250ns)(5V)(CMOS)	12.95
27256	32768x8	(250ns)(5V)	7.49

5V=Single 5 Volt Supply — 21V PGM=Program at 21 Volts

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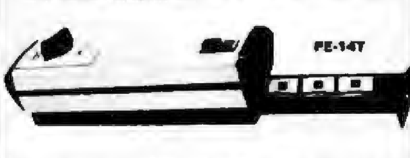

Model	Timer	Capacity Chip	Intensity (uW/Cm²)	Unit Price
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8087-2	169.95
8087	129.00
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8088-2	9.95
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8155-2	3.95
8748	7.95
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8216	1.49
8224	2.25
8237	4.95
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8251A	1.89
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1.0 MHz

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1.0 MHz

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4.032	1.95
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8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
15.0	1.95
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4.0	4.95
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6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
12.480	4.95
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74LS02	.17	74LS169	.95
74LS03	.18	74LS173	.49
74LS04	.16	74LS174	.39
74LS05	.18	74LS175	.39
74LS08	.18	74LS191	.49
74LS09	.18	74LS192	.69
74LS10	.16	74LS193	.69
74LS11	.22	74LS194	.69
74LS12	.22	74LS195	.69
74LS13	.26	74LS196	.59
74LS14	.39	74LS197	.59
74LS15	.26	74LS221	.59
74LS20	.17	74LS240	.69
74LS21	.22	74LS241	.69
74LS22	.22	74LS242	.69
74LS27	.23	74LS243	.69
74LS28	.26	74LS244	.69
74LS30	.17	74LS245	.79
74LS32	.18	74LS251	.49
74LS33	.28	74LS253	.49
74LS37	.26	74LS256	1.79
74LS38	.26	74LS257	.39
74LS42	.39	74LS258	.49
74LS47	.59	74LS259	1.29
74LS48	.69	74LS260	.49
74LS51	.17	74LS266	.39
74LS73	.29	74LS273	.79
74LS74	.24	74LS279	.39
74LS75	.29	74LS280	1.98
74LS76	.29	74LS283	.59
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74LS85	.49	74LS293	.89
74LS86	.22	74LS299	1.49
74LS90	.39	74LS322	3.95
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74LS93	.39	74LS364	1.95
74LS95	.49	74LS365	.39
74LS107	.34	74LS367	.39
74LS109	.36	74LS368	.39
74LS112	.29	74LS373	.79
74LS122	.45	74LS374	.79
74LS123	.49	74LS375	.95
74LS124	2.75	74LS377	.79
74LS125	.39	74LS378	1.18
74LS126	.39	74LS390	1.19
74LS132	.39	74LS393	.79
74LS133	.49	74LS541	1.49
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74LS151	.39	74LS683	3.20
74LS153	.39	74LS684	3.20
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74LS155	.59	74LS783	22.95
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74LS157	.35	81LS96	1.49
74LS158	.29	81LS97	1.49
74LS160	.29	81LS98	1.49
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74HC27	.59	74HC240	1.89
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74HCT08	.69	74HCT194	1.19
74HCT10	.69	74HCT240	2.19
74HCT11	.69	74HCT241	2.19
74HCT27	.69	74HCT244	2.19
74HCT30	.69	74HCT245	2.19
74HCT32	.79	74HCT257	.99
74HCT74	.85	74HCT259	1.59
74HCT75	.95	74HCT273	2.09
74HCT138	1.15	74HCT367	1.09
74HCT139	1.15	74HCT373	2.49
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74F04	.79	74F138	1.69	74F257	1.69
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B·O·M·B

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QUANTITY AND QUALITY

This month we are revising the award system. Our present method, which is based on quantity of points earned by weighting each vote cast, will continue. Each excellent vote is weighted at 3 points, 2 for good, 1 for fair, and 0 for poor. In addition, we are instituting an award for highest average vote, which removes quantity as a factor in the voting. The author (not a staff member) with the highest average score will receive $50.

The Product Preview of "The Atari 1040ST" by BYTE editors Phillip Robinson and Jon R. Edwards is the winner from the March BYTE. In second place, According to Webster, Bruce Webster discusses "68000 Wars: Round 1." "Finding the Titanic" wins third, netting for its authors, Marti Spalding and Ben Dawson, the $100 bonus. In fourth is Bruce Webster's Programming Project, "A Simple Windowing System, Part 1: Basic Principles." Steve Ciarcia's Circuit Cellar on "Real-Time Clocks: A View Toward the Future" came in fifth place. And winners of $50 are Steve A. Hersee and Dan Knopoff for "An ANSI Standard for the C Language."

This month, Marti Spalding and Ben Dawson are the first recipients of the new $50 award for quality. Congratulations to all.

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