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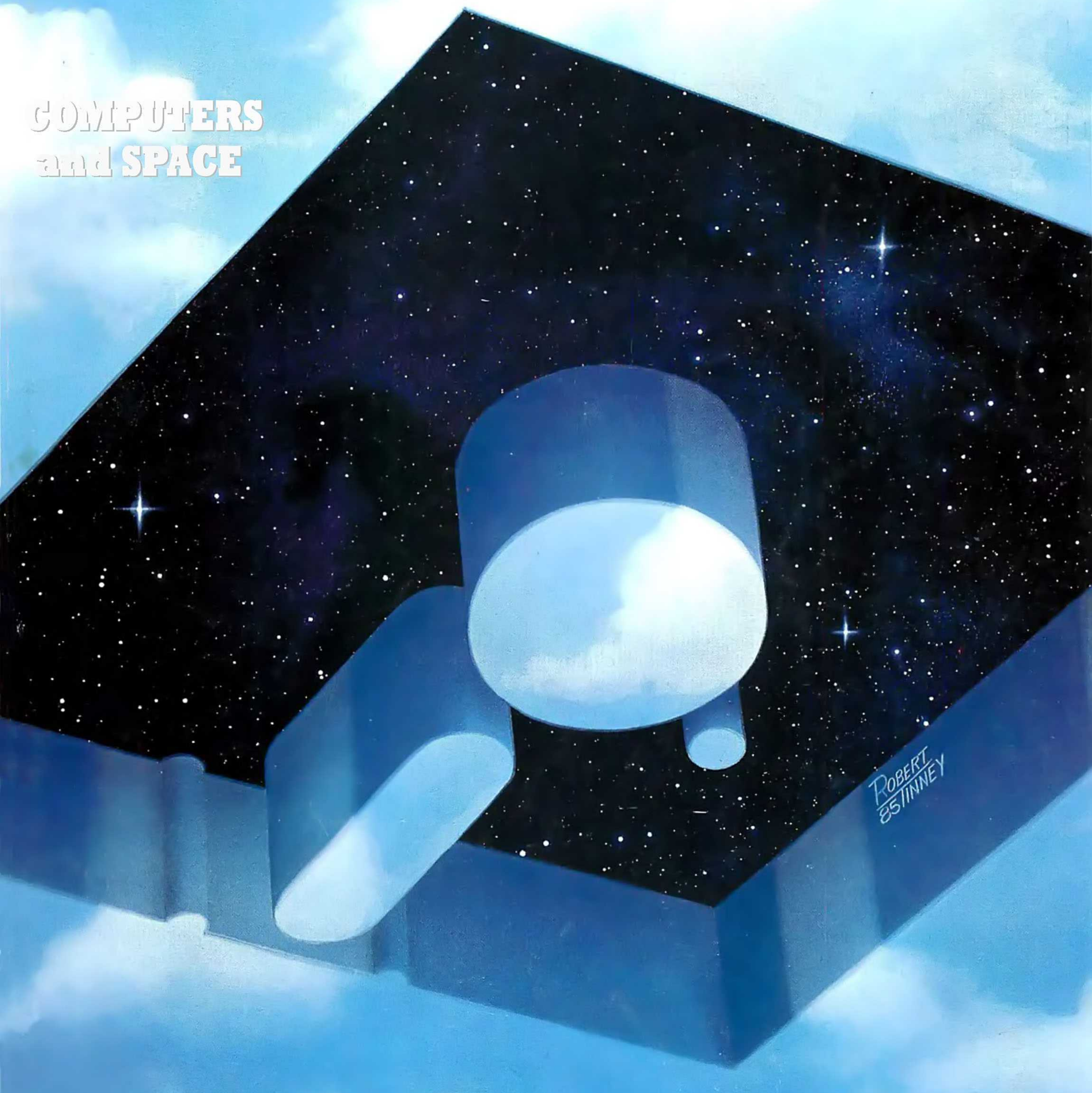

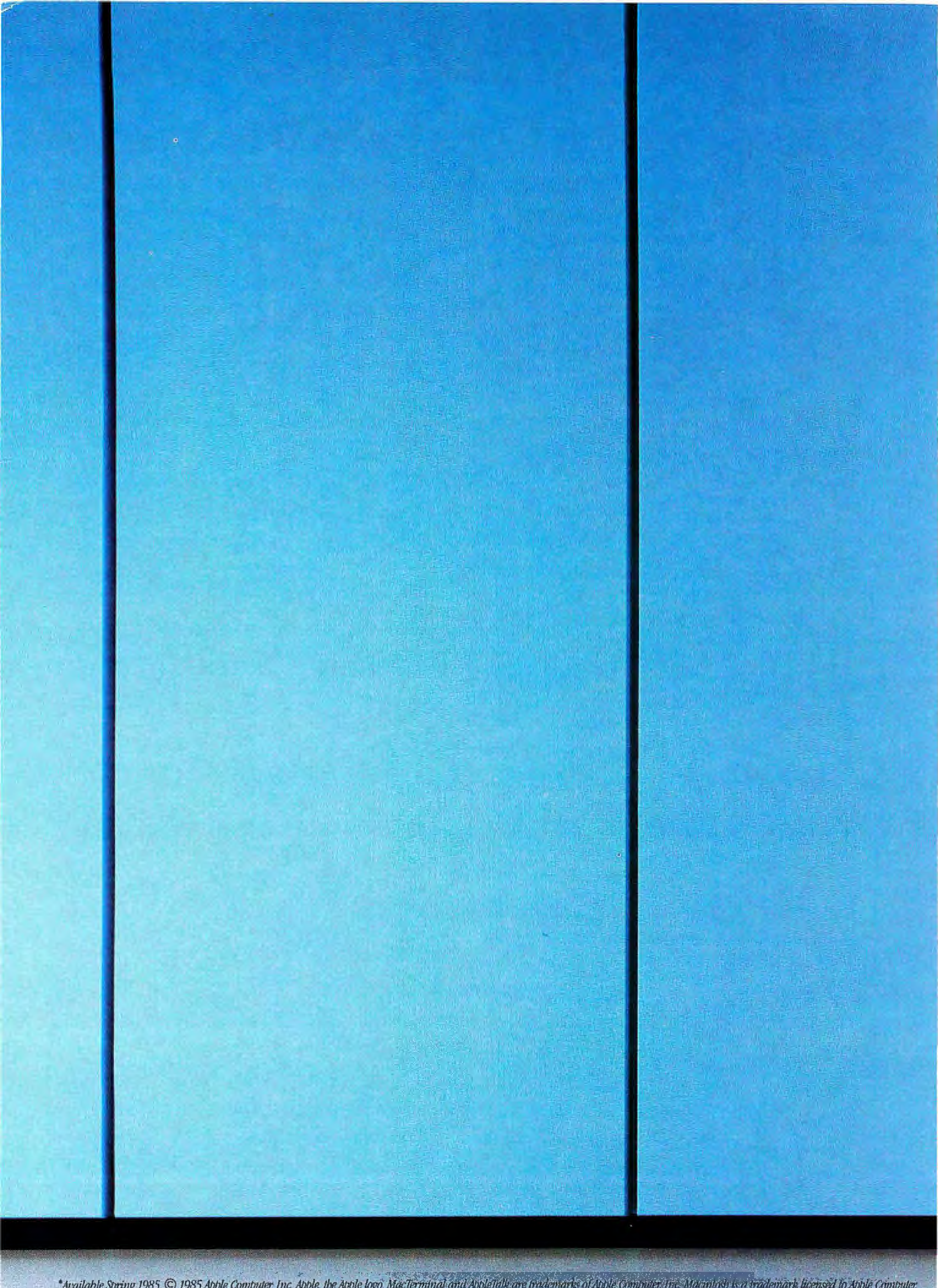

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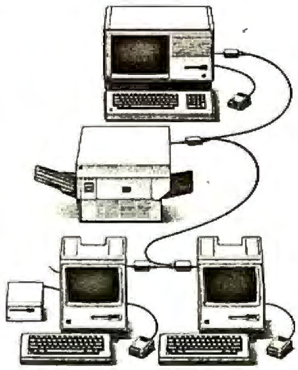

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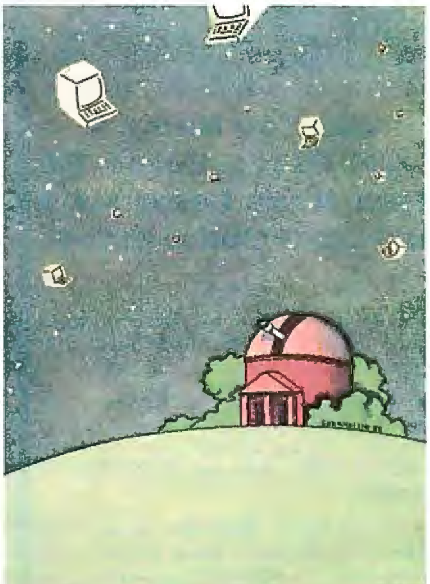

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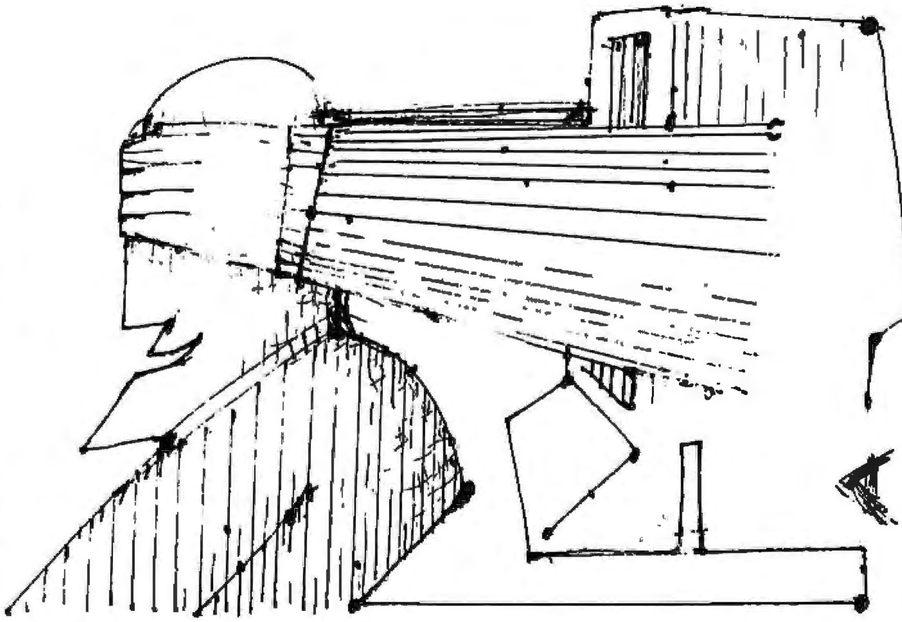

Equal Access to Computers: Scruples or Rubles?

Computer inequity emerges as a genuine problem when you consider how hard it would be for a child without a word-processing program to compete with a student who does have a word processor. The student with the word processor can revise and polish far more than the student without. All other things being equal, a once-revised essay handwritten on notebook paper can't compete with a tenth-draft essay neatly printed by machine. Of course, word processing is only one of the many ways in which computers can make schoolchildren more productive and therefore give some children a competitive advantage in school and in life.

Is there, in fact, inequity in access to computers? The answer is "yes," and the inequity is a function of both income and race. The 12,000 most affluent schools are four times more likely to have personal computers than the 12,000 poorest schools (Quality Education Data report, 1983, quoted in *Electronic Learning*, February 1985). Predominantly white schools have twice as many computers as do schools whose students come primarily from ethnic minorities (Johns Hopkins study, 1983, also quoted in *Electronic Learning*, February 1985).

Soon after taking power, Soviet Communist party chief Mikhail Gorbachev called for the introduction of small computers throughout the Soviet school system. Clearly the new Soviet leader believes that the Soviet Union will be unable to compete with the West unless Soviet students have equal access to computers. The Soviet electronics industry is far from ready to meet the needs of Soviet students. The Soviet Apple clone known as AGAT (see the November 1984 BYTE, page 134), an inferior copy of a 10-year-old computer, is reportedly being manufactured in very small volume and with significant reliability problems, and it is said to sell for the equivalent of $17,000. But some news reports have indicated that Apple and IBM may be negotiating large sales of personal computers to the Soviet Union.

If the American electronics industry is to solve the problem of computer inequity for the Soviet Union, why not for the disadvantaged of the West as well? DEC, Apple, IBM, Zenith, Tandy, and other companies have already made significant and commendable contributions to the American educational system. But many of these donations and subsidies have gone to organizations such as the Apple University consortium, made up mostly of expensive universities attended by the children of the affluent. IBM's joint projects with MIT and Carnegie-Mellon face the same criticism.

Playing to Win

At the opposite extreme from industry-sponsored programs in prominent universities is an organization called Playing to Win (106 East 85th St., New York, NY 10028). Playing to Win is a nonprofit organization dedicated to "promoting educational computer use among socially, economically, and geographically disadvantaged people." Antonia Stone, the director of Playing to Win, believes that there should be public access to computers just as there is public access to books and magazines in libraries. Playing to Win operates a community computer center in East Harlem.

We urge companies in the computer industry to support organizations such as Playing to Win. Supporting equal access will benefit the industry as well as the disadvantaged. Ms. Stone points out that providing public access to computers not only promotes equal opportunity, but also builds a larger long-term market for computer products.

Furthermore, overcoming computer inequity in the West makes much more sense in the long term than bringing the Soviet Union up to speed in computer technology. This is clearly a case in which scruples should outweigh rubles.

—*Phil Lemmons, Editor in Chief*

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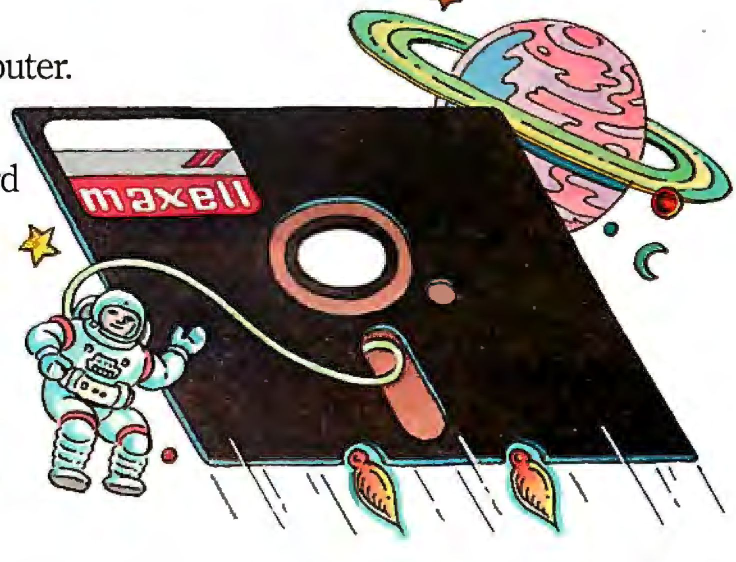

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M·I·C·R·O·B·Y·T·E·S

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

New Multiuser UNIX Systems

Symmetric Computer Systems, San Jose, CA, is selling a 20-pound computer with a 32016 16-/32-bit processor, one parallel port, four serial ports for up to four terminals, a 50-megabyte hard disk, a 1-megabyte floppy disk, and 2 megabytes of RAM. Included in the Model 375's price of $9950 are compilers or interpreters for C, Pascal, FORTRAN, BASIC, LISP, Prolog, Crystal, and APL. It also includes SPICE, Ingres, and a number of UNIX/GENIX utilities. Although the machine is now available with National Semiconductor's GENIX implementation of Berkeley 4.1 or 4.2 UNIX, Symmetric plans to offer UNIX System V and Berkeley 4.3 versions later this year.

Cadmus Computer Systems, Lowell, MA, announced CadMac, a 68010-based workstation with a 17-inch 1024- by 1024-pixel display, a 65-megabyte hard disk, tape backup, a megabyte of RAM, and a Macintosh-compatible UNIX environment for $23,300.

Digital Equipment Corp. introduced its expected MicroVAX II, which reportedly outperforms DEC's low-end VAX products. Prices for the MicroVAX II, while much lower than comparable VAX computers, still start at about $20,000.

AT&T Offers 32-bit Processor to Other Companies

AT&T announced that its WE32100 32-bit microprocessor, floating-point chips, memory-management chips, and other peripheral chips are now available to other companies. AT&T will also sell board-level evaluation systems based on the chips.

The WE32100 is an enhanced version of the WE32000 chip used in AT&T's 3B2/300 computer; the chip family was originally called Bellmac-32 when developed by AT&T's Bell Labs subsidiary before divestiture. The 132-pin WE32100 chip features a 64-word on-chip cache, a 4-gigabyte address space, 15 interrupt levels, 16 32-bit registers, and a full 32-bit bus. All of the new chips are available in 10- and 14-MHz versions. AT&T's chip is not related to National Semiconductor's 32000-series processors.

New 80286 Systems Flood COMDEX

Late spring saw the introduction of many new IBM PC AT-compatible computers. By mid-May, new 80286-based systems had been announced by Kaypro, ITT, Compaq, TeleVideo, Corona, Texas Instruments, Zenith, NCR, Tomcat, and Basic Time. Another multiuser AT-compatible computer, available from MAD Computer in both floor and desktop models, will be sold only to other manufacturers. Wang also disclosed that it is developing an AT-compatible system.

Intertec, West Columbia, SC, has redesigned its HeadStart computer, replacing its 8086 processor with an 80286 and eliminating its 3½-inch disk drive. The HeadStart ATS's standard 256K bytes of RAM can be expanded to 3 megabytes; the computer also includes serial, parallel, and network interfaces. The basic HeadStart ATS is priced at $1895 without disk drives. A dual 5¼-inch disk-drive add-on unit is $495 extra. Intertec also announced several 80186-based file servers for its MultiLAN proprietary polling network; a $695 interface card also allows IBM PCs to be attached to the network.

Network Products Announced

IBM PCs and Macintoshes can communicate using two new networking products. 3Com announced EtherMac, which allows Macintoshes and IBM PCs to link 3Com's 3Server Ethernet network file server to AppleTalk networks. Another product, IBMacBridge from Tangent, is a $595 expansion card with software linking the IBM PC to the AppleTalk network and Apple's LaserWriter printer.

Separately, Vianetics announced ViaNet, which links MS-DOS- and UNIX-based computers. Rather than requiring a central file server, ViaNet simply treats each node on the network as a separate disk subdirectory, addressable using standard MS-DOS or UNIX path names. ViaNet will be available only to other manufacturers; Tandy, Wang, and several other firms have already licensed the software.

(continued)

Add-on Makers Support Expanded-Memory Specification

Many of the companies that make expansion cards for the IBM PC have announced memory cards that meet the expanded-memory-interface specification announced by Lotus and Intel in late April. Maynard Electronics, STB, Quadram, Tecmar, Mega-Omega Systems, Emulex/Persyst, and AST Research all announced boards supporting the specification, which uses bank switching to allow application programs to directly address up to 4 megabytes of RAM. Most cards will be available in midsummer. They will be priced from $349 to $399 with the first bank of memory installed and can be expanded to 2 megabytes each.

Mosaic Unveils 1-2-3 Twin

Mosaic Software, Cambridge, MA, unveiled a $145 spreadsheet it says is compatible with Lotus 1-2-3. Mosaic's Twin has a user interface and features similar to those in the Lotus product, but initial versions of the product will not be able to read and write 1-2-3 spreadsheet files. Rather than offering graphics identical to Lotus 1-2-3, Twin's graphics module is derived from earlier products the company developed.

Two other companies—Borland International and Paperback Software—are reportedly developing low-cost spreadsheet programs compatible with 1-2-3, but neither company has formally announced or set availability dates for those products.

NANOBYTES

Congress has repealed a law requiring home computer owners to keep a complete daily log of computer use in order to claim business-use tax deductions. The law still requires some record keeping of computer use to support business-use claims. . . . **Novix Corp.**, Cupertino, CA, has unveiled the NC4000, an 8-MHz 16-bit microprocessor that executes FORTH words as its machine language. . . . **MicroPro** plans to introduce a new word processor in midsummer, priced at less than $200. The company says the new program will have a user interface unlike those of WordStar and WordStar 2000. . . . **Acuity Computer**, Austin, TX, announced The Shell, a $100 program that can either replace or enhance the Finder. . . . **Franz Inc.**, Berkeley, CA, planned to begin shipping Franz LISP for AT&T's UNIX PC this month. Franz also expects to provide a complete Common LISP for the UNIX PC by late August. . . . **Prometheus** unveiled a 512K-byte buffer plug-in card for its ProModem, which can be used to buffer incoming and outgoing electronic mail or as a printer buffer; the buffer also provides password and callback security features. The buffer card without memory is $149 and can use 16K-, 64K-, or 256K-bit chips. . . . **Intel** is now providing samples of 10- and 12-MHz versions of the 80286 processor. . . . **Brother** unveiled the TwinWriter, a $1300 printer with both daisy-wheel and dot-matrix print elements. . . . **ITT** and **NEC** both introduced new speech-recognition products for the IBM PC and compatible computers. ITT's $1350 Voice Communications System can recognize up to 200 different words and also features voice playback and phone features. NEC's SAR-10 Voice Plus supports a 250-word vocabulary for $1495 . . . . **Apple** announced in April that it would stop production of the Macintosh XL, originally introduced as the Lisa in January 1983 . . . . **Canon** announced the A-200, a $2995 20-pound IBM-compatible transportable computer with an 80-character by 25-line LCD. Standard features include a built-in 300/1200-bps modem, composite video output, two 5¼-inch disk drives, parallel and serial ports, and 256K bytes of RAM. . . . **Linguistic Products**, The Woodlands, TX, announced two language-translation programs for the IBM PC. English/Spanish and Spanish/English programs are $490 each or $790 together. . . . **Kyocera**, which manufactures computer products for several other companies, announced its first retail product: a 1200-bps modem. The $665 KM1200S will include a copy of Microsoft's Access communications program. Kyocera also announced a 10-page-per-minute, 300-dot-per-inch laser printer that it will sell to other manufacturers. . . . **Personal Touch**, San Jose, CA, announced a touchscreen that can be added to Apple IIs and IBM PCs through a standard joystick port. The Touch Window will cost $200 for the Apple II and $225 for the IBM PC when it is shipped later this year. . . . **Datran Corp.**, Los Angeles, CA, announced the Modem Accelerator, a $795 card that encodes English words into tokens. Files encoded with the IBM PC expansion card are reduced to about one-third the original size. . . . **Micro Focus** has announced a Japanese-language version of its COBOL compiler for the IBM PC 5550 and PC AT. In Japan, the compiler is priced at about $500. . . . **Edsun Laboratories**, Wayland, MA, offers a signal-converter VLSI chip that converts the Intel 80286's signals to work with less expensive 8088 peripherals. The CMOS EL286-88 allows the 80286 to operate at 8 MHz while interacting with 4.77-MHz IBM PC chips. In quantity, the chip costs $44.

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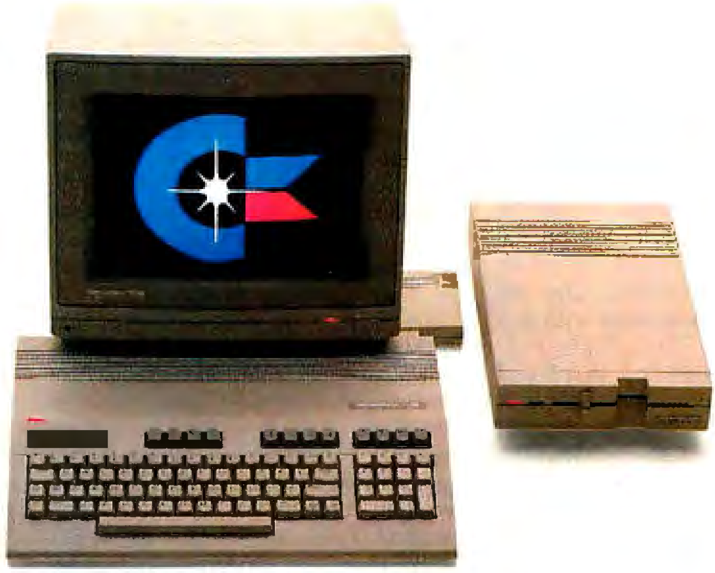

L·E·T·T·E·R·S

AN INFRARED PYROMETER

In the process of completing a master's degree in engineering at the University of Tennessee at Chattanooga, we sought an interesting project for a thesis topic. The answer to this search was the Micro D-Cam that Steve Ciarcia presented in his Circuit Cellar column ("Build the Micro D-Cam Solid-State Camera"; Part 1, September 1983, page 20; Part 2, October 1983, page 67). We decided to use the Micro D-Cam as the basis for an optional infrared pyrometer. The results of our investigation were interesting, and we thought we would share them with you and your readers.

We used an Apple IIe and an infrared filter that was opaque to visible light with the Micro D-Cam. A heating element served as an infrared source. Thermocouples with a digital thermocouple meter measured the temperature of the heating element. The only real modification to the Micro D-Cam hardware was the optical filter that we attached to the lens that was supplied with the kit.

When we obtained the hardware we conducted a few experiments that showed that focusing the Micro D-Cam's lens with the optical filter on a hot object produced an infrared image. The exposure time was shortened as the object's temperature increased. The lowest temperature from which an infrared image could be produced was about 650° Fahrenheit.

After we tested the hardware, we modified the software that was supplied with the Micro D-Cam to display the percent of pixels that are on versus the total number of pixels (light-level percent) in an area of 56 by 64 pixels located in the center of the image. This area of the image was that where a temperature measurement of the object would be made. We then used the software to develop a calibration curve to relate temperature to light-level percent and exposure time. This calibration curve showed a nonlinear relationship between temperature and exposure time. For these measurements the light-level percent was kept between 45 and 55 percent. Once the calibration curve was obtained, an equation was developed using polynomial regression that would produce a temperature output based on an exposure-time input.

When the calibration work had been completed, we modified the software for the Micro D-Cam so that on a real-time command the program would go to a pyrometer subroutine and loop, adjusting the exposure times until the light-level percent for the 56- by 64-pixel array area was between 45 and 55 percent. Once the light-level percent fell within the range established, the calculated temperature was displayed on the screen and the control of the Micro D-Cam was returned to the basic operating program.

The results of the exercise showed that the Micro D-Cam could be used as an optical infrared pyrometer when used in conjunction with an infrared filter. Due to the limitations of the laboratory equipment available, the calibration was for a temperature range of 750° to 900° F and the resulting equation was as follows: temperature of object $F = 9.12 \times 10^{-7} \times ET^2 - (.02815 \times ET) + 966.89$, where ET is the exposure time in milliseconds. Later testing of the accuracy of the system yielded results within 6° of the actual temperature.

For anyone wishing to try this type of experiment a few items should be noted, based on our experiences. The development of the calibration curve is dependent on keeping the aperture and the distance between the lens and the object constant. The second item is that great care must be exercised in measurement of the object's temperature when developing the calibration curve. Due to the relatively long exposure time required for the infrared system, the temperature of the object tends to vary a few degrees; therefore the object needs to be thermally stable before the exposure is made.

Conclusions from our work indicate that the optic RAM encased in the lens assembly is capable of being used as an infrared detector, and when used with the Micro D-Cam it can serve as an optical infrared pyrometer. It is obvious from looking at other types of infrared pyrometers that there are other pyrometers available that are already calibrated and cost about the same as the Micro D-Cam. The Micro D-Cam, however, offers the hobbyist or experimenter a vision system that can, with the use of an infrared filter, be turned into an infrared pyrometer.

VIRGIL THOMASON
GERALD A. CAUDILL
Univ. of Tennessee at Chattanooga

MACINTOSH BASIC AVAILABLE?

The April 1984 BYTE carried an article by Scot Kamins about Macintosh BASIC (page 318) that excited me, so I called an Apple dealer and asked him when the product would be released. He informed me that it was scheduled for release in June 1984. This sounded reasonable, so I purchased a Macintosh. In the meantime, I've waited, and waited, and waited. Still no Macintosh BASIC.

Dealers do not seem to be able to get any information about Macintosh BASIC from Apple Computer. I've even purchased a nice book titled *Introduction to Macintosh BASIC* by Scot Kamins (Rochelle Park, NJ: Hayden Book Co.), which includes the following statement: "Apple believes that good books are important to successful computing. The Apple Press imprint is your assurance that this book has been published with the support and encouragement of Apple Computer Inc., and is the type of book we would be proud to publish ourselves."

The unavailability of Macintosh BASIC leaves me puzzled. Could Apple have purposefully delayed the introduction of its BASIC in order to allow Microsoft a chance to get wide distribution of its BASIC? Microsoft BASIC allows you about 15,000 bytes of space for a program, and the company has no compiler for it. The multiply/divide operates in double precision, which is too slow for my use. So, you

(continued)

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

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

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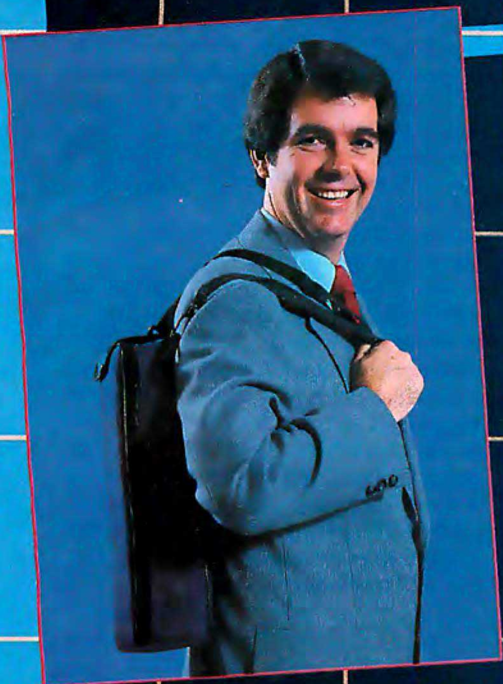

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LETTERS

can see I'm still waiting. Could you ask Apple if it would pay me interest on the money?

FRANK HARDISON
Memphis, TN

PUBLIC-KEY PATENT

As part of his article titled "Implementing Cryptographic Algorithms on Microcomputers" (October 1984, page 126), Charles Kluepfel described an implementation of the RSA Public Key algorithm and the BASIC code required. Unfortunately, he did not reference that this RSA Public Key Cryptosystem was patented by the Massachusetts Institute of Technology in 1983 (U.S. Patent 4,405,829). The worldwide exclusive license to this patent was then purchased from MIT by RSA Security Inc., a company founded by the inventors of the RSA algorithm to develop this technology.

Because the RSA algorithm has been published in academic journals, most people assume that it is in the public domain, similar to the DES algorithm. Unfortunately, some people have developed software and other products based upon the RSA algorithm without researching this point. Nevertheless, the patent exists and, in the opinion of our corporate attorneys, will be easily defended. As RSA Security Inc. paid a great deal of money for the exclusive patent rights, we plan to actively police the commercial use of the RSA algorithm.

The purpose of this letter is not to criticize either Mr. Kluepfel or BYTE for his article. Rather, the purpose is to make you aware of our patent position and ask for your help in educating your readership as to its existence. Based on Mr. Kluepfel's article, more people are going to start expending money and effort developing RSA-based software for commercial purposes. Regrettably, their effort will be wasted unless they obtain a sublicense from us. Therefore, we suggest you publish a reference to our patent in a future issue of BYTE to protect your readers from this lack of knowledge.

RALPH BENNETT
President
RSA Security Inc.
Sunnyvale, CA 94087

FOURIER RIPPLE

The article "Fourier Smoothing Without the Fast Fourier Transform" by Eric E. Aubanel and Keith B. Oldham (February, page 207) recalled my own experience with Fourier transforms as a graduate student in chemistry. In particular, the identification of the high-frequency terms as

(continued)

LETTERS

noise (I note that this is qualified with the word "usually") is not justified in the case of crystal x-ray scattering.

The noise in the examples Aubanel and Oldham discuss is typical Fourier ripple, which roughly centers around the function measured. Although this noise is a factor in x-ray structures, the more important noise is termination error caused by significant unmeasured high-frequency terms. Such noise does not generally interfere with obtaining atomic coordinates but can cause many spurious effects in an electron-density map. The high-frequency terms, in fact, primarily represent the innermost electrons; when they are missing, the unpresented electron density can, in principle, appear (i.e., be randomly smeared) anywhere in space, either under real atomic peaks or between atoms. Ironically, these innermost electrons are the least interesting, but the absence of the terms that represent them interferes with a good representation of the outer electrons.

The more general point, however, is that when using Fourier transforms, it is important to develop a "feel" for how they work. The integral of a function is entirely contained in the zero-order term. All the other Fourier terms add and subtract precisely equal quantities (because they are sine and cosine functions) of area or volume "under the function," thus "shifting" peaks and troughs. If the function has high narrow peaks or discontinuities, such as those in a molecular electron-density distribution, high-frequency terms will be necessary to adequately represent it. If the function is relatively smooth, such as those in your examples, low-frequency terms will represent it and high-frequency terms can, with some confidence, be attributed to noise. A caveat, however, is that there ought also to be noise, in principle, in the low-frequency terms. This noise will be expressed not as ripple around the function but in shifts of the peaks, either in height or position. Thus "smooth" functions may misrepresent the reality they describe, albeit hopefully by statistically small degrees of error.

STEVE GOLDFIELD
San Francisco, CA

CONVERSION CORRECTION

I have received a number of letters regarding my article "A Unit-Conversion Algorithm" (March, page 151). There were two problems with the published listing, and there is one point that I should clarify.

Line 310 of the listing on page 154 reads,

(continued)

WE INTERRUPT
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THIS MAJOR INTRODUCTION TO YOU SOMETHING REALLY IMPORTANT.

THE BIG NEWS IN DISK/TAPE IS PC/T, A SENSIBLE NEW APPROACH TO ARCHIVAL STORAGE.

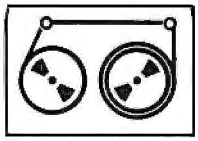
We've tamed tape. And made it docile. By making it DOS-like.

So, while this started as an ad for our five new HardFile™ subsystems, which deliver 25 to 80 megabytes of hard disk storage and 60 megabytes of tape backup, instead we want to introduce you to PC/T.™

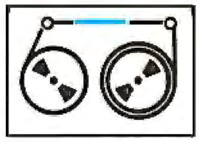
PC/T is a new format that makes tape a more sensible storage solution for personal computers. It puts tape on line, in real time, for instant access. And frees your hard disk for your most current data.

You already know how to use PC/T. Because it responds to standard DOS commands.

Here's the big news: just like any DOS-controlled hard or floppy disk, PC/T enables you to create directories and files on tape. Then you can call up the exact file you need, and change a portion of the tape without having to erase and overwrite the entire cartridge.



Without PC/T, you have to rewrite the entire 60 MB cartridge each time you make a single change.



With PC/T, you create and directly access files on tape, just like with floppy or hard disk.

PC/T formats each new tape cartridge, just like you format any hard or floppy disk, locking out bad blocks to assure that every bit of data you write to tape is recorded with utter accuracy.

What's more, PC/T gives tape true error correction capability. 50% redundancy during write operations ensures 100% reconstruction of data lost because of operator error, dust and dirt, or everyday wear and tear.

There is a catch. You can get your hands on PC/T just one way: Buy one of our powerful new HardFile subsystems. With disk plus tape. Or tape alone. Which brings us back to where we started. And gives you a place to start. Just call 1-800-228-DISK for the Tallgrass dealer nearest you.

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Inquiry 348

NUMBER SMASHER

Speeds Up Everything...Especially 1-2-3™!

The MicroWay NUMBER SMASHER triples the speed of all cpu bound software while doubling the speed of 8087 bound software. When combined with MicroWay's FASTBREAK™ it results in an increase in the speed of 1-2-3™ of up to 80 to 1! If you're tired of WAITing, the SMASHER is the card for you!

The heart of the NUMBER SMASHER is a 9.54 mhz 8086 working with a matched high speed 8087. The card comes standard with 512K of 16 bit RAM and can be expanded to 640K. It triples the throughput of your original 8088 by doubling the system clock speed and quadrupling the data bus bandwidth.

Software compatibility is guaranteed by the nature of our card. It does not augment the 8088, but replaces it with a special 8086 that runs as a true 16-bit processor in the first 640K of ram and as an 8-bit processor everywhere else.

Examples of software which show dramatic speed-ups include AUTOCAD, 1-2-3™ worksheets which depend heavily on financial or transcendental functions, and multi-user operating systems. Any program written with an MS-DOS compiler that supports the 8087, such as MS-FORTRAN or 87BASIC, will run on the NUMBER SMASHER at least a factor of 2.5 times faster! Software that comes with the card also increases the throughput of I/O bound programs and includes a disk cache routine, ram disk and print spooler.

The NUMBER SMASHER is an upgrade product for 8088 based PCs and compatibles. It works on the IBM-PC and XT, the COMPAQ and compatibles manufactured to the IBM-PC hardware standard. Contact MicroWay or your local MicroWay Installation Center for technical specifications and supporting benchmarks.

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P.O. Box 79, Kingston, Mass. 02364 USA (617) 746-7341 in part, OR X + LEN(I$). This should be OR X > LEN(I$). The program will not work at all without this correction. Most of the letters I received indicated this error.

The PRINT CHR$(12) that occurs in lines 10, 130, and 4000 deserves some clarification. First of all, in most versions of BASIC, the CLS statement is preferable. Unfortunately, the version of the BASIC compiler that I was using did not accept the CLS statement. The PRINT CHR$(12) worked with both interpreter and compiler. As I prefer to have only one active version of the program, and I don't like distributing what I don't run, the PRINT statement was submitted to BYTE. Also, line 130 is unnecessary in the MS-DOS version. The TRS-80 version prints some material between lines 10 and 130 that is not needed with MS-DOS. I left the line in to minimize the differences between the two versions.

I hope these comments are useful to you.

DAVID L. KAHN
Newton Highlands, MA

TERSE, TERSE, TERSE

Permit me to comment on Robert Kong Win Chang's one-page article "Build a Serial Card" (March, page 129) on building a serial card for the Sanyo MBC 550 computer.

Yes, BYTE, you did not title the article "Adding a Serial Card (to the Sanyo)." You verily said only "Build" a serial card. How we are supposed to actually add this to our Sanyos is obfuscated but may hopefully become the subject of a multipage article in a future BYTE.

How does the author expect us to get +12 volts, −12 volts, and +5 volts? From where? Do we simply plug the CN1 connector into the Sanyo and automatically get these voltages? Do we have to solder wires to the Sanyo? If so, where? (I am somewhat reluctant to attack *my* Sanyo with a soldering iron, with such an inadequate set of instructions from Mr. Chang!) How about sockets for the chips? Where does the perf board mount? How about a photograph? (Didn't Confucius say some time ago that a picture is worth a thousand words?) What kind of decoupling capacitors are used? (An electronic-supply catalog I have in my hand lists tantalum, polyester, metallized film, aluminum electrolytic, axial lead, radial lead, resin-dipped solid tantalum, high-frequency aluminum electrolytic, metallized polyester, stacked metallized film,

(continued)

and disc capacitors, all in a bewildering array of voltages, tolerances, and prices!) Additionally, I find literally dozens of different types of DB-25 connectors offered by as many manufacturers.

How is an ordinary reader—and you have hundreds of thousands of readers who are not experts—expected to follow such extremely abbreviated instructions (a total of only 84 words!)?

I am not being picky. It is just that as shown and as printed, your article leaves a lot to the imagination and leaves an unsophisticated reader up the proverbial estuary without a utensil for propulsion!

The article is bound to attract many readers. Obviously Sanyo (using typical contemporary marketing strategy) did not include a serial port as standard equipment so as to advertise a low come-on price to attract buyers. And since the Sanyo 55X series computers have such a good price/performance ratio anyway, they will probably sell by the millions.

However, having a serial interface to enable connection of a modem is becoming more and more indispensable in computing. The Sanyo RS-232C board, even at discounters, is still around $75. So, a probable high percentage of Sanyo owners, who bought a Sanyo in the first place because it did offer a lot for a low price, will want to add serial capability, and at a cost lower than Sanyo's $75 to $100.

Do your readers a favor, though, and make it easier and simpler to construct this good-idea serial card!

BERNARD A. MCILHANY
Marble Hill, GA

Robert Kong Win Chang replies:
I would like to make a number of comments. First, there is absolutely no need to attack or otherwise mistreat the Sanyo with a soldering iron; once the board has been built (preferably some distance from the Sanyo to avoid eventual solder splashes!), follow the instructions detailed in the Sanyo Operator's Guide, *chapter 6; page 6-3 describes how to remove the cabinet cover, whereas pages 6-15 to 6-18 show how to install the RS-232C board and how to program the correct data rate. Instead of the "blue line" mentioned in the manual, read "wire 1," i.e., the wire connecting pin 8 of IC1 to pin 1 of the CN1 connector.*

As can be seen from the schematic of figure 1 in my article, all the pin assignments of the CN1 connector on the motherboard are listed; in particular, they show that all voltages and signals required for the correct operation of the serial card are provided through this connector by the Sanyo—all that is required for installing the serial card in the Sanyo is to screw the card to the rear panel of the machine and then to plug the ribbon header socket onto the CN1 connector on the motherboad as described in the manual. It is as simple as that!

As far as the actual building of the card is concerned, I am afraid that I assumed wrongly that all readers interested enough to build the card would have the required background to do so. However, I tend to believe that Mr. McIlhany is somewhat too harsh in his criticism about the lack of details for nontechnical readers; no recent article in BYTE describing a hardware project has given the low-level details that he seems to require.

(continued)

UNIX is a trademark of AT&T Bell Laboratories. LaserLink and The Skeduler are trademarks of Unisource Software Corp. VENIX/86 is a trademark and an implementation of VenturCom, Inc. UNIFY is a trademark of Unify Corporation. The Connector is a trademark of Uniforum Software Systems, Inc.

Nevertheless, I do sympathize with him, and I wish I could refer him to a good manual or article. As a service to BYTE readers, I am prepared to mail to interested hobbyists an assembled serial card upon receipt of a check for $25 (write to me at the computer science department of Brandeis University, Ford Hall, Waltham, MA 02254). The extra $10 should enable me to cover shipping expenses and to pay a computer science student to build and test the interface.

Sockets for the integrated circuits were not mentioned, though I did socket mine; the reason is that opinions differ on the usefulness/inconvenience of sockets and I preferred to leave the decision to the reader. I personally would recommend using sockets for all ICs so as to minimize the chances of damaging them by overheating during soldering. Besides, troubleshooting is made easier should any problem arise later on.

Almost any small low-voltage capacitors may be used in this project; I used small ceramic disc capacitors rated at 0.01 μF/16 V—I bought 100 of these for $6 as these are commonly used components in digital circuits.

The choice of the DB-25 connector is not critical; however, the most convenient connector to use is a female one, of the "right angle PC solder" type. JDR Microdevices sells them under the reference DB25SR. JDR also sell the 20-pin ribbon header socket under the reference IDS20.

One thing I did forget to mention was the location of pin 1 of the CN1 connector on the motherboard to enable plugging the socket the right way. The orientation is the same as for all ICs on the motherboard, namely that, looking from the top and from the front of the Sanyo, pin 1 is the last one on the left row of pins.

MS-DOS 1.25 and 2.11 for the Sanyo do not provide adequate support for interrupt-driven serial input/output. Unless the user writes his/her own software to handle interrupts coming from the serial card, interrupt requests from the card should be disabled; the most convenient way to do this would be to leave out the 74LS32 quad 2-input OR gate. Failure to disable interrupts (particularly from TxRDY) would cause the Sanyo to "hang up" when a modem is connected to the interface.

Finally, I would like to say that I agree with Mr. McIlhany that a picture is worth a thousand words; this is why the article contained a minimum number of words (only 84, as he pointed out) and conveyed (tersely, I must admit) most of its technical information in figure 1. Note that about 20 of the 84 words that make up the article convey a lot of implied information: "The card plugs into the Sanyo's serial-interface connector on the motherboard and works exactly like Sanyo's version."

RightWriter Rebuke

In the March Reviewer's Notebook column (page 245), Glenn Hartwig dismissed RightWriter because it did not like Hamlet or the Gettysburg Address. He missed the point. RightWriter is a tool to help make business writing strong, concise, and to

(continued)

...IBM presents TopView.

And you can see everything through on-screen "windows" and control it all with easy-to-use pop-up menus.

You can even make unrelated programs work together; say a "Brand Y" spreadsheet with a "Brand Z" word processor.

But simplest of all is a certain "Brand IBM", namely the IBM Assistant Series—for filing, writing, planning, reporting and graphing.

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And the price is only $149*.

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To learn more, call an IBM marketing representative, or visit an IBM Product Center or Authorized IBM PC or Software Dealer.

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*IBM Product Center price.

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the point. It will help produce better manuals, reports, and business correspondence. It is not meant for poetry or great works of literature. Would you want to see a user manual written in iambic pentameter? Would you write a report saying fourscore and seven more employees are needed for a project?

How about a real review on an important new product? I think your readers deserve it.

Robert W. DePree
Longboat Key, FL

Glenn Hartwig replies:
Mr. DePree accuses us of missing the point of his product. In fact, we stated that the program could be used to advantage in "ordinary correspondence and reports."

Want My Business?

The vast array of computer hardware and software now being marketed is so overwhelming that anyone venturing out to buy a computer system is soon overcome by a feeling of helplessness. The biggest and most frustrating problem encountered by the prospective buyer is the failure of companies in the computer field to provide any kind of information on their products.

A case in point: I have written to more than two dozen computer hardware and software companies for general and specific information, and only four saw fit to send me some literature. The rest did not even bother to acknowledge receipt of my inquiry. Apparently it doesn't matter that I am willing to spend up to $13,000 for a CAD system. Hardly anyone seems to want my business. Why?

Manfred F. Kirchner
Redmond, WA

Elegant Logic

In spite of many very bad experiences in responding to articles I have read in April issues of magazines, I am compelled to write in comment to Marvin Minsky's article "Communication with Alien Intelligence" (April, page 126).

I don't believe in the existence of intelligent civilizations other than ours in the universe; I have never seen any evidence or heard any argument in favor of them that I find embraceable; but Mr. Minsky's article is a delightful, optimistic viewpoint that makes me hopeful that we may, at least, yet find and be able to communicate with intelligent life here on earth. Mr. Minsky's article, though couched in the

(continued)

complex, esoteric rhetoric required of academic communication, makes its case with the same sparse, incredibly simple logic that is the core of its very argument: The simplest thing will always happen first. After reading Mr. Minsky's arguments, I am reminded of another bit of elegant logic which, strangely, now seems to be very wise: Anything that can happen will happen.

Mr. Minsky's article is typical of the kind of interesting, thought-inspiring, entertaining (though sometimes difficult) reading by which BYTE transcends the label "computer mag" and through which BYTE's readers can aspire to transcend the epithet "hacker."

There is, of course, also a very practical side to Mr. Minsky's article. If, some day, I turn to speak to an intelligent alien, I will be able to do so from the reference point of similarity, rather than polarity. There is a world of difference.

ZACK T. HINCKLEY
Rockledge, FL

HONEST INTERPRETER

The development and impact of computer hardware and software is so dazzling that one hardly knows which way to turn.

During calm moments I convince myself that if I had to select one and only one software utility (beyond the operating system), I would opt for an *honest*, easy-to-interact-with BASIC interpreter, one that would never take a single-precision value for $\sqrt{2}$, tack eight arbitrary numbers onto it, and fob it off as a double-precision number in a double-precision calculation.

HAL FALK
New York, NY

MAGIC SQUARES

I read with interest Robert T. Kurosaka's Mathematical Recreations column ("Magic Squares," March, page 383) regarding magic squares and his computer program for generating odd-sided magic squares. Although his technique is powerful with respect to generating such squares for consecutive number entries, it is not able to generate squares for any desired magic number.

A number of years ago I was intrigued with the question as to whether a general solution exists for a magic square of order n. With the help of a college text on linear algebra—*Elementary Linear Algebra* by J. R. Munkres (Reading, MA: Addison-Wesley, 1964)—I was able to find the general solution of a magic square of order 3.

The general solution for a magic number equal to $-a$ is

$$\begin{matrix} x_1 & x_2 & x_3 \\ x_4 & x_5 & x_6 \\ x_7 & x_8 & x_9 \end{matrix}$$

$$x_1 = -x_9 - \frac{2a}{3}$$

$$x_2 = -x_8 - \frac{2a}{3}$$

$$x_3 = x_8 + x_9 + \frac{a}{3}$$

$$x_4 = x_8 + 2x_9 + \frac{2a}{3}$$

$$x_5 = \frac{-a}{3}$$

$$x_6 = -x_8 - 2x_9 - \frac{4a}{3}$$

$$x_7 = -x_8 - x_9 - a$$

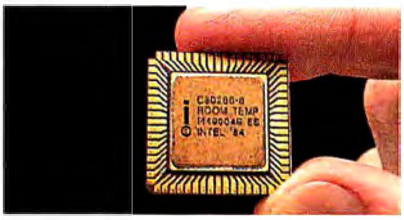
(continued on page 401)

Presenting the most capable

No other computer company has ever grown as fast as COMPAQ, because no computer company makes computers as powerful, as complete and as useful as COMPAQ. That's why the original COMPAQ Portable, COMPAQ PLUS,™ and COMPAQ DESKPRO™ became worldwide best sellers overnight. Now COMPAQ is introducing two new computers that advance the state of the art even further. While the original COMPAQ products remain cost-efficient cornerstones of business and professional use, especially for first-time buyers, the new products represent the utmost in performance for second-time buyers, or anyone who needs exceptional power and speed.

Triumphs of advanced technology

The new COMPAQ PORTABLE 286™ and COMPAQ DESKPRO 286.™ Advanced technology puts them in a class all their own. With power, performance, speed, and expandability that exceed even the IBM® Personal Computer-AT.™ They represent a new standard that makes others look



The new 80286 "chip" in COMPAQ 286 Computers processes data faster.

like what they are—the products of compromise. In fact, the new COMPAQ 286 Personal Computers can be considered the most useful in the world.

Power with a bonus—portability

The COMPAQ PORTABLE 286 redefines portable computers. We gave it power to match IBM's most powerful desktop computer, the IBM PC-AT. Then we designed it to run all the popular programs and hardware designed for the IBM PC-AT. But we didn't stop there. COMPAQ pushed the technology further.

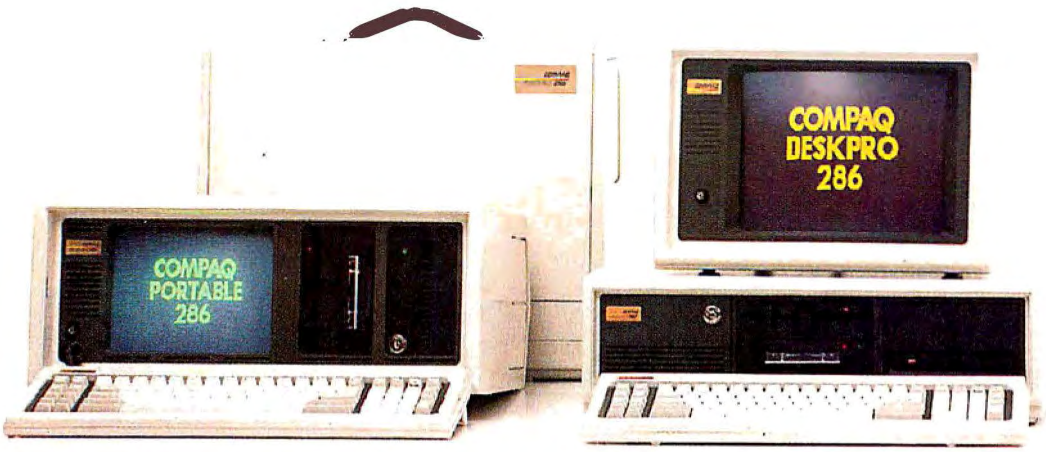
The COMPAQ PORTABLE 286 runs 30% *faster.* It can give you up to 20 Megabytes of internal fixed disk drive storage. And can come with features to make it even more useful. Like our *internal* fixed disk drive back-up system that protects 10 Megabytes of information on a single, pocket-sized tape cartridge.

But the most amazing thing about the COMPAQ PORTABLE 286 is that all these features come attached to a handle.

Our most advanced desktop computer

Like the COMPAQ PORTABLE 286, the new COMPAQ DESKPRO 286 runs all the popular programs designed for the IBM PC-AT, 30% *faster.* And it can also come with our convenient *internal* fixed disk drive back-up system for added data protection.

But we didn't stop there. We weren't content to compromise. We wanted to make the new COMPAQ DESKPRO 286 a more powerful, more efficient stand-alone personal



personal computers in the world.

computer, as well as a faster, more powerful, more useful file server. So we gave the COMPAQ DESKPRO 286 far more memory and storage capacity—over 8 Megabytes of RAM and 70 Megabytes of high-performance fixed disk storage.

The legends continue

Not everyone will need the extra performance of the newest COMPAQ Computers. That's why we built our original line to last a long time.

These workhorses—the COMPAQ Portable, COMPAQ PLUS and COMPAQ DESKPRO Computers — are essential to many professional and business users. They run thousands of industry-standard programs developed for the IBM PC and PC/*XT*.™ They're indispensable tools in use on all seven continents (yes, even the South Pole!).

Above all, no compromises

The unprecedented success of COMPAQ came as no accident. While others built limited computers, COMPAQ built expandable computers.

While others took two screens to display high-resolution text and graphics, COMPAQ was the first to do it on one.

While others were looking for ways to cut corners, COMPAQ looked for ways to eliminate downtime by building the most rugged, reliable computers in the world.

The COMPAQ commitment to a philosophy of "no compromise" made the COMPAQ Portable and COMPAQ PLUS the world's best-selling 16-bit portable personal computers. In 1983 COMPAQ sold $111 million worth of computers to achieve the most successful first-year sales of *any* company in American business history.

In 1984, we introduced the COMPAQ DESKPRO. In only four months, it became the second-best-selling 16-bit desktop business system in U.S. retail computer stores. And as a result, we've concluded the most successful second year of any computer company, with sales of $329 million.

The reason for this success is simple.

COMPAQ computers have been recognized worldwide. Awards include:

- *COMPAQ PLUS selected and voted Europe's 1984 Computer of the Year in the portable category.*
- *COMPAQ PLUS voted by readers of PC WORLD as their favorite product in its category in the "1984 World Class PC Contest."*
- *COMPAQ PLUS selected as the first-place winner in its category in the Creative Computing Top 12 Computers of 1984 Awards.*
- *COMPAQ Portable rated best personal business computer in overall user satisfaction by the Yankee Group market research firm opinion poll.*
- *COMPAQ DESKPRO named by PC Week magazine as one of the top ten products of 1984.*

We offer people personal computers that simply work better. And make no compromises doing so.

Introducing the new COMPAQ PORTABLE computer helps you

Anyone can make a portable computer. But to make one that runs all the popular programs designed for the IBM PC-AT, 30% faster—in a package almost half the size—was no small challenge. But one COMPAQ welcomed.

Go faster, go further

The COMPAQ PORTABLE 286 is paced by the advanced technology of the 8-MHz, Intel 80286 microprocessor. This advanced technology has numerous advantages. One advantage is the flexibility to work with several different operating systems so you're not forced to choose a personal computer solely on that basis.

The advanced capabilities of this microprocessor become even more apparent when you run complex programs. You can operate as part of a network. Or you can operate more than one program at the same time using multi-tasking software like IBM TopView.™ And you can handle the most difficult problems with breathtaking speed.

For many scientific and engineering programs you have the ability to add an 80287 coprocessor, which offers even more speed.

Both offer dramatic speed increases over earlier microprocessors. The faster response time means less waiting, and more productivity.

Power in a package

The COMPAQ PORTABLE 286 has the power of the IBM PC-AT. But the IBM PC-AT doesn't have a handle. Ours does. So it goes where you go. Works where you work. Whenever and wherever necessary. And it's easy to share with co-workers.

That's full-function portability, pure and simple.

A COMPAQ PORTABLE 286 can leave the office when you do. Take your work wherever you go.

Expandability without getting bigger

All the devices that increase the capabilities of the COMPAQ PORTABLE 286 go on the inside—not the outside—of the computer.

You can get it with one or two half-

286. Our fastest, most powerful portable do more – anywhere.

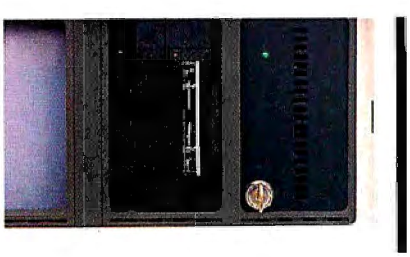
height 1.2-Megabyte diskette drives. Although they can "read" diskettes formatted for 360-K byte diskette drives, they cannot "write" to them. Therefore, as an option, COMPAQ offers a 360-K byte diskette drive to let you exchange data with other industry-standard personal computers.

There's an additional slot for a 20-Megabyte fixed disk drive. All COMPAQ Portable Computers offer fixed disk drive systems that fit *inside* the computer.

Another of our options: An *internal* fixed disk drive back-up system keeps a safety copy of your work, reducing the chance of losing your data. COMPAQ pioneered the system first in desktop computers, and now in portables.

The COMPAQ PORTABLE 286 even comes with a security lock feature that locks "on" to prevent interruption of a file transfer, or "off" to deny access to confidential information.

Because it's a portable, self-contained unit, the computer can be easily stored away after use.



Two data protection features from COMPAQ: an internal fixed disk back-up system that stores data on tape cartridges, and a security lock for locking keyboard access to your system on or off.

Who can use it?

If you're an experienced user, you may be ready to upgrade your current equipment. The COMPAQ PORTABLE 286 gives you the latest technology.

For some, power is all-important: Speed, performance, and the ability to handle the most powerful software. All are leading qualities of the COMPAQ PORTABLE 286.

Starting a business? The COMPAQ PORTABLE 286 has tremendous data base capabilities to help you keep track of your inventory, your customers, your employees, your finances. Its exceptional storage capabilities make it ideal for the complexities of accounting. Its exceptional speed means greater networking ability. Its tremendous power enables you to get the edge on the competition.

In addition, large corporations can place several of these computers with field representatives to provide clients immediate information on current prices, product availability, even shipping dates and routing. So delivery shortages can be anticipated and avoided.

The COMPAQ PORTABLE 286 can also travel within the company. From office to office. Desk to desk. From accounting, to marketing, to research.

It's powerful and versatile enough to do almost any job. Light enough to carry. And tough enough to survive lots of users.

Established reliability

Despite its newness, the COMPAQ PORTABLE 286 is in many respects a proven product. It's based on the rugged, reliable design of the original COMPAQ Portable and COMPAQ PLUS. Many of the construction techniques like cross-bracing components and shock-mounting disk drives are identical. All of which goes to prove our point: No other portable computer can measure up to the advanced power and potential of the uncompromising COMPAQ PORTABLE 286.

The COMPAQ PORTABLE 286 Specifications

Processor: 16-bit 80286; 6 or 8 MHz clock speed. **Software:** Fully compatible with all major software applications written for the IBM PC-AT. **Expansion Slots:** 3 available slots in base configuration. **Memory:** 256-K bytes RAM, expandable to 2.6 Megabytes. **Storage Devices:** 360-K byte or 1.2-Megabyte diskette drives, 20-Megabyte fixed disk drive, fixed disk drive back-up (10 Megabytes per tape). **Interfaces:** RGB color monitor, RF modulator, composite video, parallel printer, and asynchronous communications interfaces. **Keyboard:** Standard IBM PC-AT layout (84-key). **Display:** 9-inch diagonal green monochrome dual-mode monitor, high-resolution text characters, high-resolution graphics. **Security:** Locks in operating and non-operating mode to prevent unauthorized keyboard access. **Physical Specifications:** 20"W x 8½"H x 16"D. **Options:** Technical reference guide, MS-DOS™/BASIC Version 3, 512/2048-K byte memory board.

Introducing the new COMPAQ DESKPRO 286. offers more expansion,

The capabilities of the new COMPAQ DESKPRO 286 represent a personal desktop computer as practical as it is technically advanced. Plus, it maintains compatibility with the IBM PC-AT.

Utmost expandability

That's no exaggeration. The COMPAQ DESKPRO 286 can expand to give you massive storage and memory.

Without clutter. Expansion is *internal.*

It comes with a single, half-height, 1.2-Megabyte diskette drive. You can add a second drive of the same capacity, or a 360-K byte diskette drive so you can exchange information with other personal computers.

For fixed disk storage, an internal 20-Megabyte system is available. You can also choose a 30- or 70-Megabyte high-performance internal fixed disk drive sytem. The storage capacity of each is equivalent to 10,240, 15,360, or 35,840 pages of double-spaced data.

One expansion board works with all the fixed disk drives. When you upgrade to a larger fixed disk storage system, a new board is not required.

To back up data, use the COMPAQ internal fixed disk drive back-up system. It's also a safe and convenient way to store information for record keeping.

Hardworking, networking

Alone, the COMPAQ DESKPRO 286 is a tremendously useful computer. It doesn't limit you to using software under any one operating system. It runs all the popular programs designed for the IBM PC-AT. It can be configured for advanced color graphics display using a color monitor and the IBM Enhanced Graphics Adapter.

Our most powerful desktop personal computer more speed and more flexibility.

An enhanced keyboard layout, with shift keys in easy reach for touch typists, is standard on the COMPAQ PORTABLE 286 and COMPAQ DESKPRO 286.

The modular design of the computer also lets you configure RAM and storage to the exact needs of any individual. So you never have to buy more computer than you need. Or worry about obsoleting your investment because you bought less computer than you need.

The COMPAQ DESKPRO 286 also makes the ideal hub of a local area network. Using networking packages, your computers (and your people) can share information and software, and can communicate with one another. With 70 Megabytes, the COMPAQ DESKPRO 286 becomes a powerful, high-performance file server. You can store lots of data, as well as store several programs you can run simultaneously when using software programs like IBM TopView. Your computer will perform at lightning speeds. And other configurations can make economical "nodes" of the network.

A fixed disk can store enough programs and data to handle all the accounting for most businesses.

Where to start

The flexibility of the COMPAQ DESKPRO 286 allows you to begin at any level of computing power and reach beyond the IBM PC-AT.

You can use your computer for writing extensive documents, preparing professional graphics for presentations, and for doing complicated financial studies. Chances are, however, you'll not want to stop there. You'll discover new ways for streamlining your work. You'll want to do customer lists, accounting tasks and business taxes, product inventory, annual sales projections on spreadsheets. You have the option of adding a second diskette drive, a fixed disk drive, more memory, even a fixed disk drive back-up system. All are available and can be added to the inside of your COMPAQ DESKPRO 286—easily, affordably, without losing your initial investment in hardware, software, or training.

A proven heritage

The COMPAQ DESKPRO 286 is of tested lineage. It has many of the reliable construction and design qualities of the COMPAQ DESKPRO. It has further conveniences like a dual-function security lock to prevent unauthorized access. As well as greater performance, power, and speed. The COMPAQ DESKPRO 286 stretches the limits of personal computing—with no compromises.

The COMPAQ DESKPRO 286 Specifications

Processor: 16-bit 80286;6 or 8 MHz clock speed. **Software:** Fully compatible with all major software applications written for the IBM PC-AT. **Expansion Slots:** 5 slots available in base configuration. **Memory:** 256-K bytes RAM, expandable to 8.2 Megabytes. **Storage Devices:** 360-K byte or 1.2-Megabyte diskette drives; 20-(half-height), 30-, or 70-Megabyte fixed disk drives; fixed disk drive back-up (10 Megabytes per tape). **Interfaces:** RGB color monitor, RF modulator, composite video, parallel printer, and asynchronous communications interfaces. **Keyboard:** Standard IBM PC-AT layout (84-key). **Display:** 12-inch diagonal green or amber dual-mode monitor, high-resolution text characters, high-resolution graphics. **Security:** Locks in operating and non-operating mode to prevent unauthorized access; cover lock to protect internal components. **Physical Specifications:** System unit—19.8"W x 6.4"H x 16.5"D, Keyboard unit—18.0"W x 1.5"H x 7.0"D, Display unit—14.75"W x 10.25"H x 13.75"D, Weight—57–64 lbs., depending on configuration. **Options:** MS-DOS/BASIC Version 3, Tilt & Swivel Monitor Stand, Desk-Saver, Technical Reference Guide, 512/2048-K byte memory board.

COMPAQ makes full-function portability a full-fledged reality.

If you're anxious to put a computer to work for you, but don't need the extra power and added performance of our most advanced portable computer, we have the answer.

Lots of software, lots of uses

The COMPAQ Portable and COMPAQ PLUS are based on the 8088 microprocessor, one of the most popular computer technologies, so software is abundant. Integrated business programs, personal productivity, learning tools, even educational thoughtware to sharpen your business skills. Literally thousands of programs, compatible with the IBM PC and IBM PC/*XT*, will run on the COMPAQ Portable and COMPAQ PLUS.

Many businesses put the COMPAQ Portable or COMPAQ PLUS to work as a full-time computer for part-time users. Carry it from desk to desk. Office to office. Let several people use it for one or more hours a day. Or one person use it a few days a week.

Many companies use a COMPAQ Portable as a full-time computer for part-time users.

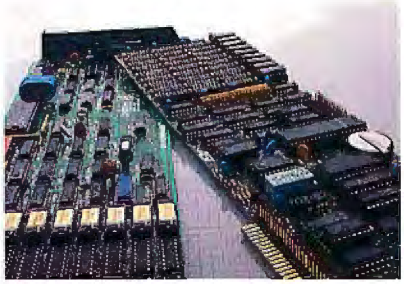
For heavy users, a COMPAQ Portable or COMPAQ PLUS can become a "second computer" for computing power away from the office.

With their rugged, uncompromising construction, they're built tough enough to pass around—something that's impractical to do with desktop computers. And because you stretch its use, you stretch your budget as well.

If you need more, it does more

How can one computer be so versatile?

One reason is the ability of the COMPAQ Portable to become a COMPAQ PLUS with the addition of a 10-Megabyte fixed disk drive. This expands storage capacity to the equivalent of 5,120 double-spaced pages of information.



Expansion boards let you add memory and extra functions inside, not out.

There are other ways to improve on your COMPAQ. Hundreds of industry-standard expansion boards are available. They fit neatly inside your COMPAQ. So you can run more advanced programs. Communicate over telephone lines. Network with other computers.

It's this kind of versatility and ease of use that makes COMPAQ Personal Computers second to none.

SPECIFICATIONS

The COMPAQ Portable

Processor: 16-bit 8088, 4.77 MHz clock speed. **Software:** Fully compatible with all major software applications written for the IBM PC/*XT*. **Storage Devices:** One or two 320-K byte diskette drives. **Expansion Slots:** 3 available slots. **Memory:** 128-K bytes RAM expandable to 640-K bytes. **Display:** 9-inch green diagonal monochrome dual-mode monitor, high-resolution text characters, high-resolution graphics. **Interfaces:** RGB color monitor, RF modulator, composite video, and parallel printer. **Keyboard:** Standard IBM PC layout (83-key). **Physical Specifications:** 20"W x 8½"H x 16"D.

The COMPAQ PLUS

Specifications the same with the exception of: One 360-K byte diskette drive, one 10-Megabyte fixed disk drive, 2 available expansion slots, and full compatibility with all major software applications written for the IBM PC and PC/*XT*.

Lasting value led to instant success for the COMPAQ DESKPRO.

If you don't need all the extra performance of the COMPAQ DESKPRO 286, you can buy the popularly priced COMPAQ DESKPRO and still get many advanced features.

A command performance at every level

The COMPAQ DESKPRO Series allows you to buy as *much* computer as you need—not *more* computer than you need.

It's a polished performer, from entry level to advanced computing, in one totally expandable unit. Its plug-in, modular design accepts up to four separate storage devices. You select almost any combination of diskette or fixed disk drives you desire. And there's the practical, internal fixed disk drive back-up system to protect and store your data. So as your needs grow, the DESKPRO grows.

In fact it will grow from an IBM PC to far beyond the IBM PC/*XT* level of functionality. The COMPAQ DESKPRO will run all the popular programs written for both the IBM PC and PC/*XT*, two to three times *faster*, without sacrificing compatibility.

Internal expandability saves desk space.

Power? It's got what it takes.

The COMPAQ DESKPRO can be easily configured for scientific, engineering, and advanced business applications.

A high-performance, 30-Megabyte fixed disk drive provides added storage capacity.

The ability to add a high-speed 8087-2 coprocessor lets you deal with complex scientific calculations and economic models.

SPECIFICATIONS

The COMPAQ DESKPRO

Processor: 16-bit 8086; 4.77 or 7.14 MHz clock speed. **Software:** Fully compatible with all major software applications written for the IBM PC and PC/*XT*. **Expansion Slots:** 6 slots available in base configuration. **Memory:** 128-K bytes RAM, expandable to 640-K bytes. **Storage Devices:** One or two 360-K byte diskette drives, 10-(half-height) or 30-Megabyte fixed disk drives, fixed disk drive back-up (10 Megabytes per tape). **Interfaces:** RGB color monitor, RF modulator, composite video, parallel printer, and asynchronous communications interfaces. **Keyboard:** Standard IBM PC layout (83-key). **Display:** 12-inch diagonal green or amber dual-mode monitor, high-resolution text characters, high-resolution graphics. **Physical Specifications:** System unit—19.8"W x 5.8"H x 16.5"D, Keyboard unit—18.0"W x 1.5"H x 7.0"D.

Features common to COMPAQ in most other

It's been easy for COMPAQ to recognize the compromises other personal computer makers have been making.

It's been just as easy to avoid them.

That's why performance, expandability, compatibility, durability, and versatility are features you'll find in the entire COMPAQ family of computers.

How advanced technology affects the choice you make

There's an ever-growing library of fast, powerful programs designed for the IBM PC-AT and compatible with the COMPAQ PORTABLE 286 and COMPAQ DESKPRO 286. These programs will utilize the full potential of the computer "nerve center"—the Intel 80286 microprocessor.

If you own a COMPAQ Portable, COMPAQ PLUS, or COMPAQ DESKPRO, you may discover that these newer programs are simply too big to run on your computer.

Therefore you have a choice: the extra power and speed of the 80286 or the popular COMPAQ Personal Computers that use the 8088 and 8086 microprocessors. Remember that the COMPAQ PORTABLE 286 and COMPAQ DESKPRO 286 offer more power, speed and performance than any other personal computer. If your needs don't require the advanced technology, or you need a second computer to complement the one you have now, consider the COMPAQ Portable, COMPAQ PLUS, or COMPAQ DESKPRO. All three are hardware and software compatible with the IBM PC and PC/*XT*. Our intention is to give you a choice without forcing you to invest in more, or less, computing power than you think you need.

Of course, COMPAQ Personal Computers maintain compatibility with the add-on devices and expansion boards available for industry-standard personal computers, without any alteration or modification.

Increased power without increased size

All COMPAQ Personal Computers can take on more memory and storage without taking up more space. The COMPAQ Portable becomes a

Internal add-on devices add greatly to the capabilities of a COMPAQ Computer.

COMPAQ PLUS when you add a 10-Megabyte fixed disk drive. The COMPAQ PORTABLE 286 can accept a 20-Megabyte fixed disk drive. The fixed disk drive fits neatly beside the diskette drive inside the unit.

With the COMPAQ DESKPRO and COMPAQ DESKPRO 286, you can install almost any available combination of diskette or fixed disk drives you desire to achieve the level of performance you need. The COMPAQ DESKPRO and COMPAQ DESKPRO 286, along with the COMPAQ PORTABLE 286, can accept the fixed disk drive back-up system as one of the internal storage devices.

There are slots inside each COMPAQ Computer for optional expansion boards. These boards greatly enhance the functionality and versatility of your computer. Literally hundreds are available to plug right in. Each lets you do something different. Like expanding the amount of memory in your computer. Or communicating with other personal computers. Or

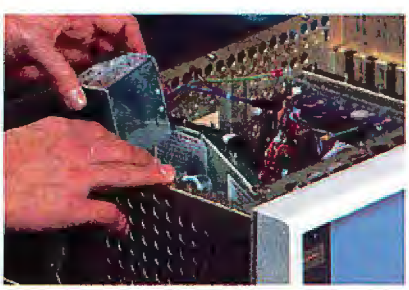
Computers are features uncommon personal computers.

even communicating with mainframe computers.

Built tough to take it

COMPAQ Portable Computers are expected to take some hard knocks. A specially designed shock isolation system protects the diskette drives from jolts and vibration.

Their inner components are surrounded by a cross-braced aluminum frame. Those equipped with fixed disk drives are protected by a triple shock mount system. Plus, the outer case is molded from high-impact plastic, the same kind used to make bulletproof windows and space helmet faceplates. COMPAQ Portable Computers are tough, protecting your data from every angle.



COMPAQ DESKPRO Computers are no pushovers, either. They're surrounded by a protective steel shell.

They're the only desktop computers made with protective shock mounts, isolating the disk drive compartments from those unexpected but inevitable bumps and knocks that can cause downtime.

Even our monitors do more

COMPAQ Computers display data on high-quality monitors. All models can display high-resolution text and graphics on the same screen. The dual-mode display saves you the cost and clutter of a second monitor. COMPAQ DESKPRO Computers give you a

High-resolution text and graphics on one screen eliminates the need for a second monitor.

choice of an amber or green display.

From pinstripe suits to flight jumpsuits

The structure and design of COMPAQ Computers best characterize their widespread usefulness and respected capabilities. COMPAQ attentiveness to construction details and concern for functionality under stressful conditions are why these computers have received worldwide acceptance.

That's why you'll find a COMPAQ Computer on the bench of a major league baseball team tracking player performance.

At the South Pole monitoring weather conditions for the research team of a major university.

On tour with famous rock stars to help plan concerts, keep up with the finances, and receive electronic mail.

On motion picture sound stages scheduling production and maintaining equipment inventory.

On military surveillance planes logging information five miles aboveground.

In the halls of the Supreme Court answering complex questions on environmental issues.

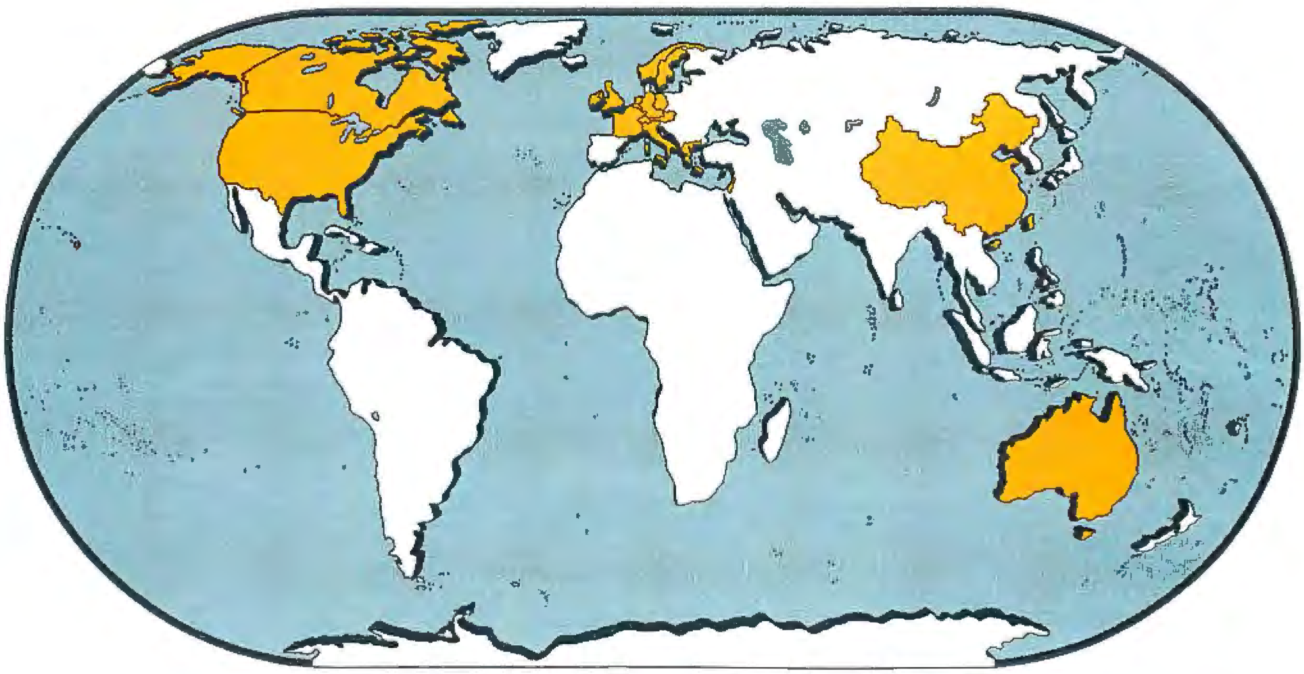
Computers people believe in

It didn't take long for the public to recognize COMPAQ Computer quality. No one builds them the way we do. Which is why no other computer company has grown the way we have.

As personal computers become more and more commonplace, more and more people have come to appreciate that quality. Our commitment to providing a product that's beyond compromise assures a product beyond compare. We like to think of it in a simple phrase that bears repeating: It simply works better.

COMPAQ Portable Computers have the ruggedness and durability for almost any work environment.

The Authorized COMPAQ Computer Dealer Network. For sales and service, there are over 2,200 worldwide.



Authorized COMPAQ Computer Dealers are carefully selected by a special review process. We make sure they are established business professionals with the expertise to provide technical service for every COMPAQ Computer they sell. Dealer technicians receive rigorous training by COMPAQ engineers.

No matter whether you're a professional on the move, or an international corporation with branch offices in dozens of states and countries, you'll find help readily available.

When you purchase your COMPAQ Computer, you'll be buying from the best in the business. Authorized COMPAQ Computer Dealers work hard to earn your respect. Because they had to work even harder to earn ours.

Authorized COMPAQ Computer Dealers, U.S. and Canada

A-Com-Plus
A-VIDD Electronics Company
ABACUS Computer Center
Agriplex Computer
All Things Computers
Allied Computer Centers
Amerisource
The AMS Computer Store
The Answer
Applied Data Systems
Arends & Sons Inc.
ASAP Computer Products
Bamberger's
Bandstra Computer Center
BasicComputer Shop
Bell& Howell
Blumberg Photo & Sound
Blumenthal'sComputers
Businessland, Inc.
Byte Shop
C.C.C. ComputerCenter
C.T.I. BusinessProductsCenter
Calculator and Computer Center
Carolina Computer Store
Casterline Computer Center
CBM Computer Center
CentralComputers
Central Valley Computer Center
Century Microcenters
Champlain Compoter Systems
Chester Inc.
Cincinnati Computer Store
Clancy-Paul, Inc.
Command Performance Computers
Compco Computer Centers
CompuGroup
Compu Net Computer Solutions
Compucentre
Compumark
Compumat Micro Center
CompuShop Inc.
Computer Applications Business Center
Computer Center of Boca Raton
Computer Center/Palm Beaches
The Computer Centre
Computer Concepts
Computer Depot
The Computer Edge
The Computer Factory
Computer Gallery
Computer House
Computer Innovations
The Computer Learning Tree
Computer Nook
Computer Plaza
Computer Pro
The Computer Room
The Computer Shoppe
Computer Solutions
Computer Source Inc.
The Computer Store
Computer Superstores
Computer Systems Resources
Computer Systems Specialists
Computer Techniques
Computer Town
Computer Trends International
Computer Utility
Computer Ware
Computer Works
ComputerCraft
COMPUTERease
ComputerLand
Computers Unlimited
Computerware
Computerworks
Computique
CompUtopia
Comuni-Center South
Connolly Data Systems Inc.
Contact Office Automation Centers
Custom Computing Systems
DataFile, The
DATAGO
Data SystemsofNew Jersey
Data Terminal Mart
DRA Computer Center
Endata Business ProductsCntr.
Entré Computer Centers
First National Computer Center
Forsythe Computers
Future Information Systems
Future Systems
Future Visions Computer Store
Garland Mears Irrigation
GatewayComputer
GeneralMicrocomputer, Inc.
Hamilton Computer BusinessCentre
Hamilton Rentals
HLA Computers
ICA Business Center
IdealComputer Systems
Idex Business Computer Center
Illini Microcomputers Inc.
Illinois Valley Computers
Inacomp Computer Centers
InacompComputer City
Infomax Computers
Information Connection
Interdynamics Data Systems
International Computer Systems
J.W. Kerns, Inc.
Jonathan's Computer Center
Khalix
Le Magasin Xerox
Legacy Computer Systems
Lexington Computer Store
Light Computer Centre
Logic Tree Computer
The Logical Choice
Lyceum Computers
M.C.W. Computers
MakenComputer Services
The Math Box
MBI Business Center
Micro Center
Micro Mart
MicroAge Computer Stores
Microcomputer Solutions
Micronic Computer Centre Ltd.
Microsource/Financial
MidaCorporation
Midwest Computer Center
Miss-Lou Computer Center
Moore Business Centers
Morri's Decision Systems
Mr. Micro
MSC Computer Store
Nabih's Inc.
Neeco of Needham
Northbrook Computers, Inc.
Office Management Systems Inc.
Olsen Computing
Omni Computer Center
Omnifax Computer Stores
OnlineComputers Plus
PAX Computer Center
Personal BusinessComputers
Personal Computer Centre
PersonalComputer Institute
Photo & Sound Company
Pittsburgh Computer Store
Prodigy Computer Center
Professional Computer Centre
Professional Computer Systems
Quantum Computer Store
RACComputers
Rainbow Computing Inc.
Sears Business Systems Centers
Sherman Howe Computer Centers
Silver Creek Computers
SnyderComputerCenter
Societe Parmic Limitee
Solutions Inc.
Southwest Automation
Spectrum Computers
Star Business Computers
Sun Computers
Taskforce Business Centres
Universal Computers
Valcom Computer Center
Varsity Computing
Wabash Computer Systems
Waldec Computer Center
TheXeroxStore

COMPAQ®

F·I·X·E·S A·N·D U·P·D·A·T·E·S

BYTE'S BUGS

ROMDISK Pricing Lowered

We provided some out-of-date prices in an article in the May What's New section. (See "ROMDISK PC Accessory Card," page 468.) The new prices are lower than those we quoted.

Curtis Inc., manufacturer of the ROMDISK line of disk emulator boards for Apple and IBM computers, reports that it recently received new quotations for the EPROMS and other semiconductors used in its products. A company spokesperson stated that its price reductions, especially for its PC-2 board, are due to the availability of 27C256 EPROMs. Previously, Curtis had to rely on 27128 EPROMs and a piggybacked board to achieve large storage capacities.

The suggested retail price for the ROMDISK A for the Apple IIe is now $349. The ROMDISK PC-1, which is equivalent to a 180K-byte single-sided disk, is $495. Both are $100 lower than before. Providing 360K bytes of storage, the PC-2 is $595, which is $400 less than reported in May.

Curtis Inc. is located at 22 Red Fox Rd., St. Paul, MN 55110, (612) 484-5064.

Statement Amplified

A discussion in the June Fixes and Updates requires some explanation. (See page 33.)

In the item "Upgrade to Lowercase Descenders," the first sentence in the second paragraph could be interpreted as saying that the Gorilla Banana printer is manufactured by DAK Industries, which it is not.

The Gorilla Banana Printer was produced by Leading Edge Products Inc., 225 Turnpike St., Canton, MA 02021, (617) 828-8150. The printer, however, is no longer manufactured.

DAK Industries Inc. sells electronic parts and instrumentation. One of the products sold by DAK Industries is the Gorilla Banana Printer. DAK Industries is located at 8200 Remmet Ave., Canoga Park, CA 91304.

We apologize for the confusion.

Some Fixes for Sunfix

An error crept into the references that accompanied Frederic N. Rounds's Sunfix navigation article, which appeared in the March BYTE. (See "Navigation: Putting the Microcomputer to Work at Sea," page 141.)

The first reference should read as follows:

Maloney, Elbert S., ed. *Dutton's Navigation and Piloting*. Naval Institute Printing, 1978.

Mr. Rounds also would like to emphasize that the Sunfix program takes the place of almanacs and reduction tables by computing the position of the sun for any time and date. The only data inputs it requires are your sextant's readings and the measurements used to make sextant corrections. Details, such as RA and SHA, are transparent to users of the Sunfix program.

It's also advisable to keep in mind the fact that microcomputers can aid sailors, but, like ham radios and other electronic navigation equipment, they are susceptible to the sea's environment.

For those who are interested, Mr. Rounds will supply a printout of the Sunfix program for $5. You can write Mr. Rounds at 894 Persimmon Ave., Sunnyvale, CA 94087.

Bugs in Frequency Analyzer

A trio of bugs in Vince Banes's article "Audio-Frequency Analyzer" have been reported. (See page 223 of the January BYTE.) Two of the bugs are in the accompanying diagrams, and the third bug is in a program listing.

In figure 3 on page 227, the labels of the two ports are switched.

On page 230, you'll find a mix-up in the pin numbers in figure 4b. Pin 25 of the 8255 integrated circuit should be connected to pin 13 of IC8.

In the program that determines the endpoints of the VCO ranges (listing 5, page 236), change line 40 to read:

```
OUT 1921,CC
```

Our thanks to David R. Butler of Cameron, West Virginia, and Mark Pinkerton of Salem, Wisconsin, for reporting these errors to us.

Name Corrected

In "Factfinder" by John Markoff (March, page 113), the name of a database service was incorrectly presented. NEXIS is a full-text database of general and business news produced by Mead Data Central Inc., a wholly owned subsidiary of The Mead Corporation.

Servo Listing Misserves a Line

John deLaubenfels, a BYTE reader in Duluth, Georgia, found a bug in the program listing that accompanied Don Stauffer's article "Simulate a Servo System." (See page 147 of the February BYTE.)

In the TRS-80 Level II BASIC program on page 150 (listing 1), line 2040, EM = ER is not correct. It should read

```
EM = EM + ER*DT
```

Our thanks to Mr. deLaubenfels for sending this correction.

(continued)

FIXES & UPDATES

Knowledge Index Numbers Change

In the December 1984 BYTE article "The On-Line Search" by Suzana Lisanti (page 215), the telephone numbers for the Knowledge Index database service were incorrect.

The correct numbers are (800) 227-1927 and (415) 858-3785. Knowledge Index is a service of Dialog Information Services Inc., 3460 Hillview Ave., Palo Alto, CA 94303.

BYTE'S BITS

BYTE Index Produced

A comprehensive index of all the articles that appeared in BYTE from January 1983 through December 1984 is available. The *BYTE '83-84 Index* is 48 pages long and cross-references articles alphabetically by subject.

For your copy, write to *BYTE '83-84 Index*, BYTE Publications, POB 372, Hancock, NH 03449. Please enclose $1 to cover shipping and handling, as well as a piece of paper with your name and address clearly legible.

Author's Guide Available

The latest edition of the BYTE author's guide has just been produced.

Writing for BYTE describes how to submit an article to BYTE, the types of articles we seek, where to go and whom to turn to when writing a BYTE article, and other information.

For your copy, send a self-addressed stamped business envelope to *Writing for BYTE*, BYTE Publications, POB 372, Hancock, NH 03449. Please note that we cannot honor telephone requests.

Public-Domain Software Offering

John Morse has written and introduced into the public domain a number of programs. Mr. Morse developed these BASICA programs on the IBM PC XT under PC-DOS.

The programs include a graphics editor, a utility that displays every character of any file with its hexadecimal and ASCII code as well as its position in a record, a drawing-pattern generator, three versions of the game Mastermind, and a character analyzer in which particular characters in a file can be omitted, highlighted, or changed.

You are free to distribute the programs, with the stipulation that you include Mr. Morse's name in each program. The programs are available from Mr. Morse for $10, which includes the disk and instructions within the program. For more information, write to John W. Morse, 274 State St., Albany, NY 12210.

FEEDBACK

Serial Version of Printer Buffer

Keith Alexander, a BYTE reader "since the dark ages of 1976," recently wrote us to say how intrigued he had been with Jon Bono's printer buffer and with Richard Carlsen's comments on the project. (See "Build a Printer Buffer" in the June 1984 BYTE, page 142, and "Printer Buffer Messaged" on page 33 of the April 1985 BYTE.)

Mr. Alexander reports that he, too, built the buffer and that he had to make a number of hardware and software modifications to suit his system, a Southwest Technology's 6809-based unit.

The main problem, according to Mr. Alexander, was connecting his serial printer to a single RTS (request to send) line. After corresponding with Mr. Bono and learning a lot about UARTs, Mr. Alexander got the circuit to work. His SwTPc 6809 now sends data to the buffer at 38,400 bps and the buffer, in turn, drives his Heath H-14 printer at 4800 bps.

Mr. Alexander has graciously offered to correspond with BYTE readers interested in his serial version of Jon Bono's printer buffer. You can write to Mr. Alexander at 20426 Lichfield, Detroit, MI 48221. ■

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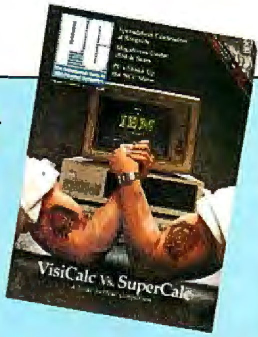

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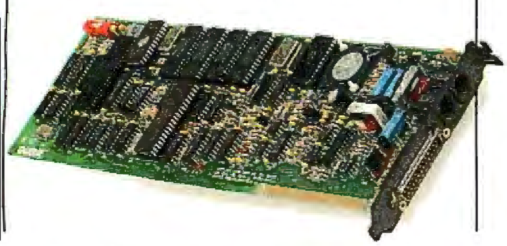

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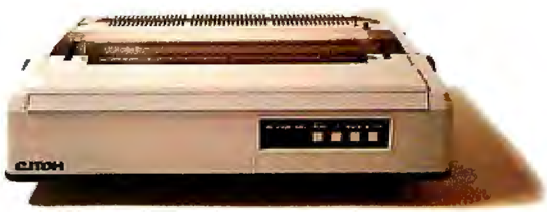

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Printers

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Xerox Products

Xerox recently announced the 6085 microcomputer, a line of personal microcomputers, and a laser printer.

The Xerox 6085 is offered in models for network, remote, and stand-alone operation. The networked and remote models can share resources linked by Ethernet.

The 6085 is founded upon Xerox's Mesa processor, an 8-MHz device. The Mesa processor has 256 auxiliary registers and executes 48-bit-wide instructions. The 6085 also uses an 80186 chip as an auxiliary processor.

The basic 6085 comes with 1.1 megabytes of memory, a 10-megabyte hard-disk drive, two serial ports, and a 15-inch high-resolution (880- by 697-pixel) monochrome display. You can expand it to include 3.7 megabytes of memory and up to 80 megabytes of hard-disk storage.

Xerox offers hard-disk drives with 20, 40, or 80 megabytes of storage, and a 360K-byte floppy-disk drive is also available. An optional board gives the 6085 the ability to run software prepared for IBM PC-DOS.

System software includes the ViewPoint windowing package, which uses icons and is controlled with an optical mouse. ViewPoint is $125. A variety of applications software, including a software-development package, is planned.

The 6085 begins at $4995.

The Xerox 6085.

The Xerox 4045 *Laser* CP.

The Xerox 6060 family of PCs comprises four computers: a pair of IBM PC work-alikes, the Xerox 6064 and 6065, and two dedicated word-processing systems, the Xerox 6067 and 6068. The 6067 and 6068 keyboards have been modified for word processing. Both systems come bundled with Xerox's word-processing software and can run MS-DOS applications software.

Each Xerox 6060 comes with ScreenMate, a menu-based shell program for interacting with MS-DOS.

The general-purpose 6064, with two 360K-byte floppy-disk drives and 256K bytes of memory, retails for $2885. The hard-disk-based 6065 lists for $4485.

At $2985, the 6067 includes dual floppy-disk drives and 384K bytes of RAM. The 6068, which is equipped with a 10-megabyte hard disk and 512K bytes of memory, costs $5150. Both the 6067 and the 6068 use a 640- by 400-pixel monochrome display.

Xerox rates its 4045 Laser CP "lasographic" printer at 10 pages per minute and 5000 pages a month. It comes with 128K bytes of memory, two fonts, and your choice of Centronics or Dataproducts parallel ports or an RS-232C asynchronous connection. Additional cartridge-based fonts are offered.

If you choose to expand the 4045 Laser CP to its full 512K bytes of memory, you can reproduce a 5- by 7-inch image in a 300- by 300-dot-per-inch format. You can reproduce a full-page graphic at 150 by 150 dots per inch. The 4045 Laser CP has a 250-sheet paper cassette, and cassettes for European paper are available. It's compatible with the Diablo 630 daisy-wheel printer.

A copier option lets the 4045 Laser CP function as a standard photocopier. Other

(continued)

options include an envelope cassette, an interface that permits four PCs to share its resources, and a network interface for linking the 4045 Laser CP to IBM 3274/3276 networks and Systems 34/36/38 environments. The suggested list price for the 4045 Laser CP is $4995.

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

Inquiry 600.

IBM PC XT-, PC AT-Compatible Computers

NCR's PC8 and PC6 are compatible with IBM PC AT and IBM PC XT computers, respectively.

The PC8 can serve as a stand-alone computer, as a 16-member multiuser system, or as a network server for up to 63 nodes. In its single-user configuration, the PC8 runs under NCR-DOS 3.1. The multiuser operating system is XENIX.

Featuring Intel's 6-MHz 80286 microprocessor, the PC8 is reportedly able to run virtually any software designed for the IBM PC AT without modification. It can also use AT-compatible hardware.

Standard are 256K bytes of RAM, a 1.2-megabyte floppy-disk drive, six expansion slots for devices with 8-/16-bit data paths, two expansion slots for devices with 8-bit data paths, and a battery-backed system clock. The keyboard has LED indicators and 30 programmable function keys.

Optional are a monochrome monitor with a nonglare 80-character by 25-line display and 640- by 400-pixel resolution and a 14-inch color monitor with 16-color capabilities. GW-BASIC is available, and internal memory is expandable up to 4 megabytes.

The NCR PC8.

The basic PC8 begins at $3795. A configuration with 512K bytes of RAM, a floppy-disk drive, and a 20-megabyte hard-disk unit is $5505.

The PC6 is supplied with Intel's dual-speed (i.e., 4.77/8-MHz) 8088-2 microprocessor, 256K bytes of RAM, twin 360K-byte floppy-disk drives, RS-232C and parallel interfaces, and eight expansion slots. It comes with NCR-DOS, which provides compatibility with the IBM PC XT. An on-line help program, GW-BASIC, and a pair of tutorial software packages are also standard.

A number of mass-storage configurations are offered, including 20 megabytes of hard-disk storage and 10 megabytes of streaming-tape backup.

Options include monochrome and color monitors. PC6 pricing begins at $2583.

Contact NCR Corp., Dayton, OH 45479, (513) 445-2075.

Inquiry 601.

Visual Environment for C Programmers

Living C—Personal is a visual programming environment for C-language programmers. It facilitates the design, development, maintenance, and debugging of C programs by showing you exactly what happens at each step of a program's execution.

You can use Living C—Personal to animate your source code during execution. You can do this statement by statement within user-specified breakpoints or through the entire program. When a bug is found during compilation, Living C—Personal does not force you to abandon the environment because its full-screen editor is still available.

With Living C—Personal, your program's output is separated from the debugging information by on-screen windows. You can use the window facility to continuously display a variable's value or to examine and alter the variable.

Living C—Personal provides help facilities and explicit error diagnostics, and it conforms to the Kernighan & Ritchie C standard. It runs under PC-DOS and is priced at $99. Contact Living Software, London House, 243-253 Lower Mortlake Rd., Richmond, Surry, England; tel: 44 1 948 5166; Telex: 946 240 cweasy.

Inquiry 602.

IBM Jetprinter and Proprinter

IBM has announced a color ink-jet printer and a replacement for its dot-matrix Graphics Printer.

The ink-jet Color Jetprinter can produce hard copy in seven colors. Its dot resolution is 100 by 96 pixels per inch. The Color Jetprinter sells for $745.

The dot-matrix printer, called the Proprinter, is compatible with the Graphics Printer but is faster, with an advertised speed of 200 cps in draft mode and 40 cps in near-letter-quality mode. It has a maximum horizontal resolution of 240 pixels per inch. The Graphics Printer, which Epson manufactured, is being discontinued. The Proprinter is made by IBM and sells for $549.

Contact IBM Corp., Information Systems Group, 900 King St., Rye Brook, NY 10573.

Inquiry 603.

(continued)

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EXECUTION SPEED	9 SEC	13 SEC	20 SEC
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BUILT-IN INTERACTIVE EDITOR	YES	YES	NO
ONE STEP COMPILE (NO LINKING NECESSARY)	YES	YES	NO
COMPILER SIZE	39K	35K	300K+
TURTLE GRAPHICS	YES	NO	NO
BCD OPTION	YES	NO	YES
PRICE	\$69.95	\$54.95	\$295.00

(*) **Benchmark** run on an IBM PC using MS Pascal version 3.2 and the DOS linker version 2.6. The 179 line program used is the "Gauss-Seidel" program out of Alan R. Miller's book: *Pascal programs for scientists and engineers* (Sybex, page 128) with a 3 dimensional non-singular matrix and a relaxation coefficient of 1.0.

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Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

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Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX version of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

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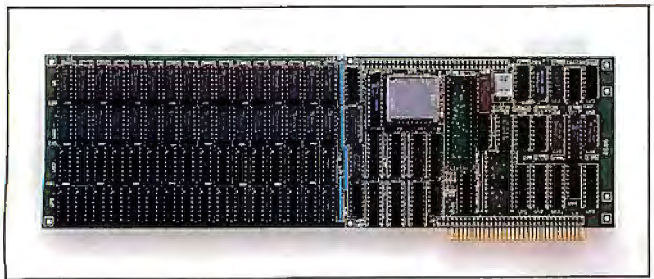

Pfaster286, an 80286 *add-in board for the* IBM.

80286 Add-in Board for IBM PC and PC XT

Phoenix Computer Products' Pfaster286 is an 8-MHz 80286-based add-in board that gives the IBM PC and PC XT the ability to process data at a faster rate than the IBM PC AT. It does not impair the functionality of the PC's or PC XT's resident 8088 microprocessor; rather Pfaster286 reassigns the 8088's intelligence to I/O management.

Pfaster286 can run MS-DOS 2.0, 2.1, and 3.1 programs, and applications designed for the IBM PC and PC AT will operate with it. Pfaster286 has software switches that let you jump back and forth into the native 8088 mode for those applications requiring that chip's performance characteristics.

The basic Pfaster286 is supplied with 1 megabyte of RAM, expandable to 2 megabytes, and an empty socket for an 80287 floating-point processor. Your operating system and applications software can use approximately 704K bytes of this board's RAM. Some of its miscellaneous features are disk caching, diagnostics, four DMA channels, eight levels of priority interrupts, and 16K bytes of EPROM expandable to 256K bytes.

Pfaster286 is $2395, which includes an 8088 service program to call up the board and to load Pfaster286's AT ROM BIOS-emulation software. The 80287 mathematics coprocessor is $350, and 512K-byte RAM increments are $400. Contact Phoenix Computer Products Corp., Suite 115, 1420 Providence Highway, Norwood, MA 02062, (800) 344-7200; in Massachusetts, (617) 762-5030.

Inquiry 604.

High-Speed Modem

An asynchronous 9600-bps modem, the UPTA 96, comes in an internal, piggyback version for the IBM Personal Computer and in a stand-alone configuration with an RS-232C connector for a variety of computers. The suggested retail price for the add-in card is $795, and the stand-alone UPTA 96 is $895.

This intelligent half-duplex modem operates over standard dial-up telephone lines or through computer-to-computer links. It's data-rate selectable for 4800-, 7200-, and 9600-bps transmission speeds, with automatic fall-back to 7200 or 4800 bps when noisy lines are encountered during 9600-bps communications. Standard are automatic adaptive equalization to ensure data integrity, auto-dial, auto-answer, full-duplex emulation, and compatibility with the Hayes command set.

The UPTA 96 comes with proprietary error-detection/correction circuitry firmware known as EDI (Ensured Data Integrity). EDI organizes data into numerically sequenced packets, with each byte subject to a cyclic-redundancy check and packet-check generation during transmission. The protocol also offers selective automatic request for transmission (ARQ).

The UPTA 96 supports asynchronous 3270 and VT-100 emulation software. It's FCC-certified for direct connection to the public-switched telephone network by means of a USOC RJ11 jack. Contact Electronic Vaults Inc., Suite 714, 8350 Greensboro Dr., McLean, VA 22102, (703) 883-0331.

Inquiry 605.

The Zenith Z-200 *is compatible with* IBM's PC AT.

Zenith's Z-200 Advanced PC

Zenith Data Systems' Z-200 Advanced PC, an IBM PC AT-compatible computer, uses Intel's 6-MHz 80286 microprocessor and no-wait-state technology for increased processing speed. The standard model comes with 512K bytes of dynamic RAM, a single 1.2-megabyte floppy-disk drive, six expansion slots that can accommodate AT hardware, and MS-DOS 3.1. It costs $3999.

RS-232C, Centronics parallel, and video interface ports are provided on this computer. A choice of video cards is offered. The Z-200 Advanced PC also comes with a combination Winchester/floppy-disk controller board that can handle two floppy- and three hard-disk drives.

The Z-200 Advanced PC's keyboard features enlarged backspace, delete/insert, caps lock, scroll lock, and system request keys. Impression marks on the home-row keys have been included.

The Z-200 Advanced PC's dynamic RAM can be expanded to 16 megabytes in 1.5-megabyte increments. XENIX is available for multiuser, multitasking environments. The Z-200 Advanced PC can be obtained with a 20-megabyte hard disk for $5599.

Contact Zenith Data Systems Corp., 1000 Milwaukee Ave., Glenview, IL 60025, (800) 842-9000, ext. 1; in Illinois, (312) 391-8949.

Inquiry 606.

(continued)

INFOWORLD'S SOFTWARE PRODUCT OF THE YEAR

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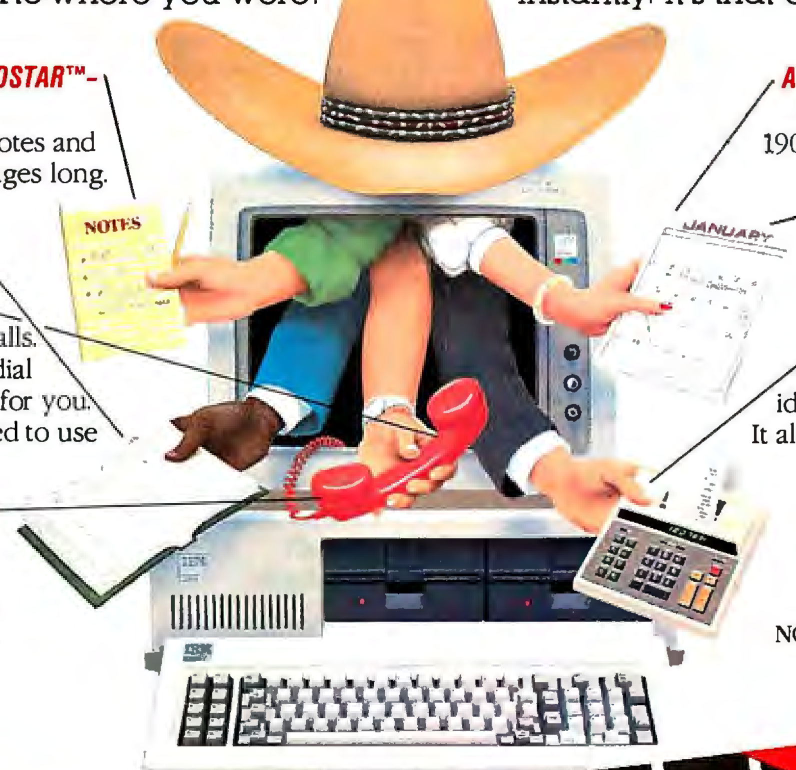

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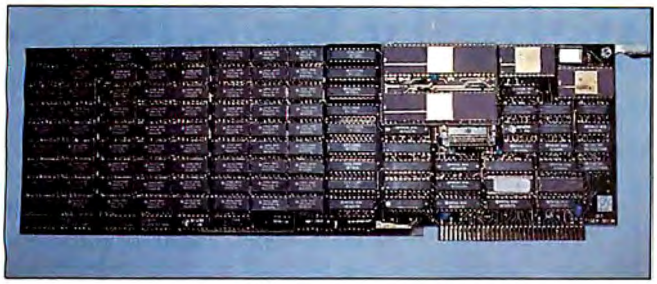


The Tiger-32 accommodates 2 megabytes of no-wait-state RAM.

NS32032 Add-in Board for IBM

The Tiger-32 is a 32-bit add-in board for IBM PC, PC XT, and PC AT computers. It has a 6- or 10-MHz National Semiconductor NS32032 or NS-32016 central processor, an NS32082 demand-paged virtual-memory manager, and from 512K bytes to 2 megabytes of no-wait-state RAM. Tiger-32 comes with Microsoft-Logica's XENIX-32 version 3.0, a two-user operating system.

The Tiger-32 can execute large programs, but it does not execute IBM PC code directly. It can function as expansion memory or as a disk emulator. Among its hardware specifications are two RAM ports, parity error checking, and 150-nanosecond access time.

The board has both linear and window modes. In its linear mode, the Tiger-32 acts as an expansion memory. The window mode lets your PC access the Tiger-32's RAM through any one of sixteen 128K-byte windows.

With XENIX-32, this board uses PC-DOS 2.0 or higher as an input/output processor. The Tiger-32 comes with a visual shell interface, software-development utilities with C and assembly language, and communications, text-processing, installation, interfacing, and test software.

Up to 2 megabytes of RAM and a 32-bit floating-point mathematics unit are optional. Software options include remote user capability, BASIC, COBOL, FORTRAN, and Pascal.

The Tiger-32 with 512K bytes of RAM, a 6-MHz NS32016, and XENIX-32 is $2495. With the NS32032, it's $2795. The mathematics unit is $425 at 10 MHz and $275 at 6 MHz. Contact DFE Electronic Data Systems, Suite 115, 5820 Stoneridge Mall Rd., Pleasanton, CA 94566, (415) 847-2024.
Inquiry 607.

Macintosh Spreadsheet

Crunch for the 512K-byte, single-drive Macintosh is an integrated spreadsheet program with graphics, data-management, and notekeeping capabilities. The suggested retail price is $295.

Crunch's spreadsheet gives you a 250-column by 9999-row work area, and it can be linked with other worksheets. Depending upon the font used, you can display up to 31 rows on the screen. Wide spreadsheets can be printed out sideways.

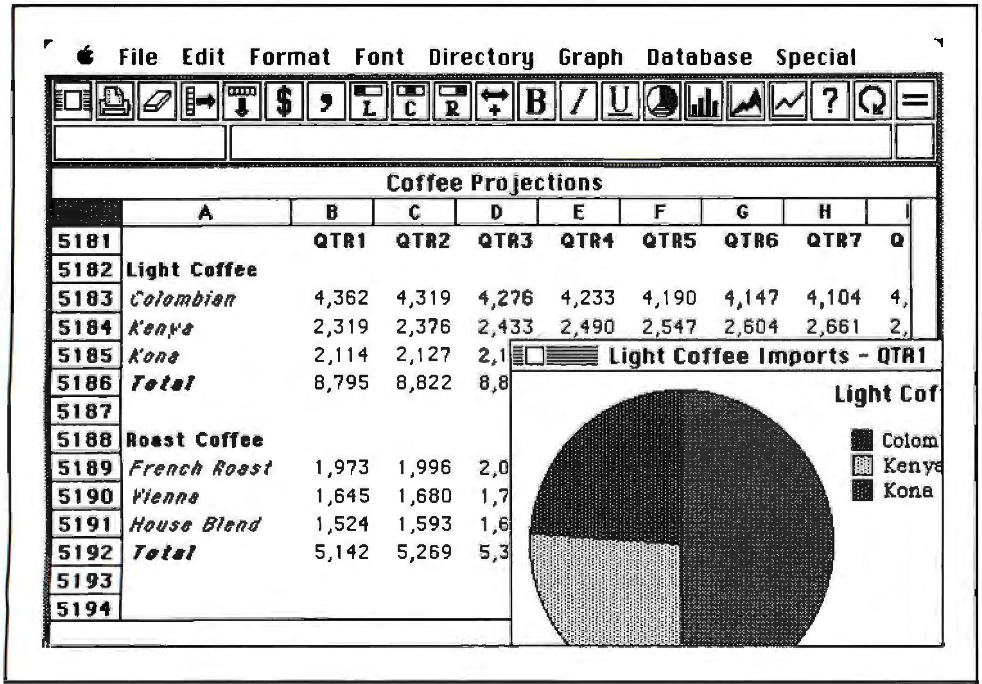
Seventy-four mathematics, trigonometric, statistics, logic, financial, table, and date functions are built into Crunch. In addition, it has three special functions and gives you the ability to define up to 1000 functions.

Crunch can perform both natural-order and row-wise calculations. You can hide or password-protect cells containing sensitive data. Other features include audit trails, variable-width columns, adjustable cell alignment, and the ability to assign names to cells, ranges, formulas, and constants.

You can link graphs to worksheets, and four graphs can be displayed simultaneously. Crunch produces pie, line, bar, and area graphs.

Crunch's data manager organizes worksheet rows into database records anywhere within the worksheet. You can use it to perform calculations on records, and you can sort records. Crunch's notepad can be used for merging information with other programs and to keep 2½ pages of worksheet documentation.

Crunch uses icons, windows, and a consistent set of commands. It works with the Apple Numeric Keypad and supports the LaserWriter and the Imagewriter. Contact Paladin Software Corp., 2895 Zanker Rd., San Jose, CA 95134, (408) 946-9000.
Inquiry 608.



Sample multiwindow display produced by Crunch.

(continued)

Spectravideo Product Line

Spectravideo recently introduced four computers: two IBM PC-compatibles, a laptop, and a dedicated word processor. In a related announcement, Spectravideo said that it will begin delivering its MSX Express (Model SVI-738) computer in September. This computer has a 3½-inch floppy-disk drive, a 73-key keyboard, 64K bytes of RAM, and an 80-column-display capability. The MSX Express will sell for $595.

Spectravideo's Bondwell 34 and 36 are 16-bit desktop computers that are compatible with the IBM Personal Computer. The 256K-byte Spectravideo Bondwell 34 comes with dual 5¼-inch double-sided double-density floppy-disk drives, an 80-column monochrome-monitor interface, and a Centronics-type parallel interface. GW-BASIC and MS-DOS are bundled with this system. The planned release date is in October, and the suggested retail price will be $1795.

The Spectravideo Bondwell 36 carries most of the features of the Bondwell 34, except that its storage system comprises a 10-megabyte hard-disk drive and a single floppy-disk unit. It, too, is scheduled for an October release. The Spectravideo Bondwell 36 will retail for $2995.

An 11-pound, battery-rechargeable device, the Spectravideo Bondwell 2 laptop computer runs under CP/M 2.2. It's built around the Z80L microprocessor and offers an integral 3½-inch single-sided double-density floppy-disk drive and an 80-column by 25-line LCD screen. The screen resolution is 640 by 200 pixels, and the formatted floppy-disk storage capacity is 360K bytes.

Six MicroPro software packages come with this computer: WordStar, ReportStar, CalcStar, MailMerge, DataStar, and Scheduler Plus. Options include an external 3½-inch disk drive and a carrying case. The Spectravideo Bondwell 2 should retail for less than $1000 when it's released in September.

The Spectravideo Bondwell 22 is a 16-bit, 8088-based word-processing system with dual monitors for text and menu displays. Its 97-key keyboard has 31 software-programmable function keys and a trackball cursor controller. The Spectravideo Bondwell 22 comes with a pair of floppy-disk drives, a hard-disk interface, a real-time clock, two RS-232C ports, a Centronics-type parallel interface, and a daisy-wheel printer.

This system's word-processing software offers document merge and forms generation, as well as a conversion program for accessing WordStar files from other computers. A clock program with an alarm, calendar, and reminder functions is provided. Shipments are to begin in January 1986. Pricing had not been determined at press time.

Contact Spectravideo Inc., 3300 Seldon Court #10, Fremont, CA 94539, (415) 490-4300.
Inquiry 609.

The BT/AT is hardware- and software-compatible with the AT.

BT/AT Computer Is Compatible with PC AT

The BT/AT from Basic Time is compatible with hardware and software designed for the IBM PC AT computer.

Based on Intel's 16-bit 80286 microprocessor, which runs at 6 MHz, the BT/AT comes with 640K bytes of RAM, eight expansion slots, and two serial and two parallel ports. Its monochrome graphics adapter card is compatible with the Hercules card, and the display resolution is 720 by 348 pixels. The BT/AT's 12-inch green monitor is mounted on a tilt-and-swivel base.

Mass storage is provided by a 44-megabyte hard-disk drive and a 1.2-megabyte floppy-disk drive that can read and write 360K-byte floppy disks. The average access time for the hard disk is 30 milliseconds.

The BT/AT comes with MS-DOS 3.1 and GW-BASIC, and it has an open socket for an 80287 mathematics coprocessor. Options include a multifunction board, a high-resolution monitor, and a color graphics adapter. A 70-megabyte hard-disk drive and a 60-megabyte streaming-tape backup are also available.

The suggested retail price for the BT/AT is $4495. Contact Basic Time, Building 52, 3350 Scott Blvd., Santa Clara, CA 95054, (408) 727-0877.
Inquiry 610.

Programmable Logic Chips

Altera's EP310 is an erasable programmable-logic chip that uses Intel's CHMOS technology for low power consumption. You can program this chip to have the equivalent of 300 logic gates.

The EP310 is a 20-pin DIP device that can be programmed using Altera's PLDS2 (Programmable Logic Development System), a $2500 software/hardware combination that attaches to an IBM PC. You can erase the EP310 with an ultraviolet eraser.

The EP310 chips cost $11.79 in 100-unit quantities. Contact Altera Corp., 3525 Monroe St., Santa Clara, CA 95051, (408) 984-2800.
Inquiry 611.

(continued on page 406)

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Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 29K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

Portability. Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX verison of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

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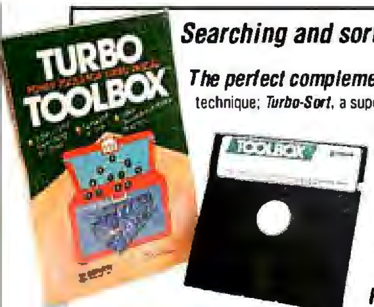

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Jerry Pournelle, BYTE: "The tools include a B+tree search and a sorting system; I've seen stuff like this, but not as well thought out, sell for hundreds of dollars."

Get started right away: free database! Included on every Toolbox disk is the source code to a working data base which demonstrates how powerful and easy to use the Turbo-Access system really is. Modify it to suit your individual needs or just compile it and run.

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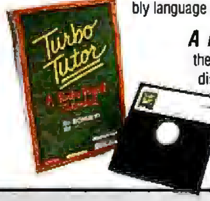

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Conducted by Steve Ciarcia

Biblical Speech Synthesizer

Dear Steve,

Being interested in the teaching of English as a foreign language, I would like to take from a disk, as input, a previously computerized text like the Bible and output it through a speech synthesizer, meanwhile delaying the video-screen readout to appear following the speech output, phrase by phrase or sentence by sentence.

Among your many circuits, is there one that could be used or adapted for this purpose?

G. Kaye
Paxton, IL

The Microvox text-to-speech synthesizer will serve your purpose with some additional software. The controlling computer needs a small program to read a line or phrase from the disk, send it to the Microvox, wait for the designated time while the phrase is spoken, and then print it to the screen. This is a simple job for the computer, and the Microvox will speak the line as it is received.

The problem with this concept is that the text-to-speech algorithm does not handle all pronunciations adequately. This could be handled with a little extra work by editing the text to correct the improper pronunciations, using the methods described in my October 1982 Circuit Cellar article.

A more sophisticated system was described in the article "Three Tiered Software and VLSI Aid Developmental System to Read Text Aloud" by Edward Bruckert, Martin Minow, and Walter Tetschner in the April 21, 1983, issue of Electronics *magazine. This system uses basically the same conversion algorithm as the Microvox, but it has more memory, a faster processor (MC68000), and tests against more rules. Write to Digital Equipment Corp. (HL2-1/E10, 77 Reed Rd., Hudson, MA 01749) for information on availability and price.*—Steve

How About the Sanyo?

Dear Steve,

I want to buy an IBM PC-compatible system, and the Sanyo MBC 555 looks very promising. I am having great problems finding out the extent of the compatibility. Scottsdale Systems states that the MBC 555 will run many programs written for the IBM PC, while National Computer Products says the MBC will run all software currently available for the PC. What is the truth?

Second, does the Sanyo have IBM PC-compatible slots?

Signor Shafik
Yonkers, NY

The Sanyo MBC 555 will run a lot of IBM PC software. The May 1984 issue of Microcomputing *magazine lists 29 programs written for the IBM PC that will run on the Sanyo. Most of these are business and word-processing packages, including dBASE II, Bottom Line Strategist, and Financial Planner from Ashton-Tate; Volkswriter from Lifetree; Type Faces from Alpha Software; and Perfect Filer and Calc from Perfect Software. Three of the programs listed in the magazine require double-sided drives, which are not yet available.*

Generally, any IBM PC program that uses only MS-DOS functions can be expected to run on the Sanyo, but programs that use IBM PC hardware-specific functions or interrupts defined in the IBM PC ROM BIOS probably won't. Unfortunately, there isn't any way to tell which programs will run except to try them.

An example of the incompatibility is that the versions of the Information Unlimited Software Easy-series programs bundled with the machine won't run on the IBM PC, even though the same programs are available in IBM PC and MS-DOS versions.

The Sanyo BASIC is somewhat different from both the IBM and generic versions of Microsoft BASIC. IBM BASIC programs will run when none of the IBM hardware-specific BASIC instructions are used.

Lastly, the Sanyo does not have IBM PC-compatible expansion slots, but double-sided disk drives commonly used in IBMs, like the TEAC 55B half-height drives, apparently will work.—Steve

Victor Software

Dear Steve,

Thank you again for your reply to my letter about Ukrainian word processing. I have taken your advice and purchased the Victor 9000. I am quite pleased with the machine. I only regret that the company has gone bankrupt. Now I am using MultiMate word processing. I also ordered the Programmer's Toolkit to be able to create my Ukrainian character set, but I am still waiting for delivery. Perhaps Victor will still be able to come through.

Victor has come out with a special controller board that permits the use of IBM software, but it costs about $900. If I had that much to spend, I would save up a little more and simply get another computer.

Do you know if it would be possible to connect another drive to the Victor 9000 so I would be able to use either IBM or Apple software? Perhaps the expense would not be worth the trouble. In any event, I would appreciate your advice.

Maxim M. Kobasuk
Glen Cove, NY

Victor did file for bankruptcy, but the company is still in business. You may still be able to get the Programmer's Toolkit from them. If it turns out that they cannot deliver, you may be able to obtain the program from United Software Co. of Tulsa, Oklahoma, a company that specializes in software for the Victor 9000 and other IBM PC clones. There are more than 100,000 Victor 9000 computers out there, so there are still interested software producers and distributors. It was recently reported in InfoWorld *that the Victor dealers have a catalog of 1000 or so software packages currently available in the U.S. and about 1500 overseas.*

Changing disk drives won't help you run Apple or IBM software. The drives on the Victor are mechanically able to read these disks, but the machine has a completely different architecture from the Apple II series and would require either an emulation program or special hardware similar to the QuadLink board available for the IBM PC.—Steve

Cheap Long Distance

Dear Steve,

In search for a reliable high-speed link for microcomputers, I read "Communica-

(continued)

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dBASE III is a registered trademark of Ashton-Tate tion Without Wires" in the June 1984 Ask BYTE. The system you suggest there may be inexpensive, but it does not satisfy my requirement of a long-distance, reliable, and inexpensive link for my IBM PC. I believe my best bet would be a high-speed modem to be used with normal long-distance calls. However, a 1200-bps modem would yield only about 120 words per minute, which makes this system very expensive when one has to pay $1.50 for those 120 words.

Do you have knowledge of a truly fast, reliable modem not so expensively priced? Or perhaps an idea of another system for a reliable long-distance link for micros?

Thank you very much for whatever ideas you can give me.

AL VILLACRES
Quito, Ecuador

There essentially aren't any long-distance data-communication links meeting all your requirements. Cost is the problem. Amateur radio is an inexpensive method, but bandwidth restrictions limit speed, and, of course, you can send only to other hams.

There is hope in the form of a new service expected to be introduced in 1985 by AT&T. This service, based on pulse-coded modulation, will allow full-duplex communication at up to 56,000 bps over regular phone lines. See "AT&T Breaks the Speed Barrier" in the September 1984 Computers and Electronics *magazine. No word on cost, but it may be some time before inexpensive equipment is available.*—Steve

FILE TRANSFERS

Dear Steve,

My problem is trying to swap data files (mostly, but not entirely, WordStar) from 8-inch double-density disks on an Altos 8002 to either the hard disk or 5¼-inch disks on a TI Professional Computer.

I do not have a modem on either computer. I plan to add one to the TI eventually but don't see much need for one at present. I still have the Altos up and running.

JOHN W. JUECHTER
East Greenwich, RI

Table 1: *Null-modem connections.*

PIN	PIN
2	3
3	2
4	5
5	4
6	20
20	6

If you have RS-232C serial ports in both computers and they are located in close proximity to each other (20 feet or so), you don't need modems to set up a communication link. Make or buy a cable configured as a null modem, as shown in table 1. You may also need a program to facilitate data transmission in one or both computers.

If you are running MS-DOS on your TI, you can use the COPY *command to copy directly from the communication port to a disk file. Simply set up the communication protocol using the* DOS MODE *command, e.g.,* MODE COM1:96,n,8,1 *to set for data transfer at 9600 bps, no parity check, 8-bit words, and 1 stop bit. See your DOS manual for other options. Follow this with the command* COPY COM1: d:filename.ext *(you may have to say* AUX *instead of* COM1:*). The computer will wait for data to come in.*

I assume you are using CP/M on your Altos. Some implementations of CP/M include a similar function in the PIP *command. If yours doesn't, you will need a program to read your files and transmit the data. An inexpensive one for 8-bit CP/M systems is MODEM7, which can be obtained from CP/M Users Group, 1651 Third Ave., New York, NY 10028.*—Steve

MX-80 SUPERSCRIPTS

Dear Steve,

I teach a course in word processing using the Apple II+ and Apple Writer. We have an Epson MX-80 printer.

Can you please explain to me how to get superscript numbers for footnotes using this equipment?

I have called both the Apple people and the Epson people, and both told me to contact the other. Help!

BETTYE JO MARTIN
Atlanta, GA

Certain special characters must first be sent to an Epson MX-80 to enable it to print superscripts. These consist of the ESC(ape) and Control-N characters. They are simply commands that tell the printer to change to the superscript print mode. When using Apple Writer, these characters should be placed immediately before the text you wish to be superscripted. Of course, you will eventually wish to turn off the superscript mode.

(continued)

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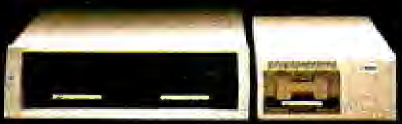

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This is done by placing the characters ESC and Control-O at the end of the text to be superscripted.

To enter the special characters mentioned above, you must use the Apple Writer Control-V command. This will cause ESC or any control characters that you now type to be inserted directly into the text at the location of the cursor, instead of being interpreted as a possible command. Control-V must be used since ESC, Control-N, and Control-D are all commands to the Apple Writer program itself. Press Control-V again to exit this special insertion mode.

The characters that must be sent to the printer to control its various printing styles can be found in the manual that came with the printer. The same technique described in the above paragraph may be utilized to print in elite, emphasized, boldface, or other styles. Simply insert the correct characters into the text using the Control-V command.—Steve

Osmosis on the Osborne 1

Dear Steve,

I have installed an Osmosis double-density modification in my Osborne 1. Even after making the circuit-board changes they recommend, I still do not get reliable double-density operation. Can you supply a reference that goes into detail about the difference between single and double density?

Robert E. Falkoski
Richland, WA

A principal difficulty encountered with storing data on floppy disks is the phenomenon of bit shifting, *which refers to the physical movement of the location of a recorded bit due to the influence of neighboring bits. If left uncorrected, this shifting could cause unreliable retrieval of recorded information. While these bit-shifting influences exist on single-density disks, the effects are small enough to ignore.*

On double-density disks, the effects are magnified, and the techniques to record and decipher information must become more sophisticated. One technique uses write precompensation *logic to adjust the spacing of the bits as they are written to disk, so that they will be evenly spaced during subsequent read operations. Such logic is usually handled by the disk-controller circuitry.*

An excellent, and very readable, discussion of these techniques, as well as a source of some practical circuit examples,

(continued)

AZTEC The Most Powerful C

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IBM PC/XT • APPLE // • CP/M-86 • TRSDOS • CROSS DEVELOPMENT

Why Professionals Choose Aztec C

AZTEC C compilers generate fast, compact code. AZTEC C is a sophisticated development system with assemblers, debuggers, linkers, editors, utilities and extensive run time libraries. AZTEC C is documented in detail. AZTEC C is the most accurate and portable implementation of C for microcomputers. AZTEC C supports specialized professional needs such as cross development and ROM code development. MANX provides qualified technical support.

AZTEC C86/PRO
— for the IBM AT and PC/XT

AZTEC C86/PRO provides the power, portability, and professional features you need to develop sophisticated software for PC DOS, MS DOS AND CP/M-86 based microsystems. The system also supports the generation of ROM based software for 8088/8086, 80186, and 80286 processors. Options exist to cross develop ROM code for 65xx, 8080, 8085, and Z80 processors. Cross development systems are also available that target most micro computers. Call for information on AZTEC C86/PRO support for XENIX and TOPVIEW.

POWERFUL — AZTEC C86/PRO 3.2 outperforms Lattice 2.1 on the DHRYSTONE benchmark 2 to 1 for speed (17.8 secs vs 37.1) while using 65% less memory (5.8k vs 14k). The AZTEC C86/PRO system also compiles in 10% to 60% less time and supports fast, high volume I/O.

PORTABLE — MANX Software Systems provides **real** portability with a family of compatible AZTEC C software development systems for PC DOS, MS DOS, CP/M-86, Macintosh, CP/M-80, APPLE // +, //e, and //c (NIBBLE - 4 apple rating), TRSDOS (80-MICRO - 5 star rating), and Commodore C64 (the C64 system is only available as a cross compiler - call for details). AZTEC C86/PRO is compatible with UNIX and XENIX.

PROFESSIONAL — For professional features AZTEC C86/PRO is unparalleled.

- Full C Compiler (8088/8086 - 80186 - 80286)
- Macro Assembler for 8088/8086/80186/80286
- Linkage Editor with ROM support and overlays
- Run Time Libraries - object libraries + source DOS 1.x; DOS 2.x; DOS 3.x; screen I/O; Graphics; UNIX I/O; STRING; simulated float; 8087 support; MATH; ROM; CP/M-86
- Selection of 8088/8086, 80186, or 80286 code generation to guarantee best choice for performance and compatibility
- Utility to convert AZTEC object code or libraries to Microsoft format. (Assembly + conversion takes less than half the time as Microsoft's MASM to produce MS object)
- Large memory models and sophisticated memory management
- Support products for graphics, DB, Screen, & ...
- ROMable code + ROM support + separate code and data + INTEL Hex Converter
- Symbolic Debugger & Other Utilities
- Full Screen Editor (like VI)
- CROSS Compilers are available to APPLE //, Macintosh, CP/M-80, TRSDOS, COMMODORE C64, and ROM based 65xx, and 8080/8085/Z80
- Detailed Documentation

AZTEC C86/PRO-AT $500
(configured for IBM AT - options for 8088/8086)

AZTEC C86/PRO-PC/XT $500
(configured for IBM PC/XT - options for 80186/80286)

AZTEC C86/BAS includes C compiler (small model only), 8086 MACRO assembler, overlay linker, UNIX, MATH, SCREEN, and GRAPHICS libraries, debugger, and editor.

AZTEC C86/BAS	$199
AZTEC C86/BAS (CP/M-86)	$199
AZTEC C86/BAS (DOS + CP/M-86)	$299
UPGRADE to AZTEC C86/PRO	$310
C-TREE Database with source	$399
C-TREE Database (object)	$149

CROSS COMPILERS

Cross Compilers for ROM, MS DOS, PC DOS, or CP/M-86 applications.

VAX - > 8086/80xxx cross	$5000
PDP-11 - > 8086/80xxx cross	$2000

Cross Compilers with PC DOS or CP/M-86 hosts are $750 for the first target and $500 for each additional target. Targets: 65xx; CP/M-80; C64; 8080/8085/Z80; Macintosh; TRSDOS; 8086/8088/80186/80286; APPLE //.

AZTEC C68K
— for the Macintosh

For power, portability, and professional features AZTEC C68K-c is the finest C software development system available for the Macintosh.

The AZTEC C68K-c system includes a 68000 macro assembler, a linkage editor, a source editor, a mouse based editor, a SHELL development environment, a library of UNIX I/O and utility routines, full access and support of the Macintosh TOOLBOX routines, debugging aides, utilities, make, diff, grep, TTY simulator with upload & download (source supplied), a RAM disk (for 512K Mac), a resource maker, and a **no royalty** license agreement. Programming examples are included. (Over 600 pages of documentation).

AZTEC C68K-c requires a 128K Macintosh, and two disk drives (frugal developers can make do with one drive). AZTEC C68K supports the 512K Macintosh and hard disks.

AZTEC C68K-c (commercial system)	$500
AZTEC C68K-p (personal system)	$199
AZTEC C68K-p to AZTEC C68K-c upgrade	$310
Mac C-tree database	$149
Mac C-tree database with source	$399
Lisa Kit (Pascal to AZTEC C68k object converter)	$ 99

AZTEC C65
— for the APPLE //

"...The AZTEC C-system is one of the finest software packages I have seen..." NIBBLE review, July 1984.

The only commercial C development system available that runs native on the APPLE II+, IIc, and IIe, the AZTEC C65 development system includes a full floating point C compiler compatible with UNIX C and other MANX AZTEC C compilers, a 6502 relocating assembler, a linkage editor, a library utility, a SHELL development environment, a full screen editor, UNIX I/O and utility subroutines, simple graphics, and screen functions.

AZTEC C65 (Apple DOS 3.3) $199
AZTEC C65/PRO (Apple DOS + ProDos) $350
(call for availability)

AZTEC C II/PRO
— for CP/M-80

The first member of the AZTEC C family was the CP/M-80 AZTEC C compiler. It is "the standard" compiler for development on CP/M-80. The system includes the AZTEC C II C compiler, an 8080 assembler, a linkage editor, an object librarian, a full library of UNIX I/O and utility routines, CP/M-80 run time routines, the SMALL library (creates modules less than 3K in size), the fast linker for reduced development times, the ROM library, RMAC and M80 support, library source, support for DRI's SID/ZSID symbolic debugger, and more.

AZTEC C II/PRO	$349
AZTEC CII/BAS	$199
C-TREE Database with source	$399
C-TREE Database in AZTEC object form	$149

AZTEC C80
— for TRSDOS (Radio Shack Model III & 4)

"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

This sytem has most of the features of AZTEC C II for CP/M. It is perhaps the best software development system for the Radio Shack Model III and IV.

AZTEC C80 model 3 (no floating point)	$149
AZTEC C80 model 4 (full)	$199
AZTEC C80/PRO (full for model 3 and 4)	$299

To order or for information call:

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(201) 530-7997 (NJ and outside U.S.A.). Or write: MANX SOFTWARE SYSTEMS, P.O. Box 55, Shrewsbury, N.J. 07701.

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SHIPPING INFORMATION - Standard U.S. shipment is UPS ground (no fee). In the U.S. one day shipment is $20, two days is $10. Canadian shipment is $10. Two days shipment outside the U.S. is by courier and is freight collect.

For Technical Support
(Bug Busters) call: 201-530-6557

ASK BYTE

can be found in Microcomputer Interfacing *by Harold S. Stone (Addison-Wesley, 1982). Another reference that discusses aspects of the disk-recording process and that may help you is "IBM Compatible Disk Drives" by Jefferson H. Harman, which appeared on page 100 of the October 1979 BYTE.*

Manufacturers' service manuals for disk drives often discuss the theory of operation and outline the necessary timing considerations for the disk drive and computer. These manuals can usually be obtained from the drive manufacturer's field offices.—Steve

VIC-20–CONTROLLED ROBOT

Dear Steve,

I tried to interface a simple robot I made to my VIC-20 via the communications port. The robot is run by small DC motors. Where can I find information about the software needed to control pulses from the port (what to poke and where) and the hardware needed to convert these pulses to a current and voltage to drive the motors? Thanks for any help that you can provide.

MICHAEL LEVIN
Swampscott, MA

An excellent series of articles by Joel Swank on interfacing to the VIC-20 ("The Enhanced VIC-20") appeared in the February through May 1983 issues of BYTE. This series should give you the necessary information about the VIC-20 and how to interface to it. You should also read my article on page 105 of the December 1984 BYTE, "Build the Power I/O System," for information on how to connect real-world peripherals to a system. This article will give you a good understanding of optoisolators, which should be used in computer real-world applications.—Steve ■

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

Ask BYTE
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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 Bill Curlew, Larry Bregoli, Dick Sawyer, Robert Stek, and Jeannette Dojan.

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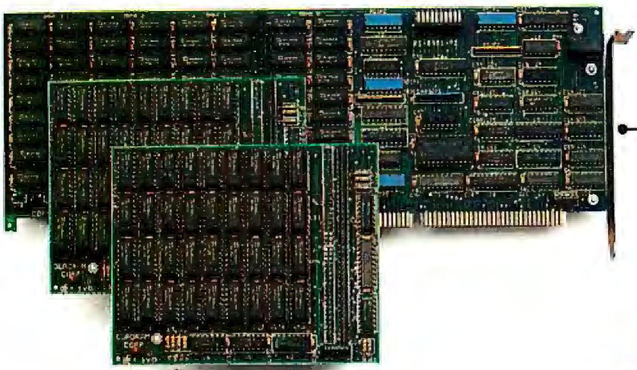

greater amounts of information, and process data faster and more efficiently than ever before. Plus, with "split memory mapping," Quadmeg-AT lets you expand the AT's base system memory to 640K without buying a space-wasting 128K card.

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When you need more than 2Mbytes, Quadmeg-AT adapts with two Quadmeg-AT Expansion Cards. Each packs 512K or 1Mbyte extra RAM.

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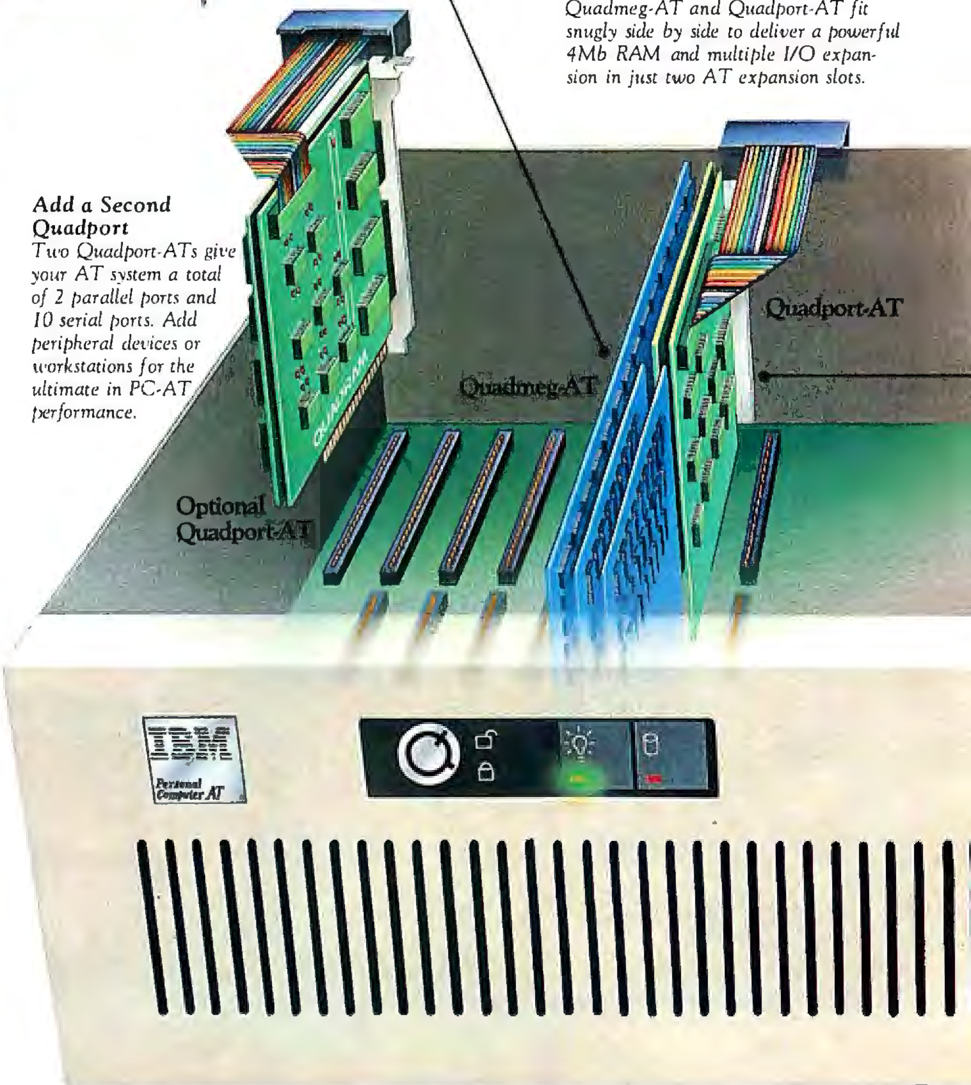

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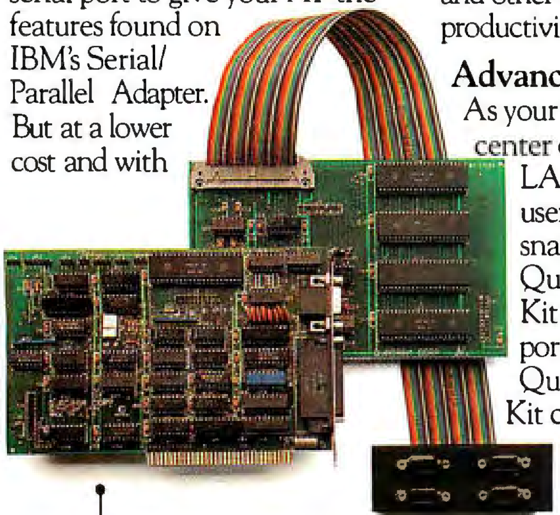

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As your AT becomes the center of a high-performance LAN or growing multi-user, multi-tasking system, snap on the optional Quadport-AT Expansion Kit and add 4 more serial ports to your system. The Quadport-AT Expansion Kit comes with software to access these ports, making it easy to add shared peripherals or workstations.

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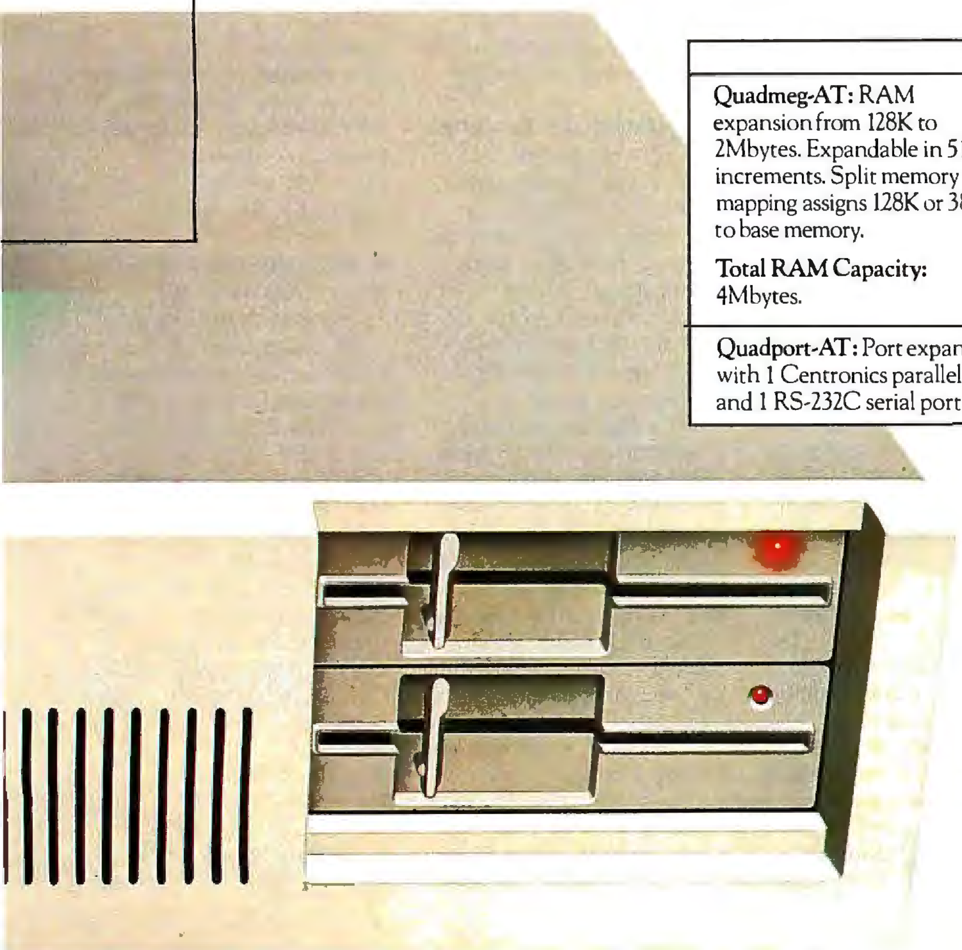

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Quadmeg-AT: RAM expansion from 128K to 2Mbytes. Expandable in 512K increments. Split memory mapping assigns 128K or 384K to base memory.	**Expansion Cards:** Two cards available. Each comes with 512K or 1Mbyte RAM installed.
Total RAM Capacity: 4Mbytes.	**QuadMaster-AT Software:** RAM Drives and Spooling for extended memory.
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● THE SILENT SPEAK
A quarterly newsletter about electronic aids for the handicapped, *Current Expressions*, contains letters written with the aid of special computers from victims of otherwise disabling diseases. Profiles, a calendar of events, new products, and advertisements all relate to easing communication for the disabled. Article submissions are welcome. Contact Susanne Shealey, *Current Expressions*, Prentke Romich Co., 1022 Heyl Rd., Wooster, OH 44691, (216) 262-1984.

● DRBBS FREE FOR ALL
The DRBBS Technical Bulletin Board System at (402) 896-3537 is free to all personal computer users 24 hours a day at 300 or 1200 bps. General messages, electronic mail, on-line information, public-domain file transfer, and special-interest sections are featured. Call the BBS or contact J. Winslade, DRBBS Technical Bulletin Board System, 14725 Emiline St., Omaha, NE 68138, (402) 895-1379.

● SEPARATE BUT EQUAL
The Federation of Computer Users in Medicine (FOCUS–MD) and the Federation of Computer Users in Dentistry (FOCUS–DDS) are two separate organizations staffed by qualified volunteers and run by the same nonprofit institution. Each group welcomes prospective health professionals who use computers. The annual membership fee of $100 for each group includes a newsletter. Each group maintains a consultant registry for which applicants must pay an additional fee to cover the cost of testing. Separate seminars are scheduled the first Sunday of each month across the country; nonmembers pay $10 to attend. For locations and membership services, contact Specific Technology Center, POB 15579, San Francisco, CA 94115, (415) 626-4600.

● ACTRIX IN ACTION
Actrix Users Southeast supports users of the Actrix computer and its built-in software. A newsletter is available, as are purchase discounts and updates. Contact Irv Koch, 1954 Stanton Rd., EastPoint, GA 30344, (404) 767-7360.

● FRIENDS IN THE SE
People on the Southeast AMIS bulletin-board service are on line 24 hours a day to answer questions about Atari, Macintosh, and Radio Shack computers. The BBS at (704) 541-3306 carries Newsoft news net, and plans include a national user-group listing. Contact Southeast AMIS, POB 1041, Matthews, NC 28106.

● TWO SYSTEMS GROUP
The benefits of joining the Micropolis/Vector Graphic Users Group (MUG) include a monthly newsletter, library disks of public-domain CP/M and MS-DOS software, and directions for obtaining parts, service, and commercial software for Micropolis drives and Vector Graphic systems. The annual membership is $18. Contact Buzz or Lynn Rudow, Micropolis/Vector Graphic Users Group, 604 Springwood Circle, Huntsville, AL 35803, (205) 881-1697.

● SIG FOR CP/M
The Wayne County CP/M Support Group (WCCPMSG) of Williamson, New York, sponsors training programs in CP/M applications software. Members' interests include BASIC programming, databases, and word processing at all levels. Computer-literacy lectures are open to the community. Club members meet at 7 p.m. on the second Wednesday of each month at the Williamson Public Library. Contact the WCCPMSG, POB 34, Williamson, NY 14589.

● COMMODORE IN NW PA
The main chapter of the North Coast Commodore Users Group (NCCUG) of Erie, Pennsylvania, meets on the third Tuesday of every month. The Edinboro chapter meets the first Thursday of every month. Both chapters enjoy the privileges of a public-domain library, a monthly newsletter, discounted blank disks, and special-interest groups. An annual membership is $20; a subscription to the newsletter is an additional $6. Contact the NCCUG, POB 6117, Erie, PA 16512, (814) 866-1625 for the Erie chapter or 398-8146 for the Edinboro chapter.

CLUBS & NEWSLETTERS *is a forum for letting* BYTE *readers know what is happening in the microcomputing community. Emphasis is given to electronic bulletin-board services, club-sponsored classes, community-help projects, field trips, and other activities. We will continue to list new clubs and newsletters. Allow at least four months for your club's mention to appear. Send information to* BYTE, *Clubs & Newsletters*, POB 372, *Hancock*, NH 03449.

● SCAN THE MBC
The Sanyo Canadian Users Group, devoted to the Sanyo MBC 550/555 computer, welcomes American participation. Members maintain a network for resource sharing, a public-domain software exchange library, and a newsletter, *SCAN lines*. A BBS is planned. Contact Eric Lillius, Sanyo Canadian Users Group, Box 210 Mountain St., Haliburton, Ontario K0M 1S0, Canada, (705) 457-2774.

● COMPUTER FILE BLUEGRASS STYLE—The Central Kentucky Computer Society produces a monthly newsletter, *Computer File*, containing ads and articles, a calendar, and membership information. Membership is $20 annually. Contact the Central Kentucky Computer Society Inc., Suite 100, Security Trust Building, Lexington, KY 40507.

● AN INDUSTRY FIRST
The International MIDI Association (IMA) is a nonprofit organization dedicated to promoting musical-instrument digital interface (MIDI) and music/computing interfacing. An electronic library, a database, and a newsletter, *The IMA Bulletin*, containing MIDI-related product and news announcements are included with IMA membership. Contact the International MIDI Association, 4128 Wilkinson Ave., Studio City, CA 91604, (818) 505-8964.

● BIRD IN HAND
The Robin Owners' Group is for users of the DEC VT-180. A software library is main-

(continued)

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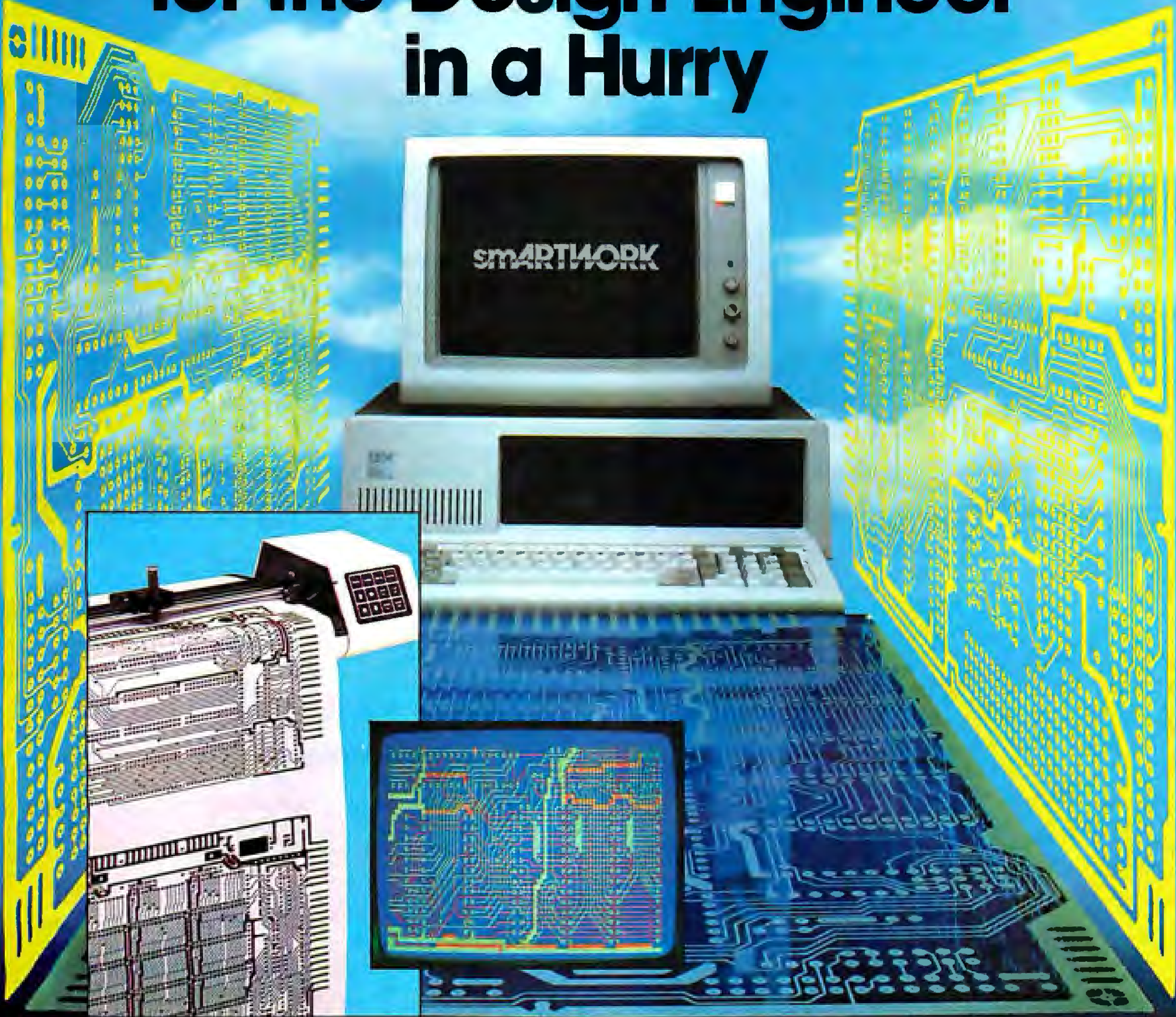

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In Europe contact: RIVA Terminals Limited, Woking, Surrey GU21 5JY ENGLAND, Telephone: 04862-71001, Telex: 859502 tained, and a newsletter contains members' contributions, product reviews, and programming ideas. Contact Jim O'Connor, Robin Owners' Group, POB 492, Rollinsford, NH 03869-0492.

● NEW FIG FORMS
Members of the Central Arkansas FORTH Interest Group (CAFIG) meet twice monthly at the National Education Center at the Arkansas College of Technology in Little Rock. For more information, contact Gary Smith, POB 7668, Little Rock, AR 72217, (501) 227-7817.

● FOR THE PEOPLE
Users of the Kaypro 16 can join a special-interest group, SIG-16, sponsored by the National Kaypro Users Group (NATKUG). *The NATKUG 4 Bits × 4 National Newsletter* is produced for users of the IBM-compatible Kaypro. Membership in SIG-16 is $15 a year; membership in People's Computer (NATKUG) is $12 annually. Contact Steven Bender, People's Computer (NATKUG), POB 28360, Queens Village, NY 11428, (212) 776-2909.

● PAIR AND REPAIR
Users and owners of the Otrona Attache computer can find a listing of repair centers and users groups from the Boston Computer Society (BCS). A $24 annual membership entitles you to receive both the Otrona monthly newsletter and one other BCS newsletter. Contact the Boston Otrona User Group, 1 Center Plaza, Boston, MA 02108.

● MEET FOR FREE
Participants of the North Jersey TRS-80 Users' Group discuss TRS-80 computers, programming techniques, and programs. The group meets at 7:30 p.m. on the second Friday of the month at Fairleigh Dickinson University in Teaneck, New Jersey. Dues are not collected. Contact Dr. Howard Silver, Electrical Engineering Department, Fairleigh Dickinson University, Teaneck, NJ 07666.

● SINGLE USERS
The Sytek Network Users Group (SNUG) encourages communication between owners and users of Sytek's LocalNet products. Funded by membership dues, the club meets informally once every nine months. Contact Greg Scott, Tektronix Inc., POB 500, MS 50-454, Beaverton, OR 97077, (503) 627-5007.

● FRENCH FIDONET
A Fidonet BBS in Paris, France, is available at 300 full CCITT on 18764.5.6.7. The team of ARTS, a nonprofit organization, is composed of people involved in radio, video, videotex, and teleservices. Contact ARTS, POB 100, 94123 Fontenay Sous Bois, Paris, France.

● MINNESOTA MEETINGS
The Central Minnesota Users Group convenes in St. Cloud. The general meetings are not limited to a specific brand of computer but are followed by special-interest-group meetings. Information on public-domain software is available. Contact Lee Larkey, Central Minnesota Users Group, Rt. 1, Box 106, Avon, MN 56310, (612) 356-7402.

● A WORD EVERY QUARTER—A word-processing newsletter, *The Quarterly Report*, is devoted to the latest in word processors, issues for businesses concerning word processing, and research information. The introductory subscription rate is $30 a year. Contact *The Quarterly Report*, POB 1060, Mercer Island, WA 98040. ■

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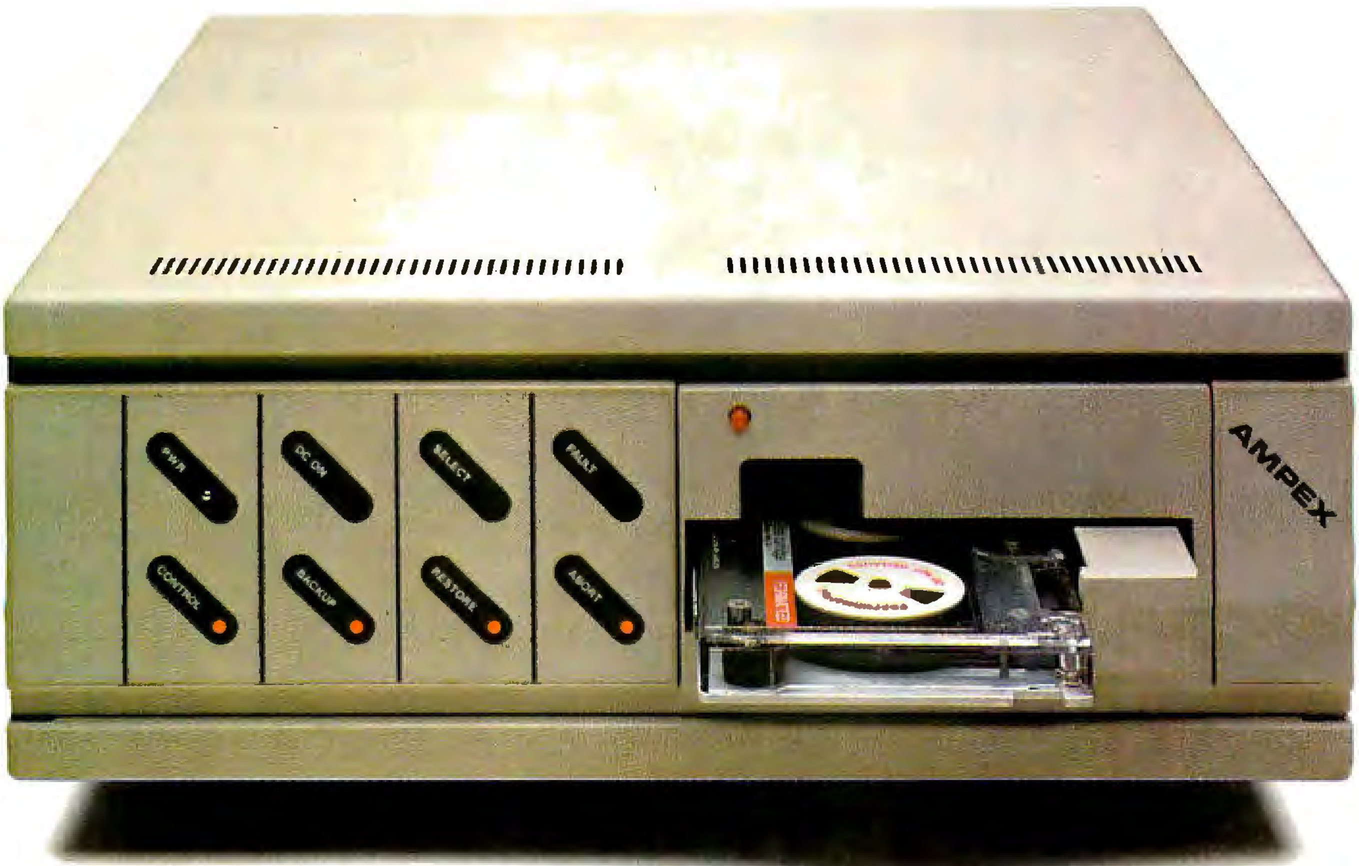

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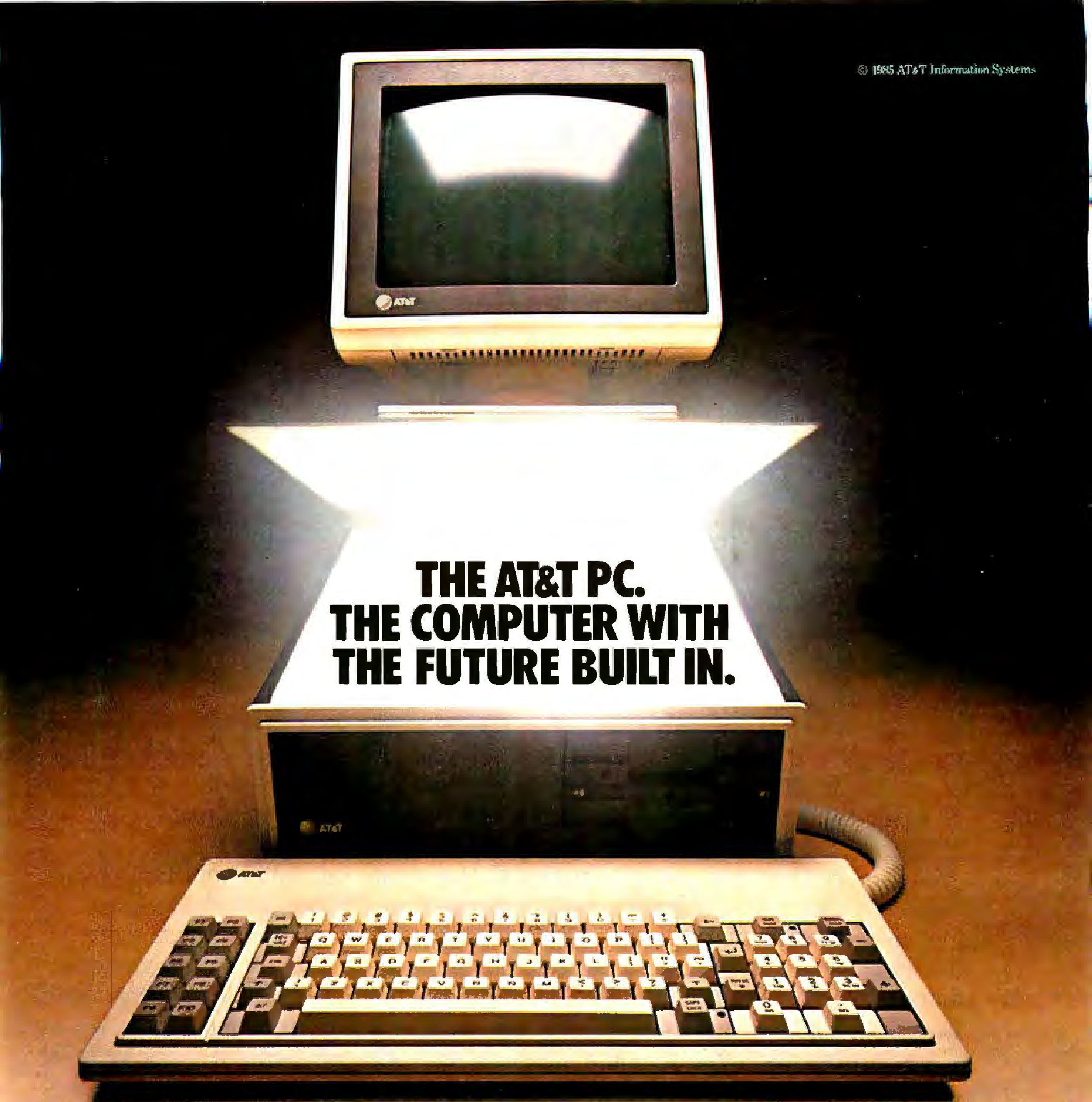
*PC Megastore is upgradeable and comes in four models: 20 MB with 25 MB tape, 10 or 20 MB disk, or 25 MB tape.



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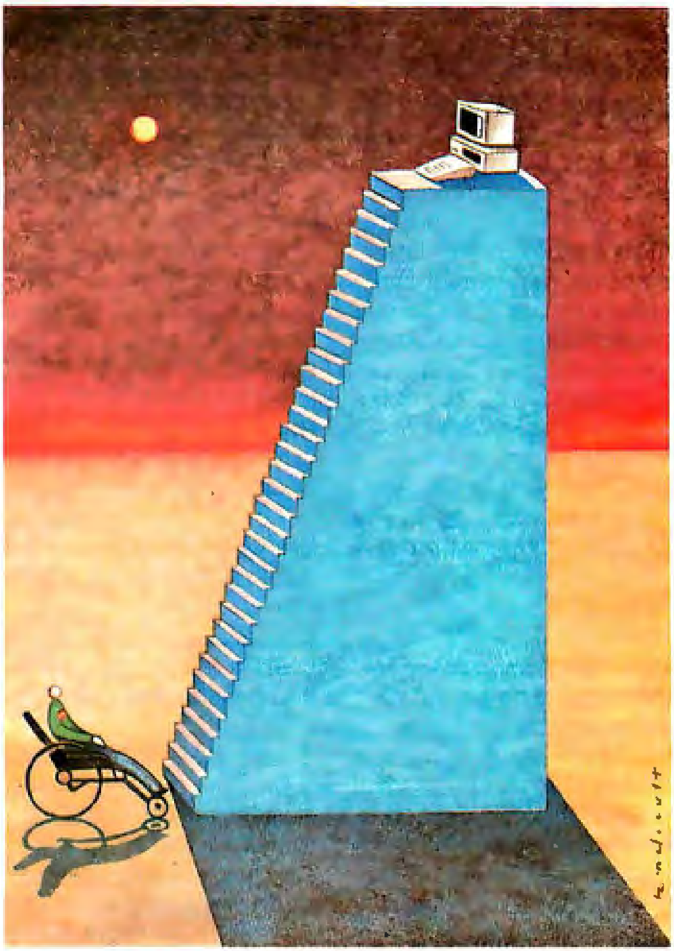

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Don Lancaster
Howard W. Sams & Co.
Indianapolis, IN: 1984
368 pages, $21.95

1985 PROGRAMMER'S
MARKET
Brad M. McGehee, editor
Writer's Digest Books
Cincinnati, OH: 1984
343 pages, $16.95

PERSONAL COMPUTERS AND SPECIAL NEEDS
Reviewed by John Wilke

In 1977, a group of activists with a variety of disabilities staged a symbolic sit-in at the Department of Health, Education, and Welfare to demonstrate support for a bill frequently called "the civil rights act for the disabled."

Since that legislation became law, engineers and city planners must design public buildings that are accessible to all people. The young man who led the HEW demonstration and lobbied successfully for the new law has turned his attention to overcoming another set of barriers: software, computers, and communications equipment that, by design, shut out the disabled.

Frank G. Bowe is quick to point out in *Personal Computers and Special Needs* that just as new technology is beginning to make it possible for disabled individuals to not only communicate more effectively but also pursue meaningful employment in the information industry, there is a lack of physically compatible and affordable computer interfaces. This paradox is an underlying theme in Bowe's book, a survey of personal computer peripherals and communications prostheses available to people whose hearing or vision is impaired or who are unable to manage normal movement.

Bowe takes what might have been little more than a listing of the latest in speech synthesizers and keyboard emulators and peoples it with firsthand accounts of how the devices are making life more productive for disabled people. Unifying this effort is his concern that with the transition to an increasingly information-based economy—with its obvious promise of fuller participation for the disabled—the danger remains that a new set of barriers will prevent them from participating.

The book, then, addresses both how-to and why. It was written first for the nearly 30 million Americans who might

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ILLUSTRATED BY JAMES ENDICOTT

benefit from the use of microcomputers for writing, "reading," and "hearing" or handling the everyday tasks that can be daunting for even the most determined disabled person. Bowe offers handicapped people and their families, teachers, and friends a practical guide containing prices, sources, and descriptions of scores of specialized interfaces designed to close the gap between disabled people and their computers. These details weave through the text and are then gathered together in an appendix for quick reference.

The products Bowe surveys range from speech-recognition units and speech synthesizers to optical text readers and software such as Logo (used increasingly by educators for their dyslexic and developmentally disabled students). The Information Through Speech Unit (from Maryland Computer Services Inc., Forest Hill, Maryland), for example, allows the blind aural access to the popular NEXIS and LEXIS databases. Bowe explores the state of the art in optical character recognition: an extraordinary unit that can scan almost any printed text and read it aloud in synthesized voice. The $29,000 machine (from Kurzweil Computer Products, Cambridge, Massachusetts) is clearly beyond the fiscal reach of most people, but Bowe reports that engineering advances will bring prices down dramatically on similar units.

Beyond just describing various adaptive products, Bowe visits with people using these interfaces every day, letting them describe in their own words the frustrations and joys the new technologies bring.

THE ROLE OF COMPANIES

Despite such adaptations, much of the promise of the new technology remains to be realized, Bowe points out. This is true in part because companies working on devices to help the disabled must overcome discouraging diseconomies of scale, producing their wares for just a small slice of the market. Indeed, he laments, many of the most significant technological advances come not from research meant to make computers more accessible to handicapped people but from industry efforts to develop talking vending machines, say, or devices allowing a businessperson to dictate letters without a secretary.

Another problem, Bowe writes, is that use of the adaptive systems now available is often hampered by incompatibility with popular applications software. Most of the software designed for disabled people is limited to addressing a specific need, such as keyboard emulation for people with severely limited mobility. But this software frequently does not then work with widely used software such as spreadsheets and word processors, which are often "locked" to prevent modification. For example, the popular Echo II speech synthesizer (from Street Electronics, Carpinteria, California) does not yet work with such protected programs as MicroPro's WordStar. Hardware, too, must often be altered to function with special devices for the disabled.

Bowe is optimistic that at least some computer makers will respond to these concerns. Toward this goal of making manufacturers more aware of the difficulties of the disabled, last year the author conceived and carried out a conference on computer accessibility, under the auspices of the White House Office of Private Sector Initiatives. The conference, which Bowe describes briefly, brought together experts on the needs of the disabled with representatives from AT&T Bell Laboratories, International Business Machines, Apple Computer, Tandy, and Honeywell. Approaches to enhancing accessibility involved relatively simple accommodations, including the introduction of standard ports for adaptive interfaces. Some companies expressed concern that the computer market is too fast paced and competitive to meet the needs of such a small market segment. Bowe answers with convincing demographic data suggesting potential market opportunities for firms willing to respond to the special-needs buyer.

Bowe's excitement when he considers what microcomputers might mean for the disabled in the not-too-distant future illuminates his book. Within a decade, Bowe believes, affordable computers will be able to "hear" speech in real time and print out what is being said. "As someone who has not heard a word in three decades," he explains, "this prospect fills me with a wonderful sense of anticipation."

John Wilke covers technology and telecommunications for Business Week *(Suite 1200, 1120 Vermont Ave., Washington, DC 20005).*

DIGITAL IMAGE PROCESSING: A PRACTICAL PRIMER
Reviewed by Richard J. Cass

In the preface to *Digital Image Processing: A Practical Primer*, Gregory A. Baxes states his intention to provide "an elementary overview of digital image processing at a practical level." On a technical level, he succeeds admirably. The book is a sound and detailed introduction to the concepts and practices of processing images using digital computers. An entire section on the hardware considerations related to image processing would be helpful for those who are interested in designing and configuring systems for digital image processing. A practical advantage of this book is a section that contains entries for each of the most commonly used digital image processing operations; a catalog format makes this section most useful as a reference for the beginner and the experienced reader alike.

In part I, the author defines image processing in general and discusses methods of image processing other than digital, such as optical and analog. He also details the historical development of digital image processing, from the early 1960s and the space program's attempts to gather pictures of the moon's surface to the later work done by NASA in the Mariner and Pioneer projects. Baxes

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moves on to an overview of some of the more recent business applications that have been made possible by image processing, including factory automation and computer graphics.

THE IMAGE

Part II covers the characteristics of the digital image—how it is formed, how brightness and resolution affect the way the image looks—and explains such terms as digitizing, pixel, frequency, and frame rate. One chapter concentrates on the image histogram, a tool used to measure and assess digital images. The histogram provides a graphic representation of the contrast qualities of the digital image by plotting the number of elements in an image against their brightness levels. Manipulating an image's histogram can affect the image, as the author demonstrates.

Baxes discusses the concept of "point processing," where each element of an image can be modified by a mathematical or logical process to create a new image. He also discusses operations such as contrast enhancement, corrections for photometric and geometric distortions, and applications for these techniques in graphic arts, as well as the fundamentals of processing picture elements in group relationships.

The chapter on image data handling describes, in great technical detail, the major functions that a hardware system must accomplish. Baxes provides examples of hardware specifications from several manufacturers to illustrate the types of hardware used to perform these functions. Digitization, storage, display of images, and the internal interface between where the memory is stored and the hardware image processor, as well as the system's interface to the host computer, are covered. The author goes into the mechanics of the hardware device that actually processes the digital image data, with block diagrams and product-specification sheets. He discusses the characteristics of single- and dual-pixel point processors, group processors, and frame processors.

IMAGE PROCESSES

The catalog of 19 digital image-processing operations concisely explained in part IV is extremely useful. It provides a detailed explanation, with images from before and after processing, of the most commonly used image-processing operations. The section includes more specific examples of histogram manipulation, as well as discussions of contrast enhancement, filtering, and edge enhancement. Each entry in this section contains a description of the purpose of the operation, possible applications for it, and practical hints on how to implement the process. The image that accompanies each piece reinforces the reader's understanding of the associated operation.

COMMENTS

With a few exceptions, the book is well structured. The author introduces terms and concepts only as necessary,

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and each discussion of technical material builds logically upon the information and terms already explained. Definitions and explanations of the intricacies of image processing are lucid enough to instruct the beginner without insulting a more knowledgeable reader. The book is, as promised, a practical introduction to digital image processing.

I have only one serious misgiving about the book: All the technical information is presented in clear, coherent prose, but the rest of the writing could have used better editing.

Richard J. Cass (29 High St., Peterborough, NH 03458) is a technical writer for Apollo Computer in Chelmsford, Massachusetts.

PASCAL APPLICATIONS FOR THE SCIENCES
Reviewed by Steven H. Rogers

In *Pascal Applications for the Sciences*, Richard E. Crandall tackles the problem of teaching scientific programming in a minimal amount of time. The book is intended to be used largely in a self-paced manner; to get the most out of it you should have ready access to a computer running Pascal. It is organized with short blocks of text followed by exercises illustrating the important points just covered. I found this technique effective in keeping my interest.

The first five chapters provide the basic tools for writing scientific programs in Pascal. Crandall then presents more advanced examples of scientific applications. The balance of the book consists of five appendixes containing libraries of functions and procedures for scientific programming.

SCIENTIFIC PROGRAMMING

Crandall begins with an intentionally brief review of the fundamentals of Pascal programming. Those readers with a background in Pascal can skip the review without missing anything; readers new to the language will need a standard Pascal text as a supplement. Exercises relate to scientific applications.

Next, the reader is introduced to mathematical programming. The author demonstrates numerical methods for approximating the derivatives and integrals of a function, proceeds to coverage of differential equations, and then moves on to the use of matrices to solve systems of simultaneous linear equations. One example and several exercises that I found quite enjoyable involved modeling a satellite orbiting the earth.

Crandall's coverage of probability presents a concise explanation of the problems involved with modeling probabilistic phenomena on computers, which are by nature deterministic. This means a given input will always yield the same output, though some people maintain that their computers don't fit this description. Examples range from population biology to card games. An introduction to the statistical analysis of data concludes this chapter.

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Graphics programming in Pascal is covered in sufficient detail for most scientific and engineering applications. Crandall provides a graphics library of two- and three-dimensional graphics procedures for the Tektronix 4012 graphics terminal and the Hewlett-Packard HP 7470A plotter. These procedures would have to be modified for use with other systems. I found this to be fairly straightforward for Turbo Pascal version 2.0 running on my Hyperion.

Advanced Techniques

The last four chapters are devoted to more advanced applications in mathematics, chemistry, physics, and biology. Most readers will want to be selective about the exercises they do from these chapters. Many of them are exploratory in nature and take on the character of a major project. Because the methods illustrated in a particular application area can be used in other fields, I advise against completely skipping a chapter that may fall outside your specialty. Advanced examples from mathematics include fast Fourier transforms for signal analysis and a method for doing arithmetic of arbitrary precision.

Chemistry applications include modeling chemical reactions and graphical modeling of molecular structure. Examples from quantum mechanics appear as both chemistry and physics applications. An interesting illustration of computer graphics in physics models the perturbation of Saturn's rings by the gravitational field of one of its moons. Biological applications vary from ecology to biological signal processing.

In addition to the graphics library, this book furnishes functions and procedures for matrix manipulation, statistics, special functions (Bessel functions and the like), and dynamic models. Many people would find these libraries alone sufficient justification to buy this book.

Developed in parallel with a course for undergraduate science students, *Pascal Applications for the Sciences* also meets the needs of graduate students, practicing scientists, and technically oriented hobbyists. Richard Crandall does a generally good job of presenting the material clearly and concisely. This book has something of the flavor of a travel guide, especially in the advanced section. It gives you the information that you need to go exploring on your own.

Steven H. Rogers (108 Brook Lane, Midwest City, OK 73130) flies F-4s for the USAF Reserves when not occupied as a graduate student in industrial engineering.

ASSEMBLY COOKBOOK FOR THE APPLE II/IIe

Reviewed by Roger Cox

Most programmers find a need for doing at least some assembly-language programming. For Apple users this usually means venturing beyond Applesoft's PEEKs and POKEs to acquire the knowledge needed to

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BOOK REVIEWS

write efficient assembly-language code. *Assembly Cookbook for the Apple II/IIe* is written for people who want to learn assembly-language skills and some of the tricks specific to the Apple itself.

As "cookbook" implies, Don Lancaster approaches his subject matter from a practical point of view. The book serves two audiences—Apple programmers looking for education and challenge and people interested in writing profitable commercial software. The "fun and profit" theme begins in the introductory chapter and continues throughout the book.

The two obvious advantages of assembly-language programs are high execution speed and small size. Yet another primary reason for programming in machine language, according to the author, is economics. He makes the rather convincing argument that nearly all commercial programs sold for the Apple today consist at least partially of machine-language code to achieve the high performance standards of the software marketplace. A would-be developer of commercial software, Lancaster contends, must learn assembly-language skills to be competitive.

GETTING STARTED

This book begins with a brief explanation of how assemblers work and contrasts the types of assemblers available: miniassemblers, macroassemblers, disassemblers, cross-assemblers, and assemblers that generate relocatable code. After this introduction, Lancaster emphasizes how to get started; he provides lists of recommended hardware, software tools, reference books, and other programming aids. Since assembly-language programming is so machine-dependent, the author also introduces the newcomer to the broader resources of the Apple community. An appendix in the book lists magazines specializing in Apple machine-language programming, article reprints, users groups, newsletters, and bulletin boards.

Chapter 2 explores the anatomy of an assembler source-code line: line number, label, operation or pseudo opcode, operand, and comment fields. Lancaster uses Apple's EDASM assembler (from Apple's DOS Tool Kit package) in all examples, but most assemblers are similar enough that the owner of any software package should benefit from most of the discussion. While the author assumes that the reader is already familiar with the 6502's operation codes, he does offer a clear, concise review of the chip's addressing modes along with suggestions to help eliminate confusion when specifying a particular address mode. The book was released just before the announcement of the Apple IIc and, unfortunately, does not include the additional operation codes and address modes of the IIc's 65C02 processor.

In chapter 3, Lancaster encourages the assembly-language programmer to structure source code to improve readability and maintainability. He suggests how to organize equate and constant statements and the various subroutines into a large program. He then explores the

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SONY
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Single Sided

BOOK REVIEWS

questions of programming technique and style. His discussion of speed-optimization techniques covers straight-line code, shared loops, table-lookup methods, and minimal use of subroutines in time-critical sections.

With the Apple (as with any other computer), the ability to create the smallest possible program is often important. Lancaster discusses several techniques for doing this, such as custom interpreters, memory overlays, compressed text and picture files, and options for building relocatable code modules; he illustrates many of these concepts with examples from commercial programs.

Lancaster devotes two chapters to the mechanics of editing assembler source-code files. He deals with the use of the line-oriented editor supplied in the EDASM package and extols the advantages of the screen-oriented Apple Writer word processor for source-code editing. I found this discussion repetitive and wordy. Lancaster belabors the differences between the two approaches; one short chapter would have been sufficient.

The eight assembly-language modules presented in the remainder of the text amply demonstrate efficient programming techniques. The reader is treated to Lancaster's humorous style as his analysis of these routines reveals the secrets of writing quick and compact Apple programs. Each programming example highlights several specific techniques, many of which are further illustrated through examples of similar methods used in actual commercial programs. Lancaster has obviously spent many hours digging into the innards of several popular software packages.

The actual code examples Lancaster presents include subroutines for generating random numbers, sound effects, and music; handling message strings; and selecting program options using a table-driven subroutine. Lancaster includes complete source listings and flowcharts for all the routines. He also includes an additional module, called an "empty shell," that lists about 200 label names equated to base-page locations, entry points to DOS and Applesoft routines, soft switches, and other hardware-specific memory locations.

Assembly Cookbook for the Apple II/IIe is written with a free-wheeling, irreverent style. If you approach personal computer programming from an academic perspective and are looking for a computer science textbook, you will be disappointed. Lancaster writes using both slang and humor, and many of the commercial programming examples are from games rather than business applications. If you are new to the Apple culture, the anecdotes and examples make the learning process more interesting and concrete. Besides developing the fundamentals of assembly-language programming, the book provides good insight into many of the practical issues that must be addressed when writing commercial software.

Assembly Cookbook succeeds in addressing the needs of programmers new to assembly language as well as those considering writing commercial software for the Apple. The two groups obviously have different needs, but Lancaster emphasizes techniques of interest to both.

Roger Cox (POB 45, Pitkin, CO 81241) is a consulting engineer specializing in computer technology and signal processing.

1985 PROGRAMMER'S MARKET
Reviewed by E. Francis Avila

Writer's Digest Books has for many years produced popular guides for writers and artists in many fields. Like the annual *Writer's Market*, the *1985 Programmer's Market* is a gold mine of information. Freelance programmers and technical writers could benefit from the data and advice on selling software creations in the competitive microcomputer marketplace.

Edited by Brad M. McGehee, author of *The Complete Guide to Writing Software User Manuals* (Cincinnati, OH: Writer's Digest Books, 1984), this book is patterned after the other publications in the "market" series.

Under one cover you will find a comprehensive listing of more than 700 software publishers from across the country that are looking to buy commercially marketable programs. McGehee includes with each publisher's entry: a name to contact (very important); hardware specifics and operating systems; the publisher's software needs; procedures for submitting your software idea; payment schedules; types of contract work; examples of the company's published programs; need for technical writers; and tips on how to break into the market.

GOOD NEWS AND BAD NEWS

The *1985 Programmer's Market* reads like a "Who's Who" in the software industry. It purports to list those microcomputer software publishers (from the famous to the obscure) that claim to be actively seeking freelance software and technical writing expertise. That's the good news.

Here's the bad news. I sent query letters to four well-known software houses and four I'd never heard of. In choosing these companies, I tried to match my expertise with their needs (as described in *Programmer's Market*). I included stamped self-addressed envelopes. Well, more than six months has passed and I've heard not a word. I'm not encouraged.

Obviously, polling 8 out of 700-plus entries cannot be considered a representative sampling of software publishers. Certainly I recognize the possibility that my qualifications did not interest those that I queried. At minimum, I expected to get back my stamped envelopes.

In the *1985 Programmer's Market*, McGehee paints an optimistic, albeit cautious, picture of the current state of freelance programming and technical writing. Given his encouragement, to say that I was disappointed in the response to my query letters is an understatement. Nevertheless, experience in the world of publishing tells me to give it another try. ■

E. Francis Avila (POB 4401, Auburn, CA 95604) is a freelance writer/programmer working on a degree in mathematics.

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E·V·E·N·T Q·U·E·U·E

July 1985

● GOVERNMENTAL COMPUTING—Managing Microcomputers in Government, various sites throughout the U.S. Two seminars, "Managing Microcomputer Usage in Government" and "Using Micros for Government Management," are offered. Fees range from $415 to $795, depending upon duration and governmental or nongovernmental affiliation. Contact U.S. Professional Development Institute, 1620 Elton Rd., Silver Spring, MD 20903, (301) 445-4400. *July*

● PBX SEMINAR
New Generation PBX: The Path to Voice/Data Integration, various sites throughout the U.S. This three-day seminar covers computer to PBX interfaces, signaling, new products, PBX selection and economics, and a comparison of selected vendors. The full registration fee is $745. Contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *July*

● LOTUS, SYMPHONY SEMINAR—Seminars on Lotus 1-2-3 and Symphony, various sites throughout the U.S. A focus on the concepts and features of these programs. Contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *July*

● CAD COURSE
Computer-Aided Design, Colorado State University, Fort Collins. Three-week courses with participants using a high-performance dynamic graphics machine. The fee is $800. Contact Professor Gearold Johnson, Center for Computer Assisted Engineering, Colorado State University, Fort Collins, CO 80523, (303) 491-5543. *July–August*

● ENGINEERING CONFERENCES—Engineering Summer Conferences, Chrysler Center for Continuing Engineering Education, University of Michigan, Ann Arbor. Conferences in such areas as biomedical, chemical, civil, computer, electrical, and environmental engineering. Contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490. *July–August*

● COMPUTER SHORT COURSES—The Fifteenth Annual Institute in Computer Science, University of California, Santa Cruz. Among the offerings are "Relational Database Management," "Data Storage," and "Computer-Aided Geometric Design." Contact Sally Thomas, University of California Extension, Santa Cruz, CA 95064, (408) 429-4534. *July–August*

● SOFTWARE COURSES
Software Short Courses, various sites throughout the U.S. Among the courses are "UNIX: A Hands-on Introduction," "Programming in C: A Hands-on Workshop," and "Software Requirements, Specifications, and Tests." Contact Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (800) 421-8166; in California, (800) 352-8251 or (213) 417-8888; in Canada, (800) 228-6799. *July–August*

● COMPUTER TRAINING
Computer Training Programs, Wintergreen Learning Institute, Wintergreen, VA. Hands-on training in word processing, information management, spreadsheets, and graphics. Contact Dr. M. D. Corcoran, Wintergreen Learning Institute, POB 7, Wintergreen, VA 22958, (804) 325-1107. *July–September*

● DEVELOPMENT SEMINARS—Professional Development Seminars, various sites around Boston, MA. A brochure describing one- and two-day seminars on computer competence, management, sales, and finance is available. Contact Boston University Metropolitan College, 755 Commonwealth Ave., Boston, MA 02215, (800) 255-1080; in Massachusetts, (617) 738-5020. *July–September*

● SME CONFERENCES, EXPOS—Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. For a calendar, contact the Society of Manufacturing Engineers, Public Relations Department, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777. *July–November*

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● SNA SEMINAR
IBM's Systems Network Architecture (SNA) Seminar, various sites throughout the U.S. Covers such topics as local-area networks, SNA distribution services, and personal computer connections. Contact Communications Solutions Inc., 992 South Saratoga-Sunnyvale Rd., San Jose, CA 95129, (408) 725-1568. *July–December*

● PICK EDUCATION
Pick System Educational Series, various sites throughout the U.S. and Europe. Seminars and workshops on the Pick operating system. Contact JES & Associates Inc., POB 19274, Irvine, CA 92713, (714) 786-2211. *July–December*

● PERSONAL COMPUTER COMMUNICATIONS—Data Communications and Networking for the IBM PC and Other Personal Computers, Atlanta, GA. Topics to be addressed include asynchronous connections, synchronous mainframe connections, data integrity, and personal computer networking. The fee is $695. Group discounts are offered. Contact Software Institute of America Inc., 8 Windsor St., Andover, MA 01810, (617) 470-3880. *July 8–9*

● ADVANCED AUTOMATION—Robot Manipulators, Computer Vision, and Automated Assembly, Cambridge, MA. Contact Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139. *July 8–12*

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EVENT QUEUE

● COMPUTATIONAL LINGUISTICS—The Twenty-Third Annual Meeting of the Association for Computational Linguistics, University of Chicago, IL. Papers, demonstrations, and tutorials. Contact Don Walker (ACL), Bell Communications Research, 445 South St., Morristown, NJ 07960, (201) 829-4312. *July 8–12*

● SYMPHONY TIPS Advanced Symphony, Georgia Institute of Technology, Atlanta. Areas covered include auto-dialing to remote computers and "smart" spreadsheets using artificial-intelligence concepts to preanalyze numeric outputs. The fee is $390. Contact Trish Stolton, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332, (404) 894-2547. *July 9–10*

● CONSULTANT TRAINING Learn How to Be a Successful Independent Computer Consultant, Honolulu, HI. The risks and rewards of consulting, planning and marketing, legal considerations, and resources are covered. Contact Education Technology Center Inc., Suite 1042, 485 Fifth Ave., New York, NY 10017, (212) 505-6148. *July 13*

● AWC CONFERENCE The Fourth Annual National Conference of the Association for Women in Computing, Allerton Hotel, Chicago, IL. Workshops and sessions on technical and career-enhancement topics. For more information, contact Joan Wallbaum, AWCC '85, 407 Hillmore Dr., Silver Spring, MD 20901. *July 13–14*

● THE NCC The 1985 National Computer Conference: NCC '85, McCormick Place, Chicago, IL. Exhibits, technical sessions, and development seminars. This year's theme is "Technology's Expanding Horizons." Contact Helen Mugnier, AFIPS, 1899 Preston White Dr., Reston, VA 22091, (703) 620-8926. *July 15–18*

● iRMX USERS MEET The iRUG Annual International Conference, Palmer House, Chicago, IL. The theme is "The Future Direction of Real-Time Software Applications." iRUG is a nonprofit organization made up of Intel iRMX operating system users. Contact Catherine Moon, MS/HF2-57, Intel Corp., 5200 Northeast Elam Young Parkway, Hillsboro, OR 97123, (503) 640-7038. *July 17*

● DATA SWITCHING Distributed Data Switching Seminar, Washington, DC. A one-day seminar on the technology and application of distributed data switching in telecommunications. The fee is $395. Contact Timeplex Seminars, 400 Chestnut Ridge Rd., Woodcliff Lake, NJ 07675, (201) 930-4600. *July 18*

● PERSONAL COMPUTER COMMUNICATIONS—Data Communications and Networking for the IBM PC and Other Personal Computers, New York, NY. See July 8-9 for details. *July 22–23*

● SIMULATION The 1985 Summer Computer Simulation Conference: SCSC '85, Westin Hotel, Chicago, IL. Contact Charles Pratt, Society for Computer Simulation, POB 2228, La Jolla, CA 92038, (619) 459-3888. *July 22–26*

● COMPUTER WORKSHOPS—Personal Computer Workshops, Aspen and Colorado Springs, CO. Tutorials, including an introduction to personal com-

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TECMAR MAESTRO	$429
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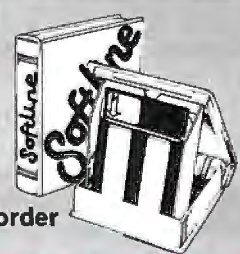

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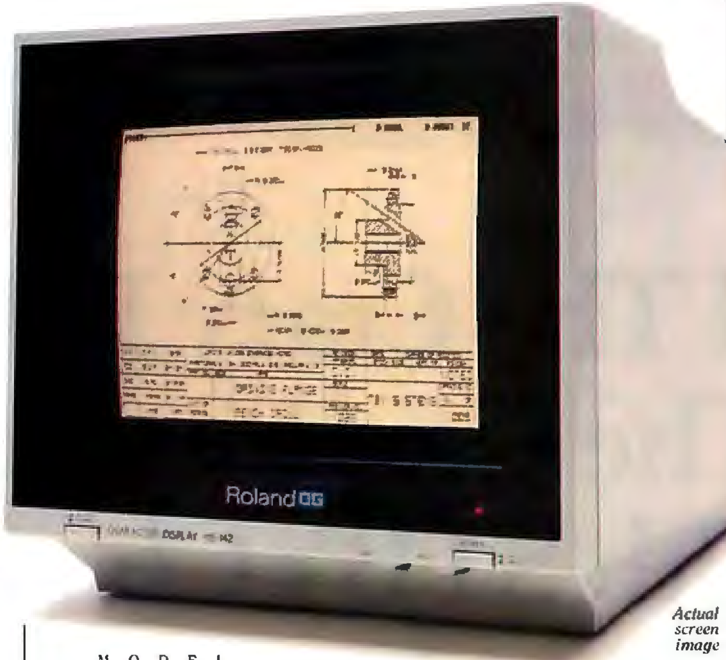
STB Systems, Inc.

Now Showing In Black And White

If you own an IBM-PC or PC work-alike, Roland's new MB-142 monitor lets you show off your text and graphics in today's hottest colors—black and white. That's right! The MB-142 gives you black characters on a paper-white background—just like people have been reading for centuries. You can also have white characters on a black background with just the touch of a button.

Both of these black and white display formats are easier on the eyes and less fatiguing than the green or amber phosphor used in standard monochrome monitors. The MB-142's large 14-inch screen, combined with its ultra-high 720 x 350 resolution, can display characters that are larger and more legible than what you can get with ordinary monochrome monitors. Another great plus is that the MB-142 plugs directly into the monochrome board of your IBM or compatible—just like your present monochrome monitor, with nothing more to buy.

Because of the MB-142's advanced electronic circuitry, you even have the ability to mix graphics and text on the same display when using graphics and text boards from leading manufacturers such as Persyst, STB, Paradise, Hercules, AST and many others. What makes it all possible? The same sophisticated technology used in color monitors.

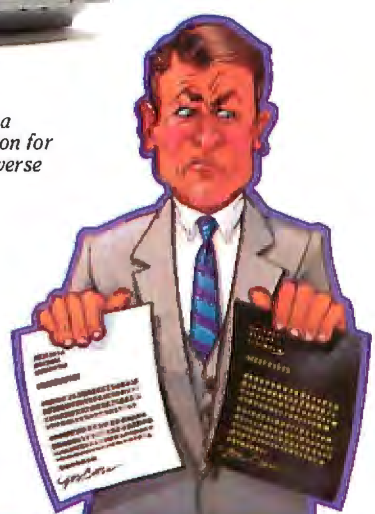


Actual screen image

MODEL
MB-142

Push a button for instant reverse screen

The MB-142 supports all the winning cards



For business, black and white makes more sense than green and black

The big difference is that the MB-142 monitor does the job for significantly less money. The MB-142 is designed to interface economically, too. Imagine seeing your favorite business graphics or CAD/CAM packages, such as Lotus 1-2-3, Energraphics, Chart-Master, AutoCAD, CADDraft and VersaCAD, in ultra-high resolution black and white. Also, take full advantage of your program's windowing capability using the large 14-inch screen.

Take a good look at the differences that set the MB-142 apart from the rest. No other monochrome monitor gives you the fatigue-free black and white viewing, text and graphics capabilities and easy interface. Naturally enough, the MB-142 is from Roland DG—the new computer peripherals company that's pointing the way to the future. Look for this and other Roland products at fine computer dealers everywhere.

For more information, contact: Roland DG, 7200 Dominion Circle, Los Angeles, CA 90040. (213) 685-5141.

The software programs listed are trademarks of the following companies: AutoCAD, AUTODESK, Inc.; CADDraft, Personal CAD Systems, Inc.; Chart-Master, Decision Resources, Inc.; Energraphics, Enertronic Research, Inc.; Lotus 1-2-3, Lotus Development Corp.; VersaCAD, T&W Systems, Inc.

Roland DG

puters, word processing, spreadsheets, and database management. Contact Rocky Mountain Institute of Software Engineering, 1670 Bear Mountain Dr., POB 3521, Boulder, CO 80303, (303) 499-4782. *July 22–26*

● SIGGRAPH
SIGGRAPH '85: The Twelfth Annual Conference on Computer Graphics and Interactive Techniques, Moscone Center, San Francisco, CA. Contact SIGGRAPH '85, Conference Services Office, Smith, Bucklin and Associates Inc., 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610. *July 22–26*

● AIRBORNE COMPUTING SAFETY—Meeting of the Radio Technical Commission for Aeronautics, Washington, DC. Special Committee 156 convenes at 9:30 a.m. to discuss the possible hazards posed by the use of lap-top computers in airplanes. Contact Radio Technical Commission for Aeronautics, Suite 500, 1425 K St., Washington, DC 20005, (202) 682-0266. *July 23–24*

● INTELLIGENT MACHINES
Logic Programming & Expert Systems, The Turing Institute, Edinburgh, Scotland. Lectures, demonstrations, and sessions on programming techniques, system structure, and Prolog. Contact The Turing Institute, 2 Hope Park Square, Edinburgh EH8 9NW, Scotland; tel: 031-668-1737. *July 24–25*

● TECH CONFERENCE
Semi-Official Get-together: SOG IV, Central Oregon Community College, Bend, OR. Sponsored by *Micro Cornucopia*, this conference features forums on communications and single-board systems design. Admission is free. Contact Micro Cornucopia Inc., POB 223, Bend, OR 97709, (503) 382-8048. *July 25–28*

● CHEMICAL ENGINEERING—The Seventh C.C.C.E. National Computer Workshops-East, Clarkson University, Potsdam, NY. Sponsored by the American Chemical Society Division of Chemical Education's Committee on Computers in Chemical Education and Project SERAPHIM. Advanced registration is $100. Contact Dr. Donald Rosenthal, Department of Chemistry, Clarkson University, Potsdam, NY 13676, (315) 268-6647. *July 28–August 1*

● PUBLIC COMPUTING
The Twenty-Third Annual Conference of the Urban and Regional Information Systems Association, Westin Hotel, Ottawa, Ontario, Canada. The conference theme is "Computers in Public Agencies, Sharing Solutions." Contact URISA Secretariat, Suite 300, 1340 Old Chain Bridge Rd., McLean, VA 22101, (703) 790-1745. *July 28–August 1*

● AI, EXPERT SYSTEMS BRIEFING—Artificial Intelligence and Expert Systems: What Users and Suppliers Must Know Today to Deploy These Technologies as Profitable Strategic Corporate Resources Tomorrow, Park Plaza, Boston, MA. A one-day executive briefing. The fee is $790. Contact Ms Lee Burgess, Professional Development Programs, Rensselaer Polytechnic Institute, Troy Building, Troy, NY 12180-3590, (518) 266-6589. *July 29*

● COMPUTERS AND EDUCATION—The 1985 World Conference on Computers in Education, SCOPE Convention Center, Norfolk, VA. Exhibits, papers, panel sessions, tutorials, and preconference workshops. Contact WCCE/85, AFIPS, 1899 Preston White Dr.,

(continued)

Reston, VA 22091, (800) 522-1985; in Virginia, (703) 620-8900. *July 29–August 2*

August 1985

● PROFESSIONAL EDUCATION SEMINARS—Advanced Professional Education Seminars, various sites throughout the U.S. and Canada. Among the titles on the agenda are "UNIX/XENIX," "The IBM Personal Computer," "Networking the IBM Personal Computer," and "SNA and Teleconcepts." Contact the Center for Advanced Professional Education, Suite 110, 1820 East Garry St., Santa Ana, CA 92705, (714) 261-0240. *August*

● IBM PC SEMINAR
IBM PC Seminar, various sites throughput the U.S. A three-day seminar covering PC hardware, PC-DOS, IBM PC work-alikes, and software selection. Contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *August*

● ENGINEERING CONFERENCE, EXPO—The 1985 ASME International Computers in Engineering Conference and Exhibition, Sheraton Boston Hotel, Boston, MA. The theme is "Expert Systems: A New Dimension in Computer Engineering." Contact The American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017, (212) 705-7100. *August 4–8*

● COMPUTERS IN BIOLOGY—Computers in Biology, University of Notre Dame, Notre Dame, IN. Concurrent, one-week courses on computers in bioeducation, the classroom and laboratory, research, and biological modeling and simulation. Tuition is $595 ($495 for educators). Contact Professor Theodore J. Crovello, Biocomputing Short Courses, Department of Biology, University of Notre Dame, Notre Dame, IN 46556, (219) 239-7031. *August 4–9*

● PREPARE FOR FACTORY AUTOMATION—How To Plan for Factory Automation, Center for Continuing Engineering Education, University of Wisconsin-Extension, Milwaukee. The strategy, technology, systems, and control implications are explored. A working knowledge of computer systems, group technology, CAD/CAM, and manufacturing management is recommended. The fee is $890. Contact Center for Continuing Engineering Education, University of Wisconsin-Extension, Civic Center Campus, 929 North Sixth St., Milwaukee, WI 53203, (414) 224-4191. *August 5–9*

● MACROS AND SYMPHONY—Advanced Application Techniques: Using Symphony Macros, Dallas, TX. A workshop emphasizing a building-block approach to learning the sequence of macro instructions and how they can be used to solve everyday application needs. Contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *August 7–8*

● EVENT FOR TRAINERS
COMTRED '85: The National Computer Training and Education Conference and Exhibition, Civic Center, Philadelphia, PA. Seminars and conferences for educators, computer trainers, retailers, and distributors. More than 50 exhibits. Preconference workshops on August 6. Contact National Computer Education Expositions Inc., Suite 200, 1411

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DATE ARITHMETIC	Y	Y	N
DATA TYPES	DYNAMIC	FIXED	FIXED
COLUMN TOTAL OPERATOR	Y	N	N
QUERY BY EXAMPLE	Y	N	EXTRA
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MAX RECORD SIZE	4000	4000	1530

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EVENT QUEUE

Walnut St., Philadelphia, PA 19102, (215) 972-8792. *August 7–9*

● COMPUTER, ELECTRONIC EVENT—Computerfest '85, Building 7, Sinclair Community College, Dayton, OH. Seminars, flea-market areas, speakers, users-group meetings, and club booths and displays are some of the highlights. Admission is $1.50. Contact Mark Hanslip, Computerfest '85, 143 Schloss Lane, Dayton, OH 45418-2931, (513) 268-7225. *August 10–11*

● TOMORROW'S COMPUTERS—International Symposium on New Directions in Computing, Norwegian Institute of Technology, Trondheim, Norway. Contact New Directions in Computing, IEEE Computer Society, POB 639, Silver Spring, MD 20901. *August 12–14*

● GRAPHICS
Ausgraph '85, Brisbane, Queensland, Australia. Australia's first international conference and exhibition on computer graphics. Contact Conference Secretariat, Ausgraph '85, POB 29, Parkville, Victoria 3052, Australia; tel: (03) 387 9955; Telex: AA 33761. *August 12–16*

● MACROS AND SYMPHONY—Advanced Application Techniques: Using Symphony Macros, Chicago, IL. See August 7-8 for details. *August 14–15*

● COMPUTER SWAP
Northwest Computer Swap Number 9, Fiesta Exhibit Hall, San Mateo County Fairgrounds, San Mateo, CA. Admission is $5. Contact Northwest Computer Swap, 4883 Tonino Dr., San Jose, CA 95136, or call Robert Kushner, (408) 978-7927. *August 17*

● AI INVESTIGATED
IJCAI-85: The International Joint Conferences on Artificial Intelligence, University of California, Los Angeles. Topics include AI architectures and languages, intelligent CAI, automated reasoning, and expert systems. Tutorials. Contact IJCAI-85, American Association for Artificial Intelligence, 445 Burgess Dr., Menlo Park, CA 94025, (415) 321-1118. *August 18–24*

● FOR EDUCATORS
Innovative Applications of Microcomputer Technology in Vocational Education, University of Wisconsin, Madison. The emphasis will be on interactive video, networking, hard-disk systems and storage backup devices, and telecommunications for agriculture, education, and health applications. Contact Dr. Judith Rodenstein, Vocational Studies Center, 964 Educational Sciences Building, University of Wisconsin-Madison, 1025 West Johnson St., Madison, WI 53706, (608) 263-4367. *August 19–21*

● MACROS AND SYMPHONY—Advanced Application Techniques: Using Symphony Macros, Philadelphia, PA. See August 7-8 for details. *August 21–22*

● INTERFACING WORKSHOP—Personal Computer and STD Computer Interfacing for Scientific Instrument Automation, Washington, DC, area. A hands-on workshop with participants wiring and testing interfaces. The fee is $450. Contact Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848. *August 22–24*

● EUROPEAN MEDICAL INFORMATICS—The Sixth International Congress of the European Federation for Medical Informatics, Helsinki, Finland. Topics include medical-record management and classification problems, expert systems, medical and clinical research and evaluation, and personal computers. Contact MIE-85 Secretary General, Raija Trevo-Pellikka, The Finnish Hospital League, Toinen Linja 14, SF-00530 Helsinki, Finland; tel: 358-0-7712640. *August* 25–29

● INFORMATION TECHNOLOGY CONFERENCE—The Integrated Information Technology Conference and Exposition: INTECH '85, Moscone Center, San Francisco, CA. Topics to be addressed include integrating personal computers, networks, information security, integrated voice and data, and managing information technology. An Applications Center will provide attendees the opportunity to observe applications in action. Contact INTECH '85, National Trade Productions Inc., Suite 400, 2111 Eisenhower Ave., Alexandria, VA 22314, (800) 638-8510; in the metropolitan Washington, DC, area, call (703) 683-8500. *August* 26–29

● VIDEODISC CONFERENCE—The Fifth Annual Nebraska Videodisc Symposium, University of Nebraska, Lincoln. The theme is "Videodisc—The Industry Comes of Age." Panel discussions, presentations, and exhibits. Registration is $375. Contact Videodisc Design/Production Group, KUON-TV/University of Nebraska-Lincoln, POB 83111, Lincoln, NE 68501, (402) 472-3611. *August* 27–30

● NEW ZEALANDERS CONVENE—The Ninth New Zealand National Computer Conference, Sheraton, Auckland, New Zealand. Speakers, panel sessions, and exhibits. For details, contact Conference Committee, POB 3839, Auckland, New Zealand. *August* 27–31

September 1984

● TRADE CONFERENCE SERIES—The Fifteenth United States Invitational Computer Conference, various sites throughout the U.S. A series of one-day, regional conferences designed to bring original equipment manufacturers together with systems integrators and quantity end-users. Exhibits and technical seminars. Fees begin at $1600 each for one to four conferences. Contact B. J. Johnson & Associates Inc., 3151 Airway Ave. #C-2, Costa Mesa, CA 92626, (714) 957-0171. *September–November*

● INFO MANAGEMENT SEMINARS—NYU Seminars on Information Management, various sites throughout the U.S. On the agenda are "Legal Issues in Acquiring and Using Computers" and "Networking Personal Computers." Contact School of Continuing Education, Seminar Center, New York University, 575 Madison Ave., New York, NY 10022, (212) 580-5200. *September–November*

● COMMUNICATIONS WORKSHOPS—Data Communications Workshops, various sites throughout the U.S. and Canada. For a catalog, contact Rhonda Carney, Intel Corp., Westford Corporate Center, Three Carlisle Rd., Westford, MA 01880, (617) 256-1374. *September–December*

● IBM SHOW
IBM System User Show, Olympia 2, London, England. A series of sessions focusing on all aspects

(*continued*)

EVENT QUEUE

of the IBM computer market. Exhibits. Contact Julian Taylor, Peter Walker Associates, 32 Fitzroy Square, London W1P 5HH, England; tel: 01-388-9871. *September* 3–5

● EUROMICRO
Euromicro '85, Brussels, Belgium. Addresses, tutorials, and exhibitions. An electronic mouse race and a robot ping-pong tournament will be held. Contact Euromicro Office, p/a TH Twente, Dept. Inf., Room A 306, POB 217, 7500 AE Enschede, The Netherlands, Attn: Mrs. C. Snippe-Marlisa. *September* 3–6

● OFFICE AUTOMATION
Third Annual Conference of the Office Automation Society International, Radisson South Hotel, Bloomington, MN. The theme is "The Integrated Office—How Soon?" Contact Office Automation Society International, 2108 C Gallows Rd., Vienna, VA 22180, (703) 790-0490. *September* 3–6

● PERSONAL COMPUTER FAIRE—The Third Personal Computer Faire, Civic Auditorium and Brooks Hall, San Francisco, CA. Conference program and exhibitions of hardware, software, and microcomputer services. Contact Computer Faire Inc., 181 Wells Ave., Newton, MA 02159, (617) 965-8350. *September* 5–7

● ROBOTICS CONGRESS
The Second International Personal Robot Congress and Exposition (IPRC), Moscone Center, San Francisco, CA. Seminars on personal robot software, hardware, human services, robots in space, education, and business. Exhibits and displays. Contact Robotic Industries Association, POB 1366, Dearborn, MI 48121, (313) 271-7800. *September* 6–8

● COMPUTER-AIDED TECHNOLOGIES—COMPINT '85: The First International Conference on Computer-Aided Technologies, Palais de Congres, Montreal, Quebec, Canada. The theory, design, and implementation of computer-aided technologies. Contact Stephen G. Leahey, POB 577, Desjardins Postal Station, Montreal, Quebec H5B 1B7, Canada, (514) 870-3526. *September* 9–12

● AUTOFACT EUROPE
AUTOFACT Europe '85, Swiss Industries Fair, Basel, Switzerland. Workshops on computer-integrated manufacturing and factory automation. Held in conjunction with SwissData '85/Ineltec '85 Exhibits. Contact Susan Gretchko, AUTOFACT Europe '85 Administrator, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500, ext. 373. *September* 10–13

● DOCUMENTATION CONFERENCE—The 43rd Conference and Congress of the International Federation for Documentation, Montreal, Quebec, Canada. The theme is "Information, Communications, and Technology Transfer." Contact Mr. E. V. Smith, Canada Institute for Scientific and Technical Information, National Research Council of Canada, Ottawa, Ontario K1A 0S2, Canada. *September* 14–18

● C SEMINAR/WORKSHOP
C Language Seminar and Workshop, Sheraton-Commander Hotel, Cambridge, MA. The fee is $695. Contact Beatrice Blatteis, CL Publications, 131 Townsend St., San Francisco, CA 94107, (415) 957-9353. *September* 16–18

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● SOFTWARE EXPO
The Sixth Annual Software/Expo, Infomart, Dallas, TX. A trade show for MIS/DP managers and corporate executives. Contact Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon Ave., Des Plaines, IL 60018, (800) 323-5155; in Illinois, (312) 299-3131. *September* 17–19

● UNIX EXPO
UNIX Expo: The UNIX Operating System Exposition and Conference, New York Hilton and Sheraton Centre Hotels, New York City. More than 400 exhibitors complement the conference. Contact Robert Birkfeld, National Expositions Co. Inc., 14 West 40th St., New York, NY 10018, (212) 391-9111. *September* 18–20

● MANUFACTURING EXPO
Eastern Computer Manufacturing Expo, Charlotte, NC. Contact Great Southern Shows, POB 655, Jacksonville, FL 32201, (904) 743-8000. *September* 19–21

● INTERFACING WORKSHOP—Personal Computer and STD Computer Interfacing for Scientific Instrument Automation, Greensboro, NC. A hands-on workshop with participants wiring and testing interfaces. The fee is $450. Contact Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848. *September* 19–21

● TIDEWATER FAIR
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● AI, FIFTH GENERATION
The Artificial Intelligence and Fifth Generation Computer Technology Conference and Exhibition: AI/Europa, Rhein-Main-Halle, Wiesbaden, West Germany. Contact Jim Hay, Tower Conference Management Co., 331 West Wesley St., Wheaton, IL 60187, (312) 668-8100. *September* 24–26

● BOSTON COMPUTING
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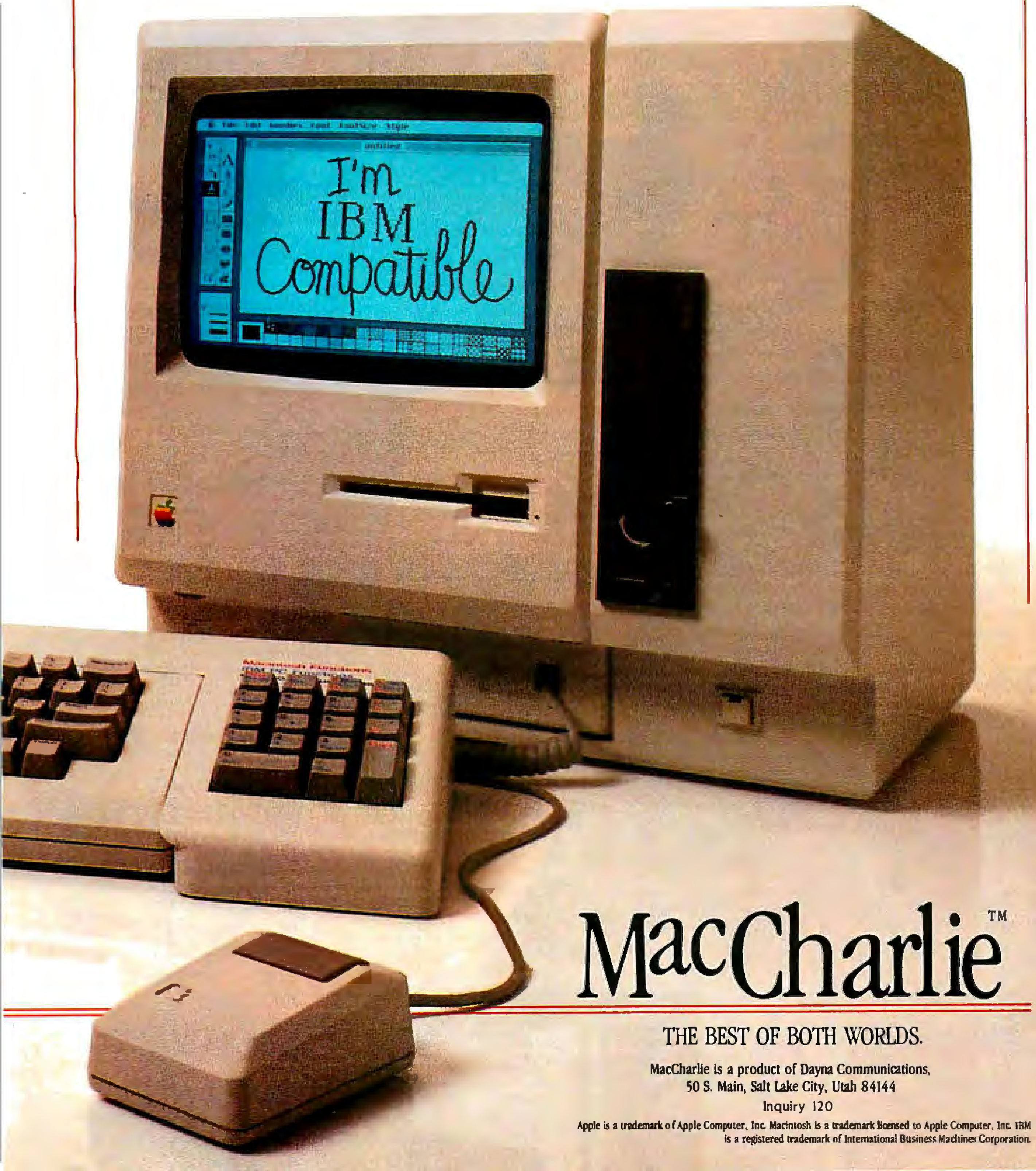

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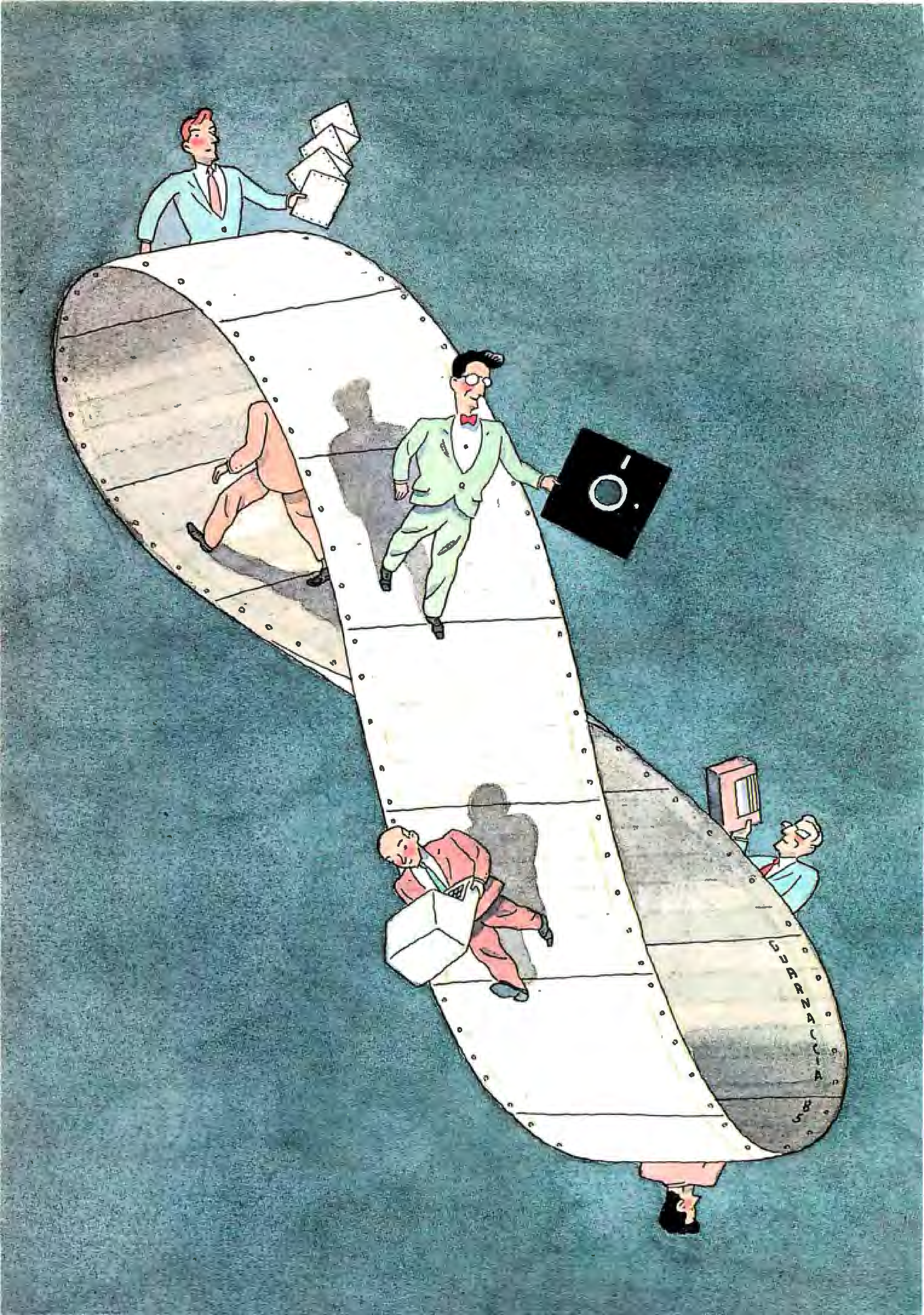

GUARNACCIA
85

Features

IN THIS MONTH'S Features section BYTE presents the first Programming Project, a new monthly column that will be written by various software experts. Bruce Webster designed the first project in keeping with the Computers and Space theme. He describes StarMap, a Pascal program for the Macintosh, which takes a list of stars with Cartesian or astronomical coordinates and shows you where they are in relation to one another.

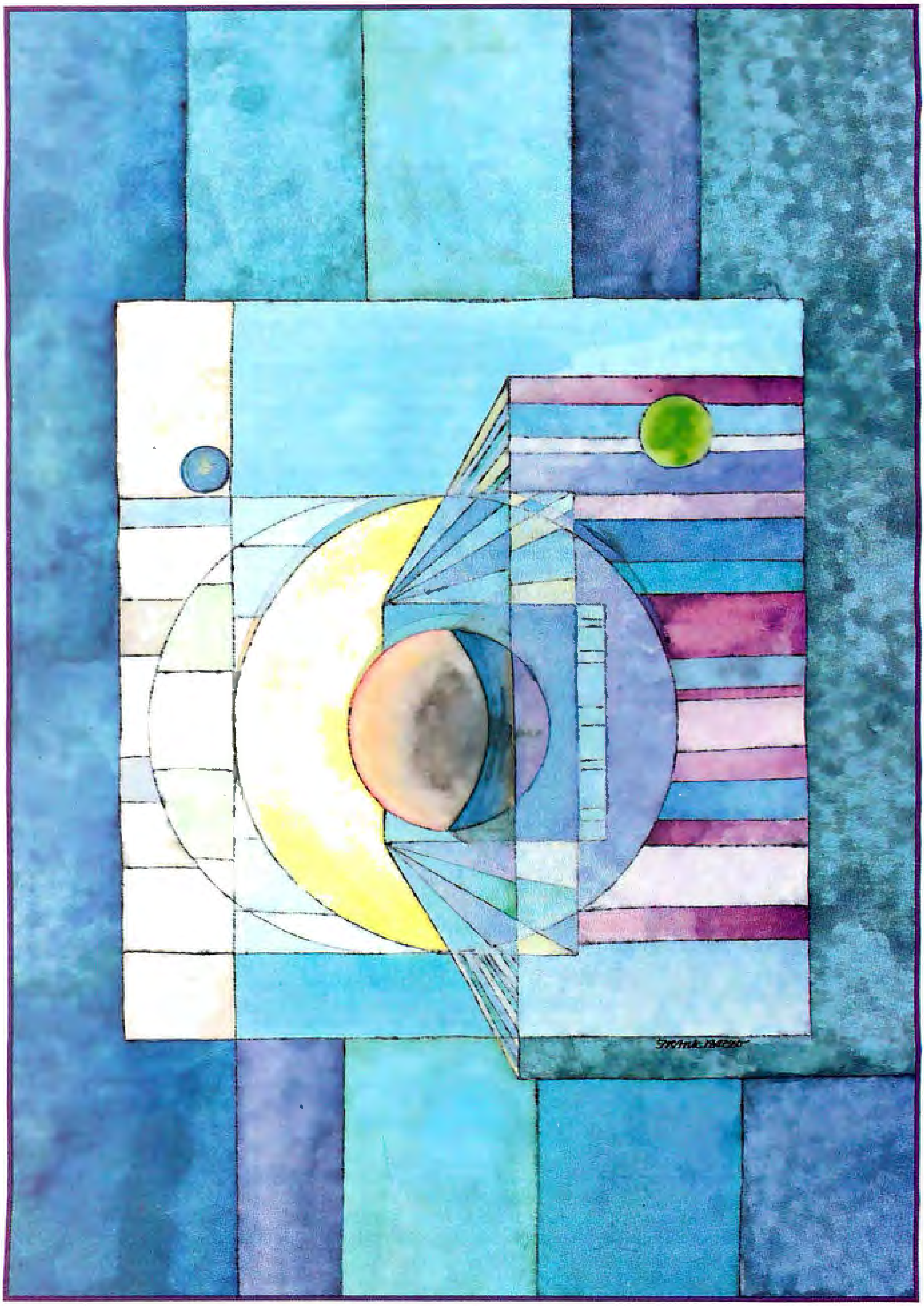
"Liquid-Crystal Displays for Portables" by Glenn Adler takes a look at the technology behind twisted-nematic liquid-crystal displays, which enable computers to be battery-operated, lightweight, and affordable.

Rich Malloy presents a product description of the GRiDCase family of portable computers from GRiD Systems Corporation. The GRiDCase is IBM PC-compatible and offers a range of display options; one version even has a high-contrast gas-plasma display.

This month's Circuit Cellar presents a number of devices that can be used with the Home Run Control System. Steve has included interrupted-beam detectors, various environmental sensors, and alarm signaling devices—all from his junk box.

As a follow-up to "A Travesty Generator for Micros" by Hugh Kenner and Joseph O'Rourke in last November's BYTE, "Travesty Revisited" by Murray Lesser redoes this lexical processor in compiled BASIC. The author believes this language is a better choice for handling a task consisting mostly of string manipulation.

In "Real-Number Formatting on Your Apple," Brent Daviduck has written a program that lets you specify the decimal length of any real number. This machine-language subroutine uses only a small amount of memory.



ILLUSTRATED BY FRANK BOZZO

NEW PERSPECTIVES ON NEARBY STARS

BY BRUCE WEBSTER

A Macintosh programming project in Pascal

To use an already overused cliche, a picture is worth a thousand words (at least). This is especially true when the words are being employed to describe the real world. Let's say you wanted to describe the physical layout of Europe. You could talk about figures and angles, explaining the size and shape of each country and where each country is in relation to all the others. Or you could use a map. Which one would convey that information more quickly and clearly? The map, of course. We perceive the universe primarily through our eyes, and we are comfortable processing information visually. In fact, if you tried to describe Europe using the figures-and-words approach, your listener would probably try to mentally "draw" a map to understand your description.

This problem—the difficulty of comprehending alphanumeric data—is common in scientific work. For example, look at table 1. This is a list of the 75 stars nearest the earth, along with their right ascension, declination, parallax, and stellar (star) classification (see "An Astronomy Glossary" on page 245 for definitions of these and other terms). Try to picture all those stars hanging in space, each in its correct position relative to all the others. In many respects, this is more difficult than the "map of Europe" problem because the coordinate system is not an easy one to decipher and because you have to deal with three dimensions, not just two.

Now look at figure 1. It presents a subset of the information in table 1 in a graphical form. The arrow is pointing at our own sun, Sol. Around it hang the nearby stars, each in its proper position, each shaded according to its stellar classification. Multistar systems are indicated by lines dividing the circles into two or three sections, each section representing a star. Figure 2 relates this cluster of stars to its approximate position in our galaxy.

Even though you don't know the names of those stars, their classes, or even their distances from Sol, you now have a much better idea of how this region of space looks than you got from reading table 1. And that's from two static figures. Now, what if you could rotate the angle of view, change the scale of the display, or make any star the center? What if you could filter out stars of a certain class, or distance from Sol, or number? What if you could point at any star and get more information about it?

In this article, I'll describe StarMap, a program for the Macintosh that lets you do just

(continued)

Bruce Webster (6215 Thorn St., San Diego, CA 92115) is a contributing editor for BYTE.

that. StarMap takes a list of stars, with either Cartesian (x,y,z) or astronomical (RA, Dec, Par) coordinates and shows you where they are with respect to one another. You can perform all the manipulations described above: limited rotation, scaling, and translation, as well as filtering. I'll first look at the basic concepts behind the StarMap program and then at some of the specific techniques it uses. I'll discuss the program itself and finish by talking about possible applications and improvements.

StarMap was developed on a Macintosh using MacAdvantage:UCSD Pascal, a Pascal development system that runs under the Finder and gives you access to most of the Toolbox routines (see the text box entitled "Development Using MacAdvantage: UCSD Pascal" on page 114). Information on how to obtain the source code for StarMap appears at the end of this article.

Basic Concepts

StarMap reads in and displays a list of stars; you view them as if from a point beyond any of them. The stars then appear to form a cluster. Each star is shown as a circle filled with a pattern that indicates its stellar classification (O,B,A,F,G,K,M). Since the computer's display is only two-dimensional, the circle's diameter indicates the third dimension (depth): the smaller the circle, the farther away the star is; the larger the circle, the closer it is. StarMap displays multistar systems by subdividing the circle into two (binary) or three (ternary) sections. Each section contains the pattern corresponding to that component's stellar classification. You can select any star (by pointing and clicking with a mouse) and get a pop-up window with the star's name, its distance from Sol (or the current origin), and the class of each of its components.

You can manipulate this display by rotating it, translating the coordinates, and scaling it up. You can rotate it by choosing to look along any of the three axes (x, y, or z), either from the positive end or the negative end. (Figure 3 depicts these axes relative to the Macintosh screen.) Admittedly, this is limited rotation; I chose this method because of its speed and simplicity, especially since it makes the detection of a click on a star easy. You can choose any star on the display as the origin (translation). Furthermore, you can then add an offset (plus or minus) to any one (but only one) of the three axes. Scaling lets you decide how much of the display is on the screen; it's as if you were sitting somewhere out in space with a high-powered telescope and you cranked up the magnification. Stars get bigger; the screen covers a smaller area, so fewer stars show up.

You can also filter out stars so that not all of them appear. For example, you can set which classes of stars will (or won't) be shown. I often choose to get rid of all the M-class stars because they tend to clutter the display. You can even eliminate all classes but one, restricting your view to, say, all G-class stars, which includes Sol. Finally, you can screen stars

Table 1: *The 75 stars closest to the earth. As the text file RawStars, this list is converted by the program ReadStar into a binary file that can be used by StarMap. (This list is taken from, among other sources,* Astrophysical Quantities, *3rd ed., by* C. W. Allen, *London: The Athlone Press, 1973.)*

Name of System	Right Ascension hours	Right Ascension minutes	Declination degrees	Declination minutes	Parallax microseconds	Stellar Class(es)	
Sol	0	0	0	0	0	G2	
Proxima Centauri	14	26	−62	28	762	M5	
Alpha Centauri	14	36	−60	38	745	G2	K5
Barnard's Star	17	55	4	33	552	M5	
Wolf 359	10	54	7	19	429	M8	
Lalande 21185	11	1	36	18	401	M2	
Sirius	6	43	−16	39	377	A1	dA5
UV Ceti	1	36	−18	13	367	M5	M6
Ross 154	18	47	−23	53	345	M4	
Ross 248	23	39	43	55	317	M6	
L789−6	22	36	−15	36	303	M7	
Epsilon Eridani	3	31	−9	38	303	K2	
Ross 128	11	45	1	6	301	M5	
61 Cygni	21	5	38	30	294	K5	K7
Epsilon Indi	22	0	−47	0	291	K5	
Procyon	7	37	5	21	286	F5	dF0
7 2398	18	42	59	33	283	M4	M5
Groombridge 34	0	15	43	44	282	M1	M6
Lacaille 9352	23	3	−36	8	279	M2	
Tau Ceti	1	41	−16	12	276	G8	
BD +5° 1668	7	25	5	23	268	M5	
Cordoba 29191	21	14	−39	4	260	M0	
Kapteyn's Star	5	10	−45	0	256	M0	
Kruger 60	22	26	57	27	253	M3	M4
Ross 614	6	27	−2	46	250	M7	M0
BD −12° 4523	16	28	−12	32	249	M5	
van Maanen's Star	0	46	5	9	236	dG5	
Wolf 424	12	31	9	18	230	M6	M7
BD −37°	0	2	−37	36	225	M4	
BD +50°	10	8	49	42	219	K7	
CD −46° 11540	17	25	−46	51	216	M4	
CD −49°	21	30	−49	13	214	M1	
CD −44° 11909	17	33	−44	17	213	M5	
AD Leonis	1	57	12	50	212	M8	
BD +68°	17	37	68	28	209	M4	
Ross 780	22	51	−14	31	207	M5	
CC 658	11	43	−64	33	206	dA5	

based on the number of components in a system (one, two, or three). If you just want to see single-star systems or if you just want to see binary systems, etc., you can do so.

COORDINATE CONVERSION

A number of minor hurdles have to be overcome to get StarMap working. First, most star catalogs give stellar coordinates as right ascension, declination, and parallax. This is just a disguised polar-coordinate system. Right ascension is equivalent to theta, the equatorial or longitudinal angle. It starts in the constellation Aries and runs eastward through the 12 signs of the zodiac. Right ascension is usually expressed as hours, minutes, and seconds (rather than degrees), ranging from $00^h\ 00^m.00$ to $23^h\ 59^m.59$.

Declination is equivalent to phi, the latitudinal angle; it's simply the angle up or down from the equator, going from 90 degrees (the north pole), through 0 (the equator), and down to −90 degrees (the south pole).

Parallax is an indirect measure of distance; it's the apparent shift (in fractions of a second) of a star's position as the earth travels around the sun. If you divide 1 by the parallax, you get the distance of the star in parsecs (where 1 parsec equals 3.26161 light-years). Note that in table 1, the parallax value 762 represents 0.762 second.

For display purposes, I chose to convert the stars' coordinates to the rectangular (or Cartesian) coordinates *x*, *y*, and *z*. To allow separation of close systems (such as Alpha Centauri and Proxima Centauri), I used 0.1 light-year as the grid-unit size. Thus, a star at (10,0,0) would be exactly 1 light-year (10 × 0.1) away from Sol. The positive *x*-axis goes out through a right ascension of $00^h\ 00^m.00$; the positive *y*-axis, through $06^h\ 00^m.00$. The positive *z*-axis goes up through a declination of 90 degrees. I used a two-step conversion process—from astronomical to true polar, then from polar to rectangular. Figure 4 illustrates the relationship between the different coordinate systems.

For both right ascension and declination, we have two values: hours and minutes, and degrees and minutes. Our very first step is to convert both into real values, for example, converting $05^h\ 30^m.00$ to 5.5 hours. Assuming that the two values are read in as integers, the function shown in listing 1 will do the conversion. Note that the sign must be propagated to the minutes, because in table 1 only the degrees have negative signs.

Having done this, you then need to multiply the right ascension by 15, to convert it from hours (0 to 23) to degrees (0 to 359). Furthermore, since the Pascal used for this program expects radians (as do most Pascal implementations), you must convert from degrees to radians by multiplying both by the value (2×pi)/360.0, which is equal to 0.01745329. You have now converted right ascension and declination to theta and phi. To convert parallax to distance, you need to divide the value into 1000 (remember that the table values are in

(continued)

Name of System	Right Ascension hours	Right Ascension minutes	Declination degrees	Declination minutes	Parallax microseconds	Stellar Class(es)		
Lalande 25372	13	43	15	10	205	M4		
Keid	4	13	−7	44	205	K1	dA0	M4
BD +20°	10	17	20	7	203	M4		
Altair	19	48	8	44	197	A7		
70 Ophiuchi	18	3	2	31	195	K0	K5	
AC +79°	11	45	78	58	195	M4		
EV Lacertae	22	45	44	5	194	M4		
AC +58°	4	26	58	53	192	M4	M4	
WX Ursae Majoris	11	3	43	47	186	M2	M8	
36 Ophiuchi	17	12	−26	32	184	K1	K1	K5
CD −20° 4125/4123	14	55	−21	12	180	K5	M2	
CD −36°	20	8	−36	14	177	K3	M5	
Sigma Draconis	19	32	69	35	176	K0		
Lalande 46650	23	47	2	8	175	M2		
Delta Pavonis	20	4	−66	19	175	G6		
L374−14	19	17	−45	37	175	M7		
CD −21°	6	8	−21	51	174	M1		
BD +4° 4048	19	14	5	6	173	M4	M5	
Luyten 97−12	7	53	−67	38	173	dM5		
Luyten 674−15	8	10	−21	24	171	M5		
UC 48	17	42	−57	17	170	M5		
CD −3°	5	29	−3	41	170	M1		
Eta Cassiopeiae	0	46	57	33	170	G0	M0	
CD −40° 9712	15	29	−41	6	169	M4		
Ross 986	7	7	38	38	169	M5		
Wolf 294	6	52	33	20	168	M4		
Ross 47	5	39	12	29	168	M6		
BD +53° 1320/1321	9	11	52	54	166	M0	M0	
LP 658−2	5	53	−4	8	166	dK5		
Ross 882	7	42	3	41	165	M4		
CD −45°	20	10	−45	19	164	M0		
Wolf 629/630	16	53	−8	15	161	M4	M4	M5
82 Eridani	3	17	−43	16	161	G5		
CD −11°	14	32	−12	19	160	M4		
Beta Hydri	0	23	−77	32	159	G1		
BD +19°	23	20	19	40	155	M4	M6	
BD +45° 2505	17	11	45	45	155	M3		

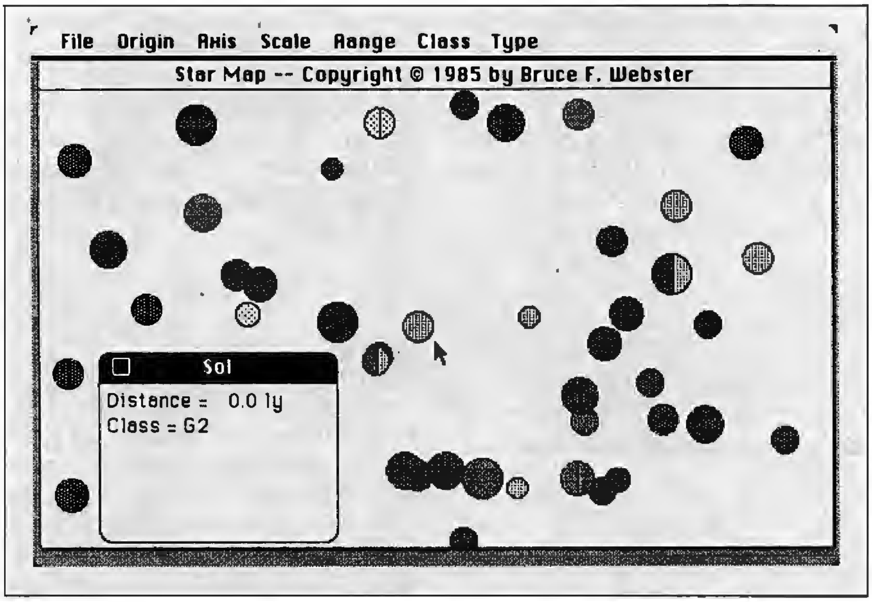


Figure 1: *The stars closest to the earth, as presented by* StarMap.

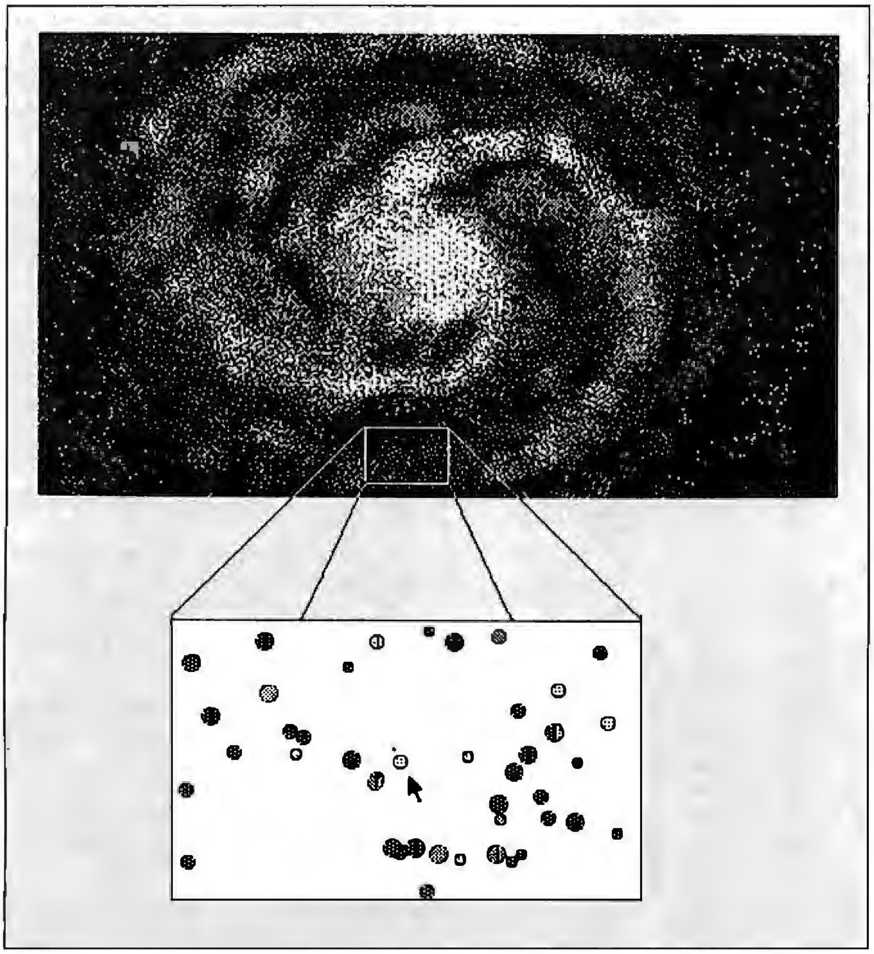


Figure 2: *The approximate location of the star cluster from figure 1 in the galaxy.*

thousandths of a second), then multiply it by 3.26161 (ParToLY, the number of light-years in a parsec). Assuming that the right-ascension values are RAH (right-ascension hours) and RAM (right-ascension minutes), the declination values are DecD (declination degrees) and DecM (declination minutes), Par is the parallax, and the constant DegToRad equals 0.01745329, then the statements in listing 2 complete the conversion to polar coordinates, with the unit distance being 0.1 light-year. Note that if we change ParToLY to 32616.1, you can rewrite the third statement as

```
Dist := ParToLY/Par;
```

The more drawn-out version is just for clarity's sake.

Conversion from polar to rectangular coordinates is well defined. Assuming the integer variables *x*, *y*, and *z*, the statements in listing 3 convert from polar to rectangular form, where the function Round takes a real value and rounds it to the nearest integer. This lets you do your calculations with real numbers and convert at the end, maximizing precision.

Stellar Data Structure

The conversion from astronomical to rectangular coordinates just described is performed by a program called ReadStar. ReadStar also converts the data file RawStars (containing the list of stars) from a text file to a binary file called Stars. That way, StarMap can read in the data faster, avoiding any sort of text-to-numbers conversion. The data types used by StarMap and ReadStar are given in listing 4.

Note that StarClass is an enumerated data type (EDT), *not* a character data type. Each star system can have up to three components, or three different stars. For example, the star system Keid actually contains three stars, with stellar classes K1, dA0, and M4. Keid's data structure would then have the values shown in figure 5.

Note that the record type Component is declared as being "packed." This is to make it as small as possible. Since each of the three fields—Dwarf, Class, and SubClass—have very small ranges of values, the MacAdvantage compiler can pack all three into just 2 bytes, the smallest possible size of a UCSD Pascal record. This keeps the size of the Stars record down to 38 bytes. If the program didn't declare Component to be packed, it would use 2 bytes for each field, for a total size of 6 bytes, and the array Comp would go from 6 to 18 bytes, kicking Stars up to 50 bytes per record. In a list of 200 stars, that's a difference of more than 2K bytes.

ORGANIZING THE STARS

After you've created the data file with ReadStar, you can now run StarMap to display and manipulate it. A few subtly related questions arise. First, in what data structure will the stars be stored? The program could just read them into an array[1 . . *n*] of Stars, but *n* has to be fixed when the program is compiled. This limits the number of stars that can be read in and also forces the program to use more memory than it might otherwise need.

Second, having read in the stars, in what order should you have the program draw them? Since stars will overlap on the display, this becomes an important question. The program should draw from the farthest star to the nearest, so that those closer to your viewpoint will cover up (when necessary) those farther away. One solution, of course, is to sort the array (if that's what you're using) along the axis being viewed. But that means the program would have to sort the list again every time you change the viewing axis, which would add a fair amount of time and overhead.

Third, if you point at a star and click the mouse, the program must detect the closest star and not any that are hidden behind it. This is similar to the second problem; again, a sorted list of stars will solve the problem. The challenge is to avoid constantly resorting.

Many solutions are possible; each has good and bad points. The approach I've chosen provides a large degree of flexibility while reducing the storage of redundant information.

(continued)

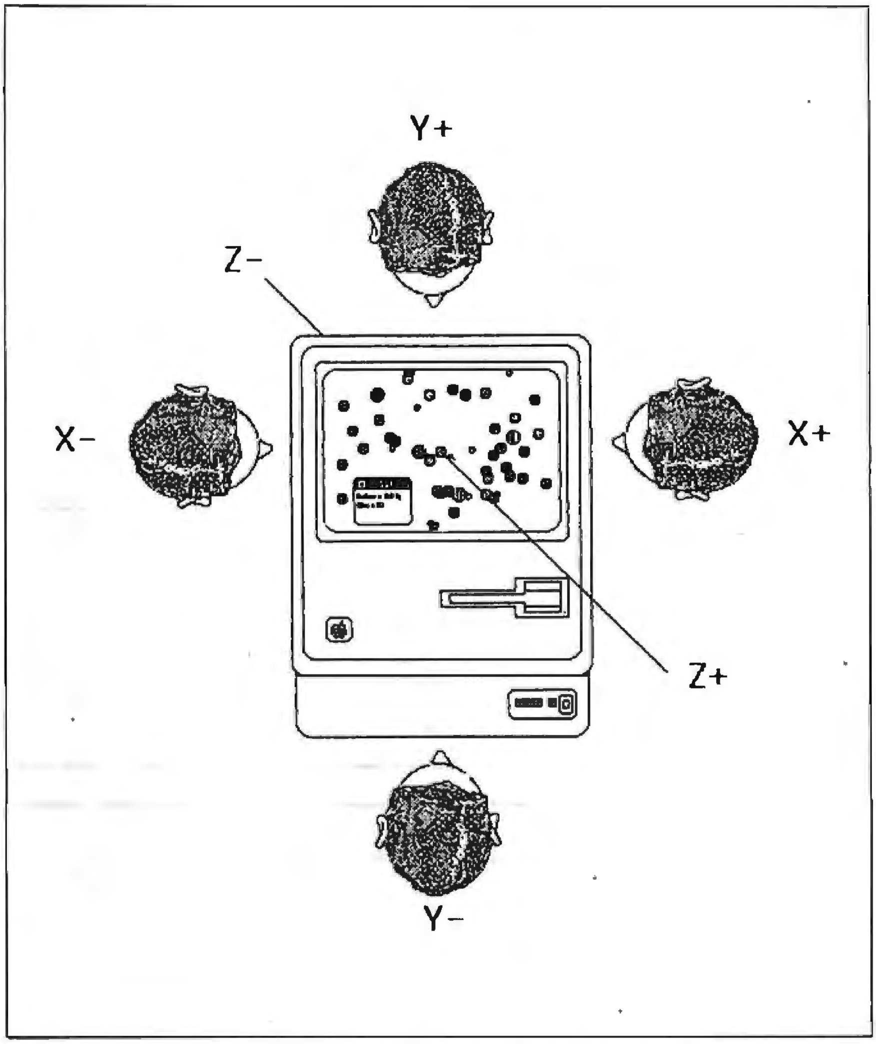


Figure 3: *The x-, y-, and z-axes for StarMap, as related to the Macintosh screen.*

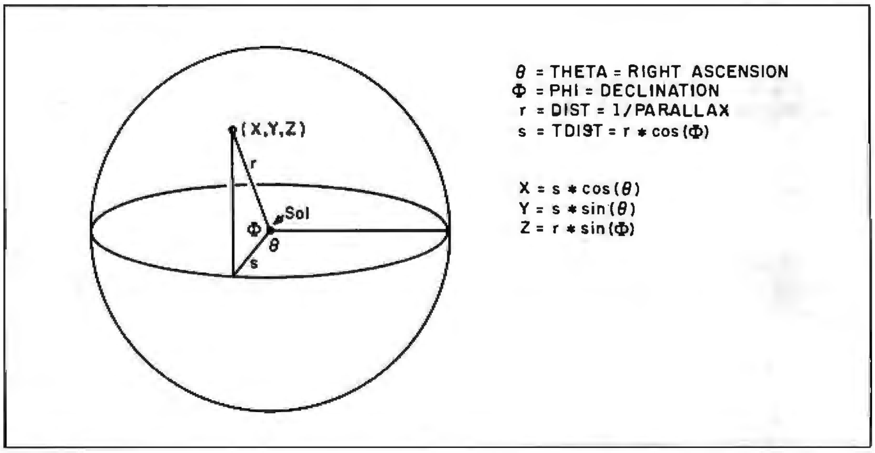


Figure 4: *The relationship between the three coordinate systems discussed in the article: stellar (right ascension, declination, and parallax), polar (theta and phi), and Cartesian (x, y, and z).*

Listing 1: *The code for converting hours, degrees, and minutes into real values.*

```
function MinToFrac(Degrees, Minutes : Integer) : Real;
{
  purpose     converts dd mm to dd.xx
}
var
  Sign        : Real;
begin
  if Degrees 0.0
    then Sign := -1.0
    else Sign := 1.0;
  MinToFrac := Degrees + Sign*(Minutes/60.0)
end; { of func MinToFrac }
```

Listing 2: *The code for converting right ascension, declination, and parallax into polar coordinates.*

```
Theta := DegToRad * MinToFrac(RAH,RAM) * 15.0;
Phi := DegToRad * MinToFrac(DecD,DecM);
Dist := ParToLY * (1000.0/Par) * 10.0;
```

Listing 3: *The code for converting polar coordinates into Cartesian coordinates.*

```
Z    := Round(Dist * Sin(Phi));
TDist := TDist * Cos(Phi);
Y    := Round(TDist * Sin(Theta));
X    := Round(TDist * Cos(Theta));
```

Listing 4: *The data types used by StarMap and ReadStar.*

```
StarClass     = (O,B,A,F,G,K,M);
SubRange      = 0..9;

Component     =
  packed record
    Dwarf     : Boolean;
    Class     : StarClass;
    SubClass  : SubRange
  end;
Stars         =
  record
    Name      : string[23];
    X,Y,Z     : Integer;
    NumComp : 0..3;
    Comp      : array[1..3] of Component
  end;
```

Each star occupies a location in a large three-dimensional grid, specified by its coordinates (x,y,z). Since you want to sort the stars along each axis, start by linking together all stars with the same x-coordinate, the same y-coordinate, and the same z-coordinate. To do this, define the data types as shown in listing 5.

Each star that is read in will have its own node; that is, the data will go into the field Star. The three pointers—Node[AX], Node[AY], and Node[AZ]—will each point at the next star sharing the same x-, y-, or z-coordinate, respectively. Of course, if there are no more stars with the same given coordinate, the respective pointer will contain the null pointer value, nil.

With this method, the program can read in as many stars as there is memory for; likewise, you allocate only as much memory as is needed. There is an additional overhead of 6 bytes per node (for the three pointers), which brings the size of each node up to 44 bytes, but we've gained a lot of flexibility with those pointers.

Now that all these stars are linked together, how do you get to the first star of each list? Use a header list. The data structures for the headers are shown in listing 6.

The array Next points to lists of stars sharing the same x-, y-, or z-coordinate. AVal tells what that coordinate

Name	Keid
X	71
Y	141
Z	-21
NumComp	3
Comp[1]	
Dwarf	False
Class	K
SubClass	1
Comp[2]	
Dwarf	True
Class	A
SubClass	0
Comp[3]	
Dwarf	False
Class	M
SubClass	4

Figure 5: *The data structure for the star system Keid, which consists of three stars.*

is. Note that there is one header for a given value along all three axes. For example, if AVal were 71, then Next[AX] would point to all stars with an *x*-coordinate of 71, Next[AY] would point to those with a *y*-coordinate of 71, and Next[AZ], to those with a *z*-coordinate of 71.

As I mentioned, you want the stars sorted along each axis. You can accomplish this by simply maintaining a sorted linked list of headers. The pointer Link[Front] points to the header with the next highest AVal; Link[Back] points to the next lowest header. Both ends of the list point to a special header called Head (and vice versa). To traverse the list, the program starts at one end and follows Link until it runs into Head. The procedure in listing 7, when given an axis and a direction, traverses the entire list of stars in the order you requested and writes out the name of each star. You won't find this procedure in StarMap, but the routines to draw the map and to find which star has been selected use code that is similar to StarMap's.

HPtr moves through the list of headers until it runs into Head. TPtr checks all the stars at each header for the given axis. For example, if HPtr^.Aval = 15 and Axis = AY, then TPtr will point at all the stars (if any) with a *y*-coordinate of 15.

TRANSFORMING THE DISPLAY

StarMap lets you transform the display by rotating it, translating the coordinates, and scaling it up. Rotation is limited to your fixing the position of the axis (*x*,*y*, or *z*) you're looking along and choosing to look from the positive or negative end. The program simply changes the values of Axis and Direction (global variables with the same data types shown in listing 7, WriteNames). The list of stars is now automatically "sorted" along that axis, while Direction fixes the direction.

Translation takes a couple of forms. First, you can change the map's origin to any star; it doesn't have to be Sol. This is done by clicking the star and then pulling down the Origin menu. The name of that star will appear in the menu; just select it to move. Sol always appears in the menu, so you can easily recenter the display. You also can add an offset of plus or minus 15 light-years to the origin along any axis. The name of the current origin always appears at the top so that you can remove the offset. It also reminds you what the current origin is. One more effect: When you click a star to get information, the

(continued)

Listing 5: *Definition of the data types for linking together stars with the same x-, y-, or z-coordinates.*

```
AxisType     = (AX,AY,AZ);
NodePtr      = ^Node;
NodeList     = array[AxisType] of NodePtr;
Node         =
  record
  Next       : NodeList;
  Star       : Stars
end;
```

Listing 6: *Data sructures for the header list.*

```
DirecType      = (Front,Back);
HeadPtr        = ^Header;
Header         =
  record
    AVal       : Integer;
    Link       : array[DirecType] of HeadPtr;
    Next       : NodeList
  end;
```

Listing 7: *The procedure that traverses the entire list of stars in the order requested and writes out the name of each star.*

```
procedure WriteNames(Axis : AxisType; Direction : DirecType);
{
  purpose     traverses all stars
  last update  09 Mar 85
}
var
  TPtr          : NodePtr;
  HPtr          : HeadPtr;
begin
  HPtr := Head^.Link[Direction];      { start at one end }
  while HPtr<>Head do begin
    TPtr := HPtr^.Next[Axis];    { check specific axis }
    while TPtr<>nil do begin { look at all stars }
      WriteLn(TPtr^.Star.Name);    { at that coordinate }
      TPtr := TPtr^.Next[Axis]
    end;
    HPtr := HPtr^.Link[Direction]
  end
end;  { of proc WriteNames }
```

distance given is always with respect to the current origin. If you select Groombridge 34 as your origin, then look at Beta Hydri; the distance shown is that from Groombridge 34.

Scaling is basically a zoom function. You are not moving "into" the cluster; you are just increasing the magnification of your mythical telescope. Each level of scaling represents a twofold increase over the previous level.

FILTERING STARS

You have three filtering functions at your disposal. First, you can screen stars according to their *stellar class* (O,B,A,F,G,K,M). The program maintains a set (DisplaySet) containing the currently allowed classes. For multiple stars, if any component is in DisplaySet, then all components are displayed.

The second filter is *distance*. Note that this is the distance *from the current origin*. If you set Groombridge 34 to be the origin, then limit the range to 8 light-years, you will see all stars within

DEVELOPMENT USING MACADVANTAGE:UCSD PASCAL

MacAdvantage:UCSD Pascal represents something of a first for SofTech Microsystems Inc.; it's a UCSD Pascal compiler running under something other than the UCSD p-System operating system. True, SofTech had released an MS-DOS hosted version of the p-System, but that isn't quite the same as this.

MacAdvantage is simply a UCSD Pascal compiler (and assorted tools) running under the Macintosh Finder. The editor is a standard Macintosh-style editor, developed by Bill Duvall at Consulair and found in other software-development packages (MDS, MacModula-2, Megamax C, etc.). The resource maker is Apple's standard resource compiler, again found in many of the other systems. The compiler produces applications that you can start by double-clicking an icon. However, those applications don't stand alone: you have to have the MacAdvantage P-machine and run-time files somewhere on the disk. The application loads these in before executing.

Program development under MacAdvantage is a pleasure. The package comes with a little executive program that takes you out of the Finder and gives you a Macintosh-like menu bar across the top. The menu bar contains selections to let you compile, run the resource maker, edit a file, run the library or set-options utilities, or exit to the Finder. When you go from the editor or the compiler into the executive program, it only takes a second or two to bring the display up, a great improvement over the 15 to 25 seconds it can take to return to the Macintosh Finder. And the Set menu lets you define where (and what) the different utility files are.

Since UCSD Pascal is basically a 16-bit language and the Macintosh is a 32-bit environment, SofTech had to make a number of changes and enhancements to fit the two together. MacAdvantage has a 32-bit integer data type (Integer2), which is heavily used in the Toolbox units, usually to represent 32-bit addresses. A new function, Locate, returns the 32-bit address of a given variable or procedure. Other functions help conversion between the 16-bit p-code pointers and the Macintosh's 32-bit addresses. Other bridges include functions to convert between the two Macintosh Boolean types and the UCSD Pascal Boolean type.

The Toolbox implementation is fairly complete. One library (with a large number of units) lets you use just the routines and definitions that you want. Most are identical or almost identical to those defined in *Inside Macintosh* (Cupertino, CA: Apple Computer Inc., 1985), although, again, some modifications have been made to bridge the different environments.

If MacAdvantage has one major drawback, it is its lack of speed. Like MacModula-2 and the Mac p-System, MacAdvantage uses pseudo-machine code running on a p-code interpreter. This makes it anywhere from 20 to 40 times slower than assembly language, although heavy use of Toolbox routines can significantly close that gap. A minor drawback is that it is necessary to copy both the application and the support files (P-machine, run-time file) in order for the application to run.

With the recent announcements of SofTech, MacAdvantage now has some strong points to balance against problems. First and foremost is price: at $119, MacAdvantage is a real bargain. On top of that, of course, is word that SofTech has completely dropped all licensing fees for MacAdvantage. This means that programmers can freely give away or sell any products developed with MacAdvantage, including the two support files needed to run them.

Even if developers don't want to release a final product in MacAdvantage form, they can still make use of the package. MacAdvantage and Lisa Pascal are similar enough that conversion from one to the other is fairly straightforward. This means that programmers could experiment and develop new programs on the Macintosh (using MacAdvantage), then produce a final version using Lisa Pascal.

Finally, MacAdvantage represents the next step after MacPascal (from Apple). MacPascal has a nice environment for beginning programs, but its speed (over 15 times slower than MacAdvantage), its copy protection, and its lack of full, direct Toolbox support severely limit it as a serious development tool. Educational institutions in particular might be interested in switching to MacAdvantage after a semester of MacPascal.

8 light-years of Groombridge 34.

The third filter is *number of components*: one, two, or three stars, or any combination of these. As with the stellar class filter, the program uses a set (CountSet) to keep track of the allowed values.

All three filters are cumulative. If you only want to see all binary K-class stars within 8 light-years of Groombridge 34, you can. As it turns out, there is one such system: 61 Cygni (6.9 light-years away; components are K5 and K7).

SELECTING STARS

To get more information about a star, you point at it with the mouse and click. The program must then determine which (if any) star you selected. Remember that StarMap draws the stars from the farthest away to the closest. StarMap detects stars in the opposite direction, so that you select what you see and not some star hidden behind it. For each star that meets your selection criteria (i.e., passes through all your filters), StarMap generates its enclosing rectangle, then checks to see if the mouse was clicked within that area. If it was, the rectangle is momentarily inverted to indicate which star was selected, and then the information window is updated. The information window, which gives the name, distance from current origin, and class of components, is shown in figure 1. If another star is selected, the information window is changed accordingly.

APPLICATIONS AND ENHANCEMENTS

The obvious application of StarMap is educational, although it can be fun to play with as well. Most important, it displays the data in a more interesting and memorable manner than table 1. This program is sure to liven up any astronomy (or general science) class.

Numerous changes and enhancements are obvious. Since you can substitute your own star list, you can create a larger star map. For example, proper motion information could be added to the star list (in table 1) as

The obvious application of StarMap is educational, although it can be fun to play with as well.

well as to the Stars data structure (in listing 4). A time menu could then be used to track the stars in relation to one another. Other information, such as the absolute magnitude of the components, could be added and displayed. My own plans include a "universe construction set," which will let me create planets in each of those systems.

You can obtain the StarMap listings from BYTEnet Listings at (617) 861-9774. You will also need BinHex, a public-domain program available on BYTEnet Listings, which changes the binary files into executable applications. The listings are STARMAP.HQX, the actual program; STARS.HQX, the data file of stars; READSTAR.HQX, only necessary if you want to create a new data file; and PRUNTIME.HQX and PMACHINE.HQX, the run-time files needed to run the program. If you have the MacAdvantage development system and want to make adaptations to the program, the necessary files are STARMAP.PAS, SMAP.R, RAWSTARS.DOC, and READSTAR.PAS. ■

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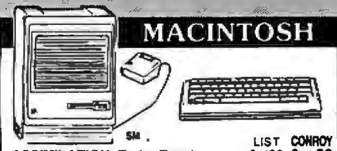

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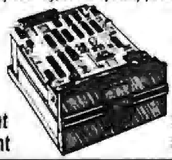

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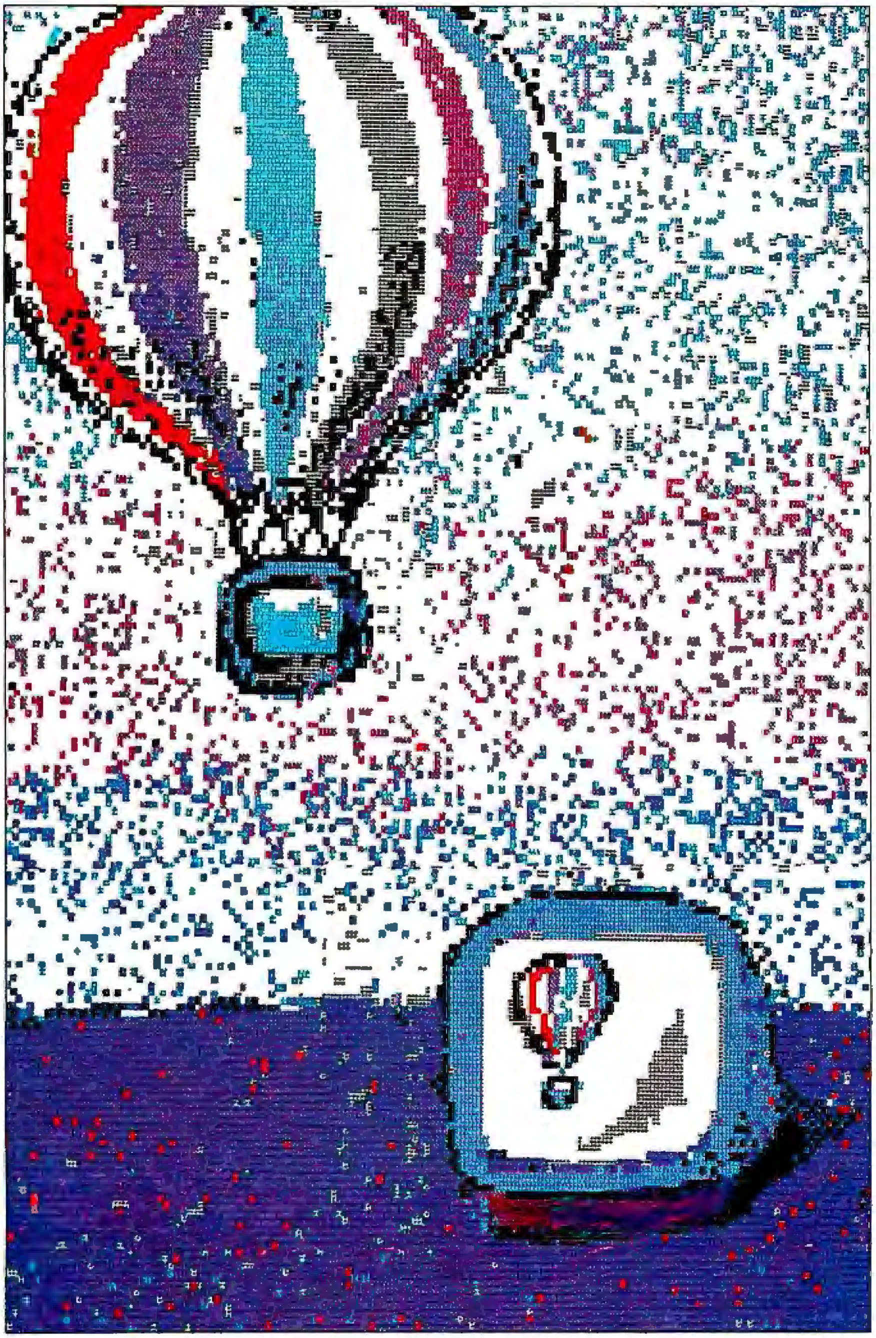

Inside the display technology that has made portable computers portable

Several months ago I got into a discussion with a computer enthusiast about which portable computer to buy. I quickly whipped out my portable and began preaching its merits and demonstrating how powerful it is. I could see the display perfectly, but the fellow standing next to me was having difficulty reading what I had typed. Poor display quality is a common limitation in portable computers. Most portables (not to be confused with transportables) have twisted-nematic liquid-crystal displays (TN-LCDs), with restricted viewing angles and limited contrast. They must be operated under proper ambient lighting conditions.

In mid-1982, there were only a few low-profile displays on the market. Of the available technologies, TN-LCD was the only one that had acceptable power requirements for battery operation. A typical 16-line LCD module dissipates approximately ⅛ watt (W). Other available flat-panel technolo-

(continued)

Glenn Adler has a B.S. in electrical engineering and does VLSI design work for Hewlett-Packard's portable computer division. He can be contacted c/o Hewlett-Packard, 1000 Northeast Circle Blvd., Corvallis, OR 97330.

ILLUSTRATED BY ELLEN HARRIS

gies use too much power for battery operation (see "Two Flat-Display Technologies" by Richard Shuford, March BYTE, page 130). Electroluminescent (EL), gas-plasma (GP), and flat-panel CRT (cathode-ray tube) displays with 25 lines dissipate 30 to 200 times the power of LCDs.

Portable computers must be lightweight, compact, and battery-operated. This necessitates a flat-panel display that uses low power. Since these microcomputers compete directly with desktops, they need to handle applications that run on the leading personal computers. Their screens must have features equivalent to standard monochrome displays: 80-character, multiple-line alphanumeric displays with full graphics capability.

Limited contrast, brightness, and viewing angle are the drawbacks associated with multiple-line TN-LCDs. These disadvantages are attributable to the fundamental electro-optical characteristics of these panels. The use of TN-LCDs requires different circuit architecture than a standard video interface and requires some unique mechanical designs to overcome their physical limitations.

VISUAL PERCEPTION

Your eyes and visual cortex are stimulated to a great extent by the edges of objects. Edge detection occurs where there is a step difference in brightness (also termed luminance in the case of a monochrome image) between adjacent objects in the visual field. For the purpose of measurement, you can define contrast ratio (CR) as the quotient of luminance of a light picture element (pixel) to a dark pixel's luminance. (Luminance is measured in foot-lamberts.)

$$CR = L_1 / L_2$$

L_1 = luminance of light pixel
L_2 = luminance of dark pixel

Contrast ratios of 2 to 1 form what you can easily detect as an edge. This CR is about the minimum acceptable for easy reading of LCDs. Typical CRT displays have CRs ranging up to 20 to 1, but once the ratio approaches 10 to 1 your eye saturates and can no longer differentiate changes in relative brightness.

Your eye samples the visual field at roughly 30 Hz and your brain integrates the information to form a continuous picture. The perception of flicker in a display is a function of this phenomenon, the persistence of the display material, and the rate at which information is refreshed. Aside from this temporal integration of information, your eye also performs a spatial integration. You can see an example of this by looking closely at the characters displayed on a CRT screen. The characters are made up of discrete pixels, but seen from a distance they appear to form a continuous item. Your brain fills in the gaps, but the perceived object has lower brightness overall than each individual dot. Furthermore, if the separation between dots increases beyond the eye's limit of resolution at a typical viewing distance (1½ to 2 feet), your brain will interpret adjacent dots as belonging to separate objects. This constraint physically limits the useful pixel-separation distance for displays such as LCDs.

TWISTED-NEMATIC LCDs

Today's LCDs use the properties of plane polarizers and ordered nematic liquid crystals to modulate light. Polarizers are light filters that selectively allow incident light through their "passing axis." Light oriented in any other direction is absorbed (see figure 1).

Some organic compounds exist in a phase called the mesophase, which is stable at temperatures between the liquid and solid phases. Liquid crystals (LCs) exhibit three such phases: smectic, nematic, and cholesteric. In the nematic phase, the long axes of the LC molecules align in parallel orientation. The alignment of LCs in this phase is sensitive to several stimuli, including temperature, surface

(continued)

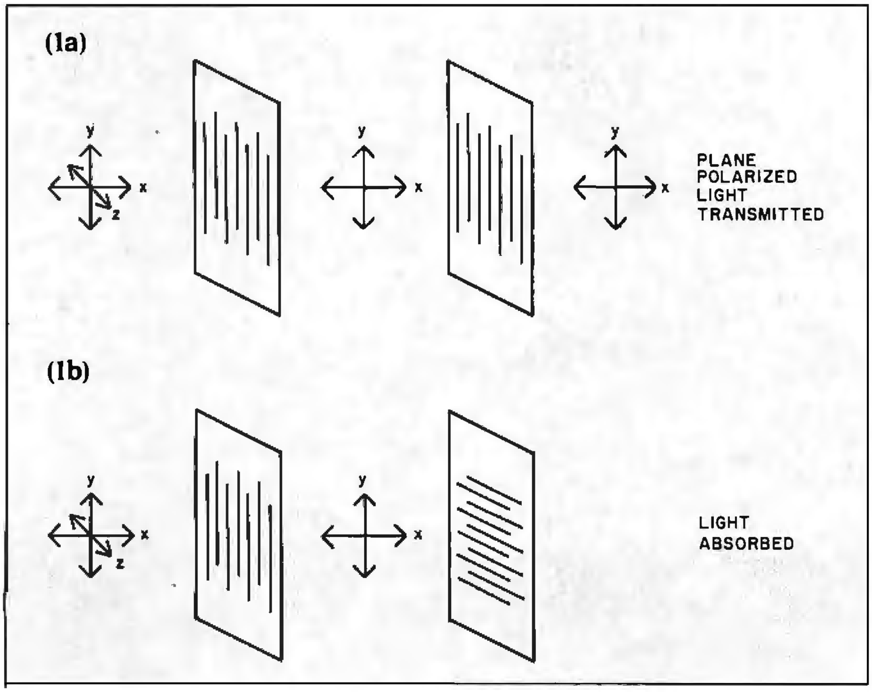

Figure 1: *This figure depicts the effects of two polarizers on noncoherent light. (a) Light passing through the first polarizer is polarized in the Y and X plane. Since the polarizer's passing axes are aligned, the light continues through the second polarizer. (b) Here, the polarizer's passing axes are oriented orthogonally, and the plane polarized light that has passed through the first polarizer is absorbed by the second.*

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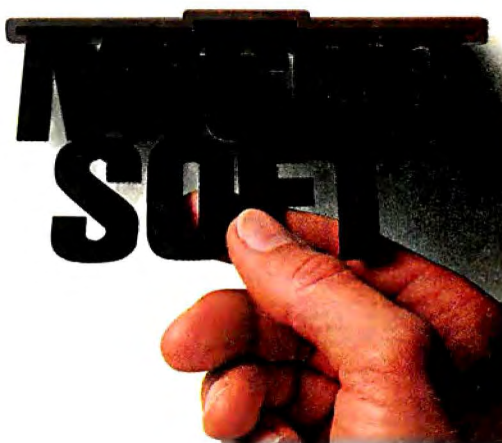

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tension, pressure, and electric and magnetic fields. These stimuli also affect the optical properties of the material.

The optical properties of twisted-nematic LCs were first demonstrated by Schadt and Helfrich in 1970. (See *Voltage Dependent Optical Activity of a Twisted Nematic Crystal* by S. M. Schadt and W. Helfrich. Applied Physics Letters, number 18, 1971, page 127.) By now, several firms have developed an efficient process for fabricating displays. The key in producing this display is to create a twisted nematic by sandwiching an LC material between two plates whose surfaces are grooved, the top plate in one direction and the bottom in a perpendicular orientation. Layers of LC adjacent to each surface align in parallel with the texturing. Layers between form a helix that twists the plane polarized light. A twisted nematic can be visualized as a polarizer with a 90-degree rotation. Next, this sandwich is placed between two polarizers, each with its passing axis in parallel with the grooves on the adjacent glass (see figure 2). Thus, a light valve can be created by applying a voltage across the LC. With voltage applied, the nematic LC molecules no longer twist the incident light but rather pass it parallel to their long axis. The planerized light entering through the top polarizer is absorbed by the lower, thus making the pixel appear dark. In the inactive state the LC is relaxed and light is passed through the helix. The panel can be used in transmissive mode (similar to a transparency) by adding a backlight source. Or the manufacturer can create a low-power, nonemissive (having no light source) LCD by adding a reflective layer.

The conductors deposited on the LCD glass are usually composed of indium-tin-oxide (ITO). Since the index of refraction of ITO is different from that of glass, this would ordinarily result in an aberrant image. Therefore

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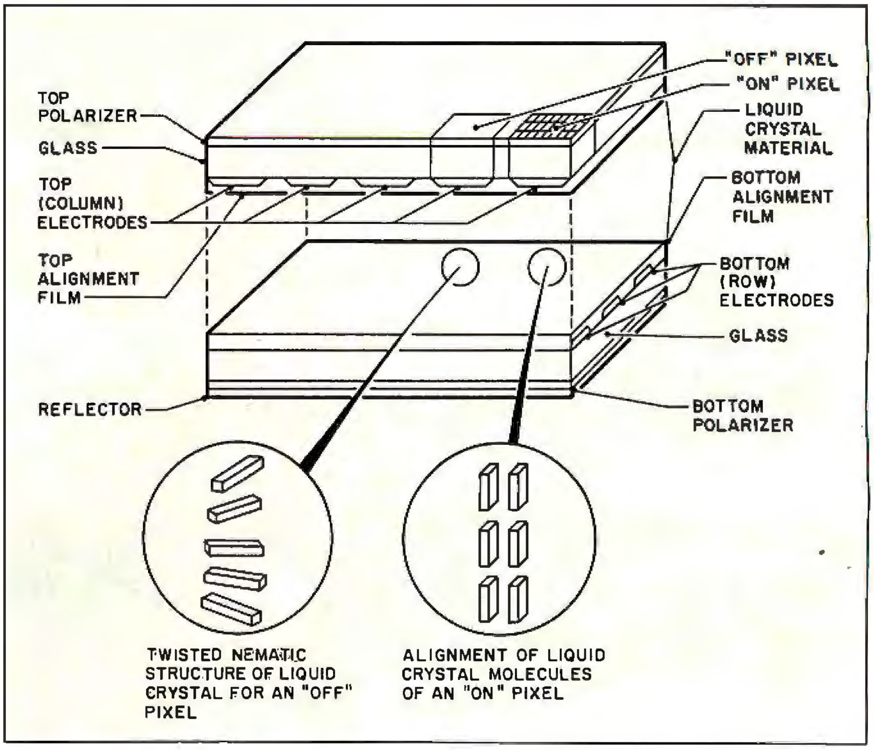

Figure 2: *A cross section of a reflective liquid-crystal panel is shown. In the "off" state the LC molecules form a helix. In the "on" state (potential applied) the molecules align in the direction of the electric field.*

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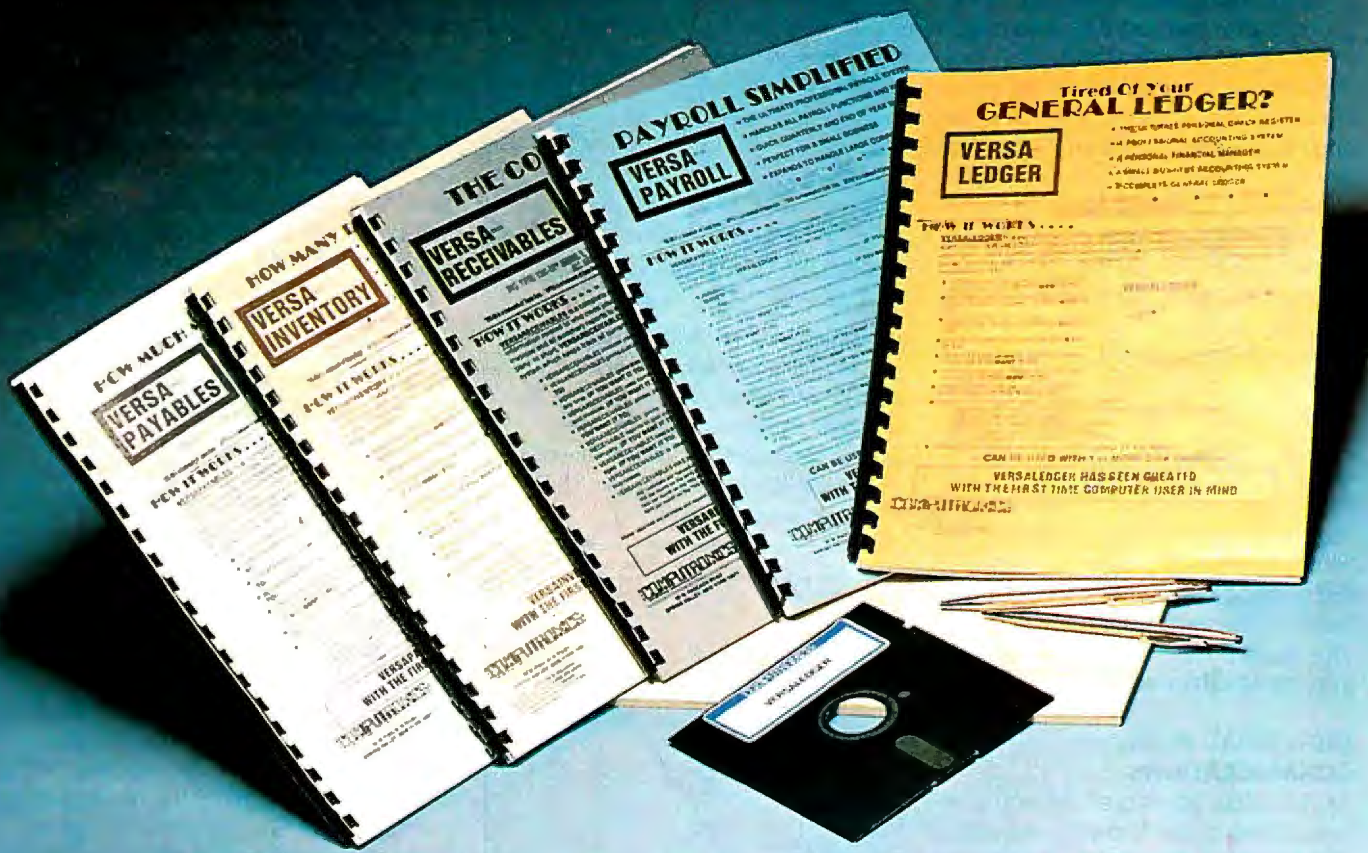

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a passivation layer (coating) is deposited after the conductor to match the indices of refraction. For dot-matrix LCDs, isolated rows of conductor are formed on one glass surface, and orthogonal columns are produced on the other by selectively etching ITO. The row and column conductors form the plates of a capacitor whose dielectric is the LC media. These capacitive elements are the discrete pixels.

When the reflective LCD panel is in the "off" state, pixels that appear bright consist of light that is polarized in one plane, although it passes through both filters twice. The intensity of light reflected off the screen is reduced by approximately 60 percent from incident light (50 percent due to the filtering effect, 10 percent due to losses in the remainder of the system). This makes the "off" pixels appear gray rather than white.

INDIVIDUAL PIXEL CONSIDERATIONS

As TN-LCDs get larger, several considerations come into play regarding the quality of the image. To examine these, you need to understand the effects of applying potential to individual picture elements.

Each pixel can be modeled as a capacitor (C_p) with a parasitic resistance (R_p) in parallel (see figure 3). The row and column lines have sheet resistances R_{sr} and R_{sc}, respectively. In order to ensure consistent contrast throughout the screen, it is necessary that all pixels see nearly the same voltages. The voltage needed to turn a pixel on to an acceptable contrast level is a function of the electrical properties of the particular LC used and the distance between glass plates. The typical cell gap (plate separation distance) is between 5 and 10 microns. Variances in the glass cause variance in the LC thicknesses, which results in "rainbowing." Larger cell gaps require higher threshold potentials and reduce the viewing angle of the LC media.

The magnitude of local voltage a pixel sees is highly dependent on voltage drops due to sheet resistance.

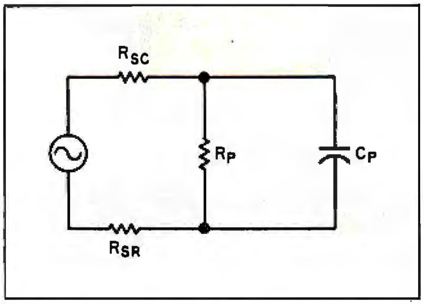

Figure 3: *C_p and R_p represent the capacitance and resistance, respectively, of a pixel: Typical values are 2 nF/cm² for C_p and 12 Mohm/cm² for R_p. R_{sc} and R_{sr} are sheet resistances of the row and column conductors. For indium-tin-oxide their value lies between 10 and 300 ohms per square.*

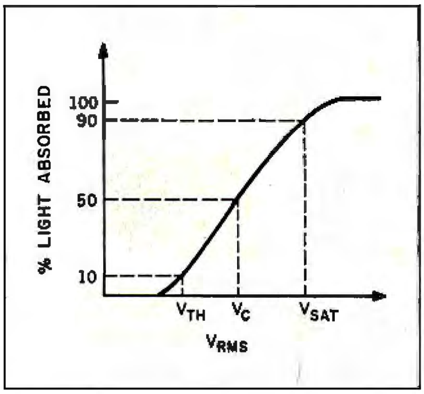

Figure 4: *The threshold voltage is the rms voltage at which 10 percent absorption of incident light occurs. V_c is the voltage at which "on" pixels reach acceptable contrast (usually 2:1) to "off" pixels (those at V_{th}) occurs. V_{sat} (saturation voltage) is the potential at which 90 percent of the light is absorbed.*

The value of this resistance depends on the physical distance of the pixel from the drive circuit and the properties of conductor deposition. Because of the tight gap requirement between the plates and sheet resistance effects, it is essential that LCDs use glass that is very flat. Presently there are only a few suppliers producing glass acceptable for large display applications.

A typical response curve for an LC is shown in figure 4. LCDs with fewer pixels (specifically, fewer dot rows) can use materials that exhibit shallow slope in their response curves and have threshold voltages (V_{th}) near 1.2 volts (V) rms (root mean square). The use of multiplexing (described later) in the larger LCDs used today requires less voltage margin between contrasting pixels. Materials currently used do have steeply sloped response curves but consequently have higher threshold potential due to their chemical properties.

MULTIPLEXING AND BIAS

For a multiple-line LCD, turning dots on and off is not simply a matter of applying a constant potential to each pixel. An 80-character by 16-line display (480 by 128 dots) would require more than 61,000 separate conductors to form a static drive scheme in which each dot is electrically isolated. The current photolithographic technique used to reliably etch ITO is limited to a minimum conductor spacing of 50 microns for good production yields. The actual conductor width itself is limited by the resistance per square of ITO. Ignoring the conductors altogether, the spacing constraint alone would necessitate a panel perimeter of greater than 3 meters to bring in all the connections. Also, producing some 61,000 minute connections reliably is no trivial problem. LCDs that use narrow conductors and spacings are under investigation. Presently the application of this technology to large pieces of glass in volume production is impractical because of processing defect problems and sheet resistance effects.

To overcome the interconnect problem, large TN-LCDs use a multiplexing scheme that is similar to a keyboard scan. In a multiplexed panel with n rows (duty panel), each "on" pixel only experiences peak voltage, V_p, for $1/n$th of the time. Along with duty cycle, the other electrical parameter that affects contrast is bias (B). The number of bias levels is the amount of discrete, uniform steps of voltage into which the LCD's supply is divided. B is usually expressed as the reciprocal of this number of levels.

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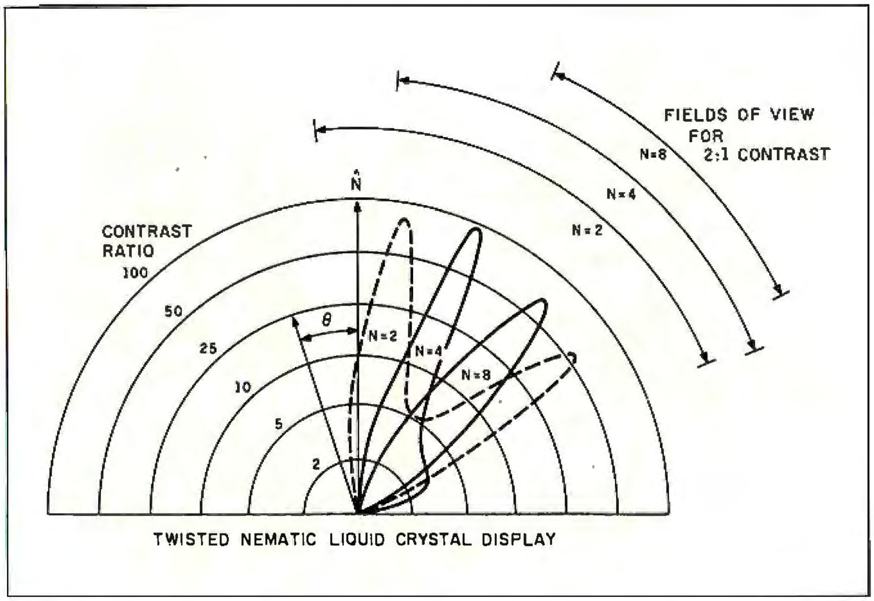

Figure 5: *Multiplexing as it relates to contrast and viewing angle for a transmission mode LCD. Concentric rings represent measured contrast ratio (CR) of "off" to "on" pixels. Theta, θ, is the displacement of viewing angle from the normal direction, N̂. The response of a liquid-crystal medium for three different levels of multiplexing, N, is shown.*

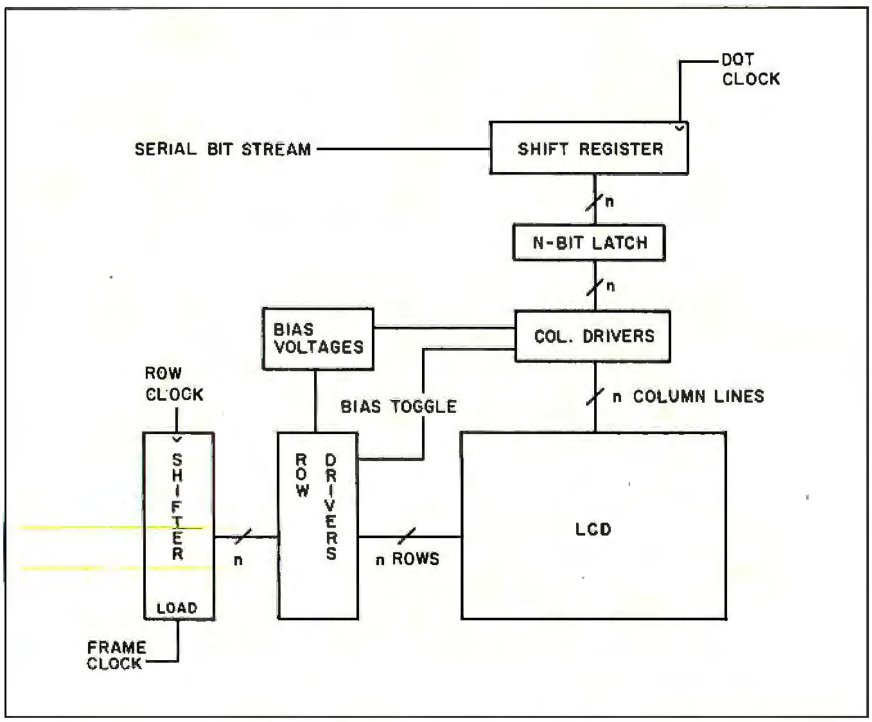

Figure 6: *Circuit schematic for an LCD quadrant. Dots are shifted on the fall of dot clock. Values are moved from the serial shifter to the n-bit latch and a new row is selected by the fall of row clock. Frame clock resets the row sequencer and initiates the next frame. The bias toggle along with the dot value determines the voltages driven on the row and column lines.*

(For example, if the peak voltage delivered to the panel is 18 V and it is divided into 2-V steps for use by the drive circuitry, then $B = 1/9$.)

The time-averaged DC voltage applied to each dot is resolved by calculating the rms voltage applied to it over the course of a single refresh period. This value reflects the energy delivered to each capacitive pixel by the applied AC waveform.

For simplicity let's assume you turn on a pixel in the first dot row of an n row display to V_p. During the next n rows of refresh, this dot experiences the "off" voltage ($= B^*V_p$). The rms voltage seen by a selected pixel (V_s) is given by

$$V_s = (V_p)\ (((1)^2 + (n-1)(B)^2)/n)^{1/2}$$

On the other hand, nonselected pixels experience "off" voltage constantly throughout the refresh period. The voltage they experience is

$$V_{ns} = B^*V_p$$

By plugging through the mathematics you will find that, given a fixed value of B, the ratio of V_s/V_{ns}, which is related to CR (see figure 4), decreases as n, the number of rows, increases. Contrast gets worse as more rows are multiplexed. Conversely, as the number of bias levels increases (up to a theoretical limit) for a fixed number of rows, the CR improves for a fixed viewing angle.

In the case of muliplexed LCDs, the best number of bias levels is given by $B = 1/(n)^{1/2} + 1$. This rule optimizes the contrast for a given value of n. For a 64-dot row display, the bias value chosen would be 1/9. In practical applications this number is not always used, but a convenient bias value is chosen.

The Effects of Viewing Angle

Application of an electric field to LC media causes alignment of the long axis of the molecules in the direction of the field lines. When a pixel is activated in a multiplexed display, the rms value of selected voltage is of lesser magnitude than the saturation value (V_{sat}) (see figure 4) for the material.

The closer the value of V_s is to the V_{sat}, the greater the rotation the LC dipoles in the direction of applied field. (Perpendicular to the surface of the glass.) Maximum contrast is achieved when the viewing direction is coincident with the alignment of the long axis of the molecules. Thus, as duty cycle decreases (V_s decreases) the optimal viewing angle moves away from the normal.

An increase in multiplexing also implies a lower voltage margin between selected and nonselected pixels. With a small voltage margin the orientation of molecules in an "on" pixel relative to an "off" pixel is only slightly different angularly. Thus, acceptable contrast is only perceivable over a narrow field of view for LCD panels with multiple lines (see figure 5).

As Displays Get Larger

In early 1982 the practical limit for multiplexing was 32 rows, and now, because of improvements in LC materials, this number has been raised to 128.

Due to the matrix design used in TN-LCDs (shared rows and columns), crosstalk between selected and nonselected pixels can occur. The visual implications of crosstalk are reduced contrast and dark streaking called "shadowing." To minimize shadowing, a design using three different biases is implemented. For a 64-row display, dots on rows that are not undergoing refresh experience a potential of $1/9(V_p)$. During a given row's refresh, the "on" and "off" dots are driven to V_p and $7/9(V_p)$, respectively. Calculating V_{rms} for these conditions using a value of $V_p = 18V$ yields $V_s = 3V$ and $V_{ns} = 2.65V$. (This is a simplified example. Actual biases chosen depend on the ease of design.) Although the voltage margin in this biasing scheme is smaller than the voltages resolved using the equations that were previously explained, crosstalk effects are reduced by decreasing potential differences between neighboring pixels.

The rms voltage experienced by an "on" pixel (for a fixed multiplexing value) is directly affected by the magnitude of peak voltage applied to it. Presently the CMOS (complementary metal-oxide semiconductor) circuitry used to drive the row and column lines is only capable of 18 to 20 volt swings. Low-power drivers are being developed that are capable of tolerating up to 30 V. These drivers will improve the optical qualities of the panels and allow for a greater number of dot rows.

Mechanical Designs

To compensate for the viewing angle restrictions and the glare of overhead lighting, the display assembly of most portables offers variable tilt. Pressure sensitivity of the LCD and ruggedness requirements make it necessary for the panel to have a protective cover. By texturing the plastic, glare can be minimized but some image sharpness is lost.

Portables must endure harsh treatment: being carried to and from work, dropped on the floor, and often mistaken for outlets of aggression; their fragile displays must be protected when not in use. Many portables use a display assembly that pivots into a closed position above the keyboard. This design, along with proper mounting and cushioning, protects the panel from direct contact with the environment when being transported and forms a compact portable package.

Limitations of TN-LCDs

No matter how adjustable the display assembly is, in low lighting situations reflective TN-LCDs become illegible. Adding a backlight source to these normally nonemissive displays is costly in terms of power (an additional 1 to 2 W is needed), but the range of acceptable lighting for readability is improved.

LCDs also limit the temperature range in which a portable can be used. Below 0° and above 50° Celsius, typical LC media undergo phase changes and the displays become unusable (although they are not permanently damaged). The LC's response time and threshold characteristics also vary with temperature. Some portables use a compensation circuit that adjusts bias voltages according to operating temperature. In purchasing TN-LCDs for portable systems it is necessary to specify the interreaction of viewing angle and temperature before they affect contrast and, therefore, readability.

Circuit Architecture

To overcome limitations of the multiplexed technology, some manufacturers play tricks in the fabrication of LCD modules. For character fonts that are 8 pixels tall the existent 64-dot row limit originally allowed for only 8 lines of alphanumeric display. To overcome this and produce a 16-line panel, two 64-way multiplexed systems are adjoined. Separate column lines enter the glass from both the top and bottom. The need for 80 characters per line causes further complications in designing LCD panels. Early in the the development of LCDs, CMOS shifters with limited clock speeds were used. Their low frequency led to flicker problems in wide displays. To alleviate this, the top and bottom halves were again divided, forming a total of four quadrants, each requiring its own serial bit stream.

Time multiplexing is handled by the digital circuitry incorporated in the drive circuits. An approach is to save a series of digital pixel states that represents the pattern for a given row. Once the potentials corresponding to these states are set up at the column lines, the row line is scanned by altering its drive voltage. During the selection of one row, the upcoming row's values are being shifted and saved for its refresh cycle. The analog voltages used to bias the display are derived by dividing the voltage supplied to the module through a resistor ladder. By periodically toggling a control line that ties to both the row and column drivers, the polarity of signals applied across the pixels is reversed, eliminating any net DC bias. The application of a net DC bias to the LC media will cause long-term damage to the display. A schematic representation of the digital circuitry is depicted in figure 6.

Portability dictates the need for a

(continued)

Without TN-LCDs, powerful, affordable, portable computers would not be available today.

low-power and highly integrated circuit to interface the LCD with a microprocessor bus. For example, the custom controller that handles both refresh and update in the HP 110 was designed for lack of an industry standard part. To avoid wiring the system bus to the display assembly, the controller integrated circuit (IC) and display RAM (random-access read/write memory) are positioned inside the main case and the LCD interface signals (four data lines, dot clock, row clock, frame clock, and bias toggle [M-clock]) and power lines are connected to the controller via a cable hidden in the display arm.

The magnitude of the supply sent to the panel can be regulated under software control. Changing this voltage affects the magnitude of each bias level and thus regulates display contrast.

THE FUTURE

Although twisted nematics currently offer the only practical, low-power solution for portable displays, several new technologies are on the forefront. Guest-host displays that use a liquid crystal doped with a dye offer brilliant contrast and do not require the use of polarizers. These panels have been demonstrated but are not yet produced with high multiplexing. Active matrix technologies have also been demonstrated, but due to cost and yield considerations their use for large panels is several years in the future.

With improvement in LC materials and the CMOS drivers used to run multiplexed displays, the visual aspects of large TN-LCDs will undoubtedly improve. Now that the age of the backlit LCD is upon us, the work environment in which a portable will be useful will be greatly expanded. Another advance being made is in the use of plastic rather than glass for the panel's plates. Using plastic makes the display lightweight, rugged, and thinner than what is currently available, although controlling the cell gap is difficult because of plastic's flexibility.

Even though TN-LCDs may be difficult for your neighbor to read, they offer a perfectly adequate solution for a single user. Without them, powerful, affordable, portable computers would not be available today. ■

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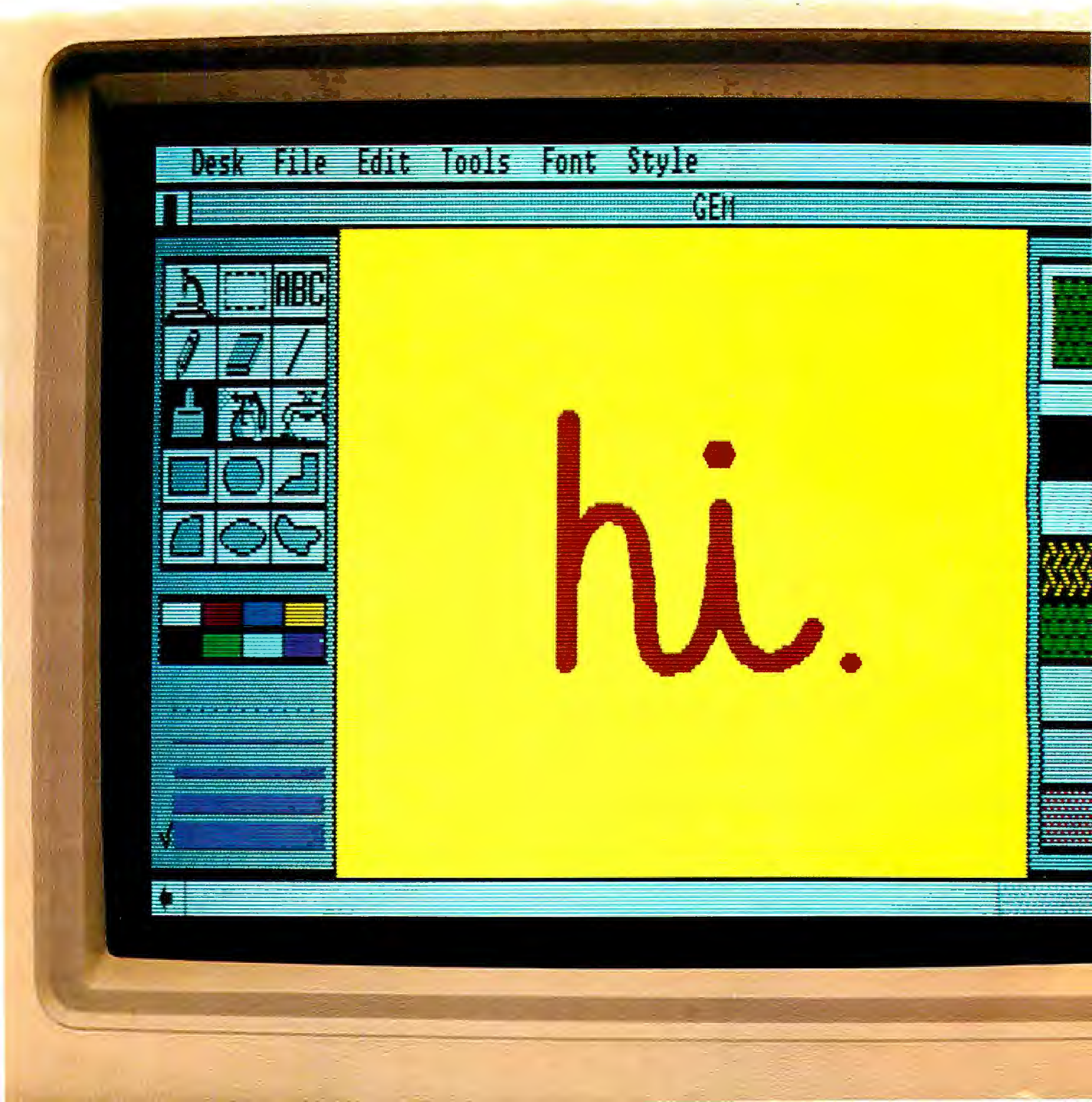

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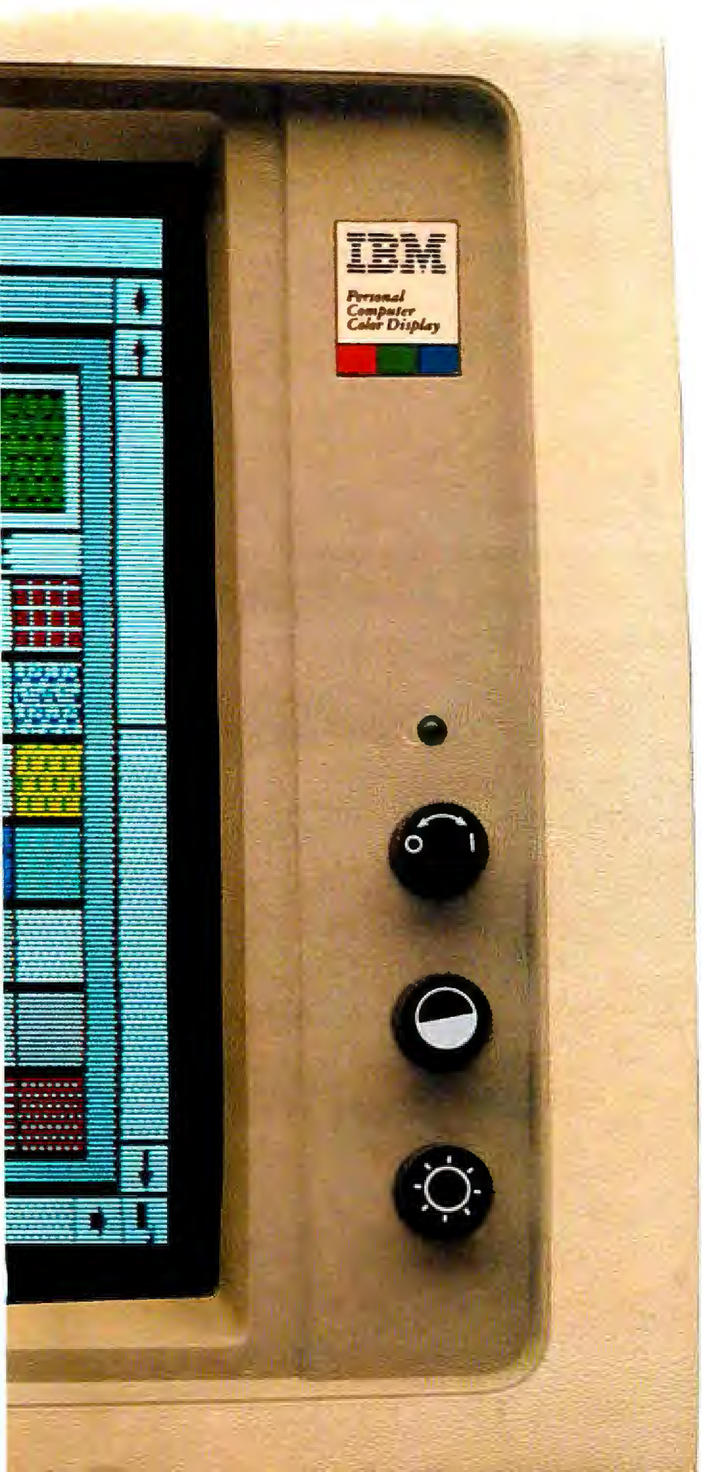

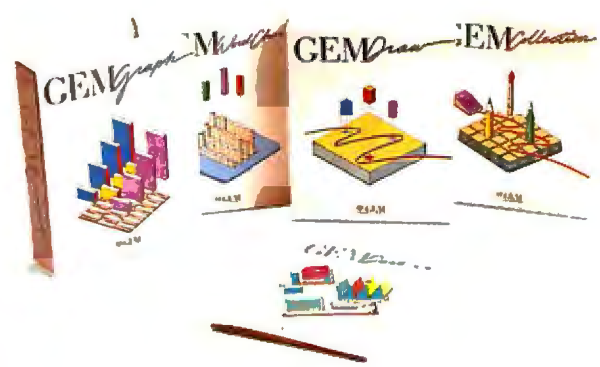

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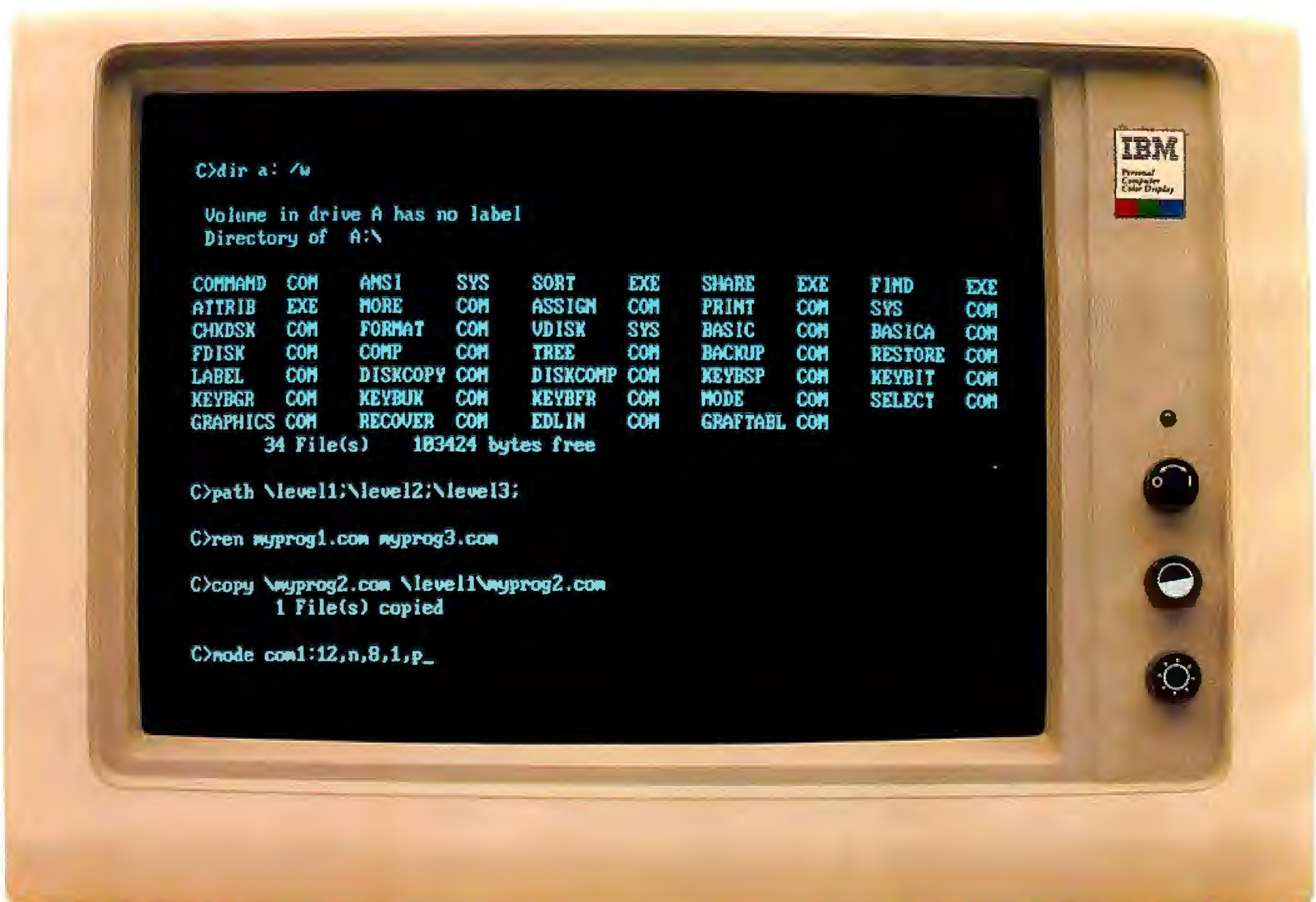

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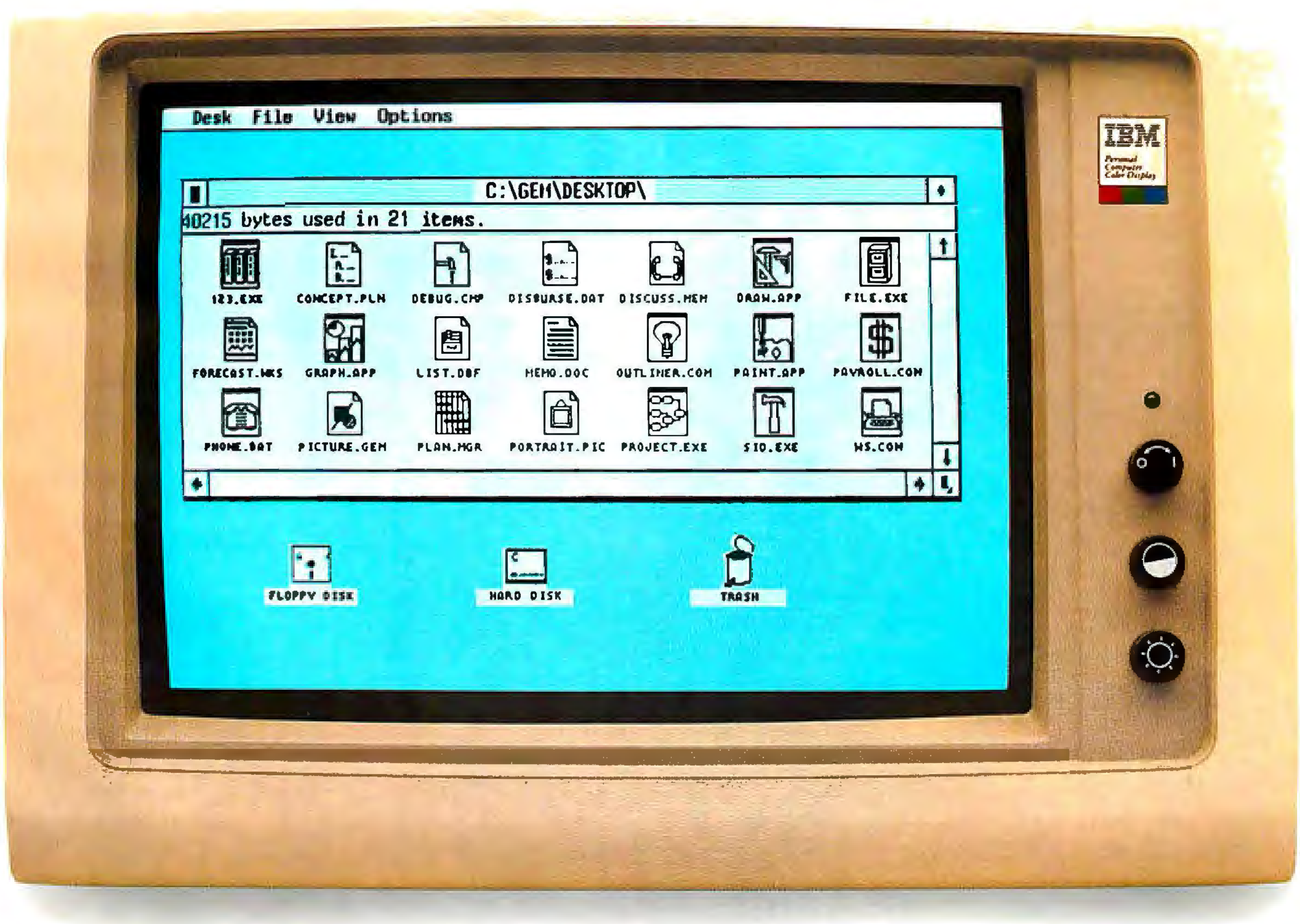

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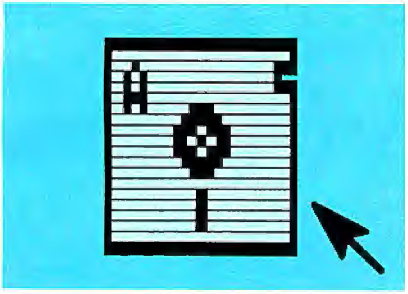

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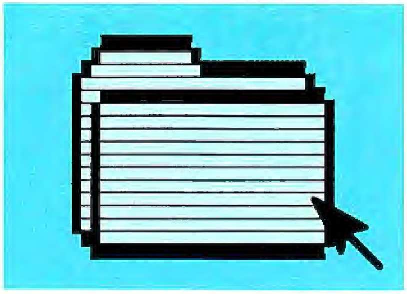
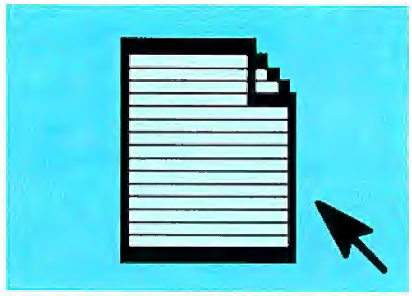
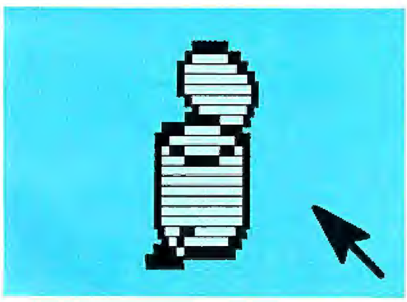


GEM file folders hold whatever you put on a diskette. From entire software programs to reports, pictures and presentations.

In fact, GEM file folders can even hold other file folders. And so on.



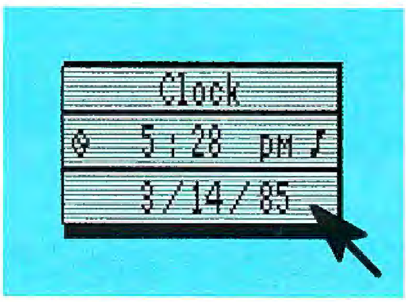
GEM software even includes "generic" file folders, places to hold random ideas, memos, numbers and the like until you're ready to file them in a GEM folder. Or in the wastebasket.



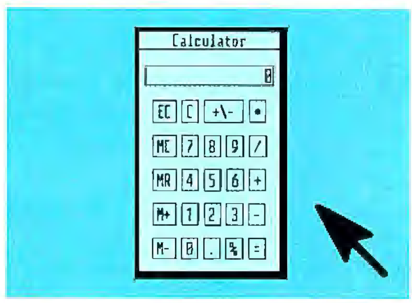
Part of getting organized is knowing when to let go of outdated files.

GEM can't tell you which files to get rid of. But it can help get rid of them.

And should you toss a file before its time, you even get a chance to change your mind.



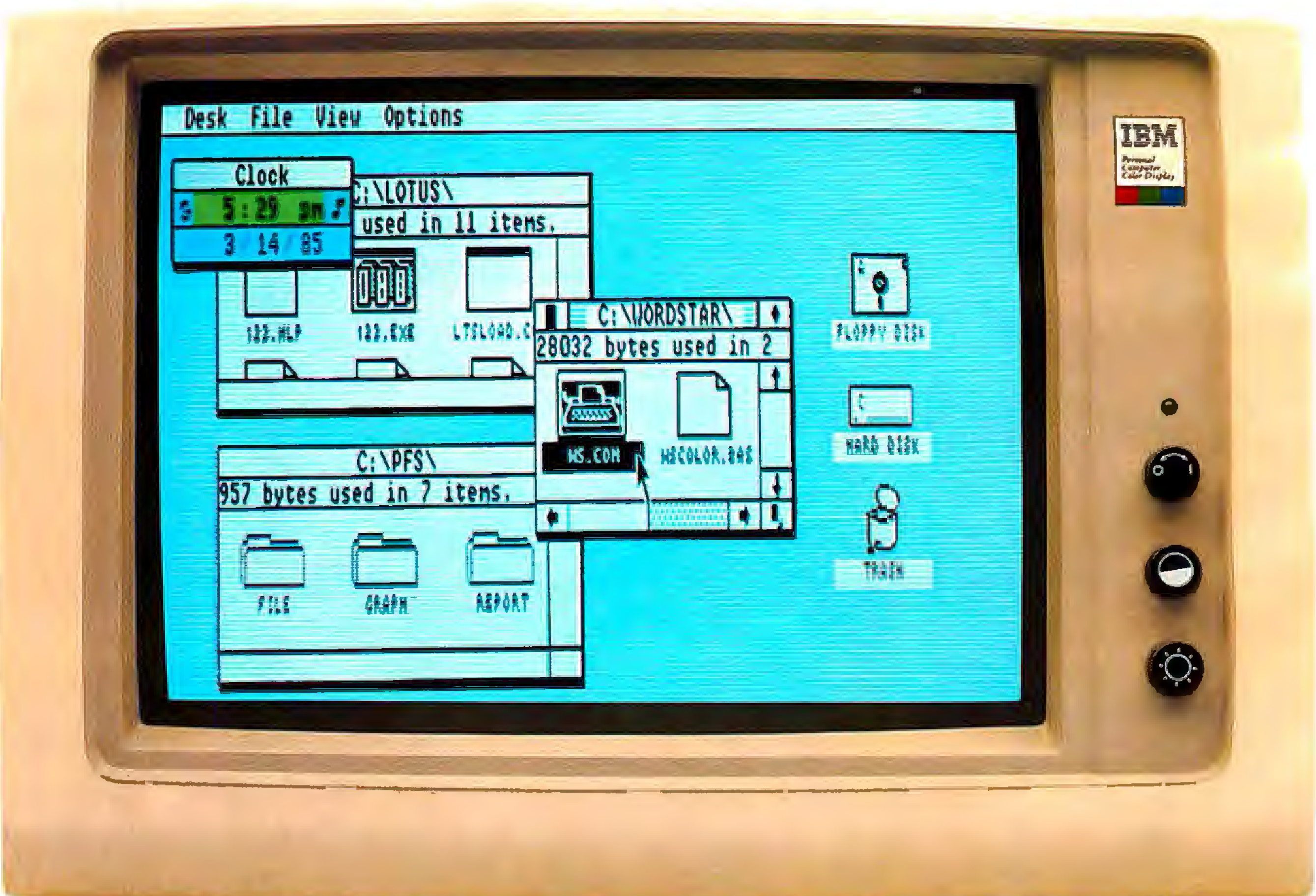
If you're clever enough to read these words, you've no doubt figured out what the GEM clock is for. Staying on schedule, for instance. Keeping track of the time it takes to do specific projects. Or getting to your airplane on time.



GEM even includes a calculator, so you can tally up all kinds of important things.

Like the time and keystrokes you save by working with GEM software.

GEM already works with most of the software you already have.



We know what you're wondering.

If GEM software is going to change the way you work with your IBM PC, will you still be able to work with your existing software?

Of course.

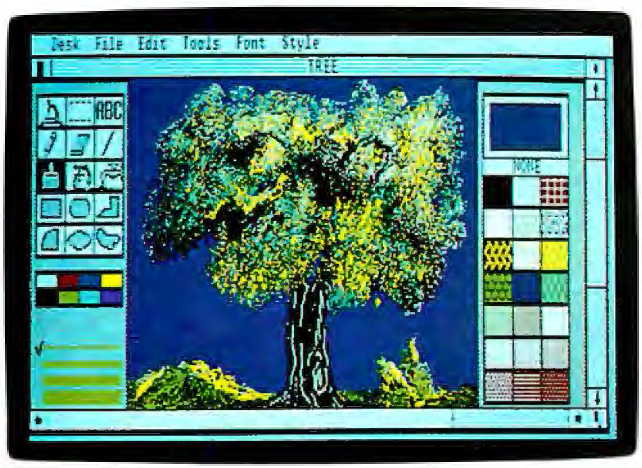
GEM works with most important programs that work with the IBM PC.

Like Lotus 1-2-3.™ Symphony.™ Multiplan.® dBASE III.™ Framework.™ And thousands more.

Technically, you see, GEM software doesn't actually change PC DOS. It just hides it.

So your software works just the way it always has. But without the long and cryptic PC DOS start-up procedures.

But the best software for GEM is GEM software.



The GEM COLLECTION
Now you can work with words and pictures together.

The GEM COLLECTION™ is a bundle of three programs, GEM DESKTOP,™ GEM WRITE,™ and GEM PAINT.™

A part of all GEM software, GEM DESKTOP* is the mask that hides PC DOS. It includes the GEM pointer, menu headings, icons and drop-down menus.

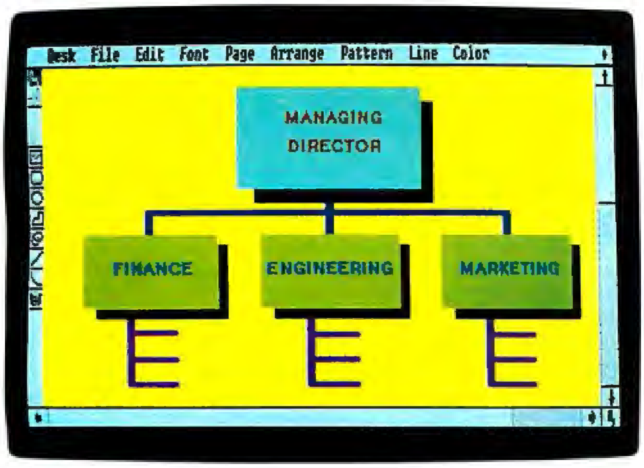
So you can point and click your way through anything you'll ever want to use a computer for.

GEM WRITE, by Lifetree Software, Inc., is a word processing program featuring fast, clear and comprehensive editing. It lets you cut and paste, make multiple block moves or even create columns. All without memorizing a single command.

And when words alone won't express what you have to say, GEM PAINT gives you the tools to turn your ideas into pictures. Up to sixteen colors. Paintbrushes, pencils and a straightedge. Plus dozens of shapes and patterns.

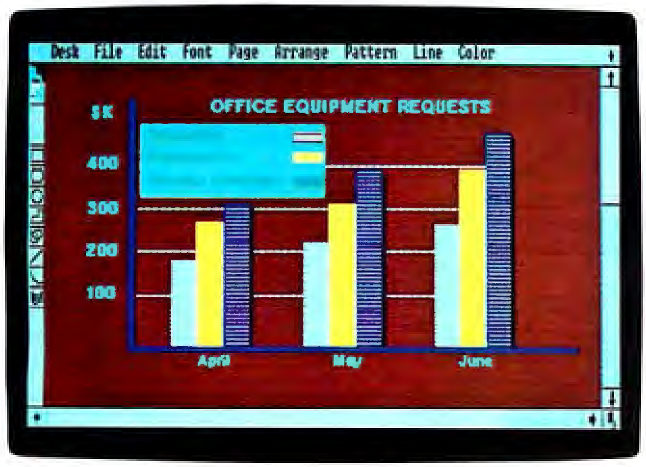
Best of all, GEM WRITE and GEM PAINT work together. So you can work

*GEM DESKTOP is also available as a stand-alone product.



GEM DRAW
A perfect illustration of the power of GEM software.

GEM WORDCHART
Present it with style.



GEM GRAPH
Let's look at the numbers.

with words and pictures on the same page.

You can also create anything from fine art to line art, whether you can draw or not.

Just put your hand on your mouse and point.

GEM DRAW™ gives you all the tools you need.

Like pencils, geometric patterns, a full palette of colors and an extensive gallery of art to use as you like.

And once you've created a GEM DRAW image, you can stretch it. Shrink it. Duplicate it. Or add text to explain it.

GEM WORDCHART™ is the perfect way to make your point in a big way.

With a choice of several type styles and sizes, plus up to sixteen colors, you can build charts that can be read from across your desk or from the far end of the conference room.

And to really drive your point home, your words can be combined with pictures from GEM DRAW.

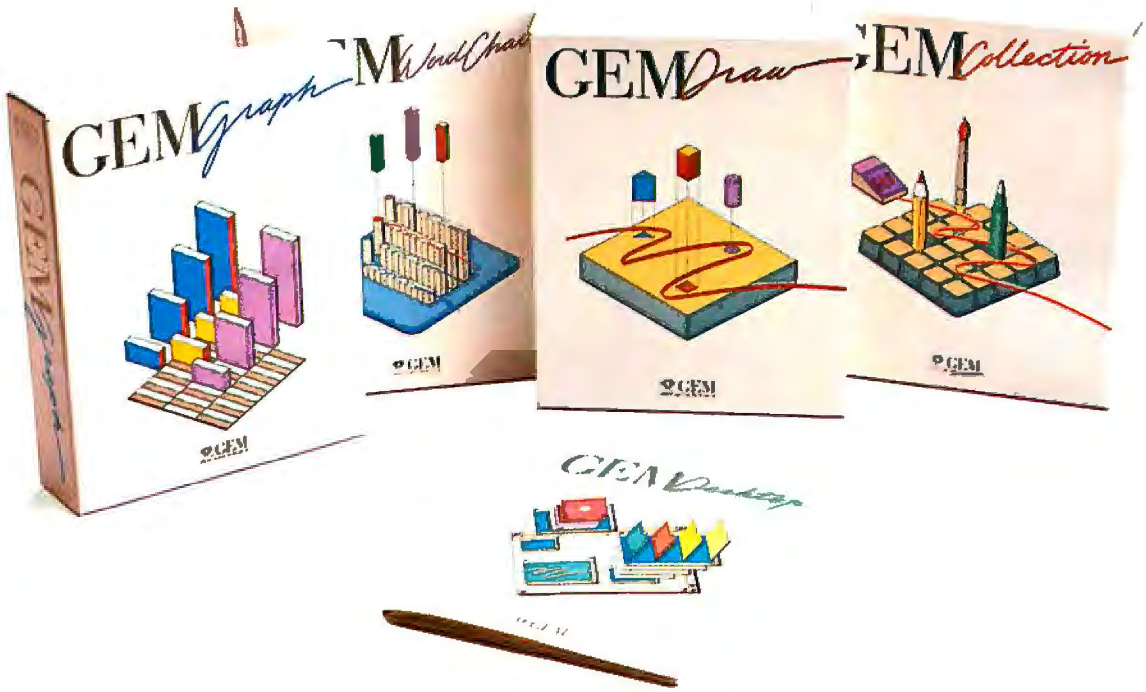
The business of creating business graphics just got a whole lot easier.

GEM GRAPH lets you turn numbers into something more tangible. Like pie charts. Bar graphs. Line plots. Even maps. All through the use of simple, well-designed templates.

Where do you get the numbers?

Directly from the business programs you're already using, like Lotus 1-2-3, Symphony, dBASE III or what have you.

Where to find a GEM.



In the months ahead you'll be seeing GEM software on a lot of familiar faces. And not just IBM PCs or compatibles.

Several leading computer manufacturers are building GEM software right into their hardware.

And with so many systems working with GEM, you'll soon see important GEM programs coming from a host of other major software houses.

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GEM DESKTOP	$ 49.95	Available April
GEM DRAW	149.00*	Available April
GEM COLLECTION (includes GEM DESKTOP, GEM PAINT, GEM WRITE)	199.00	Available June
GEM WORDCHART	149.00	Available August
GEM GRAPH	199.00	Available August
Also available:		
HERCULES GRAPHICS CARD™	$499.00	
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Sales or use tax where applicable will be added.
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BY RICH MALLOY

PRODUCT DESCRIPTION

THE GRiDCASE

These new portables are IBM PC-compatible and one version has a gas-plasma display

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

Recently, GRiD Systems Corporation brought its portable systems into the mainstream of microcomputers. The new GRiDCase computers are about the same size (briefcase-size) and feature the same magnesium case as GRiD's Compass computer, but they forgo the Compass's expensive and power-hungry electroluminescent display and bubble memory. Instead, the GRiDCase computers offer a range of display options. The GRiDCase I features a utilitarian and affordable liquid-crystal display (LCD). The GRiDCase II has an "enhanced" LCD. And, in keeping with GRiD's emphasis on what its representatives call "portable displays that more than one person can read," the GRiDCase III offers a high-contrast gas-plasma display (see photo 1). For users who like the more traditional cathode-ray tube displays, GRiD has provided an optional interface to connect an IBM Personal Computer (PC)-compatible RGB (red-green-blue) monitor (see photo 2) to the GRiDCase computers.

Other evidence of the GRiDCase family's new mainstream character include its compatibility with IBM PC software and its price. Although the GRiDCase III with the gas-plasma display sells for a hefty \$4350, the LCD-based GRiDCase I has a list price of \$2975, which is fairly competitive with that of the Data General/One. The GRiDCase II sells for \$3150.

THE DISPLAY

All three GRiDCases are almost identical except for their displays. Despite its high cost, GRiD Systems is most proud of the gas-plasma display. The company had investigated using an electroluminescent display as it had in the Compass, but all such displays were designed using a 512- by 256-pixel matrix, which would make compatibility with the 640- by 200-pixel screen of the IBM PC's graphics adapter impossible. GRiD therefore decided in favor of the gas-plasma display. The GRiDCase III's display presents a stable, sharp, high-contrast image. GRiD expects that many people will prefer it over a high-contrast cathode-ray tube screen. The display

(continued)

Rich Malloy is the New York editor for BYTE. *He can be reached at* BYTE, *43rd floor, 1221 Avenue of the Americas, New York, NY 10020.*

Photo 1: *The GRiDCase III with the gas-plasma display.* GRiDPlot, *GRiD's proprietary graphics package, is shown on the screen.*

IN BRIEF

Computer
GRiDCase I, II, and III

Manufacturer
GRiD Systems Corp.
2535 Garcia Ave.
Mountain View, CA 94043
(415) 961-4800

Physical Characteristics
2¼ by 11½ by 15 inches; weighs under 12 pounds

Microprocessor
80C86, 16-bit at 4.77 MHz; optional 8087 80-bit arithmetic coprocessor

Features
Options for 128K-byte, 256K-byte, and 512K-byte CMOS RAM; up to 512K bytes of user-installable ROM sockets; 3½-inch 720K-byte floppy-disk drive; built-in speaker

Display
LCD or gas-plasma; 80 characters by 25 lines; 640- by 200-pixel bit-mapped display (IBM PC-compatible)

Keyboard
57-key IBM PCjr-compatible with tactile feedback

Interfaces
RS-232C serial port; Centronics-type parallel port; 50-pin external expansion bus; RGB video-out option; 5-pin DIN plug for external IBM PC keyboard; RJ11 phone jack

Options
Internal Hayes Smartmodem-compatible 1200-bps modem

Power Source
External AC supply; optional internal rechargeable battery pack

Software
MS-DOS v. 2.11, GW-BASIC

Compatibility
Runs all tested popular IBM PC software

Price

GRiDCase I with LCD	$2975
GRiDCase II with enhanced LCD	$3150
GRiDCase III with gas-plasma display	$4350

is also fairly fast. I did not do any scroll tests on it, but it seemed to run Microsoft's Flight Simulator as fast as I've seen it run on any other system. Of course, the screen cannot display colors or shades of gray. It displays gray as a texture of vertical lines.

The gas-plasma screen eats up a large amount of power. The battery module can power the GRiDCase III for only about one hour. Nonetheless, for certain applications this screen may well be worth the extra cost.

For users who can forgo the extra clarity of the gas-plasma display and who may spend appreciable amounts of time away from electrical power outlets, the GRiDCase I's LCD screen could be a reasonable alternative. Although this screen does not have the speed or contrast of the gas-plasma display, it is readable. Based on my brief experience with it, I would judge it to have slightly better contrast than the LCD screen on the original Data General/One. And when you are not traveling, you can connect the GRiDCase I to an IBM PC-compatible RGB monitor. The GRiDCase II is said to have an enhanced LCD, but I did not get a chance to test it. The GRiDCase computers do not have a jack for a composite monitor, but GRiD representatives said they were investigating the possibility of producing an optional RGB/composite adapter that would allow you to connect a composite monitor to the RGB port.

KEYBOARD

The GRiDCase computers have the dubious distinction of being among the first computers to be compatible with the IBM PCjr keyboard. The main reason for this is the small size of the GRiDCase. Because some keys were going to have to double as function keys, GRiD decided to follow the example IBM set with its small home computer. The result is acceptable but confusing for those whose are used to the large IBM PC keyboard. Some users may take exception to the location of the backspace key (in the lower right-hand corner). Of course, keyboard replacement programs like ProKey and SmartKey may let you rearrange the keyboard as you like. The keyboard felt reasonably good. The typewriter keys were in their standard places, and key action seemed acceptable. Tactile feedback was provided by a key click similar to that on the IBM PC. IBM PC owners may appreciate the fact that they are not tied in to the

(continued)

Photo 2: *The* GRiDCase III *with the video-out option hooked up to an* IBM *color monitor. Ashton-Tate's Framework package is displayed on the screens.* PC *Master/Slave software allows easy cable connection from the* GRiDCase *to the* IBM PC.

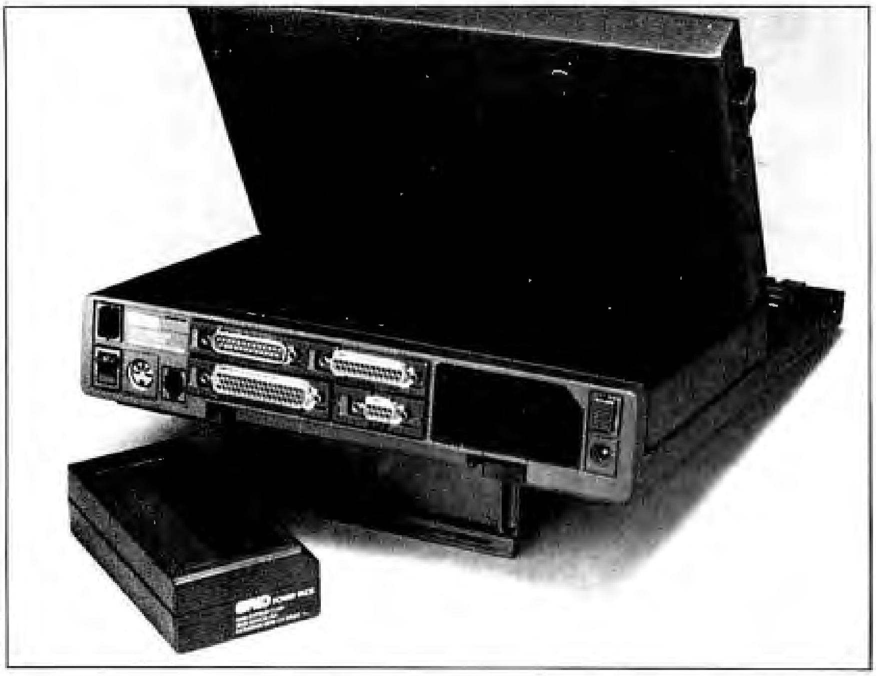

Photo 3: *The* GRiD*Case back panel (left to right): the* DIN *connector for the* IBM PC *keyboard or* 10*-key keypad, the built-in* 300/1200*-bps modem* (Hayes *Smartmodem-compatible*), RS-232C *serial interface, external bus connector for external* GRiD *peripherals and access to the* IBM PC *expansion chassis*, Centronics *parallel interface, color* (RGB) *video-out for external monitors, built-in rechargeable/exchangeable battery pack.*

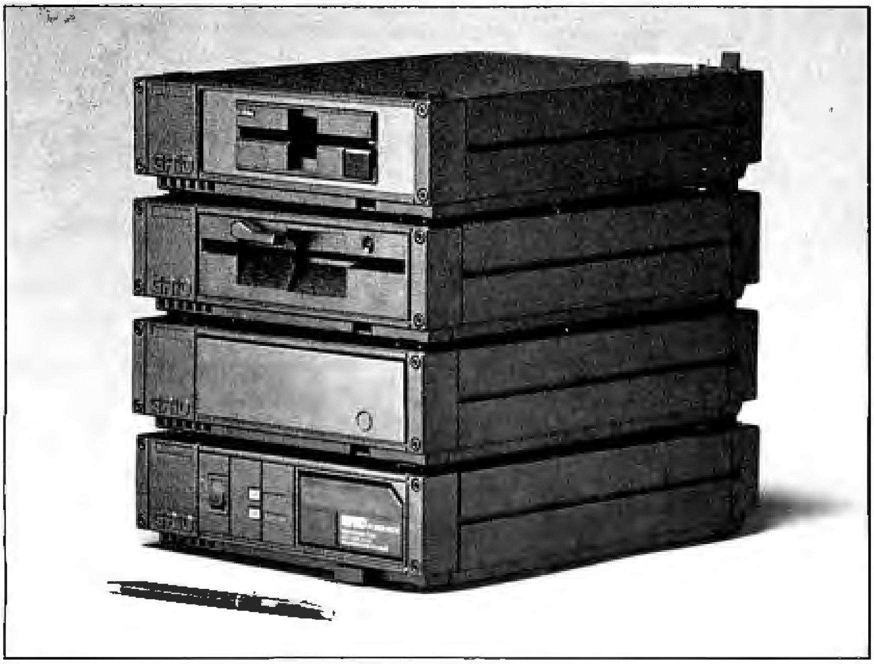

Photo 4: *The* GRiD*Case stackable portable peripherals (from top to bottom):* 3½*-inch floppy-disk drive,* 5¼*-inch floppy-disk drive,* 10*-megabyte hard-disk system, base station battery charger/power source.*

GRiD keyboard if they don't want to be. Each GRiDCase lets you plug in an IBM PC keyboard and use that instead.

Power

All GRiDCase models have two power modules available—a rechargeable battery pack and an AC (alternating current) transformer. Both are the same size (about the size of a box of ten 5¼-inch floppy disks cut in half), and both fit in the large socket on the rear panel of the machine. When traveling, you can carry several battery packs and insert them as you need to. Each battery pack lasts four to five hours for the LCD models, and one hour with the plasma model. The batteries can be recharged in about eight hours. For now, the batteries will sell for about $60. GRiD claims that it went to considerable trouble to ensure that its power supply could work with two displays having vastly different power-consumption rates.

Silicon

The GRiDCase family of computers uses a low-power version of the 8086 microprocessor with a clock speed of 4.77 MHz. As in many portables, GRiD achieved the low-power capability by using CMOS (complementary metal-oxide semiconductor) technology. An 8087 numeric processor option is also available. A standard GRiDCase system comes with 128K bytes of CMOS memory chips. Memory configurations of 256K bytes and 512K bytes are also available for approximately $600 and $1200, respectively.

The GRiDCase computers also come with eight sockets for ROM (read-only memory), although only four of these sockets can be accessed by the user. GRiD will offer programs such as MS-DOS 2.11, GW-BASIC, and Lotus's 1-2-3 on ROM chips.

Interfaces

Each GRiDCase computer comes with a serial RS-232C port with a standard DB-25 connector and a Centronics-type parallel printer port (see photo

(continued)

3). An optional 1200-bps (bits per second) modem is also available for $795. GRiD claims that it purposely avoided using low-power CMOS chips in the serial por and modem because these chips were not 100 percent compatible with the IBM PC. Also, the need for CMOS chips did not seem a high priority because most phone lines and serial devices are near electrical outlets.

THE DISK DRIVE

The GRiDCase comes with one Sony-type 3½-inch floppy-disk drive. Each disk can hold 720K bytes of data, or about the same amount as a two-drive IBM PC. GRiD claims that the disks use Microsoft's standard 3½-inch MS-DOS format, but they would not confirm that the GRiDCase could read disks used by the Data General/One. GRiD representatives claim that most major software publishers will soon begin distributing 3½-inch versions of their top-selling software products.

Just in case, however, GRiD will be offering an external 5¼-inch drive for $895. The drive can be set up as the primary drive, allowing you to run copy-protected software like the 5¼-inch version of Lotus's 1-2-3 and Microsoft's Flight Simulator. The unit is about the size of a box of ten 8-inch disks, and it is connected to the main unit by a short thick cable that attaches to the machine's expansion port. Two connectors are available on the drive, allowing you to "daisy-chain" the computer to yet another drive or another expansion peripheral.

Two other peripherals are available. One is a base station battery charger/power source ($450), which can hold certain GRiD expansion cards, keep the portable unit powered, and, according to GRiD, recharge the portable's batteries in about four hours. GRiD is also making available a 10-megabyte hard-disk drive (for $2250) that is approximately the same size as the 5¼-inch floppy-disk drive (see photo 4).

GRiD representatives say that they plan to supply a second 3½-inch drive and a cable and adapter card that will let you connect a GRiDCase to IBM's expansion chassis for the IBM PC. The card apparently would let you connect a GRiDCase to any IBM expansion board. As yet there is no price information available for this option.

Since the plasma and LCD models are practically identical, owners of the LCD model have the option of upgrading their units to a plasma model by sending the unit back to GRiD to have the display replaced.

SOFTWARE

Like the Compass, a GRiDCase has the option of running two operating

(continued)

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MULTIPLE MODEMS IN ONE

The GRiD Server

When GRiD first came out with the Compass, it instituted a novel but controversial software-distribution scheme. All software would be sent out over the phone lines from GRiD Central, the company's central computer, which GRiD has now made available to customers. These systems, called GRiD Servers, are based around two 80186 processor chips and can directly connect up to 48 computers in the office and access up to 320 megabytes of hard-disk space. It can also support up to 10 modems and a number of printers. A small system with about 40 megabytes of disk space and the ability to connect to about 8 computers and 2 modems costs about $16,500.

In the office, the GRiD Server functions as a regular local-area network (LAN) using twisted-pair cables with a data-transfer rate of 250K bits per second. Each GRiD computer has a utility program that allows it to connect to the central server and use the hard disk as if it were its own. Programs and adapter cards are also available for the IBM PC that will allow it to connect with this network.

When you take your portable out into the field, the GRiD Server becomes what GRiD calls a RAN, a remote-access network. All you have to do is connect your modem-equipped system to a phone line. Then, just as in the office, your machine can directly access the central server's hard-drive disk. Whenever you access the hard drive, your system automatically calls up the central computer and begins communicating with it. The system includes its own error-checking protocol to protect against telephone-line noise. Text files and machine-language programs supposedly can be transmitted very easily. The problem is speed. The phone-line limit of 1200 bps (bits per second) is much slower than the usual disk-access time.

One advantage of this system is that application programs such as spreadsheets running on the remote systems can directly use data files on the central hard disk. This seems to be an ideal way to ensure that everyone in a small, scattered work force is using the same data, but the transfer times for large data files may be uncomfortably slow.

systems. One is MS-DOS, which has been made highly IBM PC-compatible. The other is a proprietary system called GRiD-OS, which GRiD claims is multitasking. They have developed a number of business-productivity software packages for this system.

The GRiDCase comes bundled with only MS-DOS version 2.11 and GW-BASIC. As of this writing, it is unclear whether this software will be provided on disk or on ROM chips. GRiD's version of MS-DOS includes a special utility that lets you connect easily to one of GRiD's RANs (remote-access networks) (see the text box "The GRiD Server" on this page).

Service

GRiD is apparently taking advantage of the GRiDCase computers' small size by instituting a novel service arrangement. For an additional fee, between $540 and $720, depending on your configuration, you can arrange to have next-day replacement service. Under this policy, if your machine breaks down, GRiD claims that it will send you a new machine by Federal Express to keep until the company repairs your machine.

Summary

The GRiDCase computer seems to be a potent competitor in the briefcase computer market. I only had a brief chance to look at the machines, but I was impressed. Some questions remain, however: Do the machines really run all IBM PC software? How comfortable is the LCD screen after long hours of use? Are the serial and printer ports compatible with most peripherals? BYTE will try to answer these questions in a full system review in a later issue. For now, I look forward to seeing gas-plasma displays on more machines. ■

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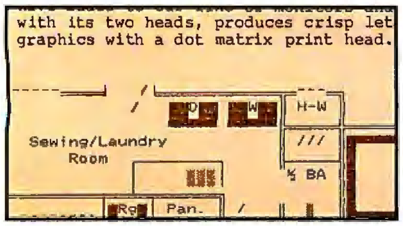

Imagine the advantage of having two heads in one printer. Need graphics or condensed print spreadsheets or a rough draft of a long letter, just touch the control panel. How about important correspondence to impress a potential client, again, just touch the control panel to switch to the letter quality daisy wheel.

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Inquiry 131

LIVING IN A SENSIBLE ENVIRONMENT

BY STEVE CIARCIA

A collection of alarm and environmental monitoring circuits

Generally speaking, I try to present projects that are commercial-quality designs. Occasionally, they get a bit grandiose when the former aerospace engineering mentality in me says, "Damn the expense" and "Who cares about chip count?"

For the most part, I work on the basis of cost-effectiveness rather than absolute expense. Since I was on a very tight schedule and the Home Run Control System (HCS) of the past three months itself was the main emphasis of my efforts, I neglected user-constructed sensors and opted entirely for commercially available units (motion detectors, contact switches, etc.). Testing the HCS was hard enough without debugging perimeter sensors and motion sensors and wasting a lot of time by stringing wire. I bought off-the-shelf detectors and had them professionally installed. This raised overall design cost but reduced the installation and checkout time considerably.

While this technique was expedient, it neglected a very important contingent of the BYTE readership. The hundreds of letters and pictures I receive each month indicate that many readers roll their own, even on complicated projects like the HCS. Deep down, behind the aerospace engineer, I am a computer hacker at heart and empathize with experimenters who want to know how to build the environmental sensors, alarm horns, and signaling devices for use with the HCS.

As an addendum to the previous articles on building the HCS, this month I've dug through the junk box for a bunch of circuits that sense, immobilize, and anesthetize a perpetrator. The same sensors can be used to provide convenience features like automatic lighting and environmental control if you are less paranoid. Among the circuits I've included are infrared and ultrasonic interrupted-beam detectors; water, temperature, voltage, and light sensors; and a variety of alarm signaling devices.

These circuits are presented for experimenters who revel in the pleasure and agony of homebrew projects. If you don't want to spend the time building these circuits, order the necessary components from the local alarm installer instead.

A CONTACT-CLOSURE WORLD

The HCS and alarm systems in general are designed to perform designated control

(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.

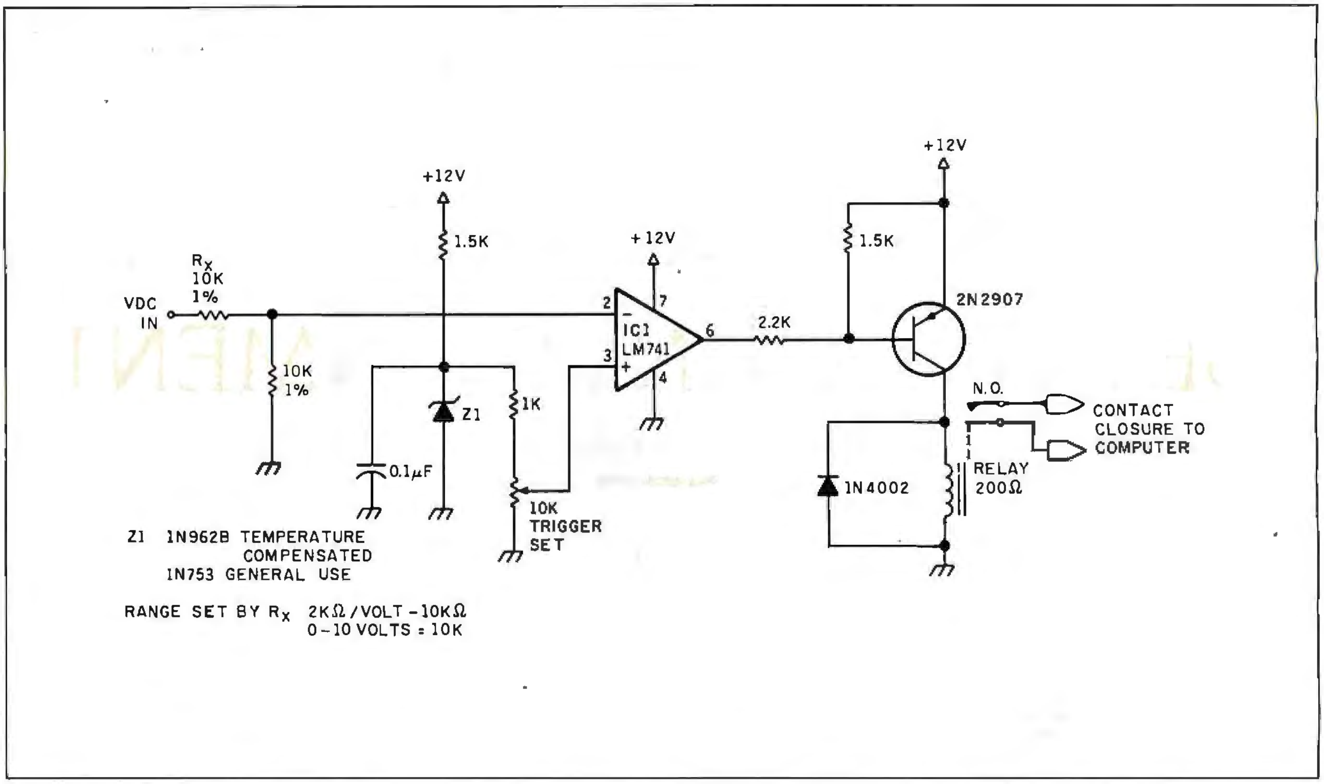

Figure 1: *An overvoltage sensor. Undervoltage can be detected by reversing the connections of* IC1 *pins* 2 *and* 3.

functions as the result of specific input activities. They rely upon contact closures to communicate these activities. Rather than monitor the physical surroundings in absolute terms, contact-closure-type alarm and control systems respond by sensing "limits."

A limit sensor is just that. If an event is to occur when the temperature in a room exceeds 85° (perhaps turning on the air conditioner), we could employ a temperature limit switch set at 85°. Knowing that it is presently 71.45° in the room is unnecessary information. Only when the temperature is at or above 85° will it indicate that the set-point limit has been reached. This simple limit switch is called a thermostat and functions much like the one you probably have on your wall. Below 85° it is open, and above 85° it is closed (neglecting hysteresis). In situations involving a temperature span, two devices are employed, one sensing high limit and the other sensing low limit. The

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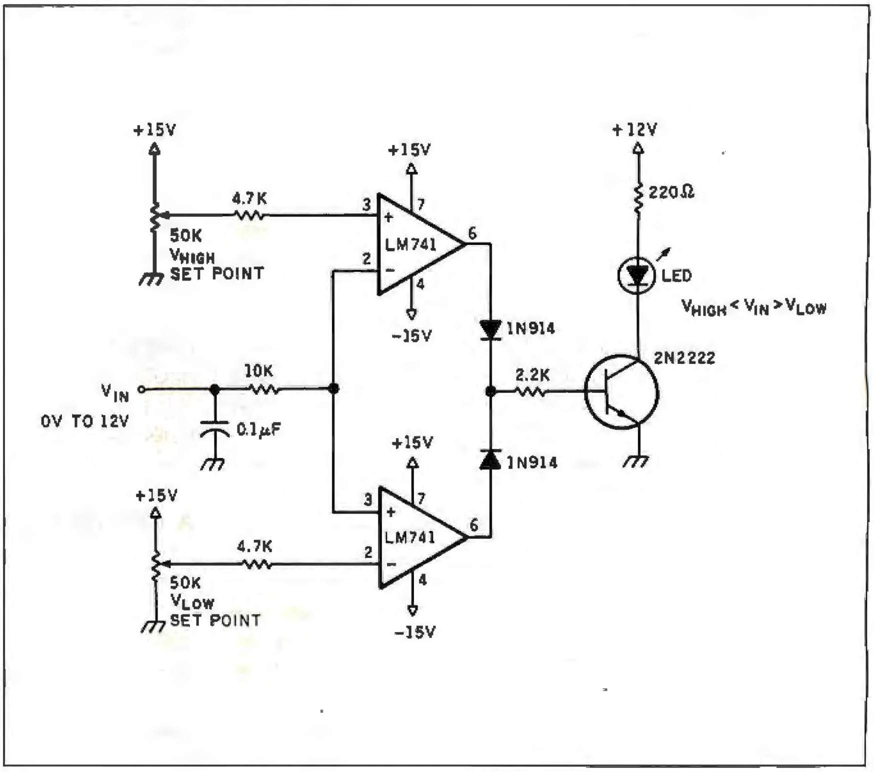

Figure 2: A *window-comparator voltage monitor.*

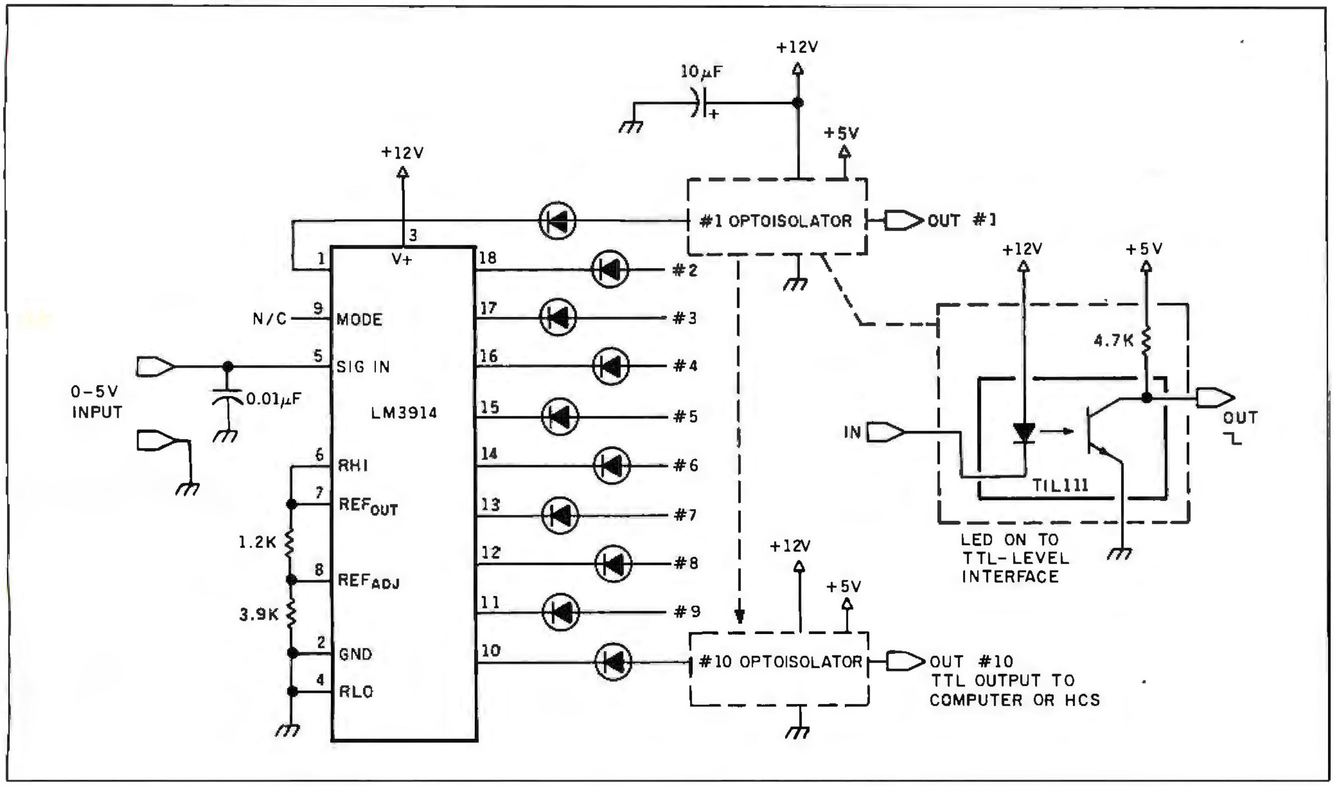

Figure 3: A *dot/bar-graph generator used as a multiple window comparator for analog inputs.*

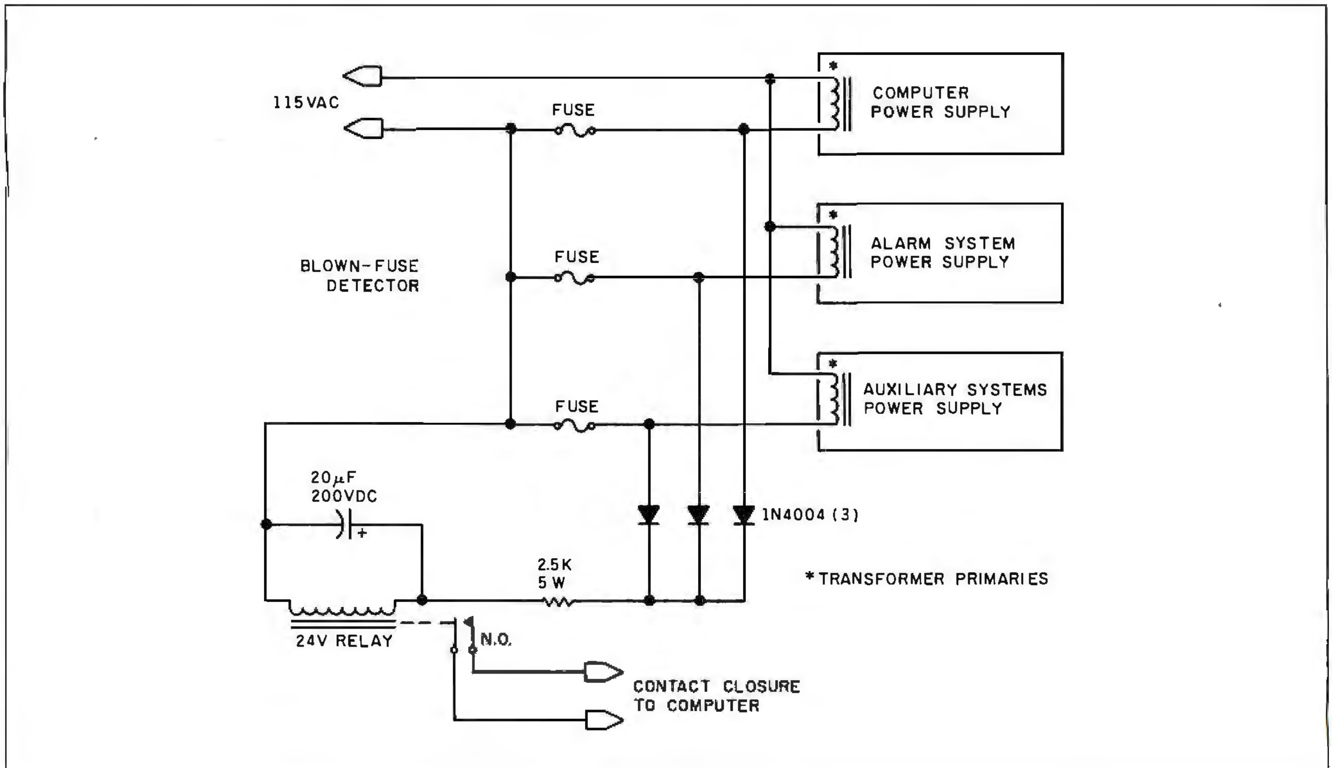

Figure 4: A *blown-fuse detector.*

operating range is the area between the two sensor trip points.

Thermostats are bimetallic contacts that open or close depending upon temperature. The key word is *contacts.* Virtually all alarm sensors are contact-closure output. The magnetic reed switches on your doorways or the motion detectors in the hall all utilize open- or closed-contact connection to the alarm system to indicate logic 1 or 0 levels. When the monitoring sensor's output contacts are wired between an HCS input pin and ground, the HCS "sees" open contacts as logic 1 inputs. A pull-up resistor at the input provides sufficient current so that inputs don't float but are connected to a voltage source that makes it a logic 1. When the external contacts are closed, the current supplied through the pull-up resistor is shunted to ground, and the input "sees" a logic 0.

Contact-closure-type sensors are frequently confused with discrete-level output sensors. The former designate physical contacts that make or break (close or open) at the limit set point, while the latter have discrete voltage-level changes (−12 volts [V] for off and +12 V for on, for example) to indicate the two logic states. The confusion comes about because both types have discrete logic-level changes as outputs and most control systems accept either type. By using actual relay contacts, however, the sensor is electrically isolated from the control system. Hazardous conditions that may be present in the environment are thus not passed back to the control system.

Application is the primary difference between discrete-level/contact-closure output sensors (like thermostatic switches) and continuously variable-analog or multibit-digital sensing systems. A varistor is a continuously variable temperature sensor that can be used in a circuit to produce an output voltage that is proportional to temperature (perhaps

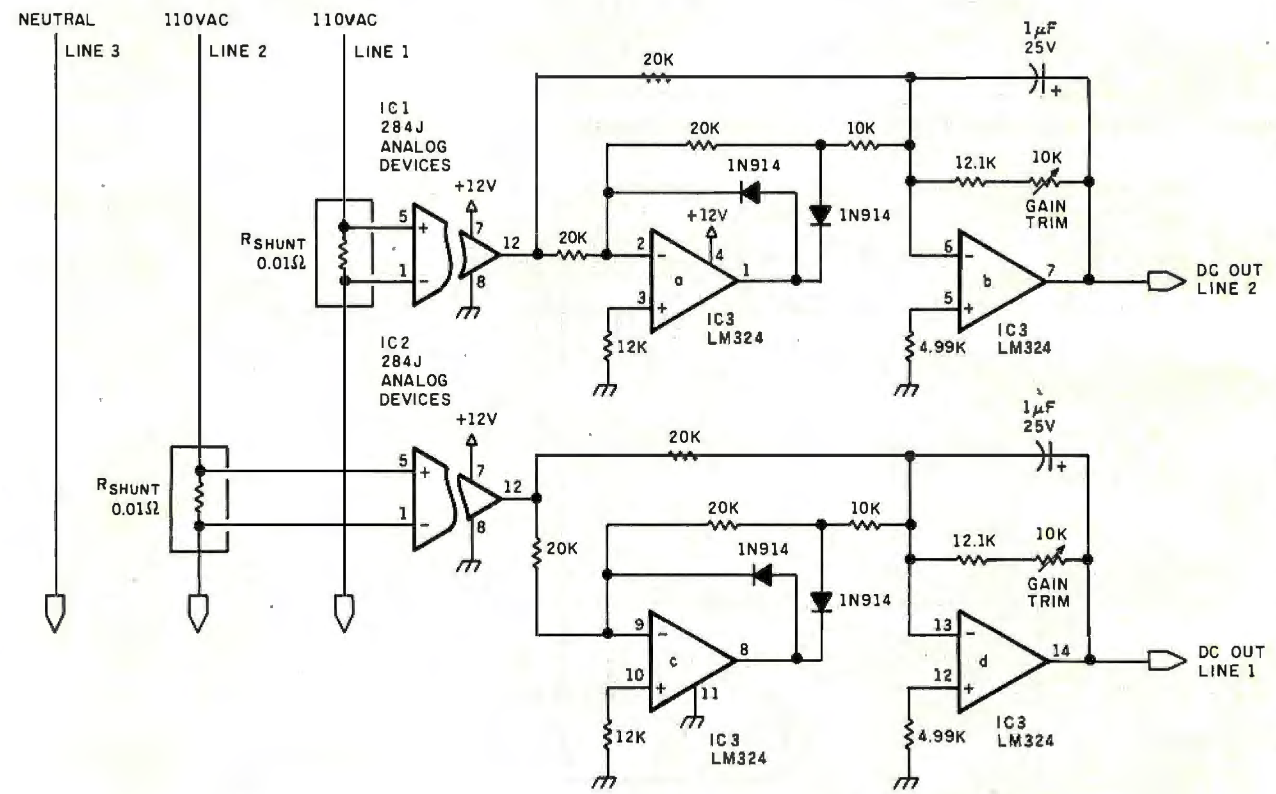

Figure 5: *An isolated current monitor for a high-current load. The circuit as shown monitors* 220 V AC *from* 25 *to* 100 *amperes. Its output is* DC.

0–21.2 V to indicate 0–212°). If, by using a voltage comparator, we compare and switch logic states when the varistor-circuit output is equal to or exceeds 8.5 V, we have produced an 85° limit switch. The control system knows only that it is above or below this limit but not how much. If the control system's action is also a simple contact-closure output (light on/off, fan on/off, alarm dialer and horn on/off, etc.), perhaps how much is unimportant.

When the application dictates that we continuously modify the control decision as a function of how much, we must use something other than the discrete limit sensor. If the air-conditioning fans can be run slowly at 80° and increasingly faster at higher temperatures, a proportional control loop using a high-resolution analog-to-digital (A/D) converter could be used to monitor the thermistor's absolute value and control the fans.

Resolution is the bottom line. Contact-closure output devices are single-bit low-resolution items. Reading the thermistor through an A/D converter merely designates more discrete points of knowledge where control actions may be triggered. If you are making simple control decisions based on a few set points that are not continuously changing, however, it hardly makes sense to read a thermistor through a 12-bit A/D converter and compare the readings to a few limit values. It makes sense to compare an analog output value with an analog set-point level in the hardware of the monitoring device. In an age of computer overkill, not everything needs to be digitized.

WINDOW COMPARATORS

The majority of the circuits I've included in this article are of this type. Some are designed to continuously monitor conditions in the environment (heat, light, moisture, etc.) and close or open contacts at presettable limits. A number of the sensing circuits are simply analog monitors that have output voltages proportional to the input stimulus. To acquire these signals with a discrete input-level controller like the HCS, they are connected to a separate voltage comparator, which compares the output with a preset limit.

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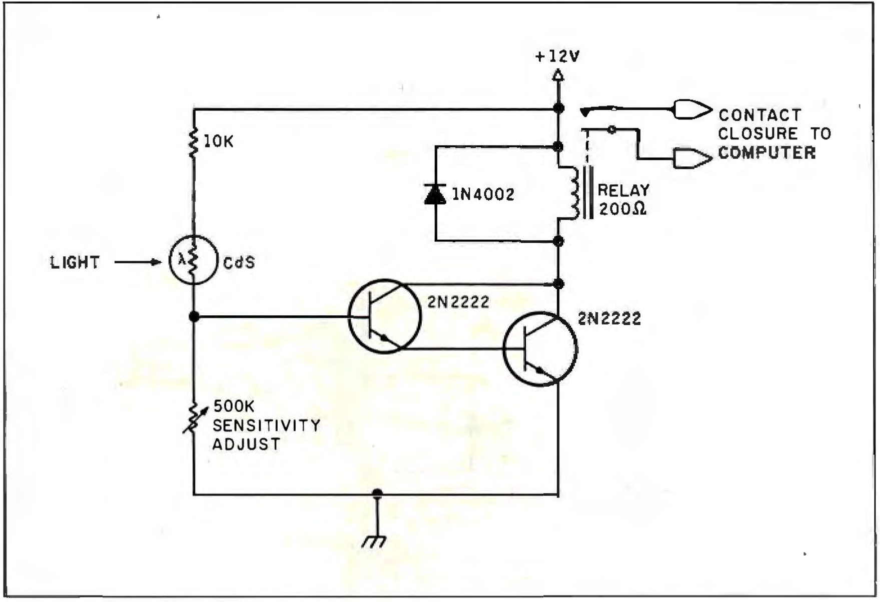

Figure 6: A *light sensor.*

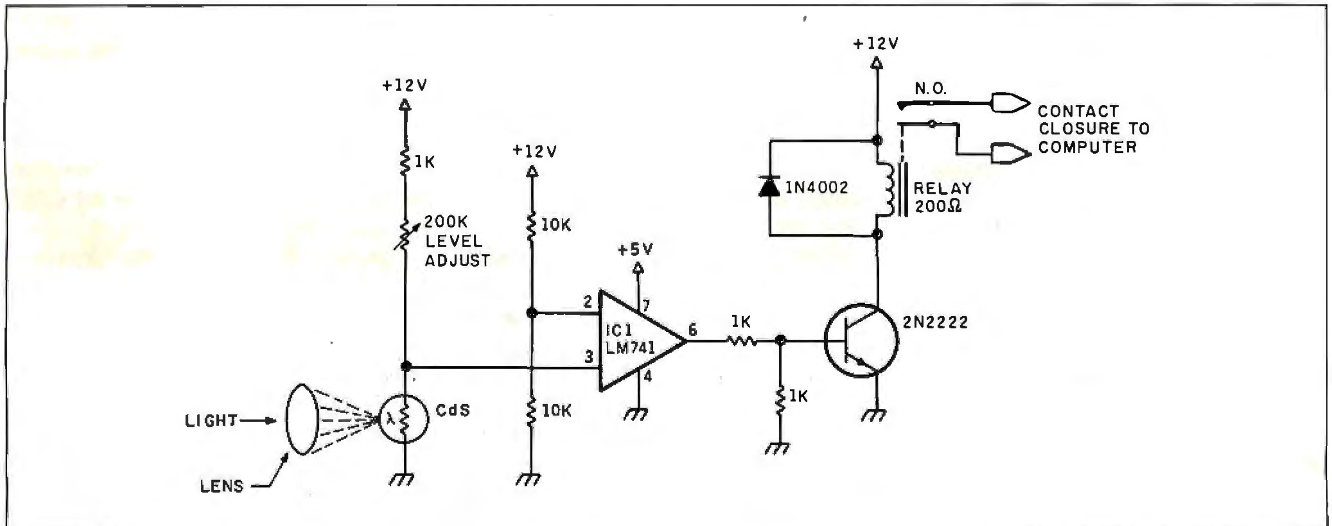

Figure 7: A *high-sensitivity light detector.*

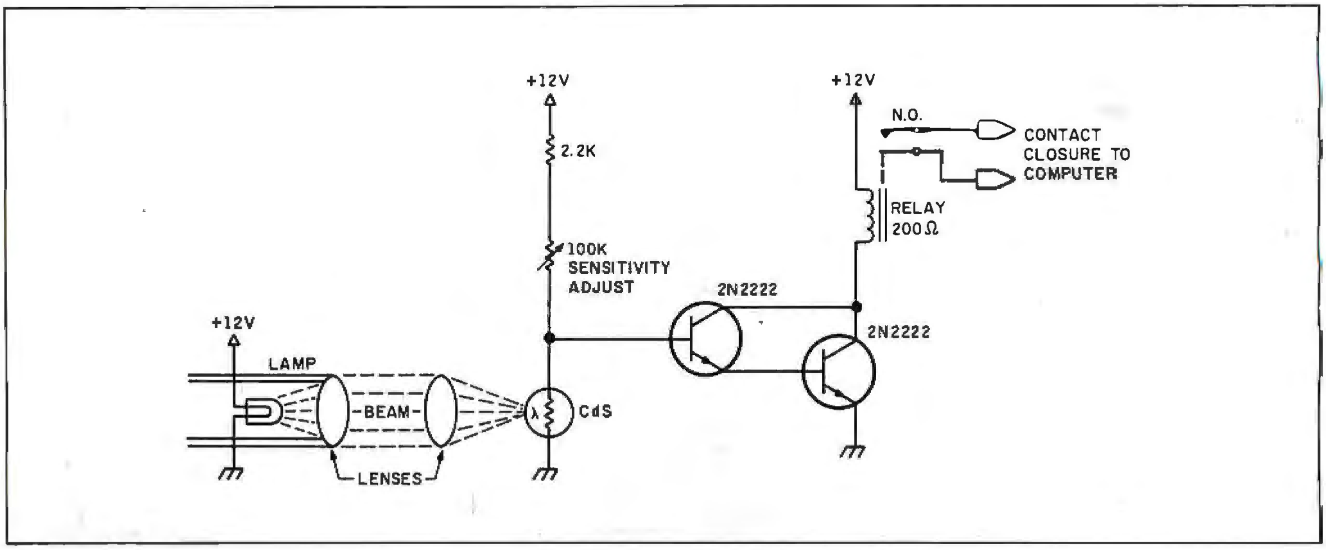

Figure 8: A *simple light-beam alarm for doorways.*

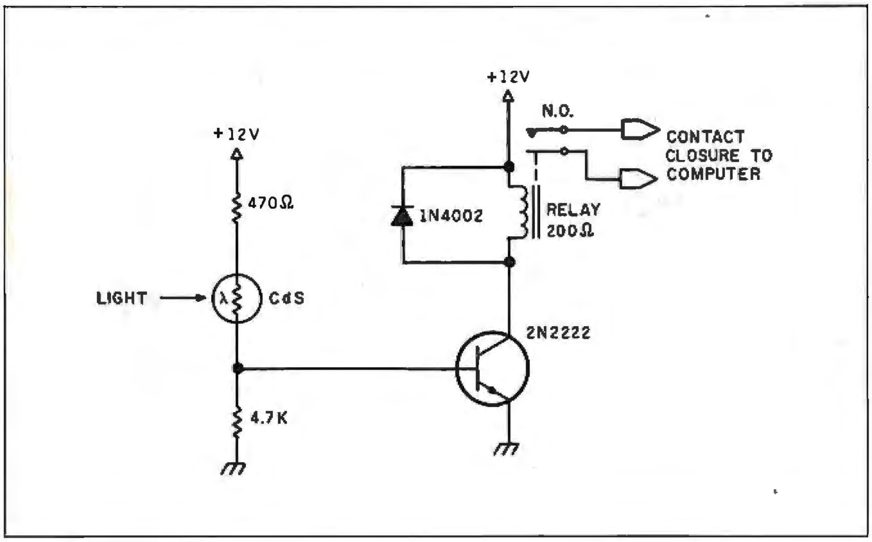

Figure 9: A *day/night sensor.*

The least complicated comparator is shown in figure 1. Configured as an overvoltage detector (or undervoltage if you reverse a few wires), the circuit closes the output contacts when the input exceeds the trigger set point. The next more sophisticated comparator is the window comparator. Shown in figure 2, the window comparator has both an upper and lower limit. An input voltage between these limits activates the output LED (light-emitting diode). A relay or opto-isolator can be substituted in place of the LED to provide a contact-closure or discrete-level-shifted input to the control system.

If more than one window is required (perhaps different things occur at 50°, 85°, and 120°), additional comparators are needed. A conveniently packaged source of 10 linearly spaced comparators is an LM3914 dot/bar-graph generator. Shown in figure 3, the LM3914 is configured as a 0- to 5-V 10-stage window comparator. Each LED represents a 0.5-V increase in input. If the desired set-point limit is 3.5 V from a temperature monitor (shown later in figure 18), the HCS would be connected to LED #7, which comes on at 3.5 V (an optoisolator in series with the indicating LED level shifts the output so that it is compatible with the HCS).

Whatever the source of the analog signal in the remaining circuits, you now have the means to convert it to a contact-closure or discrete-level input required by the HCS and other alarm/control systems.

POWER MONITORING

An important consideration in industrial-control applications is power monitoring. At the very minimum, it is often necessary to know whether a piece of equipment is out of service due to a blown fuse or if power demand exceeds a desirable limit. A blown-fuse detector can notify an operator, while limit switches triggered by AC line current can be used for load shedding.

Figure 4 is a blown-fuse detector that can be built into a power strip for convenience. If any fuse opens, the relay contacts close. Figure 5 is an isolated AC monitor. The output of the 284J will be an AC voltage proportional to the current flowing through the shunt resistor. The circuitry attached to the 284J's output is an AC-to-DC converter, which allows this circuit to be connected to one of the

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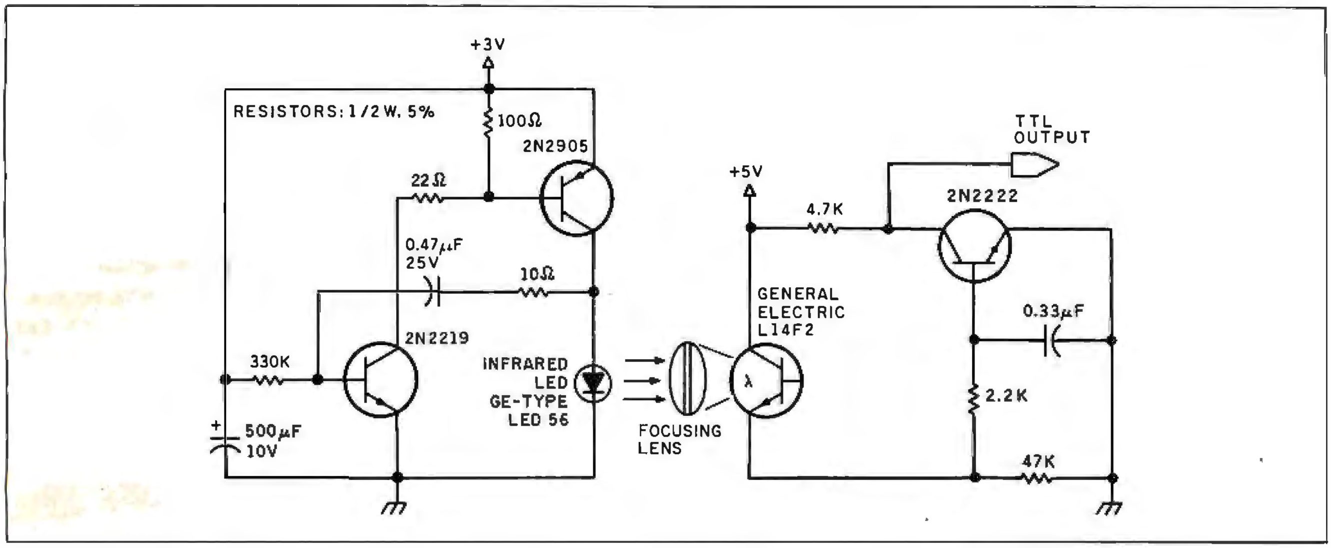

Figure 10: *An infrared intrusion alarm. The system can be used over a range of 10 to 50 feet.*

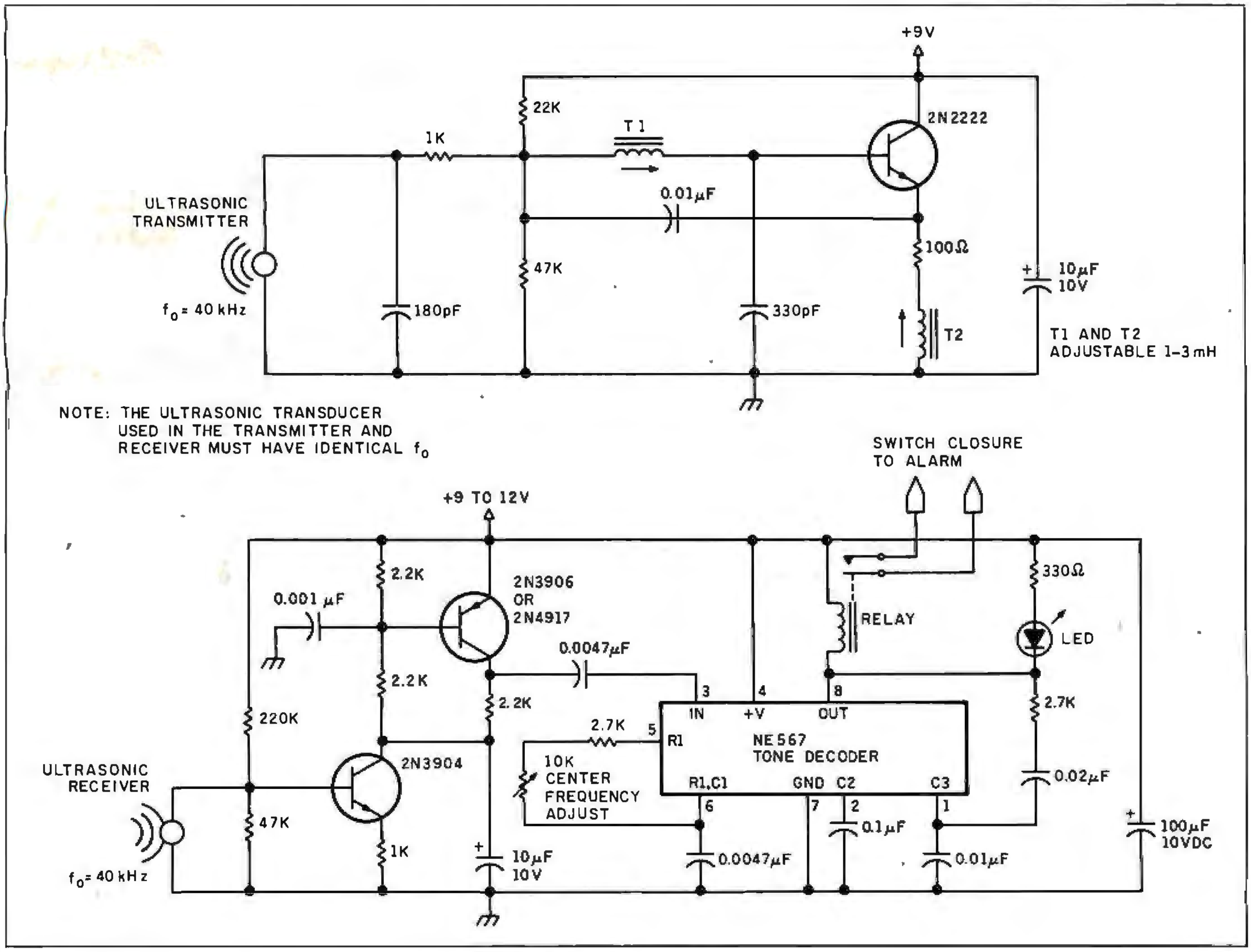

Figure 11: *An ultrasonic transmitter and receiver.*

three DC-input window comparators already discussed.

INTERRUPTED-BEAM DETECTORS

Whether they are used for alarm monitoring or convenience control, interrupted-beam detectors are the most reliable sensors for perceiving objects or people moving through a specific line of sight. These devices consist of two components: a transmitter and a receiver. The transmitter and receiver are located within line of sight of each other on opposite sides of the protected area. An infrared or ultrasonic beam is then directed from the transmitter to the receiver. Provided that the receiver always receives this beam, its alarm output remains unenergized. If the beam is interrupted by something or someone passing between the transmitter and receiver, the output contacts close and a control action may be generated.

Interrupted-beam detectors are most often infrared or ultrasonic (motion detectors, which I am not addressing, use infrared, ultrasonic, and microwave technologies). The application generally dictates which type of sensor is used, with ambient-light levels, acoustic pollution, and cost the determining factors. A low-cost infrared unit can be mounted across a doorway, for example, but would be saturated by sunlight if used across a driveway to sense incoming cars. Depending upon the distance between the transmitter and receiver and the ambient-light levels, you can choose from items like simple resistive photo cells, phototransistors, photodiodes, lenses, and LED or in-

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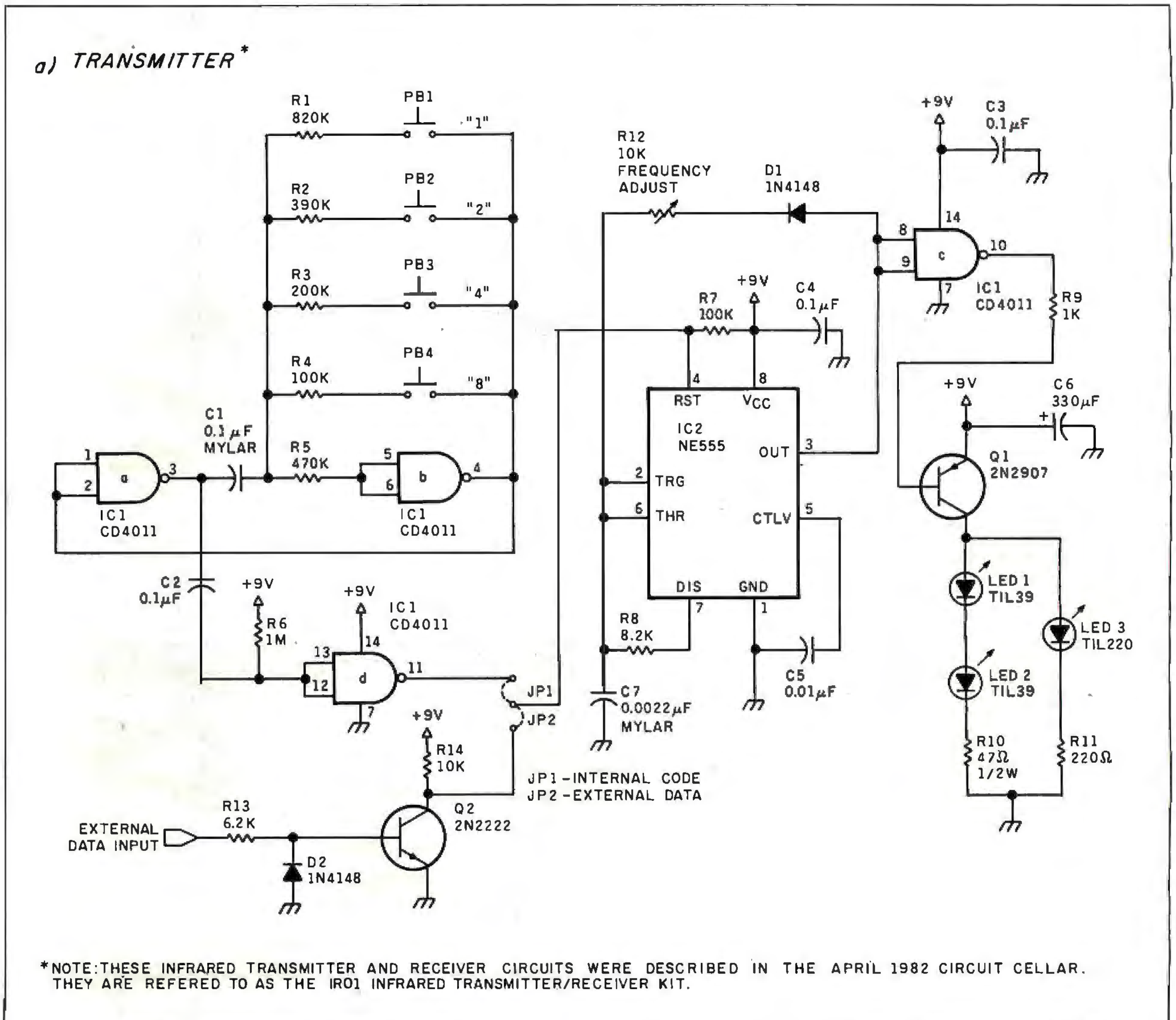
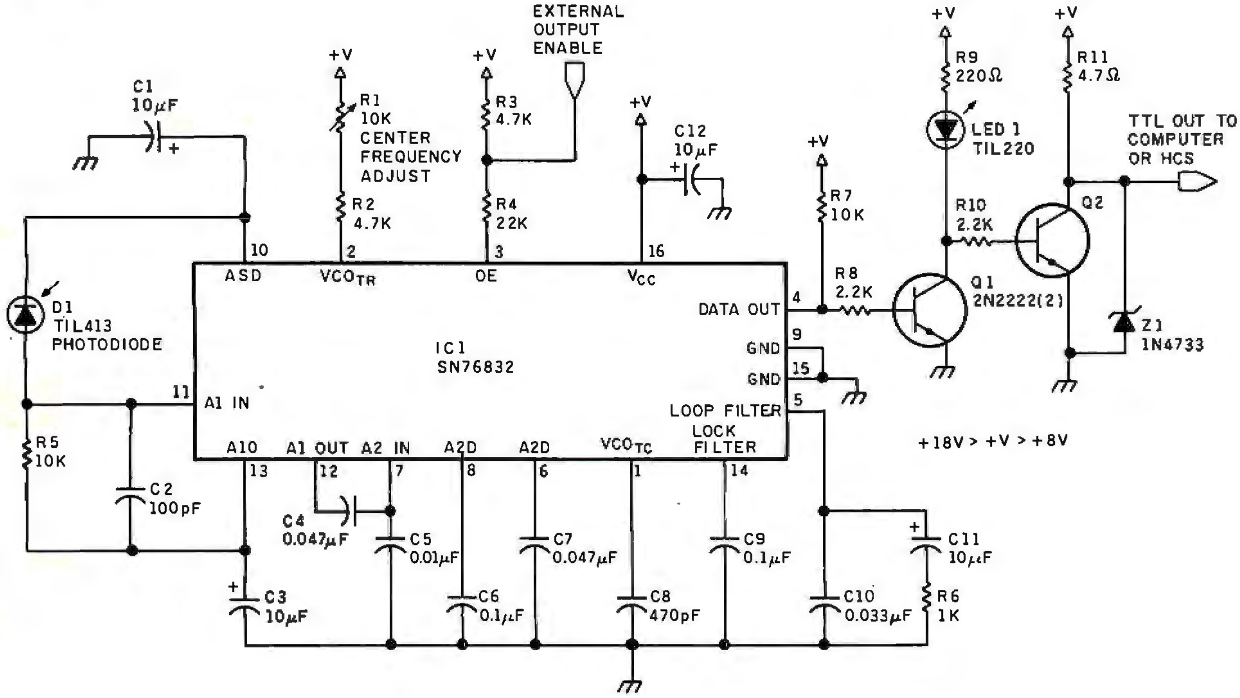


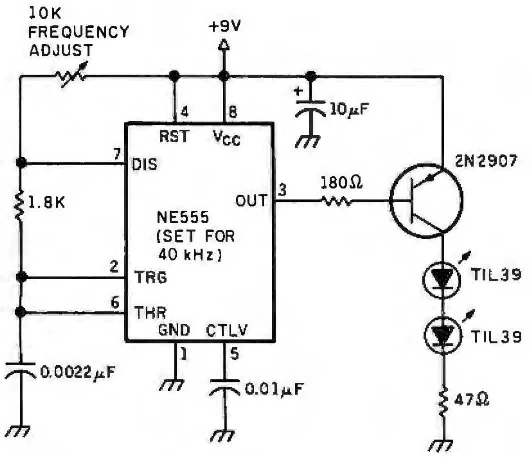
Figure 12: *The IR01 Infrared Transmitter/Receiver.*

b) RECEIVER*



*SEE NOTE ON FIGURE 12a

c) ALTERNATE TRANSMITTER CIRCUIT



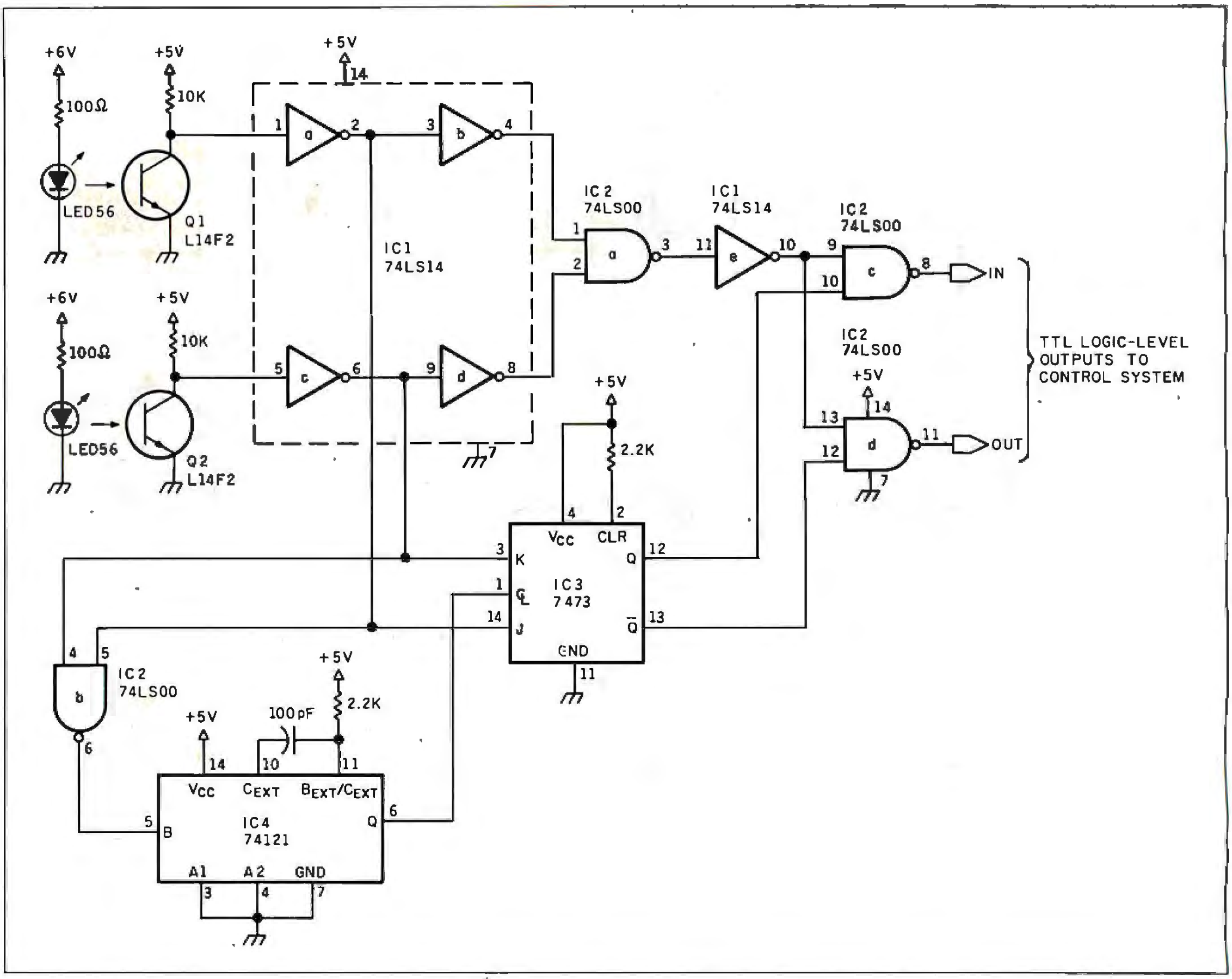


Figure 13: A *direction indicator.* Q1 *and* Q2 *are mounted a distance from each other along a hallway. The* LEDs *are mounted on the opposite wall.*

candescent modulated or unmodulated transmitters.

An entire book could be written explaining the design rules and the exceptions to the rules. The circuits I've included are general in nature. Incandescent sources with cadmium-sulfide light-sensing units (see figures 6, 7, 8, and 9) are short-distance low-ambient-light devices (which need shielding of the transmitter and receiver in opaque tubes) intended for doorways. Improved performance is obtained by switching to LEDs and phototransistors (figure 10).

Long distances (10 to 50 feet) can be accommodated only by modulating the transmitted beam so that it is distinctly different from the surrounding noise. Figures 11 and 12 demonstrate two modulated-beam systems. The infrared unit in figure 12 is the IR01 Infrared Transmitter/Receiver from the April 1982 Circuit Cellar. While designed primarily for remote control and 300-bps (bits per second) wireless data transmission, simply inserting JP2 and leaving the external data input open causes it to transmit continuously. The output of the receiver can then be connected to the control system's input.

One variation on a theme for the doorway sensor is the circuit in figure 13. In this application, two phototransistors (with separate light sources across from them) are mounted in the doorway. As someone passes through the doorway, one beam is always interrupted before the other. The additional circuitry determines the order of interruption and indicates the direction a person was passing through the doorway. Treating this output as two different discrete-level inputs, the control system could initiate different actions depending upon the direction of travel.

We can determine whether the object passing through the doorway was a dog, a child, or an adult if we modify another previous Circuit Cellar project. In October 1984 I presented the

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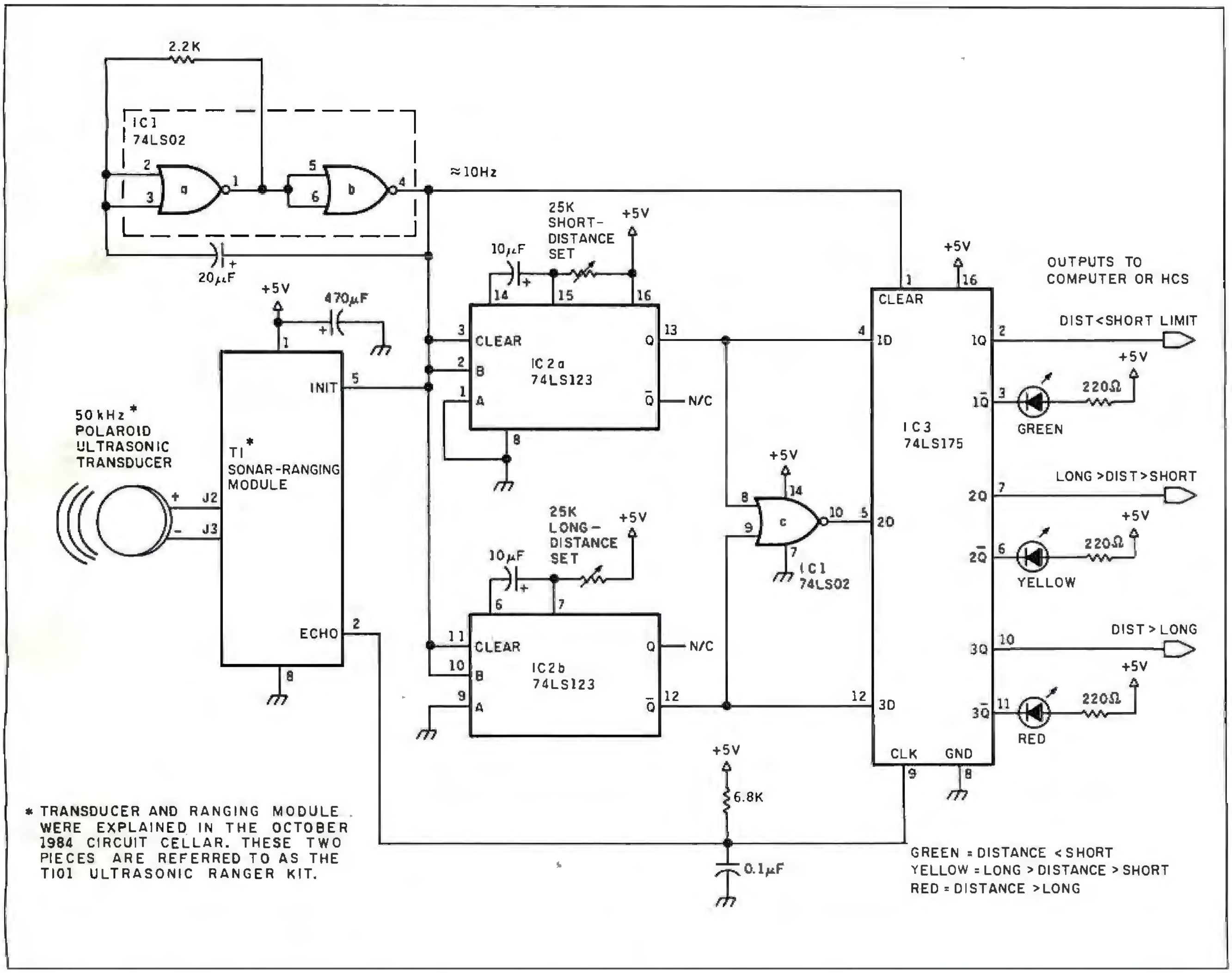

Figure 14a: *The TI01 Ultrasonic Ranger.*

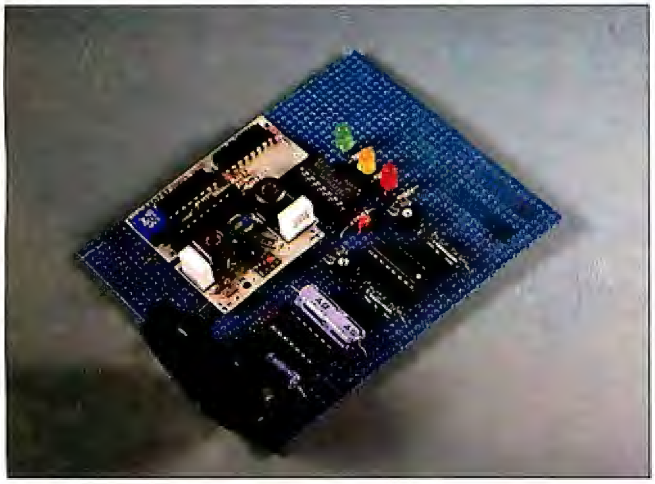

Photo 1a: *The Ultrasonic Ranger project with added components in figure 14 is configured as a discrete-level distance detector.*

Photo 1b: *The circuit in photo 1a enclosed in a box over a doorway to detect people or small animals walking through it.*

Using the Ultrasonic Ranger with some timing windows added, we can ascertain specific distances from 1.5 to 35 feet.

T101 Ultrasonic Ranger, which is based on a Texas Instruments sonar-ranging module. Using these basic components and adding timing windows to sense limit points, we can ascertain and indicate specific distances (the ranging module can detect distances from 1.5 to 35 feet).

Shown in figure 14a, the circuit is relatively uncomplicated. A 10-hertz oscillator (IC1) initializes the ultrasonic transmission and triggers the two one-shots. IC2a has its period set to the short-distance limit, and IC2b is set to the long-distance limit (1.8 milliseconds per foot). When the echo is received, its leading edge clocks the outputs of the one-shots into register IC3. If the distance out and back to the object is farther than the period of the one-shots, they time out and indicate a zero. This timing is shown in figure 14b. The three resulting outputs are distance < short limit, distance > long limit, and long limit > distance > short limit.

If the circuit is mounted in the top of a 7-foot doorway, with the short limit set for 2 feet (5 feet from the floor) and the long limit set for 4½ feet (2½ feet from the floor), we can obtain significant information about the movement through the doorway (see photos 1a and 1b). If a person taller than 5 feet passes through the sensor, we will get an indication of distance < short limit since the person's head will be less than 2 feet from the 7-foot-high sensor. If a 4-foot child walks through the doorway, the long limit > distance > short limit

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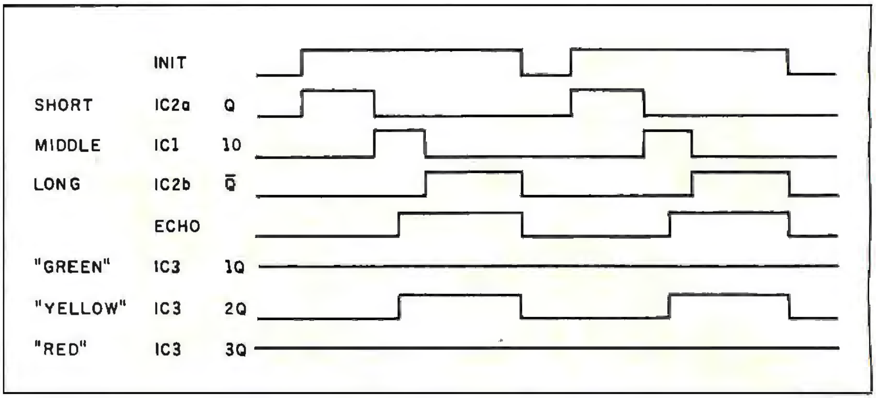

Figure 14b: *High/low-limit ranging-sensor timing diagram.*

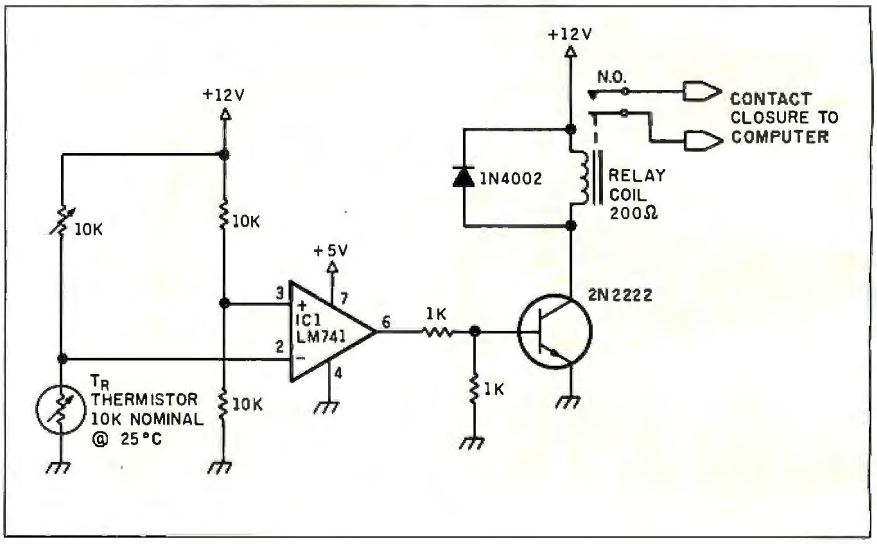

Figure 15: *An over-temperature detector.*

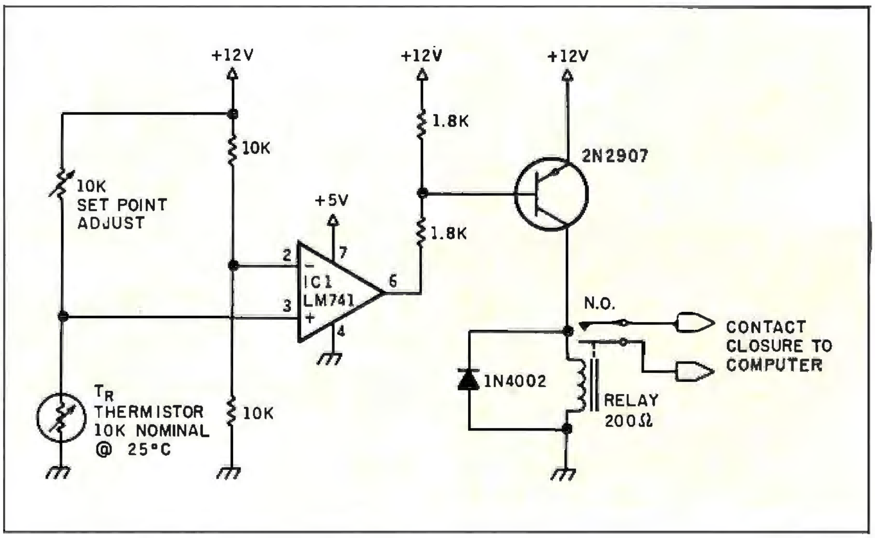

Figure 16: *An under-temperature alarm.*

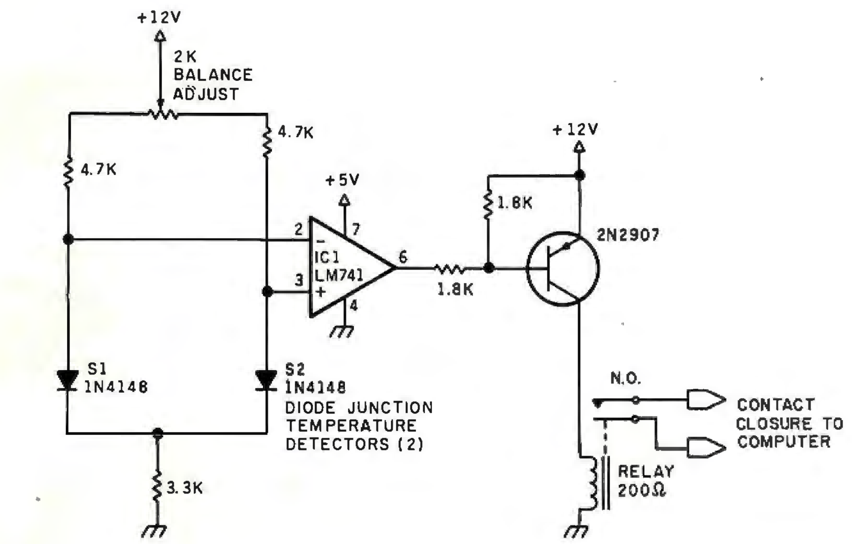

Figure 17: A *differential-input temperature detector.*

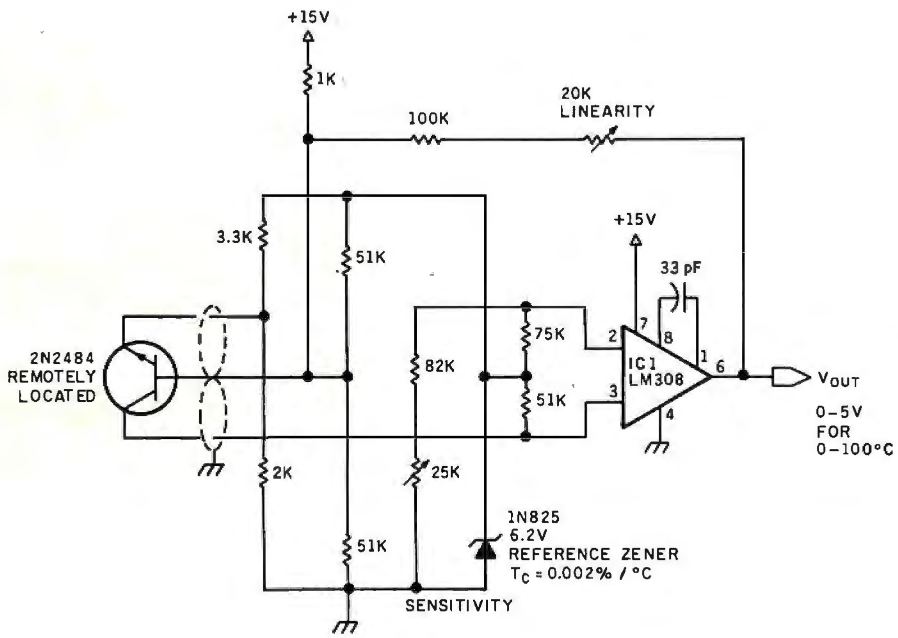

Figure 18: A *solid-state temperature sensor.*

will go high since the child's height of 4 feet is greater than the short-distance limit yet less than the long-distance limit. When a 2-foot dog walks through (indicated by the interrupted-beam sensors at the 2-foot level), the output will indicate distance > long limit.

While this is a cute application for the ranging sensor, I anticipate that this limit-switch modification would find greater application as a level indicator in grain storage bins or oil tanks. Few people are motivated to in-

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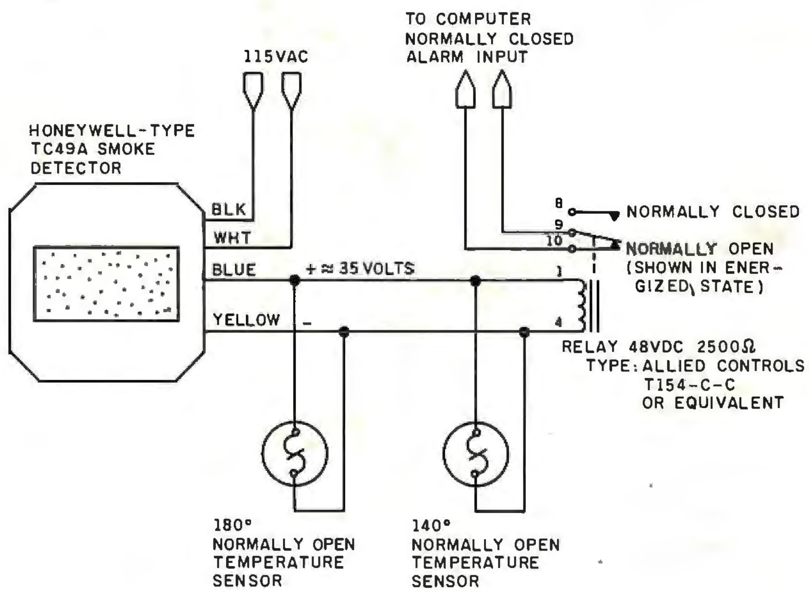

Figure 19: A *smoke-and-heat detector. Additional sensors can be added in parallel.*

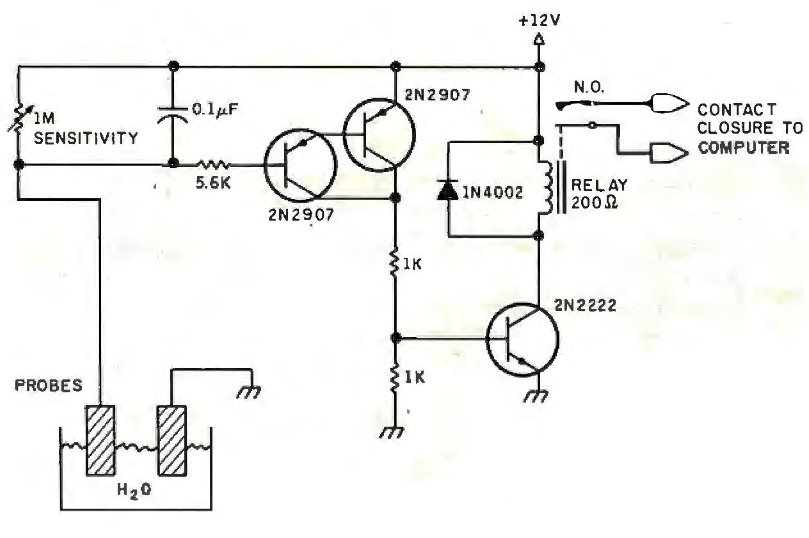

Figure 20: A *water-activated sensor.*

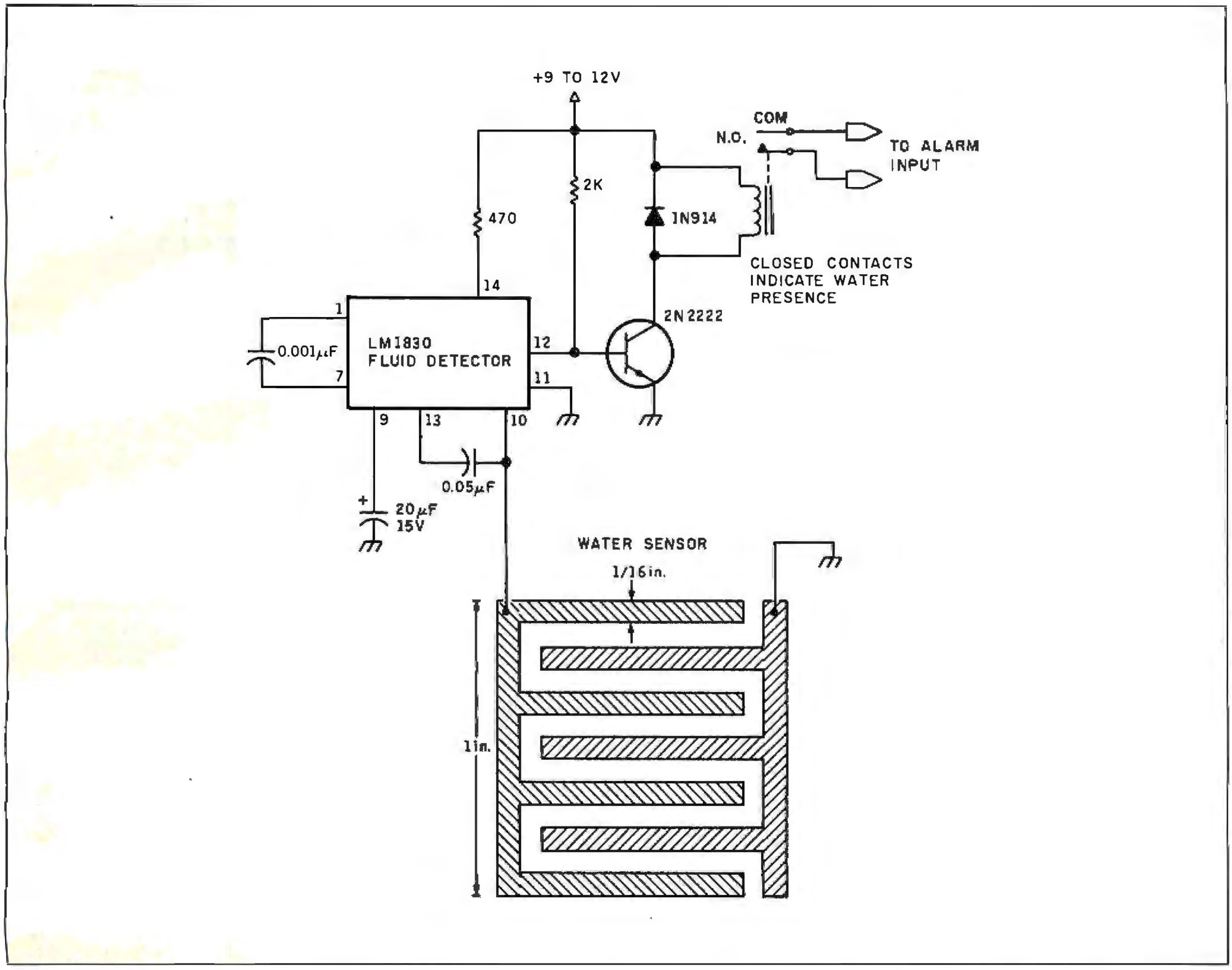

Figure 21: *This fluid-level sensor uses an LM1830 fluid-level detector chip. The detector grid can be cut from a sheet of copper.*

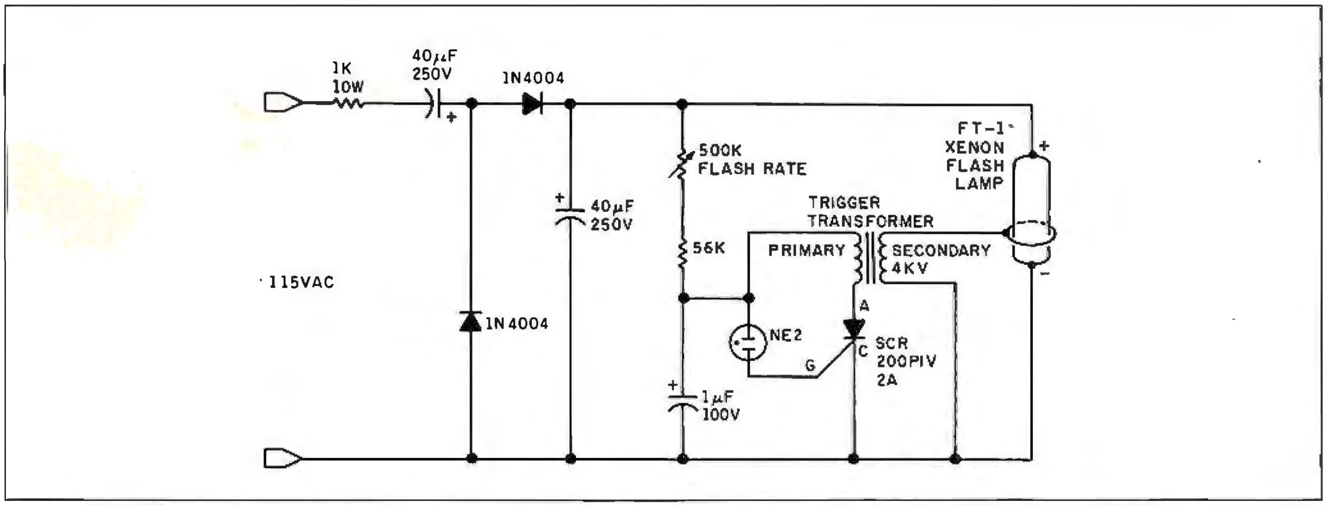

Figure 22: A 115-V AC *xenon strobe light.*

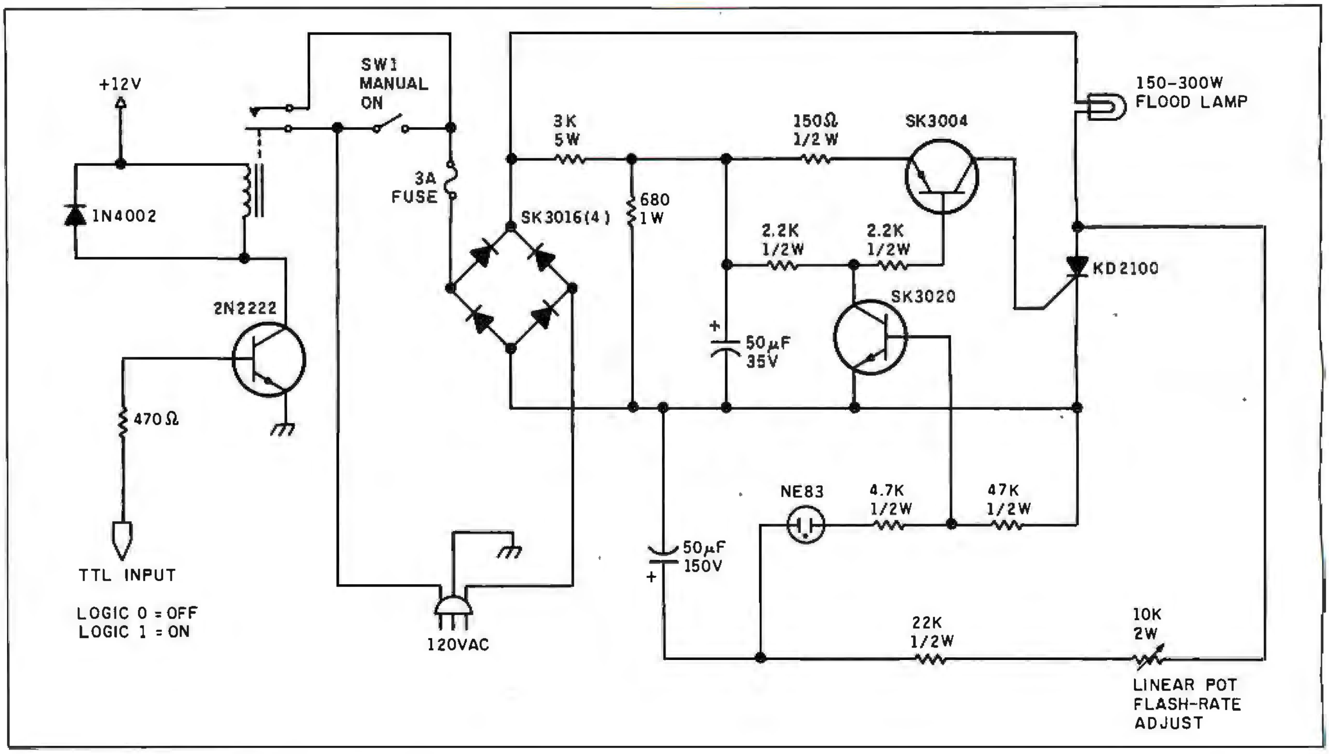

Figure 23: A 115-V AC *incandescent lamp flasher.*

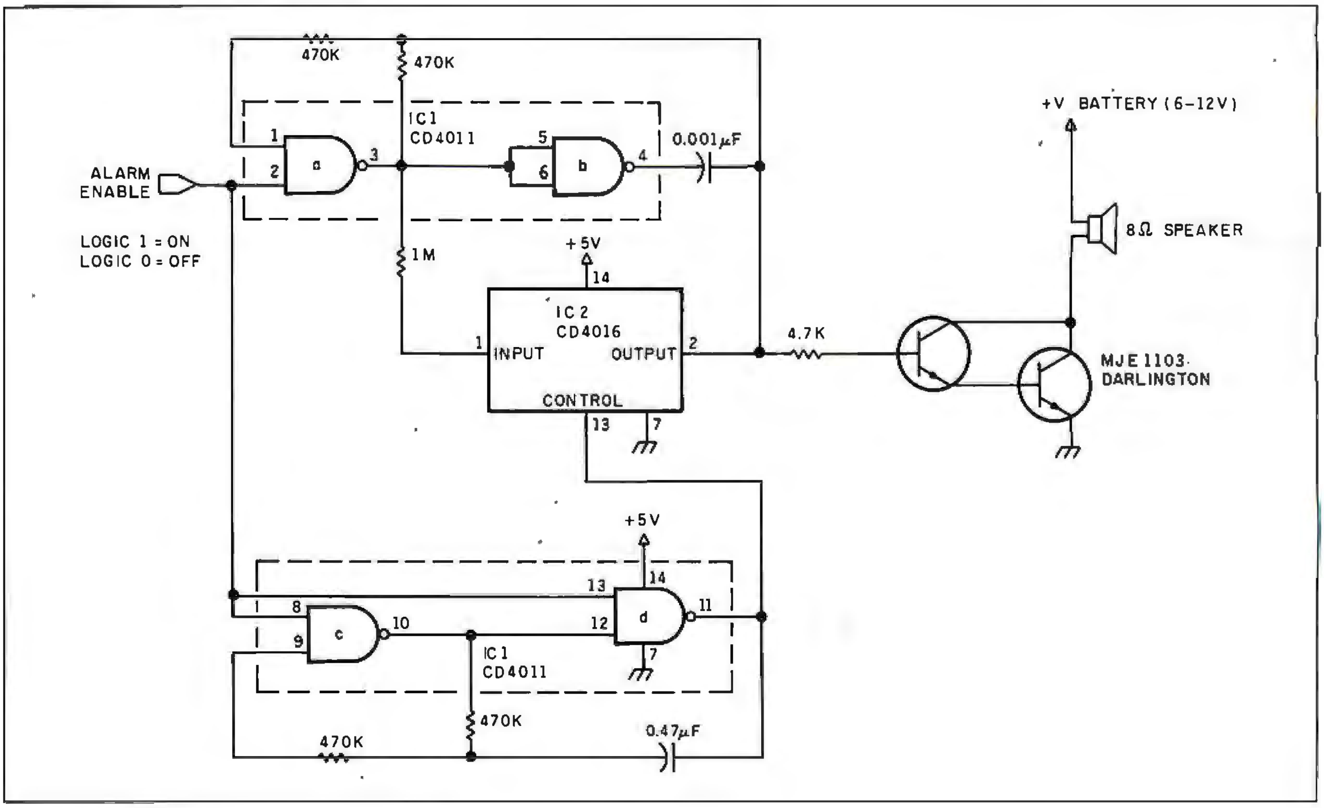

Figure 24: A *high/low-frequency beeper.*

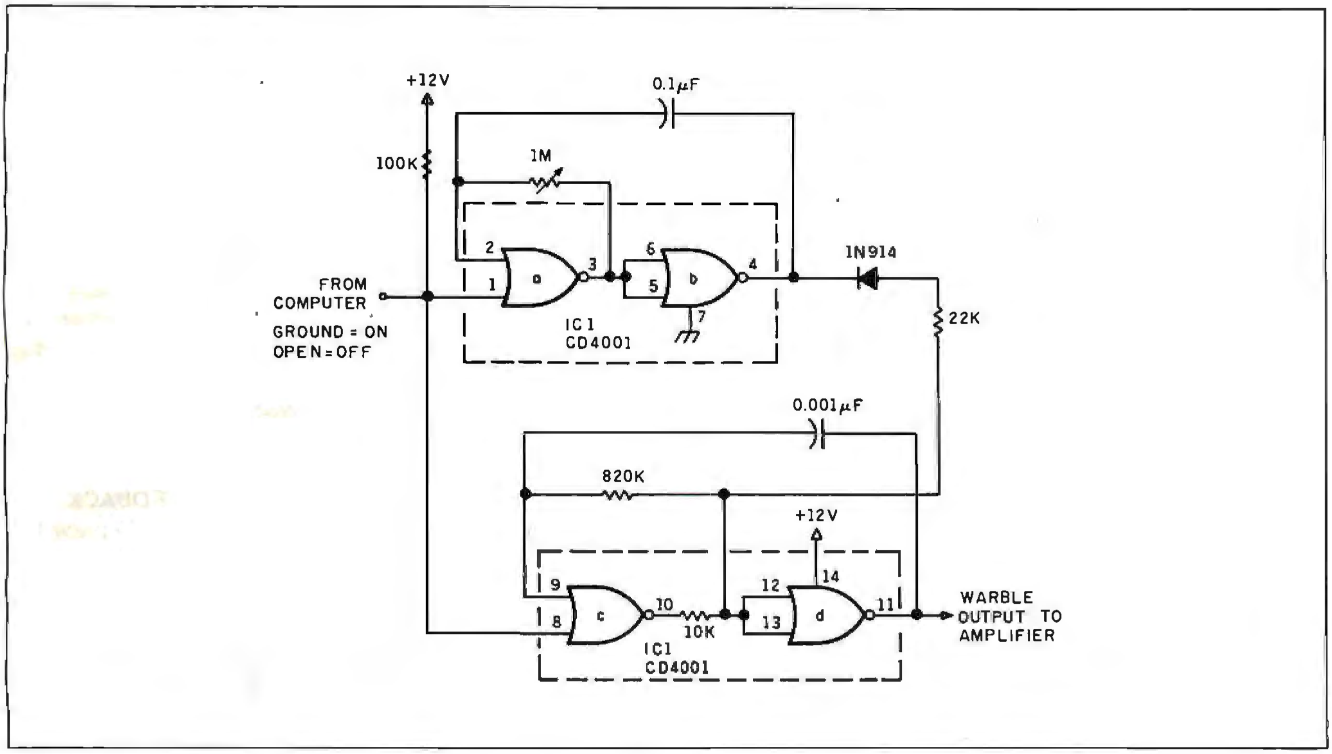

Figure 25: A *warble tone generator.*

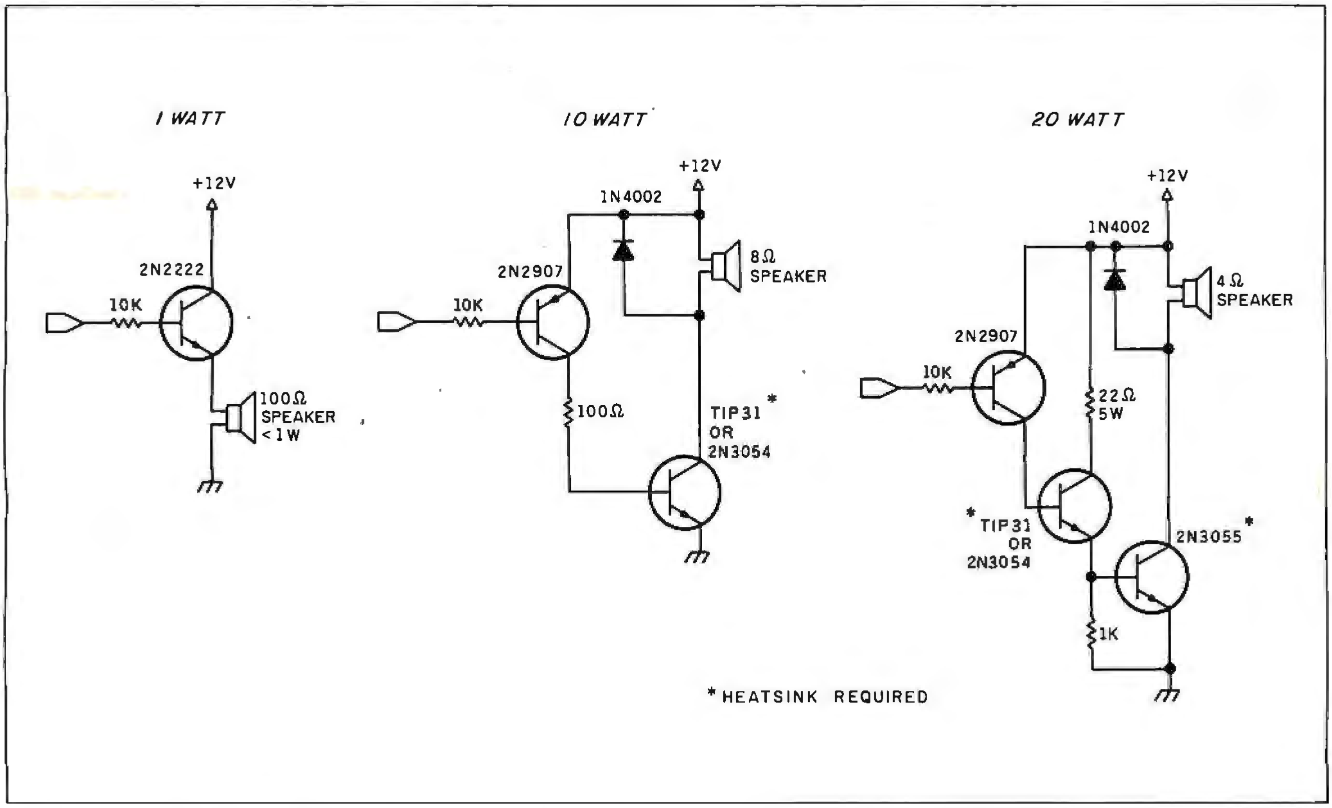

Figure 26: *Power output stages for the design in figure 25.*

stall automatic control systems for their dogs.

TEMPERATURE MEASUREMENT

An important ingredient in any environmental control system is temperature monitoring. While you can always use bimetallic thermostats, they are gross-measurement devices that exhibit a lot of hysteresis. An alternative to bimetallic switches is a thermistor that triggers a relay closure when a temperature is above or below a precisely selected limit (see figures 15, 16, and 17).

Thermistors and bimetallic junctions are not the only materials that exhibit predictable effects due to temperature. Diode and transistor junction voltages (typically 0.7 V) vary with temperature. Using two diodes (figure 17), we can create a differential-temperature switch. When the temperature applied to one diode becomes greater (by the amount determined in the balance adjustment) than the other, the output relay closes. A typical application is a window fan that automatically turns on when the temperature inside becomes greater than that outside.

This technique can be expanded even more to produce an accurate solid-state measuring instrument. As shown in figure 18, the circuit produces a 0–5-V output for 0–100° Celsius. Connecting this circuit to the window detector in figure 3 allows the control system to take a variety of control actions depending upon the temperature.

While on the subject of temperature measurement, we shouldn't forget fires, since they produce high temperatures and are definitely cause for a control system to take action. Figure 19 illustrates a combined smoke-and-heat detector.

WATER DETECTORS

If you live in New England, springtime is synonymous with water. While a worst-case water-sensing technique is to step into it, one variation is a water-detector circuit.

The simple circuit shown in figure 20 senses lowered resistance between the probes when immersed in water. A better circuit, figure 21, uses a special LM1830 fluid-level detector chip.

BELLS AND WHISTLES

If you are using your HCS primarily as an alarm system, getting the proper attention when it triggers is a necessity. After triggering the silent alarm, you may decide not to be so silent. Figures 22 through 27 will definitely liven up the neighborhood.

IN CONCLUSION

Thank you for helping me clean out my junk box. Now you have the means to bend, fold, spindle, and mutilate anything exceeding 5½ feet high and 98.6° passing from east to west through a doorway. Alternatively, anything shorter than 2 feet at 101° should trigger the automatic dog-biscuit dispenser. I say this somewhat tongue in cheek, but you don't get the mail I get.

CIRCUIT CELLAR FEEDBACK

This month's feedback is on page 391.

NEXT MONTH

I'll show you how to construct the Circuit Cellar BASIC-52 computer/controller board. ■

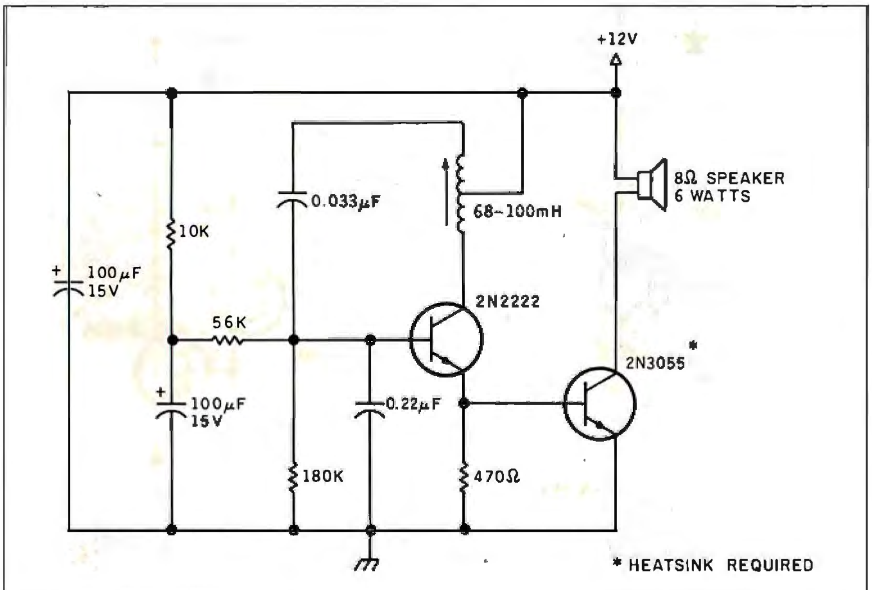

Figure 27: A *siren.*

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.

AMAZING DAISY

NOW! FULL SIZE, FULL FEATURE, LETTER QUALITY AT ONLY $353

If you have been searching for a letter quality printer you have probably found the flood of claims and counterclaims to be a real roadblock in your search. Not long ago we were in the same position. We tried to determine which daisy wheel printer had all the features our customers wanted, yet would not set them back a month's salary. Recently several manufacturers have introduced machines that had features we were seaching for. After a thorough assessment, we eliminated one model after the other for lack of one feature or another until we only had one left.

THE RESULTS ARE IN

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To load a sheet of paper, simply place it in the feed slot and pull the paper bail lever. PRESTO! The paper feeds automatically to a 1 inch top margin and the carriage aligns to the selected left margin. In this manner, each page can have identical margins automatically. You can continue to compute while the Daisy 1120 is printing. The built in 2K buffer frees up your computer while printing a page or two allowing you to go to your next job.

To really put your printer to work, the Cut Sheet Feeder option is great for automatic printing of those long jobs. Also available is the adjustable Tractor Feed option. Compare our option prices! Best of all the Daisy 1120 is quiet: only 57 dB-A (compare with an average of 62-65 dB-A for others).

COMPLETE COMPATIBILITY

The Daisy 1120 uses industry standard Diablo® compatible printwheels. Scores of typeface styles are available at most computer or stationary stores. You can pop in a 10, 12, 15 pitch or proportional printwheel and use paper as wide as 14". At 15 CPI you can print 165 columns—great for spreadsheets.

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Not only is the hardware completely compatible, the control codes recognized by the Daisy 1120 are Diablo 630® compatible (industry standard). You can take advantage of all the great features of word processing packages like Wordstar®, pfs: Write®, Microsoft Word® and most others which allow you to automatically use superscripts, subscripts, automatic underlining, boldface (shadow printing) and doublestrike.

The printer has a set of rear switches which allow the use of standard ASCII as well as foreign character printwheels. Page length can be set to 8, 11, 12, or 15". The Daisy 1120 can also be switched to add automatic line feed if required.

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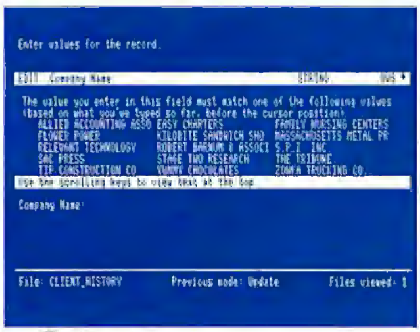

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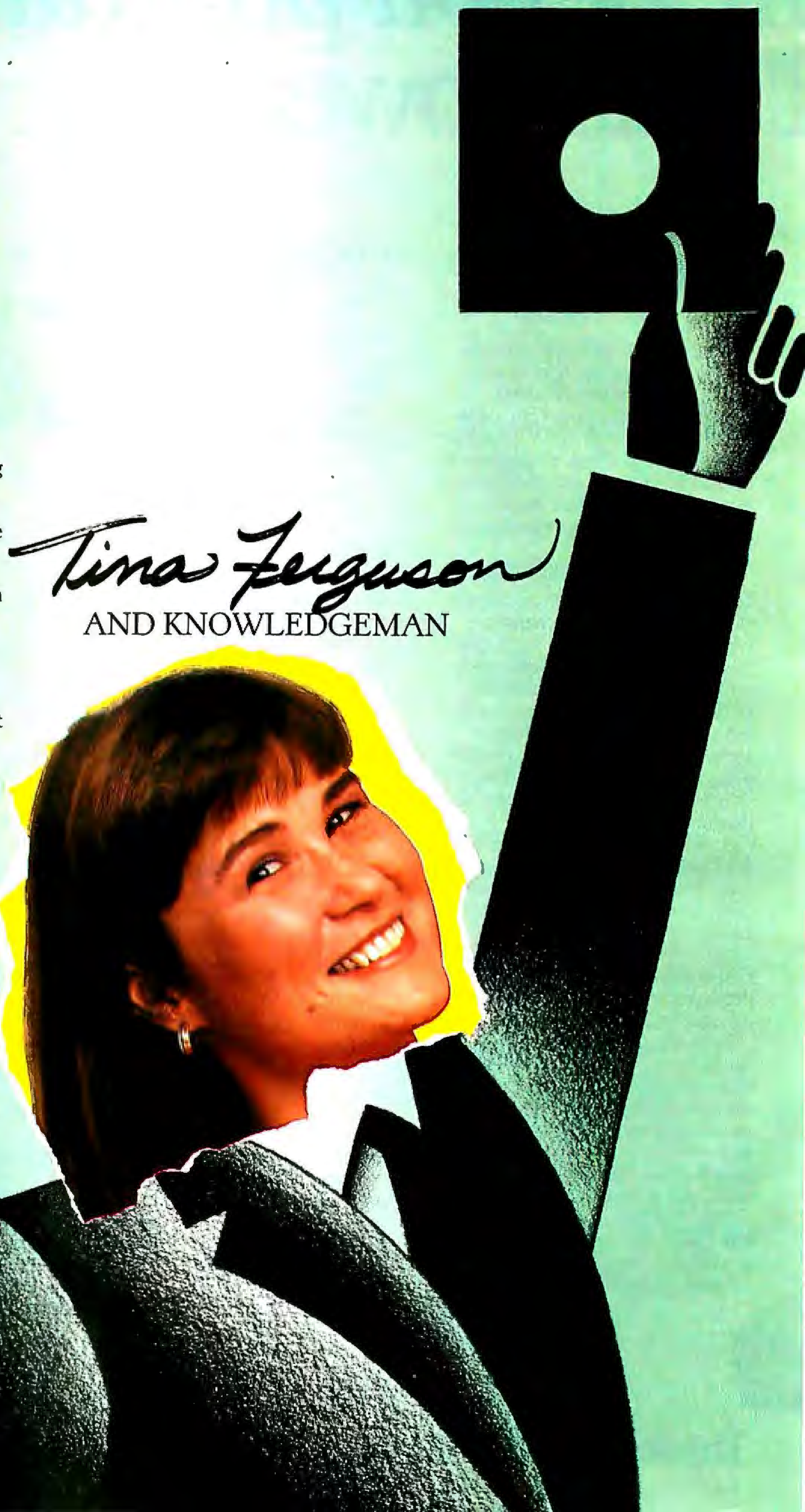


TRAVESTY REVISITED

BY MURRAY LESSER

The Travesty generator is recast in compiled BASIC

AS A WRITER, I was intrigued by the possibilities in Hugh Kenner and Joseph O'Rourke's lexical processor (described in "A Travesty Generator for Micros," November 1984 BYTE, page 129). While the procedure can't quite produce an adequate first draft of a new manuscript, it is a small step on the way to the complete automation of the writer's craft.

Unfortunately, Kenner and O'Rourke picked the wrong programming language to illustrate their point. Pascal just isn't the proper tool for handling a task consisting mostly of string manipulation. One of the Microsoft 16-bit BASIC compilers is a much better choice. They permit strings of more than 30,000 bytes (if you have enough string space) and allow all the usual Microsoft string operations to be performed on long string variables.

Listing 1 shows Travesty rewritten for the IBM PC version of the BASIC compiler. [*Editor's note: The source code for this program,* TRAVPC1.BAS, *is available for downloading via* BYTE*net Listings. The telephone number is* (617) 861-9774.] I have followed the structure of the original Travesty (leaving out those parts made unnecessary by BASIC's string-handling capabilities). Since no programmer likes to leave well enough alone, I have added a couple of extra goodies. The result is a fast program that is slightly more user-friendly than the original, requiring only about half the number of lines of code.

I added the line numbers followed by colons to the listing for discussion purposes, and they are not part of the source code.

The compiler /N switch (line 9) serves two purposes: It tells the compiler not to check for monotonic increasing line numbers and allows the underscore to be used as a logical-line continuation symbol. (Incidentally, programs containing unnecessary line numbers run slower due to a lower level of compiler optimization.) The compiler /E switch is necessary

(continued)

'Twas in that bird, and thought head, and hand:_
Long
    back!
He while in his joy.

"And the boy!
O frabe.
'Twas brillig, and withy the Jabberwock, my son!
The Jabberwock?
Come that bite, the frumious day!"

He claws the son!
The sough
The stood awhiffling
    time raths outgrabe:
All mimsy went snicker-snatch!
Beware

Figure 1: *An order-4 verse scan of the poem "Jabberwocky."*

Murray Lesser received his B.S. degree in engineering from Caltech in 1942. He can be reached at 2474 Hunter Brook Rd., Yorktown Heights, NY 10598.

TRAVESTY REVISITED

Listing 1: *Travesty written for the* IBM PC *version of the* BASIC *compiler.*

```
'                         ************************
'                         *** TRAVPC1.BAS ***
'                         ************************

' Based on the article and Pascal program Travesty by Hugh Kenner
'  and Joseph O'Rourke, in BYTE for November 1984.

'    Written by M. L. Lesser, November 26, 1984
'    Compiled with IBM PC BASIC Compiler, v 1.00, switches /N/E/O
'        (patches to May 1984 have been installed)

' TRAVESTY scans a standard ASCII text file and generates an n-order
'  simulation of its letter combinations. For order n, the relation of
'  output to input is: "Any pattern n characters long in the output has
'  occurred somewhere in the input and at about the same frequency."
' If the verse flag is set, line-end symbols will be replaced by "|",
'  which will generate line ends when they occur in the output text.
'  Otherwise, output lines will average 50 characters in length.
' The output will be displayed during operation and will be filed in
'  the standard ASCII file TRAVESTY.DOC.

      DEFINT F,I-N                     'FLAG.B, FLAG.E, FLAG.V, I, K, L,
                                       'LETTER( ), MAX.IN, MAX.OUT, MAX.PAT,
                                       'N.OUT, N.PAT
      DEFSTR O-Z                       'PASS, PATTERN, SOURCE, STRING,
                                       'OUT.CHAR
      DIM LETTER(124)
      ON ERROR GOTO 5000

' Default values:
      LET MAX.IN = 30000               'Maximum input-string length
      LET MAX.PAT = 9                  'Maximum scan-order length

' User input data:
      RANDOMIZE                              'Get randomizing seed
      INPUT "Number of characters to be output"; MAX.OUT
0100  PRINT "Scan order ( 2 - " MAX.PAT ")";  'Simulated repeat
        INPUT N.PAT
      IF N.PAT < 2 OR N.PAT > 9 THEN GOTO 100  'until
      LET N.PAT = N.PAT - 1                  'Convenience correction
0200  INPUT "Name of input file"; SOURCE     'Error RESUME point
      OPEN SOURCE FOR INPUT AS #1            'Trap if no file
      INPUT "Prose or verse"; PASS
      IF LEFT$(PASS,1) = "V" OR LEFT$(PASS,1) = "v"_
          THEN LET FLAG.V = -1               'Set verse flag
' Scan input text, deleting unwanted symbols:
' (NOTE: If in verse mode, <SP>'s following line end will be deleted)
      PRINT
      WHILE NOT EOF(1)                       'Read input file one
          LET PASS = INPUT$(1,#1)            ' character at a time
          IF PASS <> CHR$(13)_               'Bug trap while
                THEN PRINT PASS;             ' displaying input
          IF PASS = CHR$(13)_                'Change any <CR>
                THEN LET PASS = ""           ' to <NUL>
          IF PASS = CHR$(10)_                'Change any <LF>
              THEN LET PASS = " ":_          ' to <SP>
                IF FLAG.V_                   ' or (if verse)
                    THEN LET PASS = "|"      ' to special line end
          IF PASS = CHR$(9)_                 'Change any <HT>
              THEN LET PASS = " "            ' to <SP>
```

(continued)

```
            IF PASS < > " " AND PASS < > ""_        'Unless <SP> or <NUL>
                THEN LET FLAG.B = 0                 ' reset blank flag
            IF NOT FLAG.B_                          'If "blank" flag clear
                THEN LET STRING = STRING + PASS '   add to string
            IF (FLAG.V AND PASS = "|")_             'Set blank flag to
            OR (PASS = " ")_                        ' delete following
                THEN LET FLAG.B = -1                ' <SP> characters
            IF LEN(STRING) >= MAX.IN_               'If full string:
                THEN GOTO 300                       ' break out of loop
        WEND                                        'End of input loop
 0300 LET STRING = STRING + LEFT$(STRING,N.PAT)     'End around
 ' Report string space usage and force garbage collection:
        PRINT: PRINT
        PRINT "Input string contains" LEN(STRING) "bytes"
        PRINT "There are" FRE(" ") "bytes remaining in string space"
        CLOSE #1
        PRINT: PRINT
 ' Open output file:
        OPEN "TRAVESTY.DOC" FOR OUTPUT AS #2
 ' Initial pattern:
        LET PATTERN = LEFT$(STRING,N.PAT)
        PRINT PATTERN;
        PRINT #2, PATTERN;
        LET N.OUT = N.PAT
 0400                                     'Start of major "repeat until" loop
 ' Clear letter array (this compiler doesn't have ERASE):
        FOR K = 0 TO 124
            LET LETTER(K) = 0
        NEXT K
 ' Match current pattern:
        LET I = INSTR(STRING,PATTERN)
        WHILE I > 0 AND I < = LEN(STRING) - N.PAT  'Don't run off end
            LET PASS = MID$(STRING,I+N.PAT,1)   'Next character
            LET LETTER(0) = LETTER(0) + 1       'Update total count
            LET K = ASC(PASS)
            LET LETTER(K) = LETTER(K) + 1       'Update character count
            LET I = INSTR(I+1,STRING,PATTERN)   'For next match
        WEND                                    'And around again
 ' Choose next output letter based on use frequency:
            LET L = INT(1 + LETTER(0) * RND)    'Random-choice index
            FOR K = 32 TO 124                   'Scan the letter array
                LET L = L - LETTER(K)
                IF L < = 0_                     'This is it
                    THEN LET OUT.CHAR = CHR$(K):_
                        GOTO 500                'Break out of loop
        NEXT K
 0500 'Housekeeping for output character:
        LET N.OUT = N.OUT + 1                   'Increment count
        IF N.OUT MOD 50 = 0_                    'If average line length
            THEN LET FLAG.E = -1                ' set "line-end" flag
 ' Establish next pattern:
            LET PATTERN = MID$(PATTERN,2) + OUT.CHAR
 ' Display and store character found:
            IF NOT (FLAG.V AND OUT.CHAR = "|")_
                THEN PRINT OUT.CHAR;:_
                    PRINT #2, OUT.CHAR;
 ' Check for line break:
            IF (FLAG.V AND OUT.CHAR = "|")_     'Verse line end
            OR (FLAG.E AND OUT.CHAR = " ")_     'Force line end
                THEN PRINT:_                    ' Display <EOL>
                  PRINT #2,:_                   ' File <EOL>
                  LET FLAG.E = 0:_              'Reset forced-end flag
```

(continued)

```
123:                IF FLAG.V AND OUT.CHAR = " "_ 'Forced verse break
124:                     THEN PRINT SPACE$(5);:_ ' indents next line
125:                          PRINT #2, SPACE$(5);
126:          IF INKEY$ = CHR$(3) THEN END        'Emergency exit
127: ' Check for end of output:
128:          IF N.OUT < MAX.OUT OR OUT.CHAR <> " "_
129:               THEN GOTO 400                  'End of major loop
130: END
131:
132: 5000 'Error trap (on "File not found" or "Bad filename"):
133:          IF ERR = 53 OR ERR = 64_
134:               THEN PRINT CHR$(34) SOURCE CHR$(34) " does not exist. ";:_
135:                    PRINT "Try again":_
136:                    RESUME 200
137:          ON ERROR GOTO 0
138: ' End of source code
```

because I included error trapping, and the /O switch causes linking to the stand-alone support library—resulting in a smaller run-time program with more string space.

If you select the verse option (lines 44–45), the input parsing routine (lines 46–71) will substitute the vertical-line separator for the DOS (disk operating system) ASCII (American Standard Code for Information Interchange) text EOL (end of line) symbol, |CRLF|. Consequently, you can run either a verse or prose travesty from the same input file.

Each character of the input file is displayed as it is scanned. Then, if it is valid, it is concatenated to the end of STRING, the string variable. A two-line subterfuge in lines 51–52 is included to get around a bug in the IBM PC BASIC that treats either CHR$(13) or CHR$(10) as an EOL symbol when printing. Without it, the program would display an extra blank row after the end of every input line.

I have somewhat arbitrarily set the maximum input-string length (after compression) at 30,000 bytes. Both the string length and the remaining string space are displayed as part of the run (lines 74–75), so you can adjust MAX.IN for your system size. Because of the way STRING is built, the total string space must be slightly greater than twice the length of STRING. If you have enough memory, the full 64K-byte data segment will allow about 62,000 bytes of string space. Since the code segment is just under 18K bytes, you will have a full data segment if you have at least 82K bytes of available memory.

Output is quite fast, almost as fast as input. The scan loop (lines 92–98) uses BASIC's built-in INSTR( ) function to find all the occurrences of the desired pattern in the input STRING. Each "next character" is both displayed and written to the file TRAVESTY.DOC on the disk in the default drive.

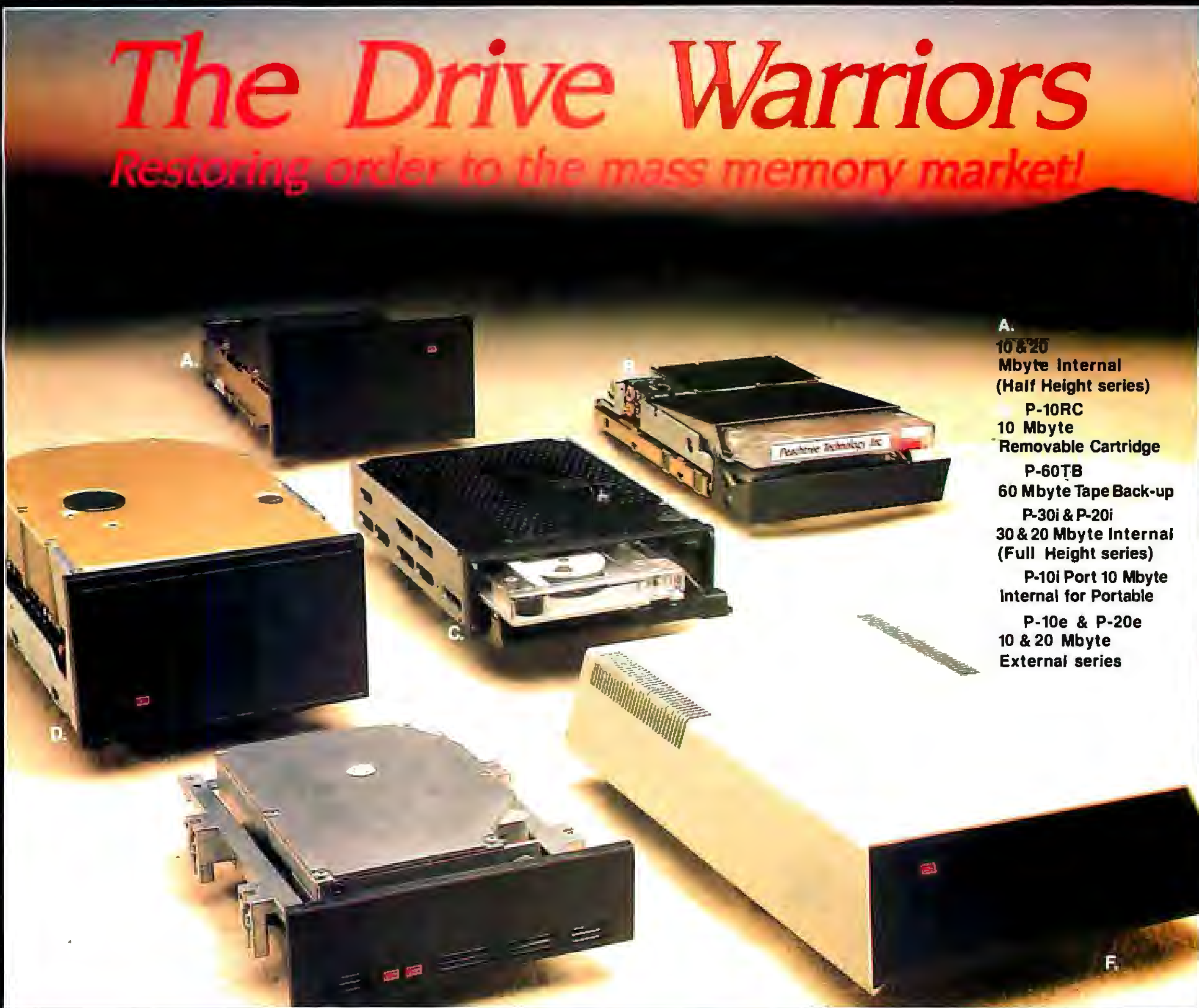
While playing with my program, I found that an order-4 scan was the most interesting to use. Shorter patterns produced mostly nonsense; longer patterns repeated large chunks of the original input.

The whole mood of a piece can be modified by changing the randomizer seed. For example, the heroic joy of Lewis Carroll's "Jabberwocky" can be converted to tragedy (see figure 1).

As one might expect, Travesty is at its best when dealing with the soul of the computer. Figure 2 shows a travesty (in verse form) of its own source code. ■

```
' ***********
' Initial line-end at a time
INPUT
        ")__ 'Rand arountil" long input of loop
END 'And
        one
LET PASS, PASS = '" " "__
THEN PRINT STRINT PASS,1)
        'Next patterse break output character next major
        "Bad index
FOR (PAT,
'OUT.CHAR;:__
GOTO 124
LET
        N.OUTPUT AS **********
' or <NUL>
IF L = "
"
'LET
```

Figure 2: *An order-4 verse scan of the program's own source code.*



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REAL-NUMBER FORMATTING ON YOUR APPLE

BY BRENT DAVIDUCK

This subroutine lets you specify the decimal length of any real number

IF YOU HAVE EVER written a BASIC program to format real numbers, you probably know your program can become cumbersome and its run time intolerably slow. (A real number may include a fractional portion, such as 3.14.) The machine-language subroutine described here uses only 116 bytes of memory and allows you to specify the decimal length of any real number.

If you have worked with FORTRAN, you may have used a statement that looked something like 100 FORMAT(F5.2). This statement formats a real number with a total length of five characters: two digits before the decimal, the decimal point, and two digits following the decimal. The BASIC program in listing 1 uses a similar syntax in line 90. The total length of the number is in the variable *L*; the number of decimal places is in the variable *D*. These parameters are then passed to the Format subroutine, listing 3, by line 10 of listing 1. (Note: The POKE statements must be present if you intend to use the ampersand, "&".)

To begin, you must determine the maximum length of any number that the program will handle. Let's say the subroutine must handle numbers as large as 9999.99. You will want *L* to equal 7 and *D* to equal 2. As an example, the number to be formatted (*N*) will be 123.8765. Once the parameters have been passed to the subroutine, here's what takes place. [*Editor's note: Unless otherwise specified, all addresses are in hexadecimal.*]

1. The number in *N* is converted to an ASCII (American Standard Code for Information Interchange) string: 31 32 33 2E 38 37 36 35 00.
2. The number of digits before and after the decimal point are counted, including the decimal place, and they are subtracted from the number's total allowable length. The result is the number of leading spaces to be left blank preceding the number.
3. For the above example, a single space is followed by the numbers before the decimal point, the decimal point, and the number of places after the decimal point, giving the number 123.87. If in this example you want to produce rounded results, add a rounding constant to the number you are passing: *L,D,N* + 0.005.

Since Applesoft BASIC cannot print a number with a length greater than 15, the subroutine in listing 1 will give you an ?ILLEGAL QUANTITY ERROR if you pass a length greater than this. The same error message is given if the number of places following the decimal point is less than 1 or greater than 8. Also, trying to print a number that contains a length greater than the length parameter passed will cause an ?ILLEGAL QUANTITY ERROR.

OTHER NOTES

Table 1 lists all the ROM (read-only memory) routines used in the program and their function. You can either use the monitor to enter the machine-language routine at location 300 from the dump of the Format subroutine in listing 2 or assemble and load the assembly-language rou-

(continued)

Brent Daviduck (311 Silverthorn Way NW, Calgary, Alberta T3B 4E8, Canada) is a student at the Southern Alberta Institute of Technology.

Listing 1: *This BASIC program will let you test the Format subroutine. You must specify the length of your number and the number of decimal places to be used.*

```
 10 HOME : POKE 1014,0 : POKE 1015,3
 20 INPUT "Number of loops: ";E
 30 INPUT "Format length: ";L
 40 INPUT "Decimal places: "D
 50 PRINT:PRINT
 60 PRINT "Unformatted: "; TAB(25);"Formatted:"
 70 FOR X = 1 TO E
 80 N = RND(1) * (RND(1)*500)
 90 PRINT N; TAB(24);: & L,D,N : PRINT
100 NEXT
```

Table 1: *A list of the ROM routines used in the Format subroutine.*

$DD67—Converts an expression to a floating-point number stored in locations 9D to A3. This routine lets you pass a variable, variable expression, or simple number to your machine-language subroutine: & 7,2,123.8765.

$E6FD—Converts the number stored in locations 9D to A3 to a single-byte number in the X register. If the number is less than 0 or greater than 255, an ?ILLEGAL QUANTITY ERROR is printed. The routine will then return to the Applesoft BASIC prompt.

$DEBE—Checks for a comma. If one is not found, ?SYNTAX ERROR is printed, followed by a return to the Applesoft BASIC prompt.

$ED34—Converts the number stored in locations 9D to A3 to an ASCII string that is stored starting at location 0100 on.

$E199—This routine will print ?ILLEGAL QUANTITY ERROR and return to the Applesoft BASIC prompt.

$F94a—Prints the number of spaces in the X register.

$DB5C—Prints the character in the A register.

Listing 2: *A dump of the Format subroutine will let you check the values you have stored in memory.*

```
]CALL-151
*300.373

0300- 20 67 DD 20 FB E6 E0 10
0308- 90 03 20 99 E1 86 06 20
0310- BE DE 20 67 DD 20 FB E6
0318- E0 09 B0 EE E0 00 F0 EA
0320- 86 07 20 BE DE 20 67 DD
0328- 20 34 ED A2 FF E8 BD 00
0330- 01 F0 04 C9 2E D0 F6 86
0338- 08 A5 06 38 E5 07 E5 08
0340- AA CA F0 05 30 C4 20 4A
0348- F9 A4 07 A2 00 BD 00 01
0350- F0 0A C9 2E F0 11 20 5C
0358- DB E8 D0 F1 A9 2E 20 5C
0360- DB A9 30 88 10 F8 60 20
0368- 5C DB E8 BD 00 01 F0 F1
0370- 88 10 F4 60
*
```

Listing 3: *The Format subroutine rounds any real number to a specified decimal place. All you have to do is supply the parameters.*

```
ORG $300
JSR  $DD67      ;Get the format length
JSR  $E6FB      ;Convert format length to single byte in X register
CPX  #$10       ;Is the length greater than or equal to 16?
BCC  $030D      ; No... continue on
JSR  $E199      ;Print ?ILLEGAL QUANTITY ERROR, go to Applesoft
STX  $06        ;Store the format length
JSR  $DEBE      ;Check for a comma (,)
JSR  $DD67      ;Get the number of places following the decimal
JSR  $E6FB      ;Convert to a single byte in the X register
CPX  #$09       ;Is the number of decimal places greater than 8?
BCS  $030A      ; Yes... go print error
CPX  #$00       ;Is the number of decimal places equal to 0?
BEQ  $030A      ; Yes... go print error
STX  $07        ;Store number of decimal places
JSR  $DEBE      ;Check for comma (,)
JSR  $DD67      ;Get the number to be formatted, store at $9D to $A3
JSR  $ED34      ;Convert number to an ASCII string starting at $0100
LDX  #$FF       ;Initialize X as index
INX             ;Increment index
LDA  $0100,X    ;Get an ASCII character
BEQ  $0337      ;End of string? Yes... go calculate leading spaces
CMP  #$2E       ;Found a decimal point?
BNE  $032D      ; No... continue counting
STX  $08        ;Store number of characters before decimal point
LDA  $06        ;Get the format length
SEC             ;Subtract from the length, the number of
SBC  $07        ; places after the decimal and the number of
SBC  $08        ; characters in front of the decimal
TAX             ;Store the result in X and decrement to
DEX             ; allow for the decimal point
BEQ  $0349      ;If equal to 0 continue on...
BMI  $030A      ;If less than 0 go print error
JSR  $F94A      ;Print number of spaces in the X register
LDY  $07        ;Get back number of decimal places in the Y register
LDX  #$00       ;Initialize X as index
LDA  $0100,X    ;Get an ASCII character
BEQ  $035C      ;If end of string go print the decimal point
CMP  #$2E       ;Is character a decimal point?
BEQ  $0367      ; Yes... go print number of places after decimal
JSR  $DB5C      ;Print the character in the A register
INX             ;Increment index to point to next ASCII character
BNE  $034D      ;Go get next character
LDA  #$2E       ;Load A register with ASCII value for decimal point
JSR  $DB5C      ;Print the decimal point
LDA  #$30       ;Load A register with ASCII value for a zero (0)
DEY             ;Decrement number of decimal places to be printed
BPL  $035E      ;Continue printing decimal places until done
RTS             ;Return to calling routine
JSR  $DB5C      ;Print the decimal point
INX             ;Increment index to point to next ASCII character
LDA  $0100,X    ;Get an ASCII character
BEQ  $0361      ;If end of string go finish printing
DEY             ;Decrement number of decimal places to be printed
BPL  $0367      ;Continue printing decimal places until done
RTS             ;Return to calling routine
```

tine of listing 3. If you don't feel like typing them in, the assembly-language routine and the BASIC program can be downloaded from BYTEnet Listings at (617) 861-9774 as Format.bas and Format.asm. ■

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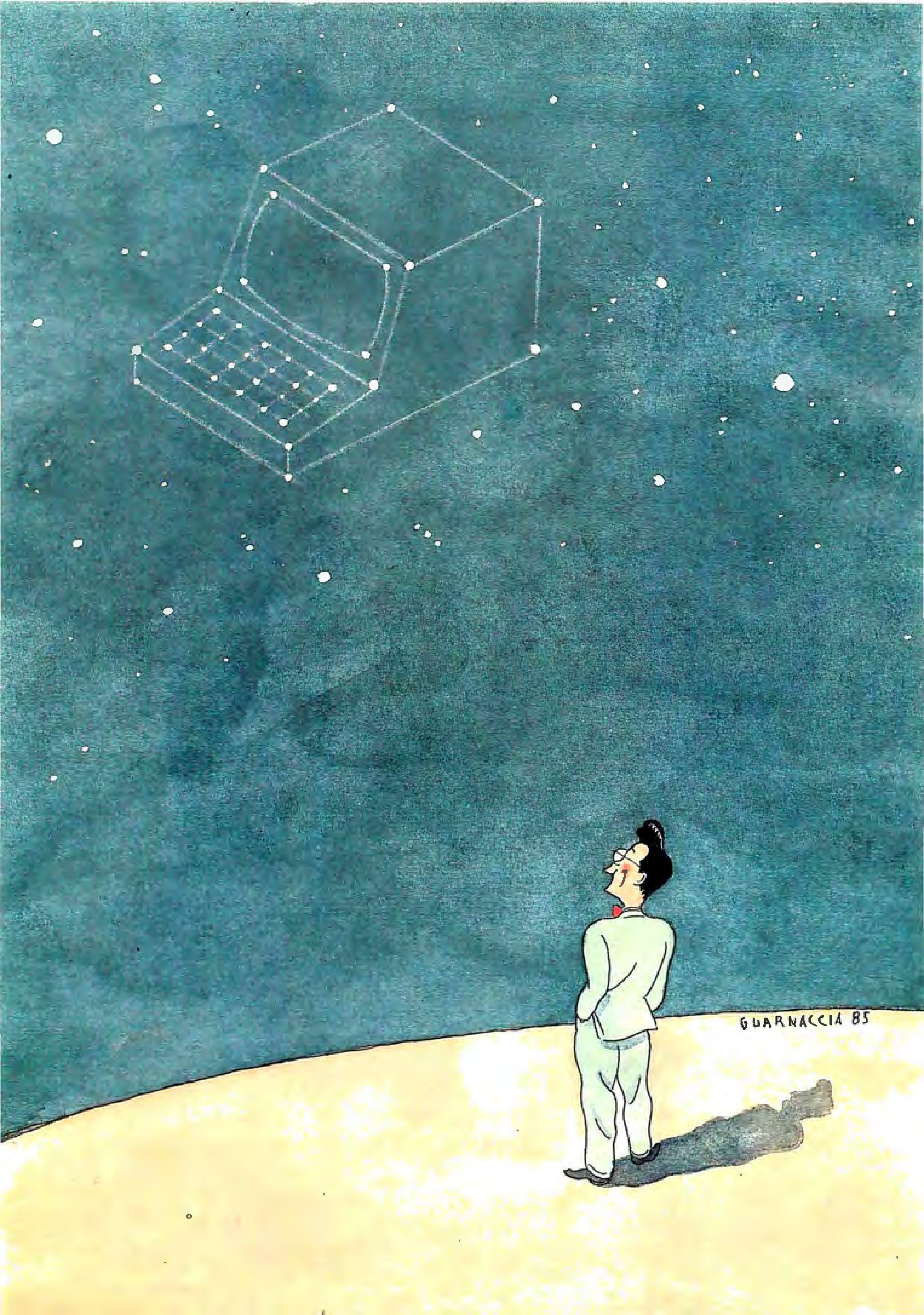
GUARNACCIA 85

BYTE

Computers and Space

ASTRONOMY IS UNIQUE among the physical sciences in that it continues to benefit from the discoveries and observations of serious amateurs. The cost of instrumentation necessary to participate in astronomy is still relatively modest, so you don't need the support of a major research institute to come aboard. Of course, huge reflector telescopes and phased-array radio telescopes are beyond the reach of individuals. But a lot of scientifically significant original research can be performed on equipment that is within the price range of serious amateurs. And the microcomputer revolution is expanding the reach of this low-end equipment.

In this issue, we take a look at some of the ways that microcomputers are used in astronomy and space exploration. We begin with a "Who's who" of astronomy by Russell Genet, codirector of the Fairborn Observatory. He seems to know everyone involved in astronomy and was instrumental in putting this issue together. He mentions a number of professional astronomers who are looking for assistance in their research. For example, Fred Franklin of the Harvard Smithsonian Center for Astrophysics is seeking amateur astronomers from all over the world to aid in his study of Jupiter's moons. If you are looking for ways to use your telescope to advance the science, this article is a very good place to start your search.

In part, we decided to do an astronomy issue because of the impending return of Halley's comet. So, of course, we have articles on tracking the comet. David Dixon's article discusses the Encke method of calculating ephemerides. He includes a FORTRAN program that can be used for comets, including Halley's (for which he gives the necessary orbital elements), and for asteroids. E. H. Weiss discusses refinements to the Encke method that improve the level of precision substantially. His sample BASIC program tracks space vehicles in earth orbit, but his discussion of the methodology will allow you to switch coordinate systems to solar orbits if you are so inclined.

We couldn't have an issue on astronomy without including a FORTH article. Richard Wilton, from Laboratory Microsystems Inc. (the PC/FORTH people), discusses his company's work designing a local-area network for the Jet Propulsion Laboratory. The LAN was used for real-time analysis of imaging radar data from the space shuttle. Be sure to read the captions to the imaging radar pictures; they'll give you a good idea of the uses of such technology.

Louis Boyd is the other codirector of Fairborn Observatory. He writes about automating an observatory, from telescope control to opening the observatory at night and selecting what to observe. He also reports on some of the original research performed at the Fairborn Observatory with its automated telescope.

Astronomy covers a lot of territory. Two things that will come in handy when you're exploring the universe are a portable computer and a good library. An article by Richard Bochonko and William Peters suggests some of the better books available in astronomy. You'll find three articles elsewhere in the issue that discuss subjects related to portable computers—a review of the TI Pro-Lite, a preview of the GRiDCase, and a feature on LCD technology.

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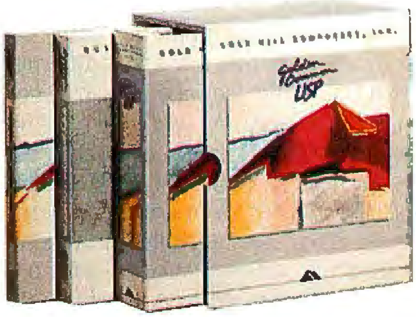

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Inquiry 161

UPDATING THE OLDEST SCIENCE

BY RUSSELL M. GENET

Astronomers are using microcomputers in a variety of applications

IN THE PAST FIVE YEARS, microcomputers have had a revolutionary impact on astronomy, the oldest of the sciences. The revolution has, perhaps, been most visible in the area of optical astronomy at smaller observatories. This is not surprising, since it is the young hackers at small colleges and amateur observatories who have most quickly embraced microcomputers with the greatest effect. We begin with that most traditional task in astronomy, computations.

ASTRONOMICAL COMPUTATIONS

At the very beginnings of civilization, astronomical calculations were made to predict the lunar cycles and seasons and—somewhat crudely—eclipses of the sun. The positions of the planets, appropriately called "the wanderers" by the Greeks, were somewhat more difficult to predict, although Claudius Ptolemaeus (Ptolemy), a Greek living in Alexandria, had by A.D. 140 devised a rather complex but fairly accurate method of mathematical prediction. Nicolaus Copernicus (1473–1543) devised a sun-centered model that, while no more accurate, was conceptually more appealing. Based on unusually accurate observations of Mars made by the Danish nobleman Tycho Brahe (1546–1601), Johannes Kepler (1571–1630) was able to establish, after years of laborious hand calculations, that the orbit of Mars was an ellipse with the sun at one of the foci. It did not take Isaac Newton (1642–1727) long to generalize this to the motion of all objects great and small, and astronomical calculations came into their own.

As the major astronomical observatories were established, each initiated its own computer division. The computer division was often housed in a single large room filled with work tables and the *computers*—the people who made the mathematical calculations. An astronomer or mathematician was in charge. When logarithms were devised, one of their first applications, via detailed tables, was astronomical calculations, and when the mechanical Friden calculators became available, they too were applied to astronomical calculations by the roomful. Mainframe digital computers were applied to this natural arena, and when microcomputers appeared, they too were quickly put to use by astronomers. While some older astronomers miss the smoothly clicking Fridens, digital computers—especially microcomputers—have made astronomical computations affordable to all observatories. The tiniest college or amateur observatory can, with an IBM PC, an Apple II, or even a Commodore VIC-20, make more calculations in an hour than a roomful of people and Friden calculators could in a week, or Johannes Kepler or Isaac Newton in an entire lifetime. And just what is this newfound power at smaller observatories being applied to?

Some microcomputer-based computations are the traditional astronomical tasks, such as conversion from Gregorian to Julian calendar date, conversion from civil to sidereal time, and determining times for the rising and setting of the sun and moon. Thanks to formulas in the *Almanac for Computers*, quite precise predictions of planetary positions can be easily made by microcomputers in a flash. (For a list of books and periodicals mentioned in this and other articles,

(continued)

Russell M. Genet (629 North 30th St., Phoenix, AZ 85008) is codirector of the Fairborn Observatory.

see the "Astronomy Sources" text box on page 244.) Certainly Jean Meeus, Vereniging voor Sterrenkunde, Belgium, is widely recognized as an expert in various positional calculations. Determining the orbital equations for asteroids and comets from just a few observations has always been tricky business. Carl Friedrich Gauss (1777–1855) put such determinations on a sound mathematical footing when he invented the "least squares" method to make such astronomical calculations more accurate. Today's expert is Brian G. Marsden, an astronomer at the Harvard Smithsonian Center for Astrophysics, and it is to him that observations on newly discovered comets (or newly reappearing ones such as Halley's) are reported. (See the "Further Contacts" text box for the addresses of many of the astronomers mentioned in this article.)

Microcomputers are now heavily used by astronomers for the reduction and analysis of scientific observations. At smaller observatories, such observations are predominantly photometric—determining the brightness and color of astronomical objects. Stars that vary their brightness over time are particular research favorites because we can learn much from such observations about the inherent nature of many types of stars. Douglas S. Hall, an astronomer at Dyer Observatory, has long coordinated photoelectric observations of spotted binary stars from smaller observatories around the world. He is always glad to hear from interested observers. The American Association of Variable Star Observers (AAVSO) also assists new observers (see the "Helpful Organizations" text box on page 181). Reduction software programs take the raw observational data and use it to account for the dimming of the light by the earth's atmosphere, the background light from nearby cities or the moon, and nonstandard color sensitivity of some particular photometer. Various microcomputer programs have been devised to calculate the exact instant of minimum light, given a series of brightness measurements. An eclipsing binary star will change its time of minimum light because, as mass is transferred between the two stars, the change in momentum changes the rotational period. Small backyard telescopes equipped with photometers can easily make such observations, and even the smallest microcomputers can accomplish the reductions and analysis.

Some astronomical problems are too complex, even with microcomputers, to solve directly, but simulations are possible. A famous case is the "n-body gravitational problem" where n is 3 or greater. Given initial positions and velocities, the future

FURTHER CONTACTS

Thomas Borlik
7239 North Butler Ave.
Indianapolis, IN 46250

David Dunham
COMPUTER SCIENCE CORP.
8728 Colesville Rd.
Silver Spring, MD 20910

David S. Evans
DEPARTMENT OF ASTRONOMY
UNIVERSITY OF TEXAS
Austin, TX 78712

Fred A. Franklin
HARVARD SMITHSONIAN CENTER FOR ASTROPHYSICS
60 Garden St.
Cambridge, MA 02138

Robert E. Fried
BRAESIDE OBSERVATORY
POB 906
Flagstaff, AZ 86002

Douglas S. Hall
DYER OBSERVATORY
VANDERBILT UNIVERSITY
Nashville, TN 37235

William Herbst
VAN VLECK OBSERVATORY
WESLEYAN UNIVERSITY
Middletown, CT 06457

R. Kent Honeycutt
ASTRONOMY DEPARTMENT
INDIANA UNIVERSITY
Swain Hall West
Bloomington, IN 47401

Mercedes Jaschek
CENTRE DE DONNÉES STELLAIRES
11 rue de Université
F-67000
Strasbourg, France

Brian G. Marsden
HARVARD SMITHSONIAN CENTER FOR ASTROPHYSICS
60 Garden St.
Cambridge, MA 02138

R. Edward Nather
DEPARTMENT OF ASTRONOMY
UNIVERSITY OF TEXAS
Austin, TX 78712

Tim Persinger
DEPARTMENT OF ASTRONOMY
VANDERBILT UNIVERSITY
Nashville, TN 37235

Manfred Stoll
INSTITUTE FOR ASTRONOMY
UNIVERSITY OF VIENNA
Vienna, Austria

Mark Trueblood, Director
WINER MOBILE OBSERVATORY
10912 Broad Green Terrace
Potomac, MD 20854

Wayne H. Warren Jr.
ASTRONOMICAL DATA CENTER
NASA-GODDARD SPACE FLIGHT CENTER
Code 601
Greenbelt, MD 20771

Nathaniel M. White
LOWELL OBSERVATORY
POB 1269
Flagstaff, AZ 86002

Michael Zeilik II
DEPARTMENT OF PHYSICS AND ASTRONOMY
UNIVERSITY OF NEW MEXICO
Albuquerque, NM 87131

courses over time of a number of gravitationally interacting bodies, such as planets, stars, or galaxies, can be simulated by a microcomputer. An interesting microcomputer simulation (with an Apple II) was devised by Clint Poe, while a graduate student at Vanderbilt University, to determine the effects of large starspots on the light intensity versus time (light curves) of binary stars as viewed from the earth. As the spots rotate in and out of the line of sight from earth, the brightness goes up and down, but in a very complex way that depends on the number, sizes, and positions of the spots. You can change the microcomputer simulation parameters until the simulated light curve matches the actually observed light curve, thus deriving information about the sizes and locations of the starspots and their changes over time. Some simulations, such as the nuclear evolution of stars, can be difficult for microcomputers, but microcomputers have now been applied to even these and other difficult astrophysical simulations.

CATALOGS AND ATLASES

Man early on noted that, except for the sun, moon, "wandering" planets, and an occasional comet, the stars pretty much stayed put on the celestial sphere. Soon the brighter stars were broken into natural groups in the sky (constellations), and the brighter stars in each constellation were assigned Greek letters. John Flamsteed (1646–1719), the first astronomer royal at England's Royal Greenwich Observatory, determined the position and brightness of 3000 stars. Edmond Halley (of comet fame, 1656–1742) and Isaac Newton rushed Flamsteed's catalog into publication in 1712 while it still contained some errors. An angry Flamsteed managed to locate and burn the 300 published copies, and he eventually published his own version. Friedrich Argelander (1799–1875) made observations of the position and brightness of more than 300,000 stars, which he published as the *Bonner Durchmusterung*.

Catalogs available in computerized form are of special interest. The *Yale Bright Star Catalog* by Dorrit Hoffleit contains all the stars visible by the naked eye, with a margin for even the darkest skies and keenest eyes. The *Henry Draper Catalog* contains spectral types and other useful information on over 200,000 stars, while the *Smithsonian Astrophysical Observatory* (SAO) *Catalog* contains detailed information on over 300,000 stars. And there are many specialized catalogs such as the *General Catalog of Variable Stars*, and others on such specific classes of objects as binary stars, planetary nebulae, galaxies, etc. The repository

(continued)

HELPFUL ORGANIZATIONS

AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS (AAVSO), Photoelectric Photometry Committee. Contact Howard J. Landis, 50 Price Rd. West, Locust Grove, GA 30248. Organized program for photoelectric photometry at amateur observatories. Inquiries on getting started in photometry are welcome. Nice newsletter.

AMERICAN ASTRONOMICAL SOCIETY (AAS), Special Interest Group for Microcomputer Use in Astronomy (SIGMUA). Contact Daniel B. Caton, Department of Physics and Astronomy, Appalachian State University, Boone, NC 28608. The AAS is a society of professional astronomers. SIGMUA helps to exchange ideas on microcomputer use in astronomy. Newsletter and semi-annual meetings.

ASTROMEDIA CORP., 625 East St. Paul Ave., Milwaukee, WI 53202. Publishes *Astronomy* magazine and *Telescope Making*, both of which occasionally have articles on the use of microcomputers in astronomy. Also has helpful books.

ASTRONOMICAL LEAGUE. Contact Donald Archer, Executive Secretary, POB 12821, Tucson, AZ 85732. National (U.S.) Organization of Astronomy. Annual national meeting, quarterly journal. Microcomputer users group.

ASTRONOMICAL SOCIETY OF THE PACIFIC. Contact Andrew G. Fraknoi, 1240 24th Ave., San Francisco, CA 94122. Society of professional and amateur astronomers. Annual meeting. Monthly scientific journal, quarterly general-interest journal (*Mercury*).

AUTOMATIC PHOTOELECTRIC TELESCOPE SERVICE, FAIRBORN OBSERVATORY, 629 North 30th St., Phoenix, AZ 85008. Provides automatic telescope systems and their operation and maintenance at a first-class Arizona site as a service for universities and research organizations.

BRITISH ASTRONOMICAL ASSOCIATION (BAA). Contact Andrew J. Hollis, Ormada Observatory, 85 Forest Rd., Cuddington, Northwich, Cheshire CW8 2ED, England. Focal point for British and European small observatory photometrists. Occasional European meetings.

INTERNATIONAL AMATEUR PROFESSIONAL PHOTOELECTRIC PHOTOMETRY (IAPPP) Association. Contact Robert C. Reisenweber, Rolling Ridge Observatory, 3621 Ridge Parkway, Erie, PA 16510. International organization of amateur and professional astronomers interested in photometry. Several meetings in various countries each year. Quarterly journal devoted to photometry, including microcomputer use.

INTERNATIONAL OCCULTATION TIMING ASSOCIATION (IOTA), POB 596, Tinley Park, IL 60477. International organization devoted to visual and photoelectric timing of asteroid and lunar occultations. Occasional meetings. Nice newsletter.

SKY PUBLISHING CORP., 49 Bay State Rd., Cambridge, MA 02238. Publishes *Sky & Telescope* magazine, which has a monthly feature on microcomputer use in astronomy. Source for catalogs and atlases, as well as books. Free catalog.

WILLMANN-BELL INC., POB 3125, Richmond, VA 23235. Source for catalogs and atlases. Also source for books in mathematical astronomy and optical design. Request their lists in these areas. Catalog available.

for such computerized catalogs in the United States is the Astronomical Data Center, directed by Wayne H. Warren Jr. The worldwide center is directed by Mercedes Jaschek at the Centre de Données Stellaires in Strasbourg, France.

Atlases are essentially "maps" of the stars. They are generated from catalog data by plotting stars and other objects on large pieces of paper. Some of the nicest atlases have been made in Czechoslovakia by Antoni Becvar. The *Borealis*, *Eclipticalis*, and *Australis* atlases cover the entire sky with brightness depicted by the size of each star, while the spectral type (temperature) is indicated by the printed color. Somewhat less detailed but popular atlases are Will Tiron's *Sky Atlas 2000* and the *Sky Catalog 2000* by Alan Hirshfeld and Roger Sinnott. Just as you use a map to guide your car to a specific house in a particular city, you use a sky atlas to direct your telescope to a specific star or other object in a particular constellation. Often, for convenience, observers make a small sketch on a larger scale of just a small part of the atlas to help locate a specific star while at the telescope eyepiece. Trying to hold up a big atlas with fine print while looking through a telescope in the dark is tough! These sketches are very helpful and are called "finder charts."

The early microcomputers (and even many of the modern ones) were not well suited for working with catalogs and atlases. Catalogs require the storage of very large amounts of information with quick access to it. Atlases require significant graphics capabilities to be effective. However, with 16- and 32-bit processors, hard-disk storage, and high-resolution bit-mapped graphics, some modern microcomputers have the needed capabilities. While most of the computerized catalogs are on 9-track tapes, versions are becoming increasingly available on disks of various formats.

There are a number of advantages to microcomputer-based catalogs. You can search entire catalogs for specific objects or classes of objects. This is very helpful in formulating observing programs and in conducting various statistical studies. One class of objects easily extracted from a catalog are all objects in a certain small area that have more than a given brightness. You can then plot those selected on the screen to form an instant custom finder chart. A small computer monitor near the telescope is much easier to see than an atlas, and you can display only the information you need, avoiding confusion. Printed atlases only look at the stars from one fixed vantage point—that of earth. With a catalog contain-

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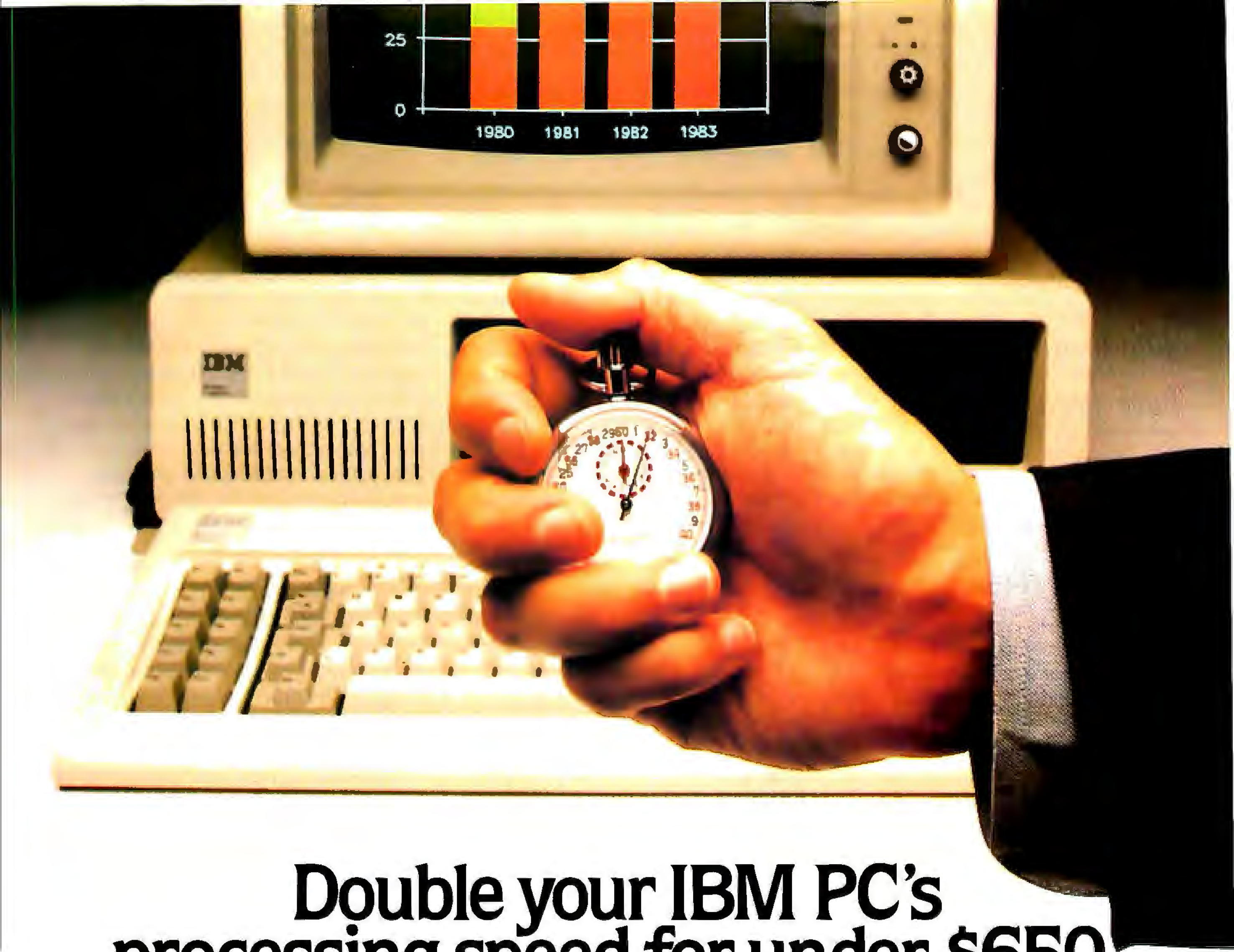

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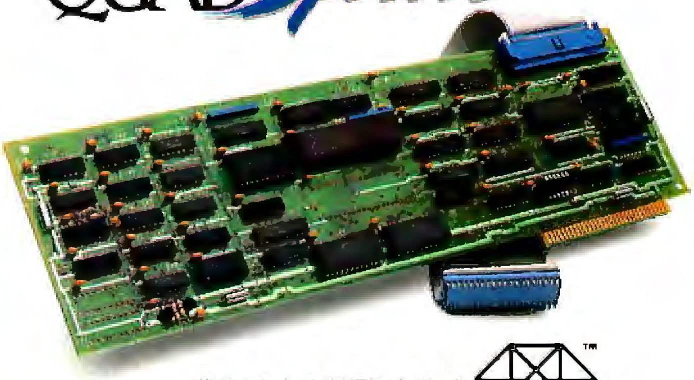

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Inquiry 294

Photometric data-logging systems have been developed for many types of microcomputers in many countries.

ing three-dimensional coordinates and a microcomputer with some computational and graphics capabilities, you can calculate and display a vantage point from anywhere in space.

DATA LOGGING

While casual visual observers may not record what they see, the serious researcher is always writing down instrument readings. Although the popular literature gives the impression that telescopes are used either to take pretty pictures or for visual observing by research astronomers, both of these activities are rarities in real research. Telescopes are light buckets for the researcher's instruments—mainly photometers and spectrometers. Because photometers are especially appropriate instruments for smaller telescopes, let's consider how microcomputers are taking over photometric data-logging tasks.

In the days before microcomputers, photometry was often a two-person operation. One person would operate the telescope and the photometer while the other recorded the results. In variable-star photometry, for instance, the sequence of observations is rigidly fixed so that the data can be reduced in a standard manner. While the task is relaxing and peaceful, I must admit that I find making photometric observations and manually recording them a bit on the boring side. In 1979, I bought a Radio Shack TRS-80 Model I to reduce and analyze variable-star photometric data (see photo 1). It seemed wasteful to manually record the data and then rerecord it into the TRS-80. To avoid this, I fed the photometer output through a voltage-to-frequency converter to a programmable counter tied to the TRS-80's bus (see photo 2). A clock/calendar chip for recording the date and time and a remote hexadecimal keypad for control were also tied to the bus. Prompts on a monitor in the observatory suggested what to do next (very handy at 3 a.m.), and the data was displayed in neat rows and columns as it was gathered. (This made it easy to compare the latest data point with all the previous similar ones and correct any mistakes.) After observations on a given star were completed, reduction, display, and printout of the results took only seconds.

Photo 1: *Laboratory testing of an early* (1979) *data-logging system for photoelectric astronomy. Developed by the author (right), this system used an early Radio Shack* TRS-80 *Model I microcomputer with* 16K *bytes of* RAM. *Programs and data were stored on cassette tape. The four electronic boxes on the right contained the computer interface, photometer* DC *amplifier, and high- and low-voltage power supplies.*

In photometric data logging, the amounts of data handled are very modest, allowing the use of high-level languages and microcomputers with small memories. Yet the improvement in the observational environment and the reduction in errors is outstanding. With photometry as the main scientific concern at smaller observatories, it is not surprising that photometric data-logging systems have been developed for many types of microcomputers in many countries. An English amateur astronomer, Andrew Hollis, has done a particularly capable job on a low-cost Sinclair ZX81.

Thomas Borlik has developed a straightforward data-logging system based on the Commodore VIC-20. However, the Apple is the favorite of many data loggers with nice systems, such as Tim Persinger of Vanderbilt University, Michael Zeilik II of the University of New Mexico, and Robert E. Fried of Braeside Observatory. Some of the fancier photometric data-logging systems are LSI-11–based, such as those by William Herbst of Van Vleck Observatory and Nathaniel M. White of Lowell Observatory.

In some types of astronomical photometry, the event of interest happens so fast that a human can't record the results. However, a microcomputer can easily record brightness readings every millisecond. An occultation of a star by the dark limb of the moon occurs when the moon (which, compared to the stars in the sky, travels east) catches up with and passes over or "occults" a star. The star winks out in a few hundredths of a second. Not only is the exact timing of the "wink out" useful in estab-

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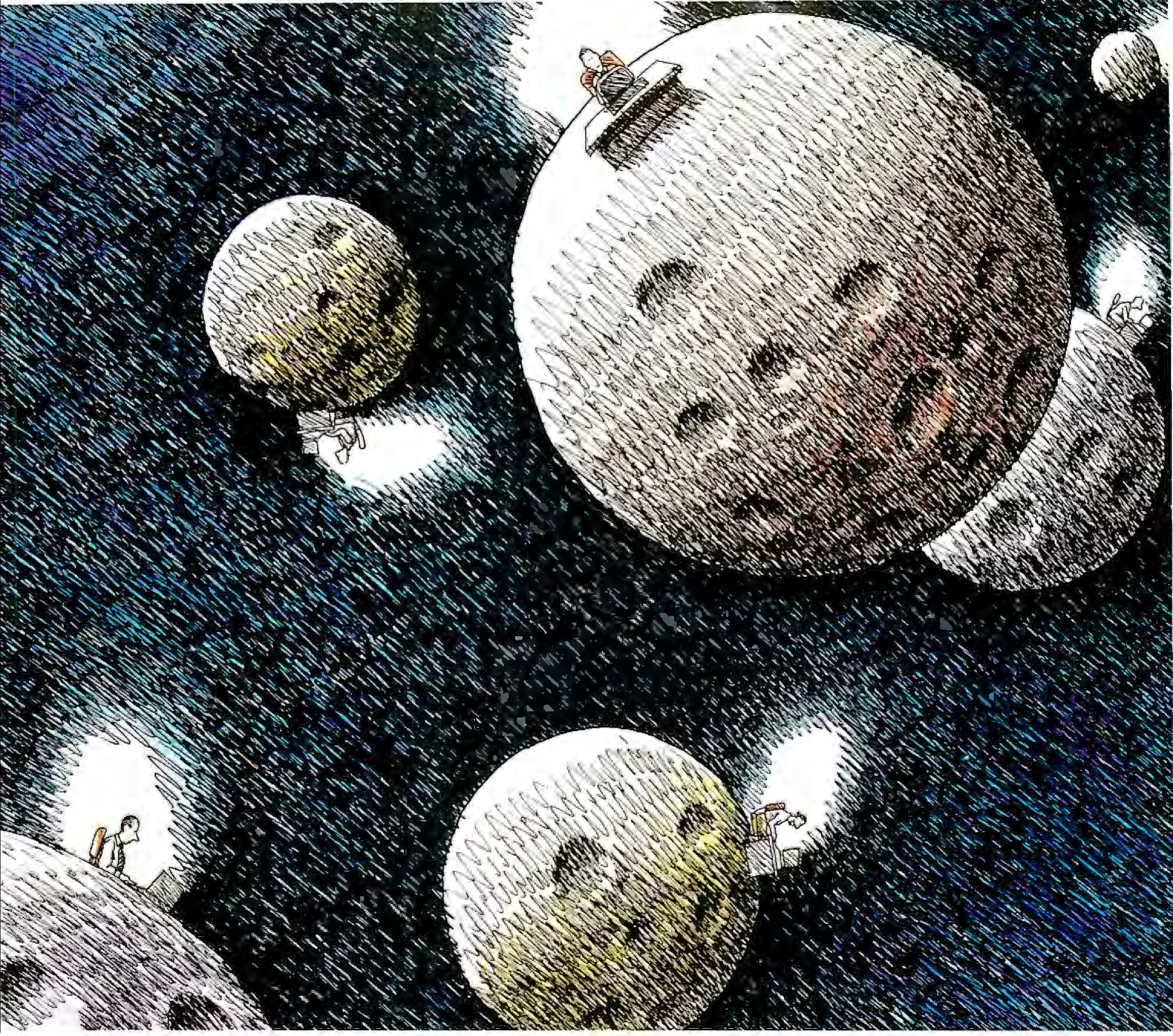

lishing the exact position of the moon and the occulted star, but if the star is binary, the light has an intermediate brightness value for a fraction of a second as one star is occulted but the other isn't yet.

For bright stars with large diameters, a fringe pattern is created when the moon, acting like a giant "knife edge," sweeps across the star in a fraction of a second. A microcomputer high-speed recording of the brightness fringes enables us to determine the diameter of the star. David S. Evans and R. Edward Nather at the University of Texas have long been recognized as experts in such high-speed photometry.

Asteroids occasionally pass in front of stars, casting "asteroid shadows" along narrow paths on the earth's surface. Exact, high-speed photometric measurements of the time at the beginning and end of the shadow enable us to determine the size of the asteroid. David Dunham, an astronomer at Computer Science Corporation, is an expert in knowing where these shadows will fall. He runs about the world to record them and is always looking for some help. Dunham heads up the International Occultation Timing Association (IOTA).

During 1985 and 1986, Jupiter's system of moons will be edge-on as viewed from earth, resulting in many mutual occultations and eclipses of these moons. High-speed photometry made from amateurs' backyards will contribute to much more precise determinations of their orbits. Fred A. Franklin, another astronomer at the Harvard Smithsonian Center for Astrophysics, has predictions of when the Jupiter events will take place and is anxious for data. He welcomes inquiries. These photometric observations of Jupiter's moons can be easily made with a Meade Instruments (1675 Toronto Way, Costa Mesa, CA 92626) 8-inch Schmidt-Cassegrain telescope that costs about $1000, an Optec Inc. (199 Smith, Lowell, MI 49331) SSP-3 solid-state photometer that costs about $800, and a microcomputer such as the Commodore VIC-20. Optec sells a cable to connect the SSP-3 photometer to the VIC-20 together with the subroutine software to make the basic measurement for $25. Interfacing to other microcomputers is readily accomplished. Heathkit makes a very accurate clock that can be interrogated by a microcomputer via an RS-232C interface.

TELESCOPE CONTROL

Telescopes are actually a lot of fun to operate manually. Moving a telescope

(continued)

Photo 2: *The early data-logging system as installed at the Fairborn Observatory (East) in 1979. The photometer, mid-left, was attached to the telescope, upper left. Photometer electronics are on the lower left. The video monitor on the right was tied to the Radio Shack TRS-80 located some distance away in a warm room. We communicated with the computer via a hand-held hexidecimal keypad. The system was used for several years to make observations of spotted RS Canum Venaticorum binary stars for Douglas Hall at Vanderbilt University. It has been superseded by a fully automatic system that was recently moved from Ohio to Arizona, the location of the Fairborn Observatory (West).*

quickly and efficiently to a specific star in the sky is a traditional skill of which many observational astronomers are rightly proud. However, by about 3 a.m. on only the second night of a two-month observing run, even the hardiest astronomers start thinking about supervising computerized telescope control from a warm room, with their feet propped up and soft music running in the background. While minicomputers control some of the larger telescopes, modern microcomputers are fully capable of telescope control and are increasingly being so used.

Microcomputer-controlled stepper motors can move smaller telescopes about, controlling two orthogonal axes. One axis is usually aligned parallel to the earth's axis to provide the ability to compensate for the earth's rotation by rotating just this single axis. If you start the telescope out at a low speed and continually increase this speed (a process called "ramping"), you can bring the telescope to a relatively high speed for long movements across the sky and then "ramp" it back down to a gentle stop just where you want it. Given the angular distance to be traveled between an object just observed and the next to be observed, you can calculate exactly how many steps the stepper should take, just how to execute the ramp up and down, and how to actually generate the steps themselves. (This last is a machine-language task as the steps must be made quickly, typically several thousand per second at top speed.)

Larger telescopes generally take more muscle to move about than steppers can generate and often use large DC motors in a servo-loop arrangement. Such systems must sense the position of the telescope on each axis; incremental optical shaft-angle encoders are often used for this. While reading the encoders and closing the servo loop complicates the control task somewhat, it still remains within the grasp of the more capable microcomputers. Because computer control tended to be applied first to the larger telescopes, most of the initial applications used DC motors and angle encoders in servo configurations. Only recently, as control has moved to smaller telescopes, has the simpler stepper system become popular.

One of the first microcomputer-controlled telescopes was the 36-inch telescope at Indiana University. R. Kent Honeycutt used an Intel 8080-based microcomputer, DC motors, and optical encoders in a classical servo control system. Another early system was the 24-inch telescope at the Institute for Astronomy at the University of Vienna in Austria, where Manfred Stoll used a Motorola 6800-based microprocessor in the control system. The 6502, another early microprocessor, was used by Lloyd Robinson, Robert Kibrick, and others for telescope control at Lick Observatory.

The 16-inch system from DFM Engineering (1035 Delaware Ave., Unit D, Longmont, CO 80501) is a good example of a recent stepper-controlled smaller telescope. It uses zero-backlash friction drives in each axis and an Apple II–based "open-loop" control system. DFM Engineering welcomes inquiries about this system.

Designing a microcomputer-based telescope-control system combines positional astronomy computation with real-time control. Mark Trueblood and I recently completed a book called *Microcomputer Control of Telescopes* that includes descriptions of all the needed parts (motors, angle encoders, etc.), astronomical and control-system formulas, and descriptions of actual systems. Mark Trueblood is the director of the Winer Mobile Observatory and is working on a 30-inch trailer-mounted telescope controlled by an LSI-11 micro-

(continued)

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Text Styles	15	3
Drawing Line Widths	10	4
Enlargement/ Reduction	Yes	No
Slide Show Presentation	Yes	No
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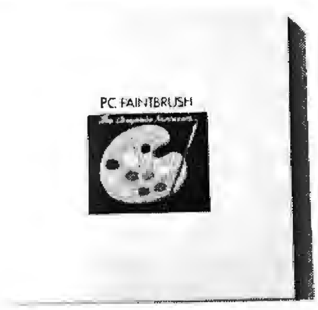

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computer. The intent of this book is to encourage hackers with an astronomical bent to design their own telescope-control systems.

AUTOMATIC ASTRONOMY

Of course the microcomputer pièce de résistance has been saved for last. It combines (1) a microcomputer-based catalog of stars, (2) microcomputer selection of the stars to be observed, (3) microcomputer control of the telescope to move it to the vicinity of the desired star, (4) a microcomputer-controlled photometer to actually find, center, and measure the stars, (5) a microcomputer-based photometric data-logging system, and, of course, (6) microcomputer data reduction and analysis. And these are not separate microcomputers. One single-board microcomputer does it all!

The first completely automatic system was built by Arthur D. Code and his associates at the Washburn Observatory in the mid-1960s. It used a DEC PDP-8. While technically a minicomputer with only 4K bytes of RAM (random-access read/write memory), the PDP-8 today would not be considered even a modestly capable microcomputer. It was built around a Titan missile-alignment system found in a junkyard and an 8-inch optical system built for a space telescope. It used optical angle encoders for position sensing and a permanently mounted photometer to sense the stars and make the measurements. The fixed-sequence observing program was stored on punched paper tape. When the sky became dark, the system started itself up, opened its roof, and went looking for the first star. This process continued all night until the last star was observed or the sky became cloudy.

While a number of semiautomatic or remotely controlled telescopes have been built over the years, the coming of capable and low-cost microcomputers and a persistent electrical engineer, Louis J. Boyd, put microcomputer-based "automatic astronomy" on a truly sound production-line basis. He began development of his Motorola 6809-based system in 1979; I was visiting him in Phoenix in November 1983 when it first ran by itself all night long. The system found, centered, and measured hundreds of stars without making a single mistake.

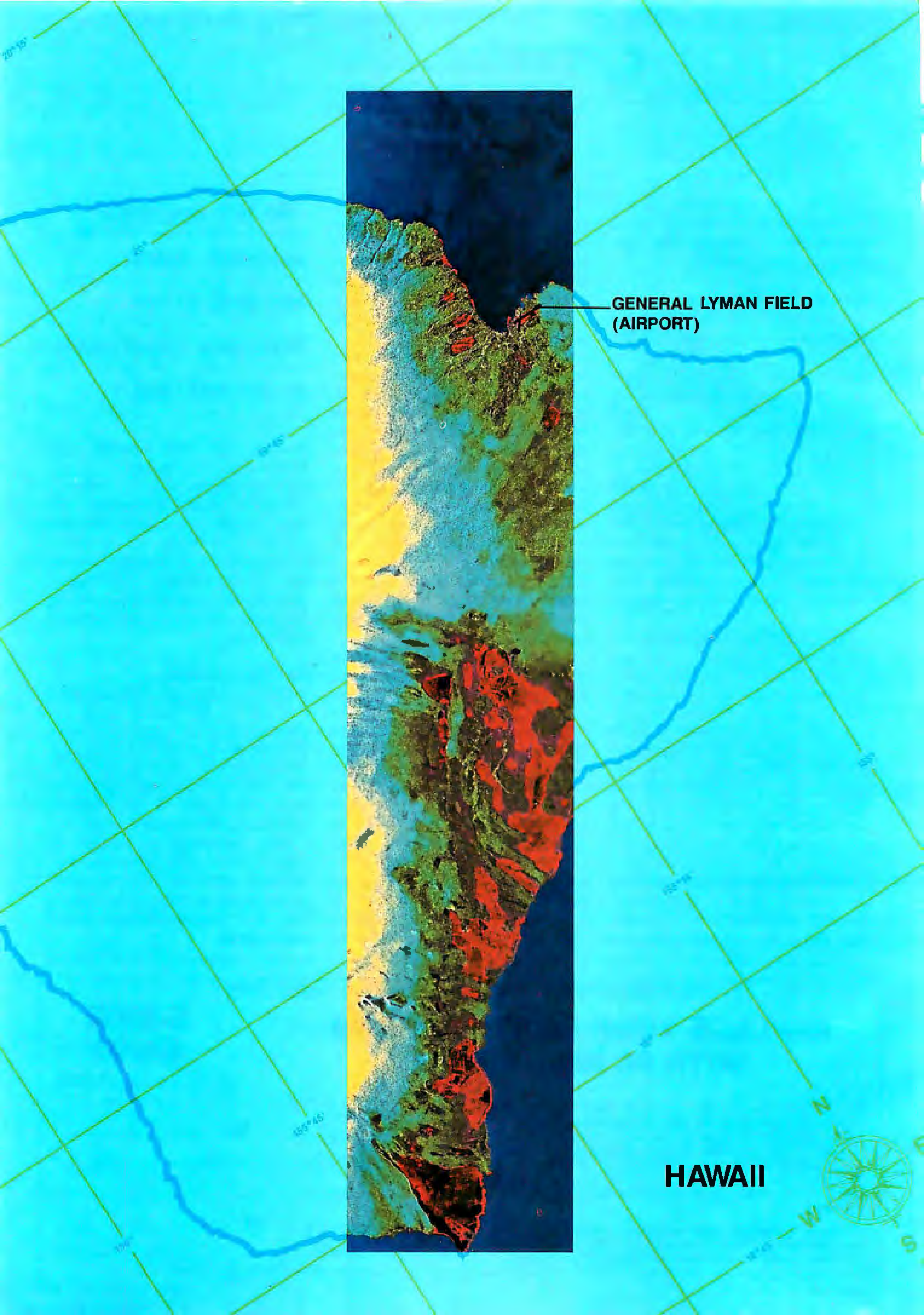
It is interesting to speculate about the future of microcomputer-based automatic astronomy. Since an experienced engineer can keep many automatic telescopes operating, it seems likely that a number of such systems owned by various institutions will be placed at a single top site where clouds are a rarity. A list of objects to be observed will be sent via phone or disk by an astronomer; after all the requested observations are made automatically, the results will be sent back to the requesting astronomer in a similar fashion. In fact, such an "Automatic Photoelectric Telescope Service" has been established in Arizona with Louis Boyd as the engineer minding the automatic systems.

The first completely automatic system was built at the Washburn Observatory in the mid-1960s.

For some types of observation, the best vantage point would be from space, where there are no atmospheric problems to contend with. In fact, the space station might make a good platform for a contingent of fully automatic, microcomputer-controlled telescopes.

GETTING STARTED

While it is only recent, the published literature on the use of microcomputers in astronomy is growing rapidly. There are a number of books that will be useful for further research in the "Astronomy Sources" text box on page 244. And, in the "Helpful Organizations" text box on page 181, I have suggested a number of organizations worth contacting. You, like many others, may have fun exploring and creating connections between the oldest science and the newest machines. ■



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MICROCOMPUTERS IN NASA'S SIR-B

BY RICHARD WILTON

A network of personal computers in the space program

SINCE 1978, SCIENTISTS at the Jet Propulsion Laboratory (JPL) have been producing remarkable images of the earth's surface using orbiting radar systems (photos 1–3). The images generated by orbiting synthetic-aperture radars are of high resolution and are unaffected by cloud cover. They are of particular interest to geologists, oceanographers, and other students of the earth's surface.

Photo 1: *This image of Hawaii was acquired on October 11, 1984, by the Shuttle Imaging Radar-B (SIR-B) during space shuttle mission 41-G. Artificial colors were used to enhance differences in surface characteristics in this computer-processed image. Red areas represent areas of smooth ash cover, dark green is smooth pahoehoe lava, light green is rough aa (cg) lava, and blue represents vegetation cover. The resolution of this image is about 30 meters (100 feet). The area covered is about 26 kilometers wide and 110 kilometers long (about 16 by 70 miles). The image was acquired by SIR-B at a rate of about 7.5 kilometers per second (4.6 miles per second) at an angle of 27.5 degrees. The radar was part of a package of experiments flown on the shuttle for NASA's Office of Space Science and Applications (OSSA). SIR-B was developed by JPL for NASA. Photo courtesy of JPL.*

The shuttle imaging radar experiment, called SIR-B, was the third synthetic-aperture radar developed at JPL to be placed in earth orbit. It flew aboard the space shuttle *Challenger* from October 4 to 12, 1984. The SIR-B team at JPL is still analyzing many of the results of the experiment.

Of course, a great deal of engineering and computing effort went into the design of the radar hardware and into generating visual images from the raw radar data. However, this article focuses on two other essential aspects of the SIR-B experiment: planning where and when the radar would be used and monitoring the status of the radar during the mission itself.

HARDWARE

The SIR-B mission-planning team at JPL put a great deal of thought and discussion into choosing the right computers for the complex task of planning the mission. The team made the decision to use several microcomputers, rather than a single mainframe or mini, as far back as 1982. The team felt that microcomputers provided the most cost-effective and flexible computational base for fulfilling the SIR-B mission-design requirements.

The overriding considerations were for microcomputers that met the following criteria:

- availability of hardware and software support
- flexibility in hardware options (including memory expansion, communications interfacing, and networking)
- floating-point arithmetic capability

Considering the diversity of software and the large quantity of numeric data to be processed, it was clear that no existing 8-bit processor would have been sufficient. Although a 68000-based microcomputer might have been faster or able to address more RAM, the availability of the Intel 8087 arithmetic coprocessor—and of programming languages that took advantage of its speed and flexibility—

(continued)

Richard Wilton is a software consultant with Laboratory Microsystems Inc., 3007 Washington Blvd., Marina del Rey, CA 90292.

was a big advantage of an 8086- or 8088-based system. The ease with which additional memory, communications hardware, and a local network could be installed on IBM PCs finally led to their use during the SIR-B experiment.

All of the IBM PCs and Compaqs that were used for SIR-B mission planning were equipped with Intel 8087 floating-point coprocessors, video graphics displays, dot-matrix printers, and lots of RAM—512K bytes was considered a minimum workable amount of memory.

SOFTWARE

A lot of new software was required from the outset of the planning phase of the SIR-B mission. Mission-planning software included a great deal of arithmetic computation as well as a fair amount of hardware-dependent programming for graphics and networking. Real-time communications and data-management software was critically hardware-dependent. It integrated machine-level code, such as port-addressed I/O and interrupt handlers, with fairly sophisticated file-management routines.

Both the SIR-B mission-planning software and the real-time communications software were written primarily in FORTH. The off-the-shelf FORTH implementation (PC/FORTH by Laboratory Microsystems) included fast display graphics for the IBM PC, a standard PC-DOS file interface, and high-level support for the 8087 coprocessor. Again, speed, adaptability, and readily available support were major considerations in choosing the programming language.

PLANNING THE SIR-B EXPERIMENT

By mid-1983, most of the planning software had been written, including an orbit propagator and world-map display graphics. The calculated orbital path of the space shuttle and the part of the earth at which the imaging radar might be aimed could be rapidly drawn on either a plotter or a video display (photo 4).

In order that the radar beam could be directed toward a specific location on the earth's surface, the calculations included the orbiter's attitude (roll, pitch, and yaw) and constraints on the way the radar antenna could be aimed at the earth (the width of the radar beam, the angle at which the radar antenna was tilted, etc.)

SIR-B mission planners could then display, print, or plot arbitrary portions of the orbital track of the spacecraft. Many complex orbit and attitude calculations were translated interactively into accurate graphical representations on the video display and on printers and plotters. Prior to the SIR-B experiment, these problems in orbital mechanics and spherical geometry had been accurately solved only on mainframe computers.

Plans for the SIR-B experiment were encapsulated in a detailed database of control commands. During the ac-

Photo 2: *The Ganges floodplain in Bangladesh.* SIR-B *observations in this area are being used to study the ability of imaging radar to detect standing water in a tropical environment to aid in locating and eradicating habitats of malaria-carrying mosquitoes. Artificial colors in this computer-processed image enhance differences in vegetation and terrain. Pink and yellow represent forested areas, seen most vividly in the coastal forest preserve of Sundarban on the Indian Ocean at the bottom. The textured green and pink area in the center shows cultivated fields connected by extensive irrigation and drainage channels. The more uniform rose-hued area at the top is an area of the Ganges floodplain subject to flooding and major rework during the monsoon season. The city of Jhalakat on the Bishkhali River is the yellow spot in the center, and Barisal is at the upper left center. The area covered in this image is approximately 23 kilometers wide and 155 kilometers long (about 15 by 95 miles). The image has a resolution of 20 meters (65 feet) and was acquired by* SIR-B *at a rate of about 7.5 kilometers per second (4.6 miles per second) at an angle of 45.6 degrees.* Photo courtesy of JPL.

tual mission, sequences of these commands were transmitted from the ground to the SIR-B radar apparatus located in the shuttle's payload bay (photo 5). Each command sequence initiated a specific function, such as aiming the radar antenna, adjusting its power, or turning the radar transmitter on and off.

Communications Software

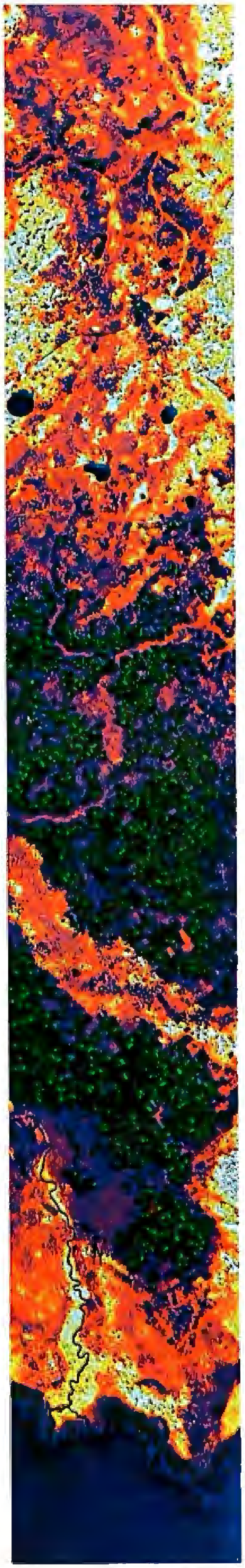
Monitoring the status of the SIR-B radar equipment during the mission produced a large amount of telemetry data that had to be processed in real time. Data from two separate telemetry streams (serial-bit streams) was archived. Information concerning the status of the radar equipment (voltages, temperatures, and so on) as well as the position, velocity, and attitude of the spacecraft itself was recorded. Changes in the status of the radar were "logged" in print and on disk for reference during the mission and afterward.

Programming for the telemetry communications interface began in June 1984. The use of FORTH greatly accelerated the development of reliable hardware interfaces. Assembly-language code was easy to incorporate into high-level FORTH programs. Because of the interpretive nature of the FORTH language, the communications software was easily tested and debugged on the hardware.

During the Mission

For the duration of the actual mission, four IBM PCs and two Compaqs were combined on an Ethernet local-area network (figure 1). The equipment was assembled in a user-support room at the Mission Control Center in Houston.

The data pertinent to the SIR-B experiment was extracted from the shuttle's telemetry streams by mainframe computers at the Mission Control Center. The radar telemetry data was formatted in blocks. Each block of data contained a date and time code, the attitude and orbital position of the spacecraft, and a sequence of engineering telemetry values.



A 68000-based computer, designed and built by SIR-B engineers, converted the raw telemetry data into several formats for further processing. This custom-built machine was programmed in C and cross-compiled to ROM from a VAX. The output from this machine included a 4800-bps (bits per second) asynchronous data stream.

A separate telemetry stream was processed by another mainframe computer at Mission Control. This data was provided as a 4560-bps binary synchronous bit stream.

These two serial telemetry streams, one asynchronous and one binary synchronous, were received on a single Compaq. The data was reformatted on the Compaq and transferred across the network to the network server, an IBM PC XT with a 10-megabyte hard disk. All of the machines on the network, including a 60-megabyte cassette tape drive, had access to the telemetry data as soon as it was saved on the server. Three color graphics displays, two dot-

(continued)

Photo 3: *This image of northeastern Florida will be used to assess coniferous timber stands and management practices in conjunction with extensive ground measurements at experimental forests and test sites in the area. Artificial colors in this computer-processed image enhance differences in vegetation and terrain. Yellowish-green areas are generally stands of cypress drenched in early morning dew (the image was taken at 3:59 a.m. local time). Three prominent bodies of water (from left to right) are Ocean Pond, Palestine Lake, and Swift Creek Pond. At the bottom is the Gulf of Mexico. Dark green and purple areas are agricultural fields, and bright orange regions denote drainage channels. The image was acquired at an angle of 28.4 degrees at a rate of about 7.5 kilometers per second (4.6 miles per second). The area covered is approximately 29 kilometers wide and 174 kilometers long (about 18 by 106 miles). The resolution of the image is 28 meters (90 feet). Photo courtesy of JPL.*

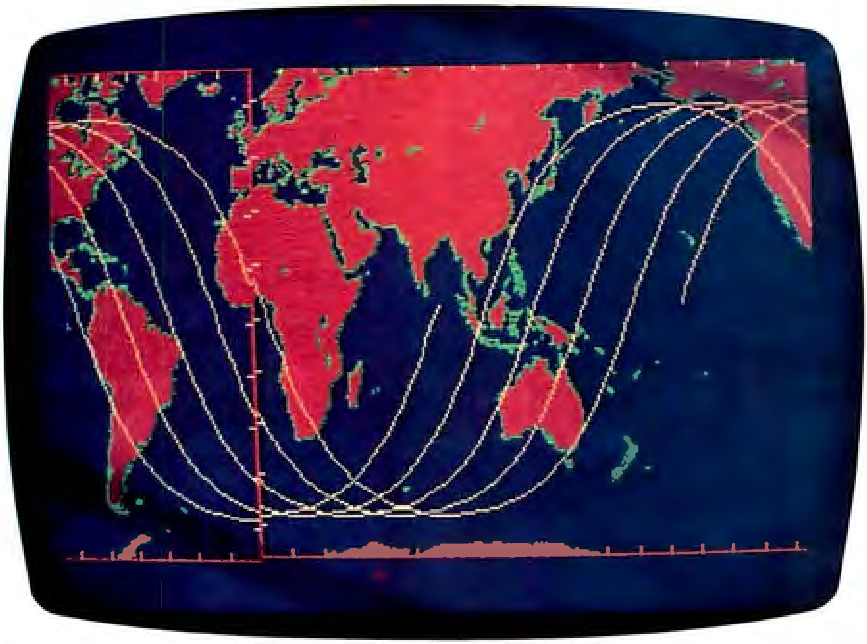


Photo 4: *The path of five orbits of the space shuttle is superimposed on a map of the world. Photo by* Su Kim.

Photo 5: *The* SIR-B *radar antenna in the payload bay of the spacecraft during the mission. The antenna, at the left, was built in three rectangular segments that were folded together when not in use. This was the case when this photo was taken. You can see most of the antenna's triangular support base, one of the hinges on which the segments of the antenna unfold, and, at the far left, a clasp that locked the antenna closed. The entire apparatus is covered with a white thermal fabric. Photo courtesy of* NASA.

All the commercially available hardware was used "as is"; no special hardware modifications were needed for the system.

matrix printers, and a line printer were used as output devices.

All of this commercially available hardware was used "as is"; that is, no special hardware modifications were needed to configure the system. Throughout the mission, the networked system performed reliably 24 hours a day.

When a KU-band communications antenna failure aboard the spacecraft compromised one of the essential telemetry links, a great deal of contingency planning was required. Because the SIR-B mission-planning software was easily accessible on the microcomputer network, the SIR-B planning team was able to work around some of the problems created by the loss of the communications antenna.

Also, because it was possible to "replay" events from the telemetry stream over the network shortly after they occurred, the SIR-B engineers were able to keep a close eye on the performance of the radar and its subsystems.

CONCLUSIONS

All in all, the networked microcomputer system that was created for SIR-B planning and data archiving performed remarkably well. The advantages of using networked micros in this real-time engineering application were clear: hardware redundancy, distributed processing, and reliability and ease of use of off-the-shelf components.

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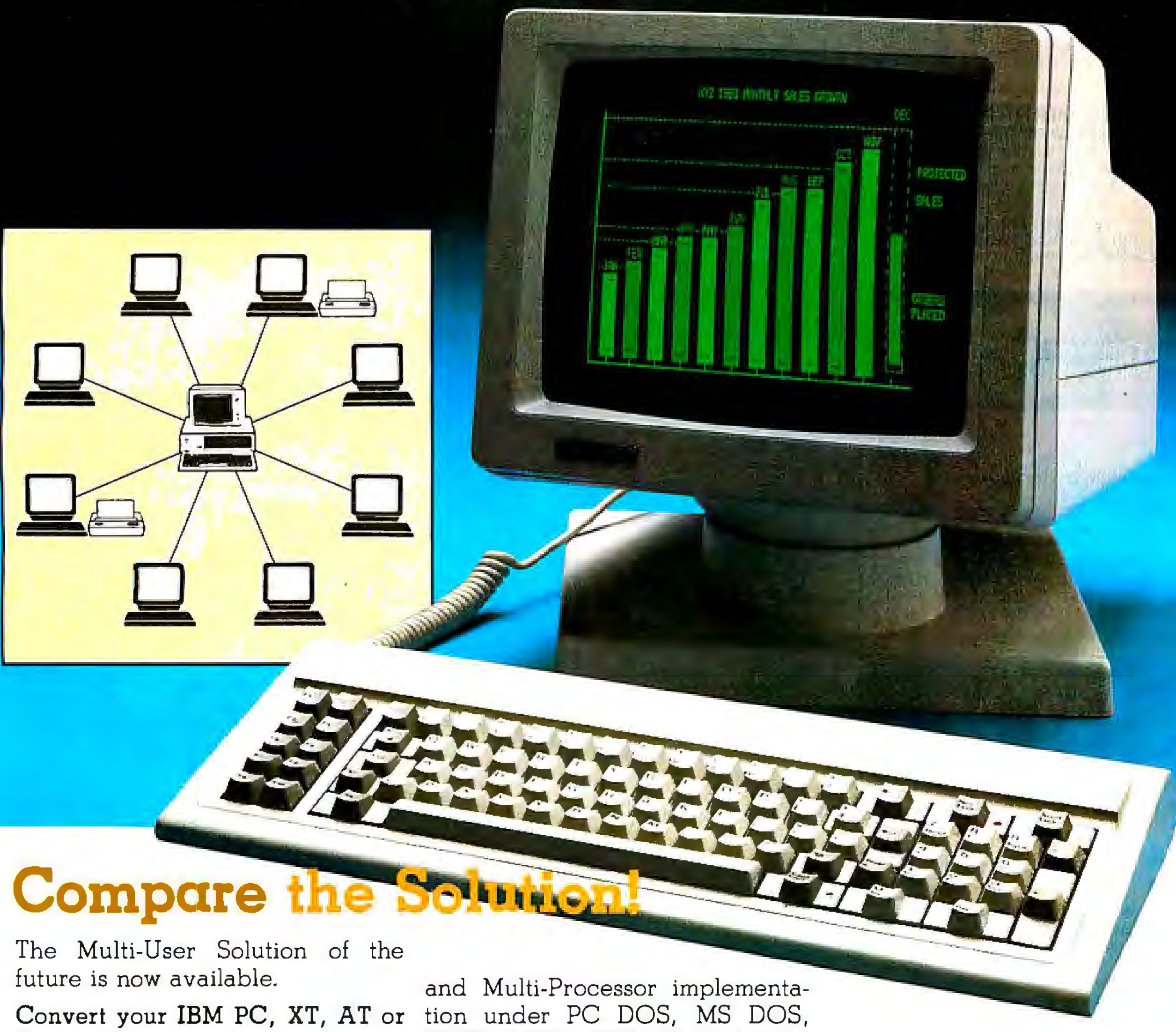

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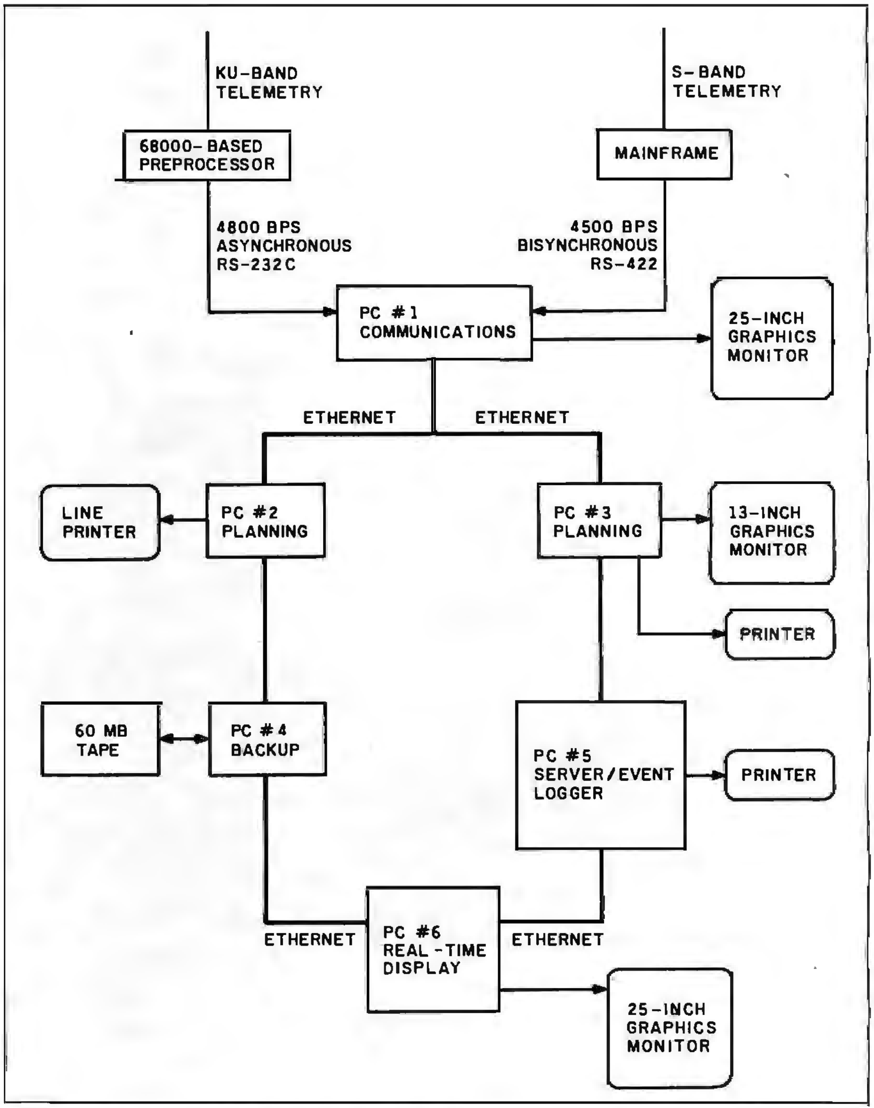

Figure 1: *This diagram illustrates the flow of telemetry data during the* SIR-B *experiment.*

The experience gained from SIR-B (as well as the hardware and software) will be used in upcoming imaging radar missions. The SIR-B experiment itself will be repeated on a space shuttle flight in early 1987. A more sophisticated experiment called SIR-C is currently planned for the late 1980s.

The type of network microprocessing system that was created for this particular experiment will find increasingly widespread use in similar environments: hospitals, laboratories, and industrial data-gathering systems, for example. In such settings, distributed microprocessors will be the most reliable and cost-effective way to gather data and use it flexibly. ■

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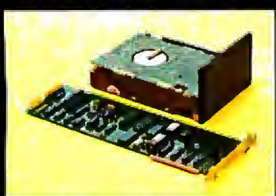

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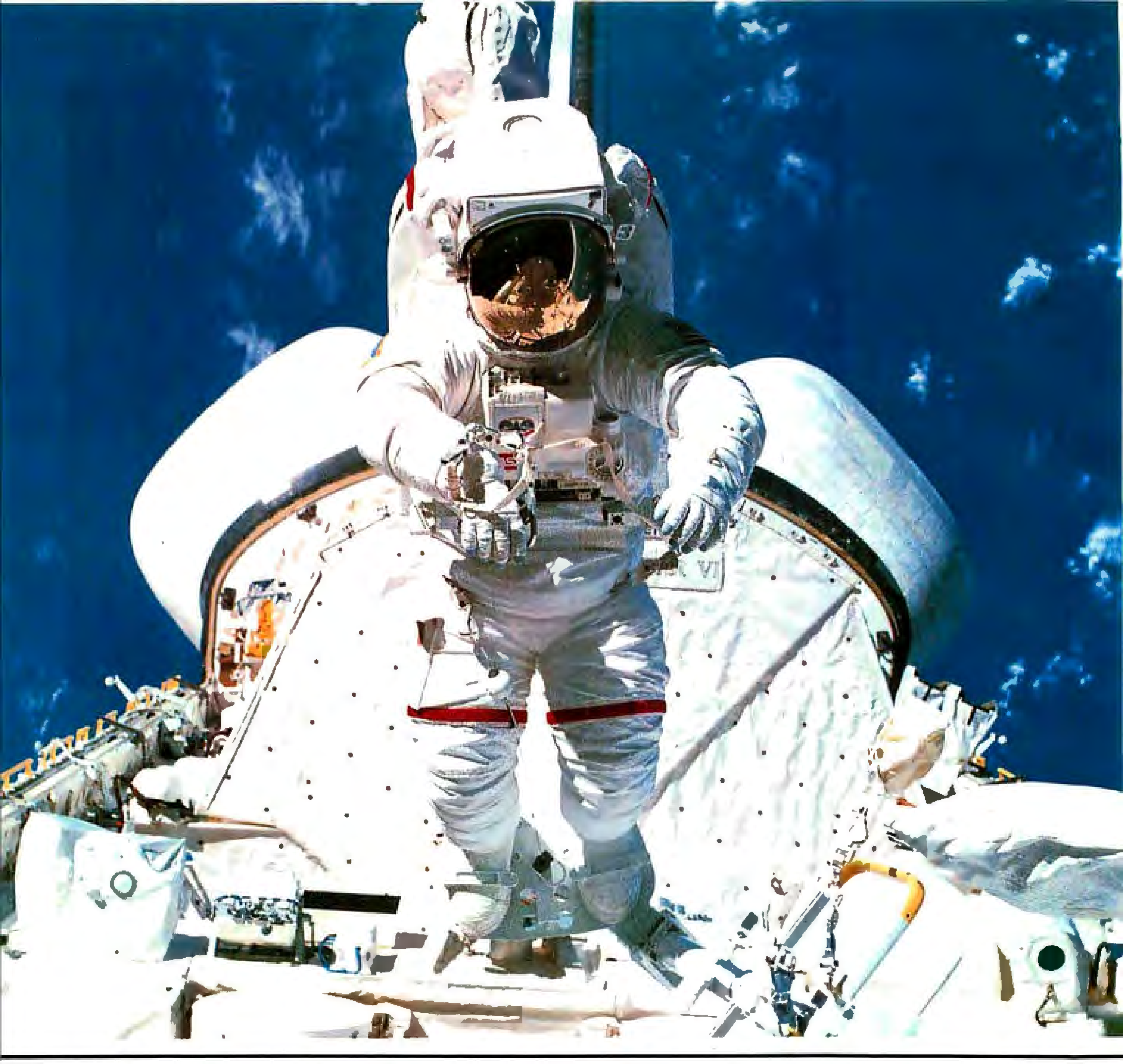

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COMET LINES IN FORTRAN

BY DAVID S. DIXON

The program described calculates the positions of asteroids and comets

THE PROGRAM DISCUSSED in this article is intended to allow amateur astronomers to calculate the positions of asteroids or comets with greater accuracy than the programs previously published in general literature. Written in FORTRAN IV, the program should be translatable to any BASIC that supports double-precision calculation. But be advised that this is a number-crunching program; it may run for hours if rewritten in interpreted BASIC.

Asteroids are a very challenging target for the observer: they appear as points of light just like the stars. Depending on the asteroid's position relative to earth, it may or may not demonstrate detectable motion against the background stars. Frequently, several nights of observation are required to see displacement and identify the asteroid. Successfully hunting a particular asteroid usually means having a good idea of the asteroid's position at the intended time of observation and having a good set of star charts.

The problem is that accurate tables of locations for asteroids, known as ephemerides, are not easy to come by. The United States Naval Observatory publishes ephemerides for the four major asteroids in *The Astronomical Almanac* each year, but there are thousands of named asteroids. (For a list of books and periodicals mentioned in this and other articles, see the "Astronomy Sources" text box on page 244.) The Soviet Union's Institute of Theoretical Astronomy publishes the *Ephemerides of Minor Planets*, which gives ephemerides for thousands of asteroids, but only for a few weeks at opposition, and it is a difficult publication to obtain. Both the Russian and the Naval Observatory publications, however, also give the orbital elements for a large number of asteroids, and with the elements it is possible to calculate the ephemerides of an asteroid yourself.

Many of the books and magazine articles that address calculating the position of a planet solve the problem by the model devised by Johannes Kepler in 1609. The method models the motion of a body in the solar system as involving only the sun and the body in question. This means that to find the relative positions of Earth and Mars in a common coordinate system you solve the two-body sun-Mars problem, solve the two-body sun-Earth problem, and, using spherical trigonometry, combine the two results to solve the Earth-Mars problem. The method can produce results satisfactory for use in finding planets, but the accuracy for use on asteroids is frequently inadequate. Kepler's model is a remarkable achievement since he derived it by geometry as an empirical solution based on position measurements made by Tycho Brahe. Kepler's model is summarized in his first two laws:

First Law: The orbit of each planet is an ellipse, with the sun at one of the two foci.

Second Law: The line joining the planet to the sun sweeps over equal areas of the ellipse in equal intervals of time.

It was not until more than 50 years after Kepler's work was published that the work of Sir Isaac Newton explained the process that Kepler's model described and how the model was incomplete. Newton's law of gravi-

(continued)

David S. Dixon is a quality engineer at a NASA test facility. His hobbies include microcomputing and amateur astronomy. He can be reached at 3208 Jupiter Rd., Las Cruces, NM 88001.

ty showed that the orbit of a body in the solar system is not just a function of the sun and the body but involves every mass in the system, i.e., not a two-body problem but an *n*-body problem. And Newton's three laws of motion allowed mathematical derivation of what Kepler had deduced from empirical data and geometry. An *n*-body celestial mechanics problem is not trivial. It involves evaluating the mutually perturbing effects of the planets, asteroids, satellites of planets, and the sun. In practice one usually restricts the calculations to the sun and the planets.

The two main classes of perturbation techniques used to attack the *n*-body problem are referred to as either general perturbations (absolute solutions) or special perturbations (solutions using iterative numerical techniques). Special perturbation techniques fall into two categories, Cowell's model and Encke's model, with numerous variations of each. Both use similar numeric integration methods, but because of the differences in the models, one model or the other may have an advantage in solving a particular type of problem. Cowell's model can be derived by direct application of Newton's laws.

In Cowell's model, which was developed in the early 1900s, all gravitational attractions by all *n* bodies are summed and integrated to give the motion of the body in question. Encke's model was developed in 1857 (before Cowell's) and is a very straightforward result of combining Kepler's first two laws and Newton's laws of motion and gravity. Starting at a given point in time, Encke's model describes the motion of a body as the combination of a Keplerian two-body orbit between the body and the primary (the sun) and the integration of all the other perturbing accelerations. In figure 1, *p* is the radius vector of the Keplerian orbit, *r* is the radius vector of the true orbit, and *e* is the difference between the Keplerian and true orbits due to perturbation.

Encke's model is therefore a little more complex than Cowell's, but I chose it for my program because, when used on problems dealing with elliptic motion, it usually allows larger integration steps and controls the growth of truncation errors somewhat better than Cowell's model.

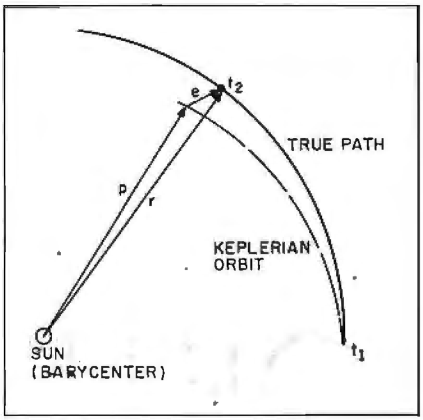

Figure 1: *Illustration of Encke's model for calculating orbits around the sun: p is the radius vector of the Keplerian orbit, r is the radius vector of the true orbit, and e is the perturbation (the difference between p and r).*

What Encke's model provides is an expression for the second order differential equation of *e*. I don't know of any closed-form solutions to Encke's model or any of the other special perturbation models of the *n*-body problem. In other words, there is no equation or formula that is the solution of the problem. Since there is no closed-form solution, an iterative numerical integration technique is used. The program uses a Runge-Kutta numerical integration method that, while not the fastest calculating method, is easy to program, is easy to change step size, and provides good stability and accuracy. The accuracy I was trying to obtain was about 0.1 right-ascension minute (6 RA seconds), and 1 minute in declination. The program will generally satisfy this accuracy for periods of calculation of two years or more if the initial osculating orbital elements are accurate. For comets and for asteroids with extremely eccentric orbits, I would not expect accuracy this good, but fortunately the images for comets are generally different than the background stars. The program employs several simplifications that restrict the time over which the perturbations can be integrated and accuracy can be maintained.

During my research for writing this program, I had the opportunity to examine several perturbation programs used by professional astronomers. These programs were substantially longer and used either tabular data and interpolation for the positions of the planets or a program that calculates perturbed motion for the planets as well as the asteroid. The former requires large amounts of data entry or access to data in machine-readable form. The latter increases the amount of calculation further still. This program uses a series of polynomials that are calculated and gives the orbital elements of each of the planets considered to be perturbation sources. The planetary positions derived from these orbital elements are not as accurate as the other methods. This error, and several others, leads to restrictions on the period of time over which the perturbations can be integrated by this program to about 800 days before the error exceeds the desired accuracy.

One perturbing acceleration has been left out of the program. This is the acceleration resulting from the displacement of the body from the Keplerian path about the primary. The Keplerian path is a force-balanced path only so long as the body is on the path. When the asteroid is perturbed off the path, an additional acceleration due to the primary comes into effect. Equation 1 is the expression for the acceleration, and as long as *e* is small then this term is very small. The program forces a recomputing of the osculating elements of the asteroid whenever *e* reaches a predetermined small value. For the desired accuracy, this perturbation term can be ignored. This is the major mathematical departure of the program from Encke's model. Encke's model includes this acceleration and still requires a routine to compute new osculating elements, but it allows *e* to grow to much greater size before

(continued)

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rectifying the orbit.

$$a = m*|p/|p|^3 - r/|r|^3| \quad (1)$$

The differential equation on which the program is based is given in equation 2. If equation 1 and equation 2 are added you have the differential equation of Encke's model.

$$d^2e/dt^2 = \sum_{k=1}^{N} -m_k*|(s_a-s_k)/|s_a-s_k|^3+(s_k/|s_k|^3)| \quad (2)$$

Subscripts a and k in equation 2 refer to the asteroid and perturbing body; N is the number of perturbing bodies; s is the position vector of the body corresponding to the subscript, relative to the solar system barycenter; m is the gravitational parameter of body k.

The program consists of the main code and four subroutines. The main program handles initial parameter input for the asteroid number, dates and increment for the ephemeris, and an initial integration step size. As written, the program expects to find a file of asteroid osculating orbital elements on disk. The short program DSKPRP is an example of a program used to initialize this file. The main program integrates the perturbations from the beginning epoch of the asteroid orbital elements to the first date of the ephemeris. When the integration has reached the first date in the ephemeris, the main program continues the integration at whatever time interval was specified for the ephemeris and calculates the coordinate transformation from heliocentric ecliptic coordinates to equatorial coordinates and prints the ephemeris. Subroutine KEPLER solves Kepler's equation for the asteroid, Earth, and the other planets. This calculation is done in polar coordinates and then transformed to heliocentric rectangular coordinates. Subroutine NEWTON accepts the rectangular coordinates of the asteroid and a perturbing body and calculates the perturbing acceleration due to the body. Subroutine ENCKE calculates a new set of osculating orbital elements for the asteroid from the old set and the perturbations that have occurred to the asteroid. The last subroutine in the program, subroutine ORBIT, calculates the orbital elements of the Earth and other perturbing planets by a set of polynomials and the Julian date.

Using the program is not difficult. The program first prompts for the date on which you want the ephemeris table to start, the interval of the table, and the length of time to be covered in the ephemeris. The unit of time is in days, i.e., 0.01 day or 10 days. The time scale is universal time, which for the purposes of the program can be considered coordinated universal time, which is broadcast by WWV and other time stations. The program then prompts for an integration step size. This generally should be between 5 and 40 days, with a maximum of about 2 percent of the orbital period and a minimum of about 0.1 percent of the orbital period. The closer the epoch of the orbital elements is to the first date in the ephemeris, the longer the integration step may be. The objective in selecting the integration step size is to pick an interval small enough to make the truncation errors in the integration small and have an interval large enough to keep round-off buildup minimized. The program then prompts for the asteroid number and fetches the asteroid's orbital elements stored on disk. The asteroid's orbital elements from the file are displayed. If more recent elements are available, the elements are entered and the file updated. The program then calculates an ephemeris for the dates and time interval entered.

Table 1 contains the osculating orbital elements from the 1980 *Ephemerides of Minor Planets* for asteroid number 90, named Antiope. Table 2 is the ephemeris calculated by the program for a 0.1-day period on August 13, 1983. This period was chosen because it coincides with the

(continued)

Table 1: *Osculating orbital elements for asteroid* 90 *for epoch* 27.0, *December* 1980, *in the order they would be entered in the program.*

Julian date	2444600.5
Inclination (*i*)	2.23553 Deg.
Longitude of the ascending node	70.62207 Deg.
Argument of perihelion (*w*)	234.84993 Deg.
Mean radius (*a*)	3.1477109 AU.
Daily motion (*n*)	0.17648663 Deg.
Eccentricity (*e*)	0.1659135
Mean anomaly (*M*)	212.56103 Deg.
Brightness *B*(1,0)	9.3

Table 2: *The ephemeris calculated by the program for asteroid* 90 *in the period* 13.35, *September* 1983 *to* 13.45, *September* 1983.

Asteroid Number 90
Astrometric 1950.0

D	M	Y	JD	Right Ascension			Declination			Mag.	Distance
13.35	8	1983	2445559.85	23	8	24.1	−9	16	31	12.6	1.734
13.36	8	1983	2445559.86	23	8	24.1	−9	16	31	12.6	1.734
13.37	8	1983	2445559.87	23	8	23.8	−9	16	33	12.6	1.734
13.38	8	1983	2445559.88	23	8	23.4	−9	16	35	12.6	1.734
13.39	8	1983	2445559.89	23	8	23.1	−9	16	38	12.6	1.734
13.40	8	1983	2445559.90	23	8	22.8	−9	16	40	12.6	1.734
13.41	8	1983	2445559.91	23	8	22.5	−9	16	43	12.6	1.734
13.42	8	1983	2445559.92	23	8	22.1	−9	16	45	12.6	1.734
13.43	8	1983	2445559.93	23	8	21.8	−9	16	48	12.6	1.734
13.44	8	1983	2445559.94	23	8	21.5	−9	16	50	12.6	1.734
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period in which the Lowell Observatory made photographic plates of the asteroid and the resulting positional measurements were published in *Minor Planet Circular* #8193 (October 21, 1983) of the Smithsonian Astrophysical Observatory. The positions for asteroid 90 are as follows:

Date 13.39167 *Aug.* 1983
R.A. 23 hr 8 min 17.70 sec
Dec. −9 deg 17 min 18.8 sec

Date 13.42951 *Aug.* 1983
R.A. 23 hr 8 min 16.40 sec
Dec. −9 deg 17 min 28.6 sec

As you can see, the program satisfies the accuracy required. For a further comparison, table 3 is an ephemeris calculated by a program that uses only Keplerian motion and does not calculate the perturbations due to the major planets.

The program was originally written to calculate ephemerides of asteroids but can also be used to calculate ephemerides of comets. When the program is used for comets it is necessary to do some minor calculation to translate the orbital elements from the conventional form for comets to elements usable by the program. Also, comets are named by several different methods: year and order of discovery, name of discoverer and subsequent rediscoverers, season of the year, or placement in the sky. Comet names just do not seem usable with the simple form of random-access file used for the numbered asteroids. I maintain separate ASTRO.DAT disks for comets and asteroids and keep a manual index of what comet is in each record. Table 4 is a set of orbital elements for Halley's comet from *Minor Planet Circular* #9214 (November 8, 1984). For this set of elements the mean anomaly (M) is not provided. Instead, the time of perihelion (T) is given. This is typical of the convention for reporting comet orbital elements. The calculation of M is not complicated. M equals the daily motion times the difference between the epoch of the elements and T. Equation 3 is the mathematical expression for the calculation of M:

$$M = n*(\text{Epoch of elements} - T) \qquad (3)$$

The comet orbital elements generally do not include the mean anomaly (M), the mean radius (a), or the daily motion. Usually the time of perihelion (T) and the perihelion distance (q) are given instead. Like M, missing parameters can usually be calculated from what is given. For example, to calculate the mean radius from the perihelion distance q and the eccentricity, use equation 4:

$$a = q / (1 - e) \qquad (4)$$

If the daily motion (n) is not provided, you only need to have the mean radius and from equation 5 you can calculate n:

$$n = 0.985609 / (a)^{3/2} \qquad (5)$$

These relationships should be sufficient to allow calculation of any orbital element parameters that are not provided. The brightness coefficient $B(1,0)$ is not applicable to comets. I have written the program to use this coefficient as a flag to prompt for the name of the comet and to change the output format slightly. A $B(1,0)$ greater than 1000 flags the program that the ephemeris is of a comet. Sources of comet orbital elements are numerous. Occasionally a periodical on astronomy will include orbital elements as part of an article. I expect to see this more frequently as amateur astronomers acquire and use personal computers to calculate ephemerides and indicate a desire to publishers to see orbital elements included in articles.

Because comets are made of materials that vaporize, they undergo some mass loss each time they form a *coma*, or tail. This mass loss also introduces a source of perturbation not found in asteroids. The program does not in-

(continued)

Table 3: *The ephemeris as in table 2, but calculated using only Keplerian motion.*

Asteroid Number 90
Keplerian Motion Ephemeris Astrometric 1950.0

D	M	Y	JD	Right Ascension			Declination			Mag.	Radius
13.35	8	1983	2445559.85	23	12	27.9	−8	50	53	12.6	1.732
13.36	8	1983	2445559.86	23	12	26.7	−8	51	1	12.6	1.732
13.37	8	1983	2445559.87	23	12	26.4	−8	51	4	12.6	1.732
13.38	8	1983	2445559.88	23	12	26.1	−8	51	6	12.6	1.732
13.39	8	1983	2445559.89	23	12	25.8	−8	51	8	12.6	1.732
13.40	8	1983	2445559.90	23	12	25.4	−8	51	11	12.6	1.732
13.41	8	1983	2445559.91	23	12	25.1	−8	51	13	12.6	1.732
13.42	8	1983	2445559.92	23	12	24.8	−8	51	16	12.6	1.732
13.43	8	1983	2445559.93	23	12	24.5	−8	51	18	12.6	1.732
13.44	8	1983	2445559.94	23	12	24.2	−8	51	21	12.6	1.732
13.45	8	1983	2445559.95	23	12	23.9	−8	51	23	12.6	1.732

Table 4: A *set of orbital elements for Halley's comet.*

Julian date	2446480.5
Time of perihelion passage (T)	9.43867 Feb. 1986
Inclination (i)	162.23932 Deg.
Longitude of the ascending node	58.14397 Deg.
Argument of perihelion (w)	111.84658 Deg.
Mean radius (a)	17.9390115 AU.
Daily motion (n)	0.01297198 Deg.
Eccentricity (e)	0.9672725
Calculated from equation 3.	
Mean anomaly (M)	0.1240284 Deg.

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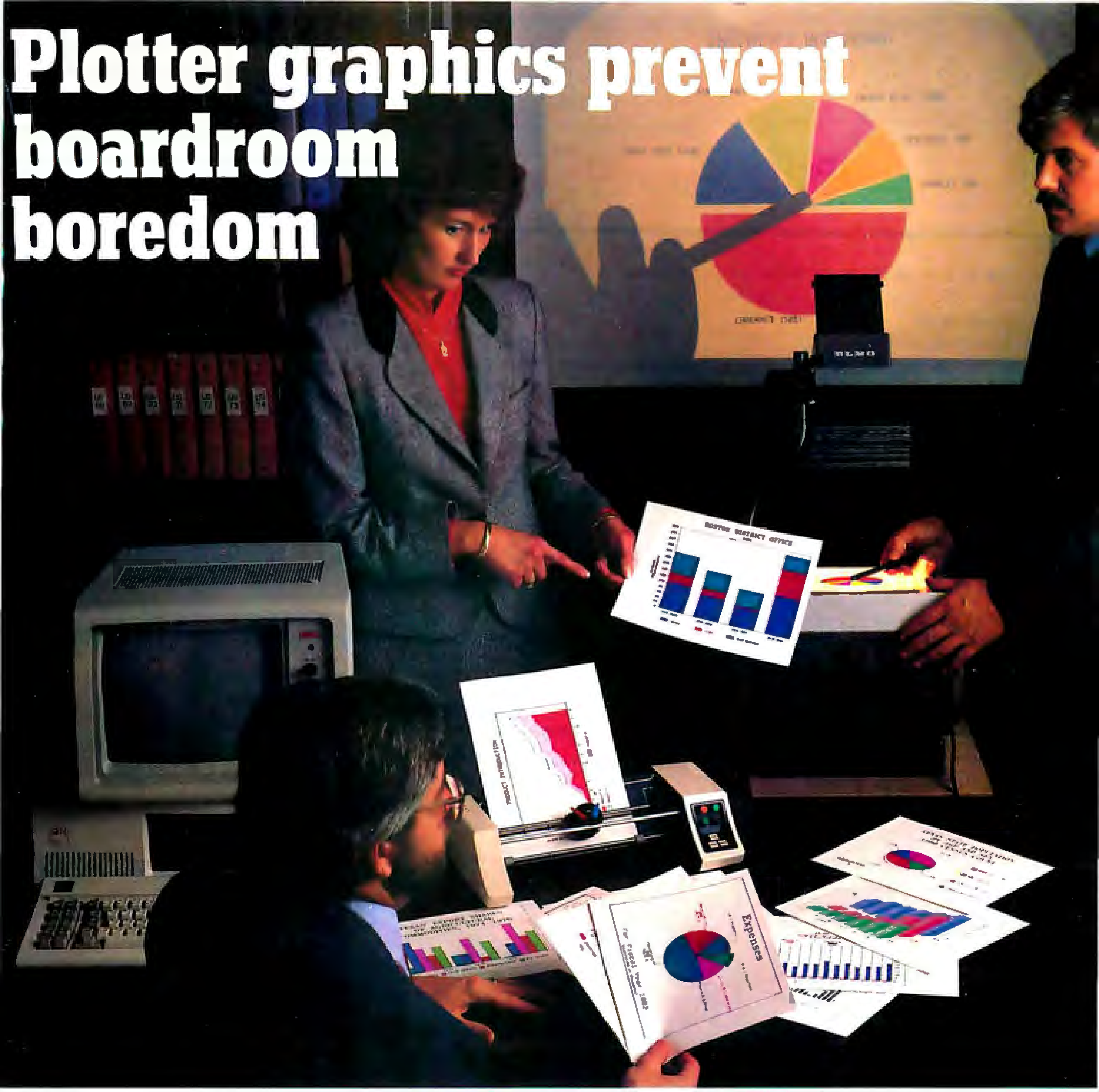

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Table 5: *A set of test calculations for Halley's comet.*

Comet Halley
Astrometric 1950.0

D	M	Y	JD	Right Ascension			Declination			Distance
26.97	11	1984	2446031.47	6	21	49.1	11	57	4	4.739
26.98	11	1984	2446031.48	6	21	50.0	11	57	5	4.740
26.99	11	1984	2446031.49	6	21	49.5	11	57	4	4.740
27.00	11	1984	2446031.50	6	21	49.0	11	57	4	4.739
27.01	11	1984	2446031.51	6	21	48.5	11	57	4	4.739
27.02	11	1984	2446031.52	6	21	48.0	11	57	4	4.739
27.03	11	1984	2446031.53	6	21	47.4	11	57	3	4.739
27.04	11	1984	2446031.54	6	21	46.9	11	57	3	4.739
27.05	11	1984	2446031.55	6	21	46.4	11	57	3	4.739
27.06	11	1984	2446031.56	6	21	45.9	11	57	3	4.738
27.07	11	1984	2446031.57	6	21	45.4	11	57	2	4.738
27.08	11	1984	2446031.58	6	21	44.9	11	57	2	4.738
27.09	11	1984	2446031.59	6	21	44.3	11	57	2	4.738
27.10	11	1984	2446031.60	6	21	43.8	11	57	2	4.738
27.11	11	1984	2446031.61	6	21	43.3	11	57	1	4.737
27.12	11	1984	2446031.62	6	21	42.8	11	57	1	4.737

Table 6: *The ephemeris for Halley's comet for July and August 1985 as calculated by the program.*

Comet Halley
Astrometric 1950.0

D	M	Y	JD	Right Ascension			Declination			Distance
1.00	7	1985	2446247.50	5	32	2.0	18	13	56	4.424
3.00	7	1985	2446249.50	5	33	19.5	18	16	54	4.392
5.00	7	1985	2446251.50	5	34	38.3	18	19	51	4.358
7.00	7	1985	2446253.50	5	35	57.2	18	22	44	4.324
9.00	7	1985	2446255.50	5	37	16.1	18	25	32	4.288
11.00	7	1985	2446257.50	5	38	35.1	18	28	15	4.251
13.00	7	1985	2446259.50	5	39	54.0	18	30	55	4.214
15.00	7	1985	2446261.50	5	41	12.9	18	33	30	4.175
17.00	7	1985	2446263.50	5	42	31.5	18	36	1	4.135
19.00	7	1985	2446265.50	5	43	49.9	18	38	29	4.095
21.00	7	1985	2446267.50	5	45	7.9	18	40	52	4.053
23.00	7	1985	2446269.50	5	46	25.5	18	43	11	4.010
25.00	7	1985	2446271.50	5	47	42.7	18	45	27	3.967
27.00	7	1985	2446273.50	5	48	59.2	18	47	39	3.922
29.00	7	1985	2446275.50	5	50	15.2	18	49	48	3.876
31.00	7	1985	2446277.50	5	51	30.4	18	51	54	3.830
2.00	8	1985	2446279.50	5	52	44.8	18	53	57	3.783
4.00	8	1985	2446281.50	5	53	58.3	18	55	56	3.735
6.00	8	1985	2446283.50	5	55	10.9	18	57	53	3.686
8.00	8	1985	2446285.50	5	56	22.5	18	59	48	3.636
10.00	8	1985	2446287.50	5	57	32.8	19	1	40	3.585
12.00	8	1985	2446289.50	5	58	41.9	19	3	31	3.533
14.00	8	1985	2446291.50	5	59	49.6	19	5	19	3.481
16.00	8	1985	2446293.50	6	0	55.8	19	7	6	3.428
18.00	8	1985	2446295.50	6	2	.3	19	8	53	3.374
20.00	8	1985	2446297.50	6	3	2.9	19	10	38	3.319
22.00	8	1985	2446299.50	6	4	3.6	19	12	23	3.264
24.00	8	1985	2446301.50	6	5	2.2	19	14	8	3.207
26.00	8	1985	2446303.50	6	5	58.6	19	15	53	3.151
28.00	8	1985	2446305.50	6	6	52.5	19	17	39	3.093
30.00	8	1985	2446307.50	6	7	43.7	19	19	27	3.035

clude these nongravitational perturbations in the calculation. The accuracy of the results is acceptable for most purposes. Table 5 is an ephemeris calculated by the program using the orbital elements for Halley's comet in table 4. From *Minor Planet Circular* #9316 are measured positions for Halley's comet in the same period:

Date 26.973 *Nov.* 1984
R.A. 6 hr 21 min 48.88 sec
Dec. 11 deg 56 min 58.3 sec

Date 27.109 *Nov.* 1984
R.A. 6 hr 21 min 41.80 sec
Dec. 11 deg 56 min 55.6 sec

The accuracy for the comet ephemeris is well within the tolerance established for use in locating asteroids and should be equally satisfactory for locating comets. Table 6 is an ephemeris for Halley's comet for July and August 1985. In July the comet will be rising in the early morning in the eastern horizon about an hour before the sun.

I need to give a word of warning to users about a future complication in the process of using this program. Astronomical positions are almost invariably referenced to the Earth's equinox and ecliptic at some date. The problem is that with respect to the star field, this is a continually rotating set of coordinates. So, when you find osculating orbital elements or ephemerides for planets, asteroids, or comets, they are noted as mean ecliptic of 1950.0, or ecliptic of date, or mean ecliptic of 2000.0. The program is set up to calculate positions referenced to the equinox and ecliptic of 1950.0 and to use osculating elements referenced to this set of coordinates. The astronomical convention for comet and asteroid orbital elements and ephemerides is that the reference equinox and ecliptic will be at the century and half-century dates—1900, 1950, 2000. We are nearing a change point. Some reference sources are now using the ecliptic of 2000 as the coordinate base, while many others retain the ecliptic of 1950 as the base. If the source of orbital

(continued)

The convention for comet and asteroid orbital elements and ephemerides is that the reference equinox and ecliptic will be at the century and half-century dates.

elements you use is referenced to the ecliptic of 2000, you will need to change the parameters for planetary position that are used in subroutine ORBIT, the value for the obliquity of the ecliptic (EPSLN) in the main program, and the heading message for the printout in the main program. Values for the changes to be made can be found in *Astronomical Formulae for Calculators*.

The program was originally written on a Digital Equipment Corporation PDP-11 in DEC FORTRAN IV. Later I translated the program to Digital Research FORTRAN-77 for the IBM PC, and that is the version available on BYTEnet Listings ((617) 861-9774). As I mentioned at the beginning of the article, the program is a number cruncher. The Digital Research FORTRAN has the option at link time of producing code for the 8087 coprocessor or linking 8087 simulation routines.

I have timed the program on a variety of PC-DOS and MS-DOS systems. If the 8087 coprocessor is not used, a single integration loop of the program will take from 60 to 130 seconds, depending on the machine. With the 8087 coprocessor the time drops to about 1 second per loop. The program in its present form is intended to be as readable as possible. At least one change to speed up execution is possible. You can reduce the number of times you call subroutine KEPLER by almost one-third by modifying the program to assign the previous values of POS(I,J,3) to POS(I,J,1) at the beginning of any integration loop in which the preceding loop did not call subroutine ENCKE and then began the loop calculating POS(I,J,2). I do not know how much this would improve execution time, but if your system does not have an 8087, it is a modification that may be worth making. If you use the program extensively, the execution time improvement of the 8087 may be the justification for adding one to your system.

The program is written so that even if you don't have a mainframe computer and a degree in astrophysics, you can convert the program to your microcomputer's BASIC or FORTRAN and, I hope, not get lost in the process. Comments have been added to the program listings to reference the source of many of the values used for the calculations, so I am not going to discuss them further in text. I recommend that you obtain a copy of *Astronomical Formulae for Calculators* since I am confident that you will eventually need to refer to it for changes in the reference ecliptic. If you have a background in calculus and are interested in the derivation and physics behind the program, I recommend *Fundamentals of Astrodynamics* as a very readable reference on the topic. ■

Editor's note: If you are unable to obtain the source-code listings from BYTEnet Listings, *Mr. Dixon will provide an* IBM PC-*compatible disk containing source code and compiled code for* $18. *Write to David S. Dixon,* 3208 *Jupiter Rd., Las Cruces,* NM 88001.

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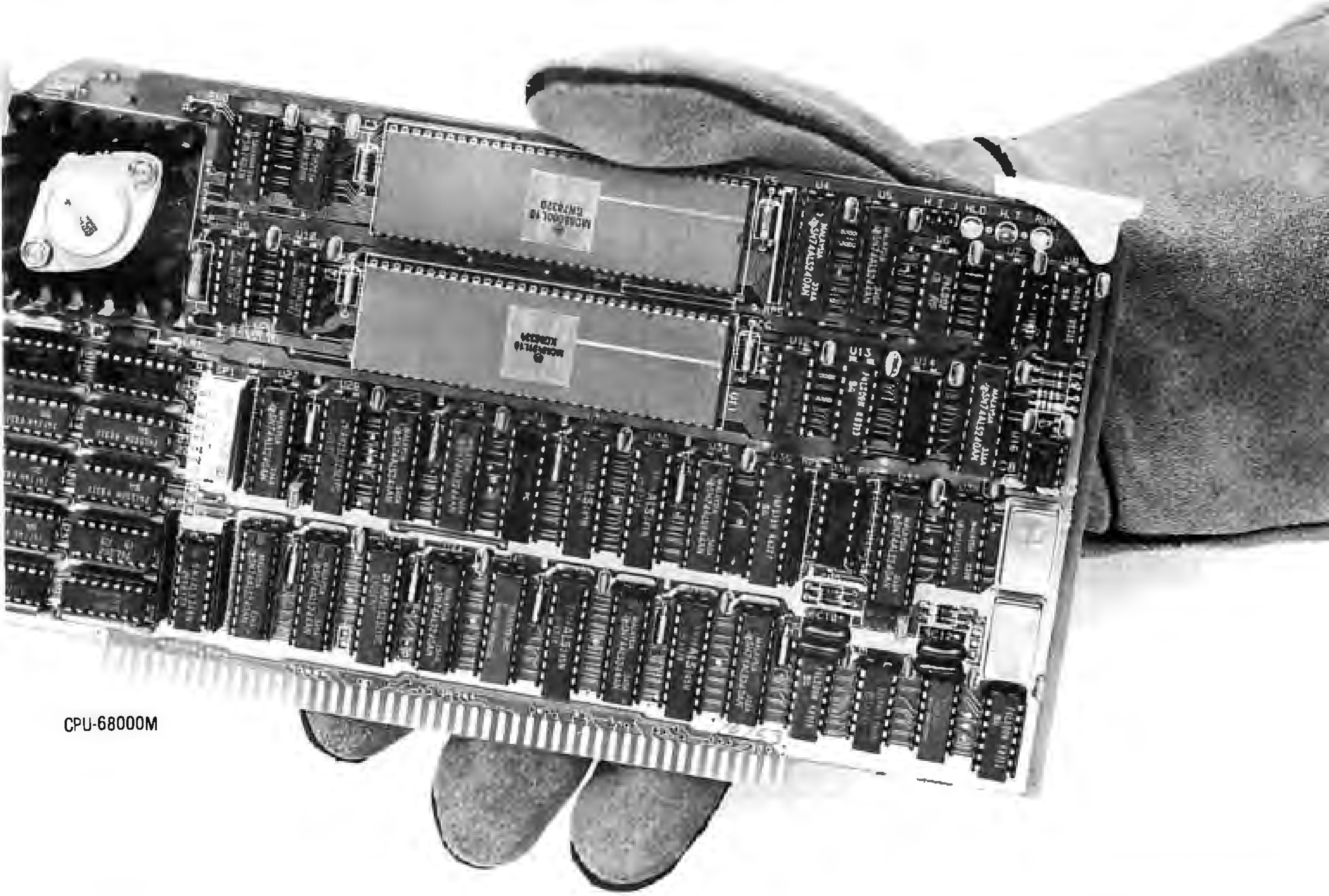

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TRACKING EARTH SATELLITES

BY E. H. WEISS

The Stumpff program can help you calculate earth-orbiting satellite positions with high precision

THE PURPOSE OF the program Stumpff is to compute the orbit or trajectory of a body of negligible mass (spacecraft or minor planet) in the gravitational field of three massive bodies. In the point-mass problem, each body behaves as if its entire mass is concentrated at a single point. In that case the Stumpff program converges to the exact solution. Another use of Stumpff is to obtain fast approximations, especially to orbits within our solar system. In that case an accuracy on the order of one part in a thousand is usually maintained, even for lengthy and stressing cases.

The program is named in honor of professor Karl Stumpff (1895–1970), who developed the theory upon which the program is based.

The method described here has two major advantages over traditional methods. First, it is 10 to 15 times faster. Second, there is no need to store the positions of the massive bodies, called ephemerides, on disks or tapes. This point is crucial; without it a personal computer could not perform the computations.

Stumpff is written for a minimum-configuration IBM PC. An 80-column display console and a printer are required. A listing of the BASIC source code and a compiled version for the IBM PC are available for downloading from BYTEnet Listings at (617) 861-9774.

HISTORICAL AND TECHNICAL BACKGROUND

The two-body problem (motion of a planet around the sun) was solved by Johannes Kepler (1571–1630). Kepler's solution to the two-body problem enabled him to compute the position of a planet at any value of time by a series of formulas. Isaac Newton (1642–1727) tested his law of universal gravitation by rederiving Kepler's laws with his own invention, the calculus. Newton found that the solutions are not only ellipses, as stated by Kepler, but also parabolas and hyperbolas (if the velocity of the less massive body is sufficient to escape the gravitational field of the more massive body).

The search for the solution of the three-body problem occupied mathematicians and astronomers until Karl G. J. Jacobi (1804–1851) proved that a closed-form (general) solution is impossible if a body is gravitationally attracted by two or more other bodies. It is, however, possible to obtain the solution by numerical techniques.

NUMERICAL TECHNIQUES

The motion of a small body is described by a set of differential equations and is traditionally computed by numerical integration. In order to perform a numerical integration, you must first know the values of all motion parameters at t_0, the start time. Then look up the coordinates of the massive bodies in a table of ephemerides. Next, numerically integrate the position of the small body to time t_1. This is possible provided that the time step $h = t_1 - t_0$ is sufficiently small. Then, using the known values of the small body at time t_1, compute the values at t_2. The values of the motion parameters of the massive bodies are again obtained from tabulated ephemerides. Similar-

(continued)

E. H. Weiss, *an advisory analyst for* IBM, *has more than* 35 *years of experience in government and private industry as a programmer, instructor, analyst, and manager. His Stumpff program is his alone—it was not developed by or for* IBM. *He can be reached at* 7568 *Remington Rd., Manassas,* VA 22110.

ly, "march" from time t_2 to t_3, then to t_4, t_5, etc., until the values of the motion parameters at the desired end time are obtained.

What has been said so far about numerical integration is quite general. It is equally valid for the numerical integration of the equations of motion of a spacecraft and for any other differential equation. Is there a better approach for astronomical or spacecraft problems? Johann Franz Encke (1791–1865) thought so. His clever method is useful if the major contribution to the motion of the small body is caused by the gravitational attraction of just one body. (This is frequently satisfied in our solar system.) In that case, a two-body method is used to compute the spacecraft motion due to that one massive body; this is called the reference orbit. The contribution of all other effects, called the perturbation, is obtained by numerical integration. To obtain the spacecraft motion, you add the values of the reference orbit and the perturbation. Since the quantity to be integrated—the perturbation—is small relative to the reference orbit, a comparatively large time step can be used. Thus, even though the calculation time spent on one Encke time step is greater than for straightforward integration, the Encke method generally performs the entire computation in less time.

CONNECTION BETWEEN THE ENCKE AND STUMPFF METHODS

The Stumpff method is an extension of the Encke method. The Stumpff reference orbit includes the gravitational attraction of all massive bodies and thus accounts for all point-mass effects. Furthermore—and this is crucial—the deviation between the reference and the actual orbits remains small even over protracted time intervals. Therefore, the time step for the Stumpff method can be larger than that for the Encke method, which in turn is larger than that for straightforward integration. The bottom line is that the Stumpff technique is about 10 to 15 times faster, even though the computing time per time step is slower than for other methods.

The Stumpff method was first described in 1942 in reference 1. The article explains and proves the method and illustrates it by computing the orbit of a minor planet. References 2 and 3 provide a new and shorter proof and also include applications to artificial satellites. Reference 2 includes four FORTRAN listings of the Stumpff technique for mainframe computers.

A SAMPLE CASE

Stumpff can compute the orbit of any body of negligible mass in the gravitational field of any three massive bodies. The program is set up to compute a sample case; other cases require input changes, to be discussed shortly. The sample case computes the orbit of Explorer 33, which was launched on July 1, 1966. Explorer 33 describes more than 10 highly eccentric orbits around the earth and moon in 180 days. There are several close approaches to the earth and the moon.

NOTATION

Stumpff computes the trajectory of a spacecraft in the gravitational field of three massive bodies. The mass of q_0, the spacecraft, must be negligibly small. The sample case is set up with q_1 as the earth, q_2 as the moon, and q_3 as the sun. The masses of the four bodies are denoted by m_0, m_1, m_2, and m_3.

Any coordinate system can be used, provided that the origin is at the center of body q_1. The sample case uses the standard 1950.0 coordinate system. The x-axis points to the first point of Aries (also called the vernal equinox), the z-axis points north, and the y-axis completes a right-handed orthogonal coordinate system. All input and output is in kilometers (km) for position, kilometers per second (km/sec) for velocity, and days for elapsed time.

The vector from q_1 to q_0 is denoted by p_{10}. That is, p_{10} is the position vector of body q_0 relative to (or as measured from) q_1. The three coordinates of p_{10} along the x-, y-, and z-axes are denoted respectively by $Y_{10}(1)$, $Y_{10}(2)$, and $Y_{10}(3)$. More generally, let i = 0, 1, 2, or 3; j = 0, 1, 2, or 3. Then p_{ij} is the position vector of q_j relative to q_i, and its components along the coordinate axes are $Y_{ij}(1)$, $Y_{ij}(2)$, and $Y_{ij}(3)$. The time derivative of p_{ij} is a velocity vector; it is denoted by v_{ij} and its components by $Y_{ij}(4)$, $Y_{ij}(5)$, and $Y_{ij}(6)$.

INPUT

The Stumpff program always prompts for four data entries. It prints the default parameters for the sample case, then asks "DO YOU WISH TO MODIFY ANY OF THE ABOVE CONDITIONS? Y OR N:" If you respond with "N" or "n," the program immediately continues with the next of the three remaining prompts.

In response to the prompt "RESULTS WILL BE PRINTED EVERY N'TH DAY:" type the desired frequency (e.g., 10 to obtain printouts every tenth day). In response to the prompt "LARGEST VALUE OF TIME TO BE PRINTED, IN DAYS:" type 180 if the length of the mission is 180 days, and so on. The last prompt is "TIME-STEP CONTROL CRITERION. 1E−5 OR 1E−6 RECOMMENDED:" Respond with an appropriate number, remembering that smaller values yield greater accuracy, but the calculations require more computer time.

If you respond to the first prompt, "DO YOU WISH TO MODIFY ANY OF THE ABOVE CONDITIONS? Y OR N:" with "Y" or "y," the program prints all initial conditions, one at a time. If no change is required, merely press Enter; to change a value, type a new value, then press Enter. The initial conditions are displayed in the following order:

Y10(1) . . . Y10(6)
Y12(1) . . . Y12(6)
Y13(1) . . . Y13(6)
The canonical unit of length
The canonical unit of time
The starting time, in days
m1, m2, m3

Program lines 320 to 360 and the subroutine on lines 1930 to 2790,

(continued)

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Inquiry 2

Table 1: *Printer output of Stumpff using the default sample data for Explorer 33 and 1E−5 as the time-step control criterion.*

Position in km and velocity in km/sec. Origin at Q1.
Lines 1 & 2 Y10; lines 3 & 4 Y12; lines 5 & 6 Y13.
Line 1 ends with time in days. Line 7 gives spacecraft distance from Q1 and Q2.

+1.8352641E+05	−2.4094338E+05	−3.6452766E+04	+0.0000000E+00
+1.0044146E+00	−3.2081303E−01	−1.5168001E−01	
+2.1384734E+05	−2.9619053E+05	+1.6430464E+05	
+8.4600699E−01	+4.7626001E−01	+1.7218044E−01	
−9.3856136E+07	+1.0949798E+08	+4.7486128E+07	
−2.2920521E+01	−1.6789843E+01	+7.2817683E+00	
R10,R20	+3.0506469E+05	+1.4254020E+05	

Canonical units of length and time are:
+6.3781650E+03 +8.0681366E+02
Masses of bodies 1, 2, and 3 are:
+1.0000000E+00 +1.2299896E−02 +3.3295128E+05

Start time, Date 08:32:41 07-01-1984
Time-step criterion +1.0000000D−05

+4.0406591E+05	+5.7658706E+03	−9.9387773E+04	+1.0000000E+01
−4.8275355E−01	+5.1666003E−01	+8.1928223E−02	
+1.7381369E+05	+3.1362872E+05	+1.4380152E+05	
−9.3196988E−01	+3.2447833E−01	+2.3401709E−01	
−1.1224846E+08	+9.3514536E+07	+4.0555028E+07	
−1.9551346E+01	−2.0131100E+01	+8.7292433E+00	
R10,R20	+4.1614953E+05	+4.5490291E+05	
+3.7403688E+05	−2.5159747E+05	+7.2772000E+04	+2.0000000E+01
+5.6283206E−01	+1.9169375E−01	−1.5092811E−01	
−3.2397141E+05	+1.6550636E+05	−5.8775484E+04	
+4.5049697E−01	−8.4750861E−01	−4.5995513E−01	
−1.2746285E+08	+7.4866512E+07	+3.2467906E+07	
−1.5571598E+01	−2.2928595E+01	−9.9447031E+00	
R10,R20	+4.5661869E+05	+7.0343669E+05	
+3.0188719E+05	+1.0132476E+05	−7.8300773E+04	+3.0000000E+01
−9.3400902E−01	+3.8737997E−01	+1.9829461E−01	
+3.6786394E+05	−1.4087461E+05	−9.8210367E+04	
+4.1416159E−01	+7.9788619E−01	+3.7135252E−01	
−1.3902795E+08	+5.4090352E+07	+2.3457196E+07	
−1.1139797E+01	−2.5052975E+01	−1.0864564E+01	
R10,R20	+3.2792316E+05	+2.5181314E+05	
+4.5098631E+05	−1.9036528E+05	−9.6550414E+04	+4.0000000E+01
+3.2330784E−01	+3.2467601E−01	−1.0042379E−01	
−5.6318953E+04	+3.2954591E+05	+1.7090238E+05	
−1.0172640E+00	−2.3190196E−01	−4.1716743E−02	
−1.4661626E+08	+3.1767970E+07	+1.3777301E+07	
−6.3732409E+00	−2.6502871E+01	+1.1492944E+01	
R10,R20	+4.9894850E+05	+7.7407838E+05	
+1.0722097E+05	+1.3195153E+05	−3.3376625E+04	+5.0000000E+01
−1.7199315E+00	−2.0821010E−01	+4.3421927E−01	
−1.5787850E+05	−3.1072731E+05	−1.4608538E+05	
+9.0786868E−01	−4.1719040E−01	−2.7912253E−01	
−1.4996200E+08	+8.5147130E+06	+3.6924375E+06	
−1.3445547E+00	−2.7184437E+01	−1.1790426E+01	
R10,R20	+1.7326725E+05	+5.2815294E+05	

(continued)

available on BYTEnet, deal with input to Stumpff.

OUTPUT

Seven lines are printed every *n* days, where *n* is an input parameter:

Line 1: Y10(1), Y10(2), Y10(3), elapsed time
Line 2: Y10(4), Y10(5), Y10(6)
Line 3: Y12(1), Y12(2), Y12(3)
Line 4: Y12(4), Y12(5), Y12(6)
Line 5: Y13(1), Y13(2), Y13(3)
Line 6: Y13(4), Y13(5), Y13(6)
Line 7: "R10, R20", R10, R20 (where R10 is the distance between *q*1 and *q*0 and R20 is the distance between *q*2 and *q*0).

Lines 1260 to 1570 of Stumpff deal with computer output.

Table 1 shows the sample case integrated for 90 days. The time-step control criterion is 1E−5.

CANONICAL UNITS

The equations of motion include the Gaussian constant of gravitation, which involves the units of length, time, and mass and therefore assumes different numerical values for different basic units. But the constant appears in the equations of motion only as a multiplicative factor. Therefore, it need not be coded if it assumes the value of unity.

Canonical units are a set of consistent units for which the Gaussian constant equals unity. Canonical units are used in all internal computations of Stumpff. The definition of canonical units is as follows: Let *d* be the distance between point-mass bodies *a* and *b*. Let body *b* describe one complete revolution around body *a* due to the gravitational attraction of *a*, and denote the period of one complete revolution by PER. The units of mass, length, time, and the constant of universal gravitation are considered to be canonical if

- the mass of body *a* is the unit of mass
- the distance *d* is the unit of length
- the period PER, divided by (2 *

(continued)

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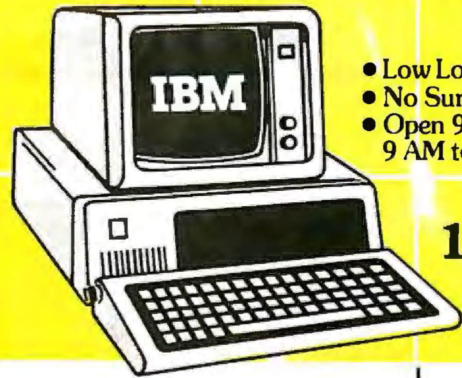

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+4.0053797E+05   +6.0884805E+04   +1.5494327E+03
-1.4566940E-01   +8.5460287E-01   +4.4591239E-01
-1.4892976E+08   -1.4973616E+07   -6.4940470E+06
+3.7287424E+00   -2.7058577E+01   -1.1733729E+01
R10,R20          +4.5063006E+05   +2.0136027E+05

+2.2461516E+05   -2.8893991E+05   -3.9640344E+04   +7.0000000E+01
+8.1509495E-01   -6.4160638E-02   -2.9409379E-01
-2.6377850E+05   +2.1918655E+05   +1.3143569E+05
-7.0102608E-01   -7.3732376E-01   -3.2422194E-01
-1.4353605E+08   -3.8023476E+07   -1.6489461E+07
+8.7413425E+00   -2.6167715E+01   -1.1348359E+01
R10,R20          +3.6811628E+05   +7.2525019E+05

+3.4287069E+05   +6.1140590E+04   -1.2910519E+05   +8.0000000E+01
-6.4364934E-01   +5.7552481E-01   +1.6853730E-01
+6.8223969E+04   -3.3873609E+05   +1.7829113E+05
+9.9896520E-01   +1.2927669E-01   -8.4648142E-03
-1.3387658E+08   -5.9954040E+07   -2.6001038E+07
+1.3563957E+01   -2.4460604E+01   -1.0608757E+01
R10,R20          +3.7143862E+05   +4.8759766E+05

+3.2928400E+05   -2.8257238E+05   -9.0272820E+04   +9.0000000E+01
+5.4575258E-01   +2.4833123E-01   -2.2335909E-01
+3.0065381E+05   +2.4090578E+05   +1.0086758E+05
-6.7142922E-01   +6.2881094E-01   +3.7202370E-01
-1.2021711E+08   -8.0078016E+07   -3.4727984E+07
+1.7979109E+01   -2.2009541E+01   -9.5437965E+00
R10,R20          +4.4319781E+05   +5.5801769E+05

End time         08:39:14
```

3.14159), is the unit of time
- the universal constant of gravitation equals unity

The following canonical units are frequently used in astronomy. The unit of mass is the mass of the sun, the mean distance from the sun to the earth is the unit of length, and the unit of time equals one sidereal year divided by (2*3.14159), or 58.132 days.

The sample case in the program uses the mass of the earth as the unit of mass and the equatorial earth radius (6378.165 km) as the unit of length. The computation of the canonical unit of time can be left to the astronomers, who have stated that its value is 806.813645 seconds.

Lines 260 to 300 of the listing initialize the canonical values for the sample case. In the program, variable CML holds the canonical unit of length and CMT is the canonical unit of time.

Mathematical Statement of the Problem

There are four bodies, denoted by q_0, q_1, q_2, and q_3, with masses m_0, m_1, m_2, and m_3. The mass of body q_0 is negligible. The position vector of body q_j relative to q_i is denoted by $p_{ij}(t_n)$, where i and j may assume numerical values 0, 1, 2, or 3; also, n is any integer, t is the abbreviation for time, and therefore t_n denotes a specific value of time. The time derivative of $p_{ij}(t_n)$ is the velocity vector $v_{ij}(t_n)$.

The mathematical statement for the problem of this article is as follows. At the outset the values of the six vectors $p_{10}(t_0)$, $p_{12}(t_0)$, $p_{13}(t_0)$, $v_{10}(t_0)$, $v_{12}(t_0)$, and $v_{13}(t_0)$ are known; they are called the initial conditions. The objective is to determine the value of $p_{10}(t_f)$, where t_f is the specified final time. This is accomplished by first computing the values of the six vectors at time t_1. Then, using the just-obtained values as new initial conditions, compute the vector values at t_2. Continue "marching" to t_3, t_4, etc., until the values for t_f are determined.

It is mentioned in passing that any vector p_{ij} can be computed from the three vectors p_{10}, p_{12}, and p_{13}. To see this, remember the obvious vector relations

$$p_{ij} = -p_{ji}$$
$$p_{ij} + p_{jk} = p_{ik} \quad (k = 0, 1, 2, \text{ or } 3)$$
$$p_{ii} = 0$$

Thus, for example, $p_{20} = p_{21} + p_{10} = -p_{12} + p_{10}$.

Two-Body Motion

Suppose there are only two bodies, say q_0 and q_1. As before, $p_{10}(t_0)$ and $v_{10}(t_0)$ denote the position and velocity vectors of q_0 relative to q_1 at time t_0. The corresponding values at time t_1 are denoted by $[p_{10}(t_1)]$ and $[v_{10}(t_1)]$, where the square brackets show that the values are the result of two-body motion. Over 100 useful procedures exist for solving two-body problems. In the days of paper-and-pencil computation, the human computer could easily switch procedures—for example, from an efficient procedure for elliptic motion to another procedure as the motion approached parabolic characteristics. Programmers for electronic computers prefer one universal method for all types of two-body motion. Stumpff uses a universal method called "sub1." See lines 1680 to 1910 of the program. Stumpff spends the bulk of its time in this subroutine.

Stumpff Reference Orbit

This section presents the equation for P_{ij}, the Stumpff reference orbit for position, and V_{ij}, the reference orbit for velocity. To simplify the equations, the following conventions are used: P_{ij} and V_{ij} refer to time t_1; the two-body values, enclosed in square brackets, also refer to time t_1; all other terms refer to time t_0; $h = t_1 - t_0$ is the time step.

It is easier to state the equations for

(continued)

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four massive bodies; therefore, the condition that $m_0 = 0$ is temporarily removed. The equations are:

$$P_{10} = |p_{10}| + m_2/(m_1+m_2) * (|p_{12}|-p_{12}-h*v_{12}) + m_2/(m_2+m_0) * (|p_{20}|-p_{20}-h*v_{20}) + m_3/(m_1+m_3) * (|p_{13}|-p_{13}-h*v_{13}) + m_3/(m_3+m_0) * (|p_{30}|-p_{30}-h*v_{30})$$

$$V_{10} = |v_{10}| + m_2/(m_1+m_2) * (|v_{12}|-v_{12}) + m_2/(m_2+m_0) * (|v_{20}|-v_{20}) + m_3/(m_1+m_3) * (|v_{13}|-v_{13}) + m_3/(m_3+m_0) * (|v_{30}|-v_{30})$$

These equations exhibit remarkable symmetry. By interchanging the roles of subscripts 0 and 2, for example, P_{12} and V_{12} are obtained. By similar interchanges, one can obtain any Stumpff reference orbit, though the program requires only P_{10}, P_{12}, and P_{13}, as well as V_{10}, V_{12}, and V_{13}. Of course, the program saves time by using the condition that $m_0 = 0$.

$P_{ij}(t_1)$ and $V_{ij}(t_1)$ are excellent approximations to the true orbital parameters, even for a relatively large time step. Therefore, Stumpff equates $p_{ij}(t_1)$ and $v_{ij}(t_1)$ with $P_{ij}(t_1)$ and $V_{ij}(t_1)$.

The reference orbits are computed on lines 760 to 1330. The two-body subroutine, "sub1," which starts on line 1680, is invoked six times. Note that the subroutine would be invoked five times to compute just one reference orbit yet is called only six times for all reference orbits.

TIME STEP

The time step h is defined by $h = t_1 - t_0$. (The program, however, uses TAU instead of h). Considerable effort was spent in finding a good criterion for the magnitude of the time step. It should be large to reduce the computing time, yet small to prevent the truncation error from building up to an intolerable level. The criterion that was eventually chosen is based on an overestimate of the error. There exist better time-step criteria for the sample case, but the chosen criterion has the virtue of working well for all cases that were investigated.

The time step is calculated on lines 620 to 740. It equals the fourth root of (q/ERRERR); q is computed on line 1400 and involves the overestimate of the error; ERRERR is the user type-in following the prompt TIME-STEP CONTROL CRITERION. 1E−5 OR 1E−6 RECOMMENDED. A safeguard prevents the time step from becoming larger than 100 canonical units. Moreover, the time step is adjusted so that results are printed for the days that the user has specified.

MATHEMATICAL THEORY OF ERRORS

Functions encountered in the physical sciences can usually be represented as Taylor series. If a procedure agrees with the Taylor series up to and including terms of order n but not terms of order $n+1$, then the procedure is said to be of order n and the error of order $n+1$. Higher-order procedures provide a better approximation than lower-order ones. Therefore, in general, equivalent accuracy is maintained by high-order procedures with large time steps and low-order procedures with small time steps.

The reason the Stumpff method is so attractive can now be stated succinctly: For point-mass bodies, the error of the Encke reference orbit is of order two, while that of the Stumpff reference orbit is of order four. ■

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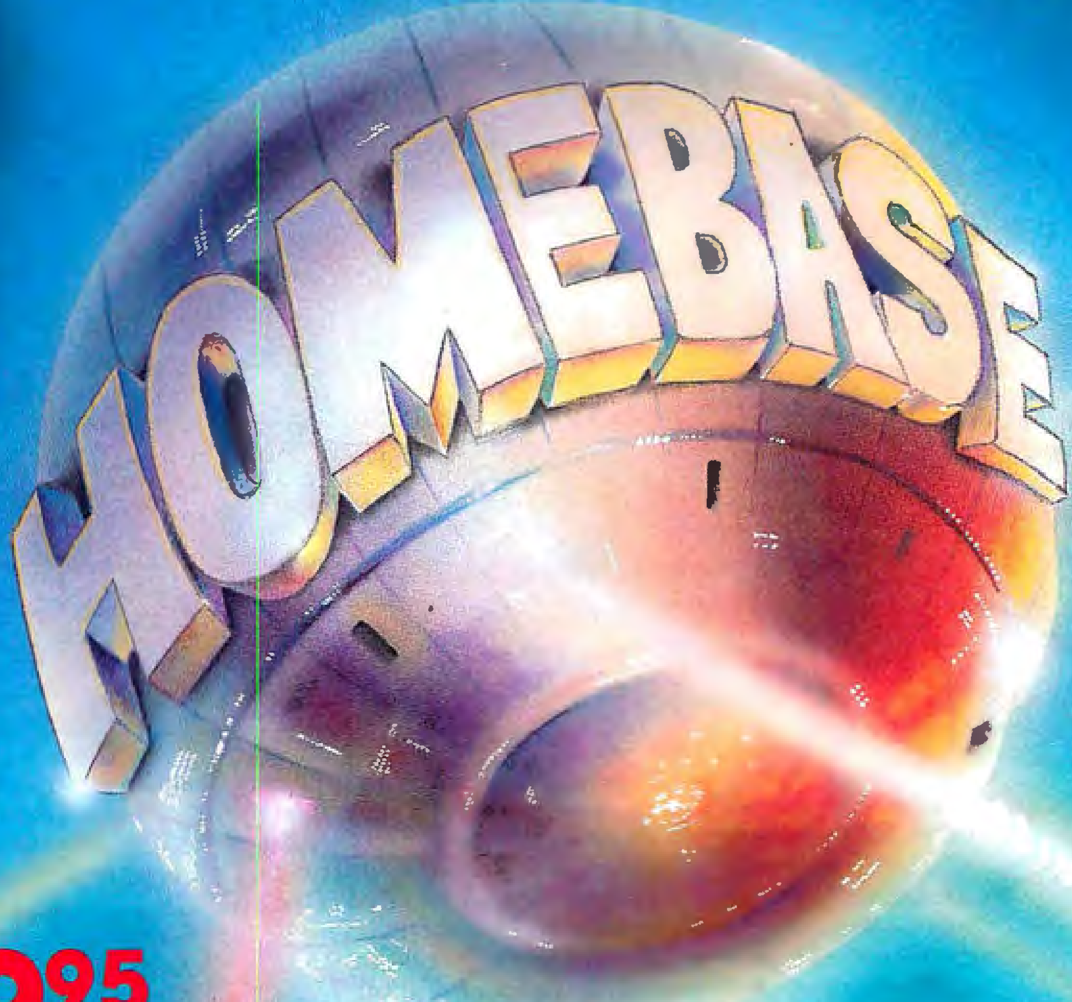

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AUTOMATING A TELESCOPE

BY LOUIS J. BOYD

Computerizing the repetitious tasks in variable-star photometry

RECENTLY AT FAIRBORN Observatory West, we completed automating a telescope (photo 1) for a considerable portion of the research process of photometry of variable stars requiring long-term observation. This article will explain the entire process from one end to the other, with emphasis on what was automated, how it was automated, and what was purposely left to be done manually.

SELECTING THE STARS

Much of the success of this project has been due to our making observations on the particular class of stars most suited for automation. As it is easier and less expensive to automate a small telescope than it is a large one, it was important that the type of observations being made were suitable for small telescopes.

The main difference between large and small telescopes is the number of photons they can collect from a given star. Wide-bandwidth photometry (brightness measurement) makes the most use of the meager photons available to smaller telescopes. Photometry, as compared to spectroscopy or direct imaging, also has the advantages of having a very repetitive measurement sequence and a low data-output rate, easing automation.

Further, automation is ideally suited to the kind of research that requires observations each night for months or years on end.

Finally, it is helpful if the observed class of stars has many bright members to match the capabilities of a small automatic telescope, that there be strong current scientific interest in the results, and that there be an expert on the class of stars willing to work with an automatic system.

The RS Canum Venaticorum binaries and Dr. Douglas S. Hall fit the criteria in all respects. The RS Canum Venaticorum (or RS CVn) binaries are an exciting new class of stars that have highly active atmospheres, often with large groups of starspots that move about and change their sizes over time. These stars are similar to our own sun, but in a greatly exaggerated form. To learn how their starspots evolve and change over time, you must observe a significant number of the stars almost nightly for years. Besides the 40 or so known RS CVn binaries observable by a small telescope from the northern hemisphere, there are a number of stars suspected of being starspotted RS CVn binaries. Until recently, the photometry needed to detect any intensity variations as the spot groups rotate in and out of the line of sight from earth had not been done. There simply is not enough telescope time or enough astronomers for such long-term observations. However, the automatic system described in this article has discovered 15 such new variables during 1984 alone. One of these newly discovered RS CVn binaries can serve as an example to illustrate the approach we took to automation. (See the text box "A New Variable Star" on page 230). Douglas Hall compiled the list of known and suspected RS CVn binaries from available data on the stars and, with the help of Russell Genet, screened the list to eliminate stars not suited to the automatic system (e.g., stars that are too dim, too far north or south, or too near other stars). For each variable (or suspected

(continued)

Louis J. Boyd has a B.S. in electrical engineering and is codirector of the Fairborn Observatory (629 North 30th St., Phoenix, AZ 85008). He designed the automated photoelectric telescope described in this article.

The system must first determine if the sky is dark enough to begin observing.

variable). Hall and Genet selected two additional stars to use in comparing the brightness differentially and to assist in locating and identifying the variable by the three stars' relative positions. Information about all of these stars was obtained from appropriate catalogs and entered into a data file. The data included the coordinates of each star, the expected brightness of each star, periodic data on the variable star, if known, and coordinates of a nearby place in the sky containing no detectable star.

This group data, together with similar data on all of the other groups of stars to be observed by the system, constitutes the astronomical input to the observational process. The process of deciding what variable or suspected variable stars to observe is, of course, a case of scientific intuition, and no attempt has been made to automate it. The selection of comparison and check stars could be based on a set of rules relating brightness, separation from the variable star, and spectral class. The selection could be automated by allowing the computer to search star catalogs, but, as it is a one-time task for each variable star, there is little incentive to do so.

Observing the Stars

Almost all of the observing process has been automated (figure 1). The part that hasn't is the simple (for a human) process of looking at the sky in the afternoon, deciding if the weather is acceptable for observing, and opening the observatory roof. This manual process takes at most two minutes per day and has been a low-priority item to automate. Because this task is repetitive, it will eventually be automated. We have made progress in that direction, but the difficulty is to reliably detect all forms of inclement weather including rain, hail, blowing dust, high wind, and heavy clouds that are likely to produce rain. We are currently testing an infrared clear-sky detector. After opening the observatory, we power up the system and compare the computer's real-time clock against the National Bureau of Standards' WWV time signals. From this point on, operation is automatic.

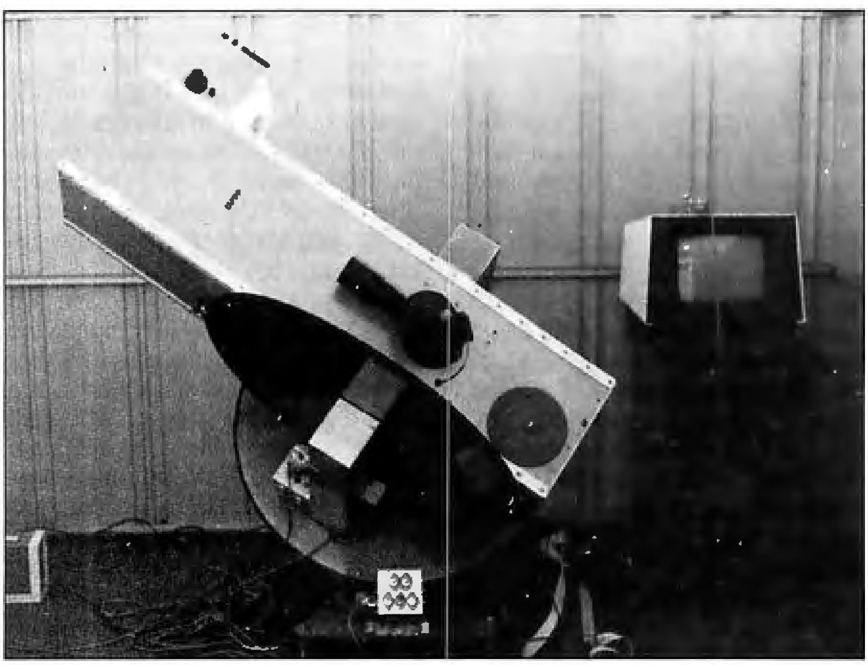

Photo 1: *The automatic photoelectric telescope used to gather the measurements discussed in the article. The small box at the top of the telescope is the photometer.*

The system must first determine if the sky is dark enough to begin observing. A human would do this by simply looking up and making a decision. Not so for the computer. The program starts by repeatedly determining the position of the sun by calculating the orbit of the earth and its rotation, given the date and time from the clock and knowing the location of the observatory. This function could have been handled with a lookup table for each week of the year. When the sun is 10 degrees below the horizon, the telescope is initialized to the southeast limits of its allowable travel range and the related position in the sky is calculated based on the time. At that instant, a frequency generator is turned on that steps the right-ascension motor of the telescope at a rate that very accurately compensates for the rotation of the earth. Thus, the software does not have to constantly take the earth's rotation into account. Most manually operated astronomical telescopes also have a motor that compensates for the earth's rotation, even though the stars are located by an operator.

The system then decides which group it will observe first. The logic used is about the same as a human would use. Because viewing stars at low angles introduces errors due to all the air the starlight must penetrate, the maximum distance the star is from the zenith when it is observed is restricted to a 45-degree cone overhead. The program calculates the time that each group will rise and set within the defined observing cone and selects the group that will be the first to move out of the cone. The program determines whether the selected group is within 10 degrees of the moon. If it is, that group is skipped. Again, a human would simply judge the angle by looking at the moon and the selected group, but the computer must calculate the position of the moon and compare it to the position of the group.

The telescope must now be moved to the check star of the group being observed. A human observer would push the appropriate slew buttons to move the telescope to the position or release clutches and move the telescope by hand. The star is found by a combination of the use of setting circles, comparing the observed star field to "finder charts," and by simply recognizing the pattern of stars. The equivalent process for the computer is complex. First, the computer must calculate the angular distance the telescope needs to be moved to go from its present position to the sky position for the group. All star positions are corrected for precession of the earth's axis. The angles are passed to a module that breaks them into two separate moves, one with both right-ascension and declination motors being stepped together, and a second move with only one motor running. The exact number of steps required for each move is calculated and the direction and number of steps is passed to a stepper-motor driver routine. This is the only assembly-language routine used in the entire operation. It must calculate which windings of each motor need to be turned on for each step that the motors make. In addition, it must provide smooth acceleration at the beginning of each move and smooth deceleration at the end of each move. The maximum stepping rate is on the order of 4000 steps per second, which could not be done in a high-level language. The next task is to take several measurements of the sky brightness in positions near the sky position to set a threshold to use while searching for the stars. The telescope is then moved to the position where it expects to find the star. A square spiral search is then started taking $\frac{1}{10}$-second readings of the sky brightness and comparing this to a value calculated from the expected brightness of the star. If the reading exceeds about one-half the difference of the sky background and the expected value, it is assumed that the star has been found. By using an adjustable threshold, there is little chance of the system locking onto the wrong star.

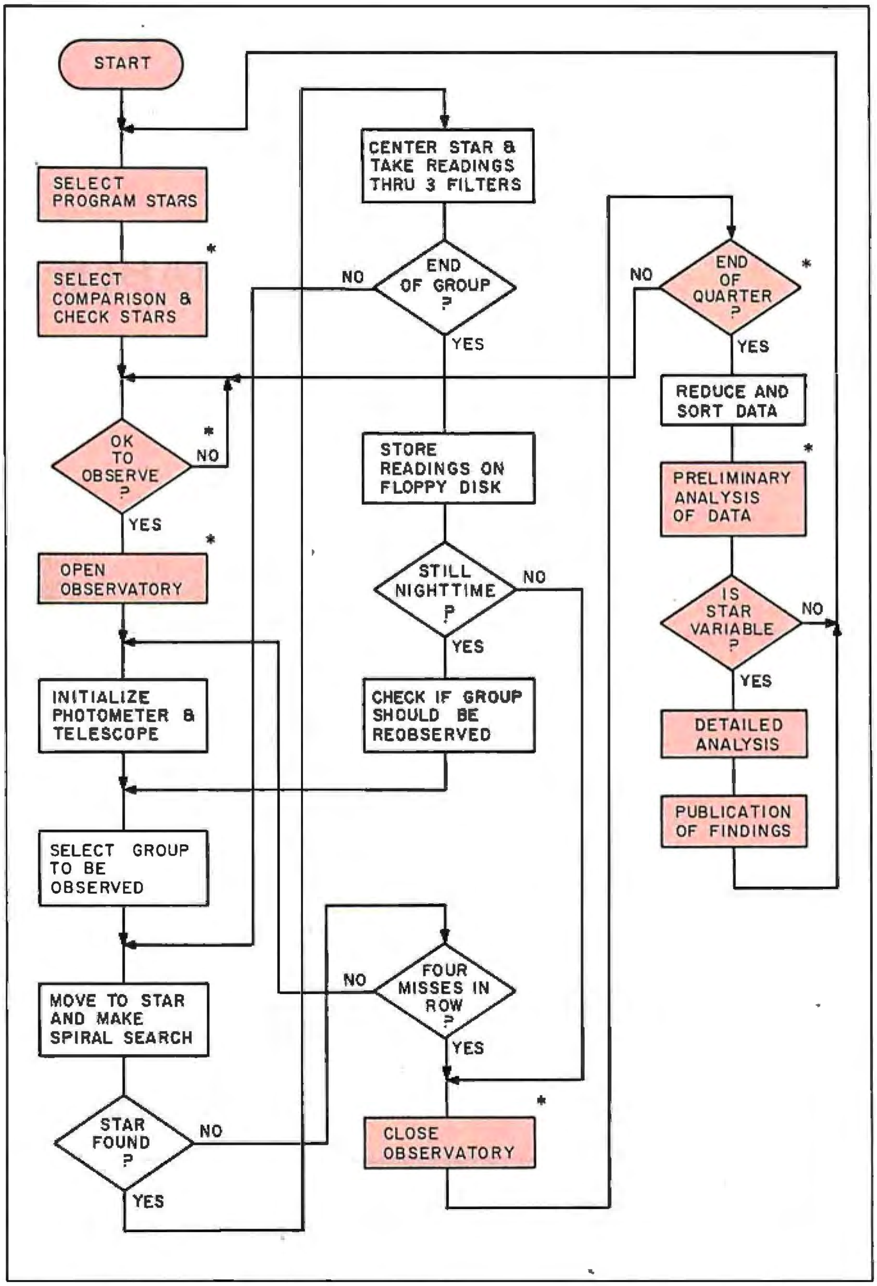

Figure 1: A *diagram of the operation of the automatic photoelectric telescope described in the article. The shaded boxes were left as manual processes, while all other activities were automated. Boxes marked with an asterisk are candidates for future automation.*

The next step of the process is to center the star. A human would look through the eyepiece and make sure that the star's image was centered, carefully adjusting the telescope's fine-motion controls. The automated system uses an iterative procedure, in which the telescope is offset to each of four positions by a little less than the radius of the diaphragm, and a reading is taken in each position.

(continued)

There are 16 possible combinations that dictate which direction and how far the telescope must be moved to center it. This process is repeated until the star is detected in all four positions, where it is close enough to the center to take measurements.

Measurements of 10 seconds each are made in three color passbands, changing the position of a wheel with colored glass filters between each measurement. The telescope then moves to the sky position repeating the measurements, then to the comparison, variable, etc. When all of the

A NEW VARIABLE STAR

Table A: *Program parameters.*

NAME: HR 4430 DIAPHRAGM=60"

	NAME	RIGHT ASCEN.	DECLIN.	V-MAG.
CHECK	HD 102224	11 46 3.0	+ 47 46 46	3.71
SKY		11 34 29.0	+ 46 45 44	.00
COMP	HD 101133	11 38 33.0	+ 46 50 3	6.10
VARI	HD 99967	11 30 25.0	+ 46 39 27	6.35

Table B: *Sample data.*

GROUP=HR 4430
HELIOCENTRIC CORRECTION=.0045

TYPE	NAME	ULTRA	BLUE	VISUAL	SECZ	HH	MM	SS
CHECK	HD 102224	308.72	2533.51	4371.71	1.05	7	56	47
SKY		9.11	21.69	24.65	1.04	7	57	21
COMP	HD 101133	176.54	619.36	515.79	1.04	7	57	58
VARIABLE	HD 99967	35.02	233.10	410.78	1.03	7	58	53
COMP	HD 101133	174.15	619.39	515.04	1.04	7	59	32
VARIABLE	HD 99967	34.47	218.37	389.12	1.03	8	0	21
COMP	HD 101133	173.12	601.62	509.49	1.04	8	1	1
VARIABLE	HD 99967	35.21	227.78	406.96	1.03	8	1	51
COMP	HD 101133	173.98	615.16	511.58	1.04	8	2	38
SKY		8.85	21.68	25.34	1.03	8	3	11
CHECK	HD 102224	313.27	2577.48	4426.84	1.04	8	3	54

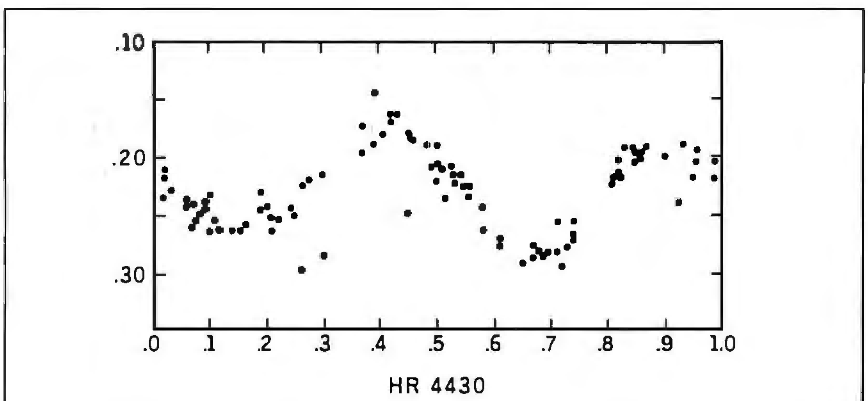

Figure A: *Light curve for* HR 4430.

HR 4430 is the number of a star in the Yale Bright Star Catalog. It is also known as HD 99967. It was found to be photometrically variable by the automatic photoelectric telescope and process described in this article. Shown in table A is all the input information needed by the system to observe this suspected variable star, as well as comparison and check stars and a sky position. Given are the positions (right ascension and declination) and the magnitude (brightness) of each star in the V (visual) band of the UBV photometric system.

Table B shows actual photometric measurements as recorded directly by the system. The check star, HD 102224, was measured in the ultraviolet, blue, and visual bands, and this was recorded along with the amount of air through which the star was observed (straight up is 1.00 air masses), which is the secant of the zenith angle (SECZ). The universal time in hours, minutes, and seconds was also recorded. Note that after moving to the check star, 10 additional moves to other stars or the sky are required to complete the sequence of 33 separate measurements. When reduced, all these measurements give but a single brightness point in each color band on a light curve.

The final product of the entire process is a light curve that shows the variations in brightness of the star, confirming its variability (figure A). As mentioned in the text, this was published in the *Information Bulletin of Variable Stars.*

measurements have been completed, which takes about six minutes including all of the searching and centering, the measured data is stored on floppy disk. The data that is saved includes the measured star brightness, the angle of the group from the zenith, the time, and a correction to apply as if the star had been observed from the position of the sun rather than from earth. One set of actual data taken one night on our example group, HR 4430, is shown in the text box.

The next group to be observed is then selected. It is again the group that will set first and has not yet been observed. If every group in the 45-degree cone above the telescope has already been observed once, the system will start observing them a second time. Of course, as the earth turns, new groups keep coming into the observing cone from the east. If the observing program has the optimum number of groups in it and the groups are not too highly clustered together, the system will not miss groups that come within the observing cone, but it will not observe many for a second time. Although the searching and centering appears complex, it is done considerably more quickly by the automatic system than can be done manually. (Human observers usually skip the reobserving portion of the program and go have a cup of coffee.)

Between each group the program calculates the position of the sun; if it is less than 10 degress below the horizon, the system moves the telescope to its rest position and shuts down. If, during the course of the night, the system cannot locate a star, it reinitializes its position and moves to the next group. If this occurs four times in succession, either it is hopelessly cloudy or there is a mechanical malfunction, in which case it also shuts the system down.

DATA REDUCTION, ANALYSIS, AND PUBLICATION

Reduction is a highly repetitious process involving a great deal of mathematical computation. It calculates the differences in brightness between the variable and comparison stars and between the check and comparison stars. The difference between the check and comparison star should be constant and provides a way to detect comparison stars that are variable. Corrections are applied to account for the background glow of the sky, atmospheric attenuation, nonlinearities in the detector, and deviations in the color response of the system from that of the standard system. Repeated observations within a group are averaged together. If no measurement errors have occurred and the comparison star is stable, the reduced values of the variable star minus the comparison star represent the true changes in the brightness of the variable star.

Currently, we allow the data to accumulate for three months and then reduce it all at one time. After a week's data is gathered from the telescope, it is transferred to a high-density disk that can store about one month's raw data. Other than the changing of disks, the data-reduction process has been completely automated.

The primary output of the data-reduction program is a tabulated list of the brightness differences along with the time of the measurement and the mean error in the measurement. Measurements that have excessive internal inconsistencies are automatically thrown out.

"Quick look" plots of brightness changes versus time are produced by the system, and it is on such plots that a human first knows that a suspected variable star is really variable. While useful in analyses, such plots made on a printer are not of sufficiently high quality to publish in most journals, and human graphic art must still take the final step. At the operator's request, a particular program can plot the data by phase rather than date if the period of a star's variation is known, and another program can detect periodic variations in the data.

For our example star, the final "product" was a paper coauthored by Boyd, Genet, and Hall in the July 6, 1984, issue of the *Information Bulletin of Variable Stars* (IBVS), an international publication received by all variable star researchers. The light curve of the new variable has been reproduced with the permission of the IBVS editor, Dr. Bela Szidel of Konkoly Observatory, Budapest, Hungary.

Measurements with excessive internal inconsistencies are thrown out.

SOFTWARE AND HARDWARE IMPLEMENTATION

Microware's OS-9 operating system and the BASIC-09 high-level language are used in this system. BASIC-09 is a structured language with most of the good points of both BASIC and Pascal. Of the many good features of OS-9 and BASIC-09, one that was particularly important to this project was the use of position-independent code, which allows executable modules to be loaded anywhere in memory without recompiling. Also, BASIC-09 allows passing of parameters between modules and to assembly-language modules using pointers. This feature made the use of completely software-driven stepper motors practical. Further, BASIC-09 allows programs to be edited, traced, and debugged prior to compilation, easing the job of optimizing hardware performance.

The program is broken into tasks and subtasks, each with its own position-independent code module. Each module performs a specific task. For example, one module calculates the coordinates of the sun, given the date, time, and observer's location. Another calculates the number of steps required to move between specific coordinates. Modules call other modules as required, and modules may be released from memory if they are no longer needed, freeing memory space for other modules. The pro-

(continued)

The highly productive automated observatory still requires human attention.

gram to operate the telescope and gather data uses approximately 40 modules.

A Peripheral Technology PT-69 single-board computer forms the heart of the telescope control system. This computer features a 6809E processor, 56K bytes of RAM (random access read/write memory), a clock/calendar, two serial ports, two 8-bit parallel ports, and a 2797 floppy-disk controller. The computer is used "stock" except for replacing the PIA (peripheral interface adapter) chip with an address decoder and bidirectional buffer on a DIP (dual in-line package) header to provide direct access to several memory locations.

The rest of the control system electronics is contained on a small wire-wrapped board that consists of a counter-timer chip to count the pulses from the photometer, output latches for the stepper motors, input buffers for the limit switches, weather detectors, and manual controls used during alignment. The power-handling circuits for the stepper motors use a switching constant-current source and allow up to a five-times overvoltage to the motor during high-speed operation.

The hardware just described is actually a third-generation design being assembled as part of a joint Vanderbilt University–Fairborn Observatory program under the auspices of the National Science Foundation. An Optec photometer is being used because its solid-state photodiode detector, which is sensitive in the visual, red, and near-infrared portions of the spectrum, is well suited to observations of the relatively cool RS Canum Venaticorum stars. A small stepping motor changes the filters through a rack-and-pinion mechanism. The telescope being used is a 16-inch diameter DFM Engineering unit employing very rigid aluminum castings and a stiff, backlash-free friction-drive system, which is ideal for computer control.

KEEPING IT GOING RIGHT

While this automated observatory is highly productive, easily outproducing most manually operated observatories, it does require human attention. There are, of course, the normal housekeeping functions, such as

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cleaning the telescope's mirrors. Because the telescope spends so much time in operation exposed to the sky, cleaning and lubrication need to be done somewhat more often than would otherwise be the case.

While the system has been highly reliable, finding tens of thousands of stars with no known errors, it has had a few interesting problems and failures. On February 29, 1984, it refused to find any groups although the sky was clear and everything appeared to be working properly. It was finally determined that the clock/calendar (in the first-generation system) had not been set for leap year, throwing the system off 1/365 of a circle, or almost an entire degree. And there have been a few more subtle problems that were only caught on close examination by the astronomer (Douglas Hall), such as a half-day error in the initial reduction of data. The software was corrected and the data reduced again.

It has been vital that the end user of the data take an active part in assuring that the system is doing what it is supposed to do. In spite of the fact that the system immediately started producing large amounts of very usable data, it has seemed prudent to develop self-checks of increasing sophistication. While from a superficial viewpoint the software and hardware seem simple for an essentially fully automatic system, the number of things that the astronomer using this system must do correctly is large, and thus the appearance of simplicity is perhaps deceptive. Much of what the user must learn for proper operation is learned by personal experience, and it appears that a close and continuing association between the system, its engineer, and the astronomical end user is required. While much of the process has been automated, the need for human participation has in no way been eliminated. What, then, has been gained?

What has been gained, of course, is greatly increased productivity. Not only can an automatic system greatly outproduce nonautomatic systems, but a single experienced engineer can easily take care of a number of systems at one location with time to develop new systems and techniques. And everybody gets to sleep at night! ■

ACKNOWLEDGMENTS
My thanks to Russell M. Genet, who helped think through many of the fine points of this process and this article, to Richard and Helen Lines, who provided the original catalyst for the project, and to the Vanderbilt University astronomer Douglas S. Hall, whose astronomical research has primarily occupied this automatic system.

ASTRONOMICAL COMPUTING WITH MICROS

BY RICHARD BOCHONKO AND WILLIAM T. PETERS

Increasing the amateur astronomer's reach

ASTRONOMERS LIVE AND DIE by computation. All aspects of astronomy deal with numbers and computations of varying degrees of complexity. Among the many problems that require a lot of computational power are the creation of models of the structure and evolution of stars, black holes, and galaxies; the synthesis of the spectra of stars; the determination of orbits of binary stars; and the determination of the positions of the sun, moon, and planets in the past, present, and future.

As astronomers, we use microcomputers by themselves and as terminals to mainframes. We use them to graphically analyze data and to prepare graphics for presentations and publication. By themselves, micros are becoming standard equipment at the telescope for equipment control, data acquisition, and initial data reduction. At our desks, we use micros for computing problems of moderate complexity, to establish and maintain databases, for teaching, and for word processing.

In addition to assisting the professional astronomer, the microcomputer has been valuable to the amateur. Until now, amateurs could not afford the powerful calculating tools that are so important to professionals. The availability of inexpensive micros with outstanding software has led to their use by amateurs at the telescope as well as at home.

If you have a micro that speaks BASIC, a good way to develop some useful programs—and to learn introductory astronomy—is with *Celestial BASIC* by Eric Burgess. (For a list of books and periodicals mentioned in this and other articles, see the "Astronomy Sources" text box on page 244.) Burgess devotes each of his 23 chapters to a brief description of an astronomical principle or phenomenon and then follows the description with a program that helps you predict or learn about the phenomenon.

Celestial BASIC is divided into four main sections: "Time," "The Moon," "The Planets," and "General and Tutorial." The author has chosen excellent programs, so after you have typed them in or purchased the disk with all the programs from the book's publisher, you're left with a set of utilities that replaces many of the tables in standard references like *The Observer's Handbook* and *The Astronomical Calendar*.

The "Time" section offers a perpetual calendar, a date-of-Easter program, a variety of time and date conversions, and two programs of special interest to amateur observers: Epoch, which updates star coordinates for precession (the slow change in the direction that the earth's axis points among the stars); and Pstar, which helps determine the precise position of Polaris with respect to the true North Celestial Pole. Polaris is nearly

(continued)

Richard Bochonko and William T. Peters are astronomers living in Winnipeg. Contact them as follows: Dr. Richard Bochonko, Department of Mathematics and Astronomy, University of Manitoba, Winnipeg, Manitoba R3T 2M8, Canada; William T. Peters, Manitoba Planetarium, 190 Rupert Ave., Winnipeg, Manitoba R3B 0N2, Canada.

ASTRONOMICAL SOFTWARE RESOURCES

Here are some of the software resources we have discovered. Keep checking the ads in astronomy magazines for new announcements, or contact the Griffith Observatory as listed for periodically compiled updates.

BEAR CREEK SURVEY SERVICE, 1991 Bear Creek Rd., Kerrville, TX 78028, (512) 367-4390. Astro: Yields altitude and azimuth of sun and 57 bright stars. (HP 41cv)

CELESTIAL SOFTWARE, POB 95, Dell Rapids, SD 57022. Utilities covering telescope properties, observing conditions, time, coordinates, and stellar properties.

CELESTRON INTERNATIONAL, POB 3578, 2835 Columbia St., Torrance, CA 90503, (213) 328-9560. Computer-controlled pointing for the Celestron line of quartz stepper-motor-controlled telescopes.

CHESNUTT PROGRAMMING, Rt. 5, Box 348, Fayetteville, NC 28301, (919) 588-4511. SID.CLOCK: Turns a Commodore 64 into an accurate sidereal clock that also displays civil and universal time. ($15 U.S., $18 foreign) Catalog of other astronomy programs available. (Commodore 64)

COMMODORE BUSINESS MACHINES INC., 1200 Wilson Dr., West Chester, PA 19380. Sky Travel: Fully utilizes the Commodore 64's high-resolution graphics to display the constellations and solar system objects from any location on earth over a 20,000-year range. Available from Commodore dealers. (C-64 and disk drive)

COMPUTER ASSIST SERVICES, 1122 13th St., Golden, CO 80401. The__Sky: Plots a graphic representation of sun, moon, planets, stars, and Messier objects given a location, time, and date. Numerous utilities included. ($60 U.S.) (IBM PC 128K DOS 1.1 or higher; will support 8087)

COSMIC COMPUTER WORKS, 243 White St., Belmont, MA 02178. Myoptics: Optical design program generates spot diagrams for telescopes and other optical systems. Planets: Yields the celestial and horizon coordinates of the sun, moon, and planets, along with apparent diameter, brightness, and percentage of illumination. Ephemeris: Converts orbital elements for a newly discovered comet or asteroid to celestial coordinates. Almanac: Rising and setting information for sun and moon. Also beginning and end of twilight. JMoons and SMoons: Graphic presentations showing the positions of the moons of Jupiter and Saturn visible in small telescopes. (Apple, North Star, TRS-80, some others; disks or cassettes)

DESIGN STUDIO SOFTWARE, 6209 South Joshua Lane, Lantana, FL 33462. Solar System Ephemeris: Celestial coordinates of solar system objects to very high accuracy. (Apple)

GRIFFITH OBSERVATORY, 2800 East Observatory Rd., Los Angeles, CA 90027. Send a legal-size, self-addressed envelope with two first-class stamps for a directory of astronomical programs for microcomputers when this list has gone stale.

HOPKINS PHOENIX OBSERVATORY, 7812 West Clayton Dr., Phoenix, AZ 85033. Computerized stellar photometers and data-reduction software. (Most home computers)

CHARLES KLUEPFEL, 11 George St., Bloomfield, NJ 07003. Planets: Precise coordinates for the sun, moon, and planets. New Orrery: A view of the solar system looking down from the "top" for any date. Shows all nine planets. Planetarium: Screen plots a star map to a magnitude of 3.5 or deeper for any date and location on earth. World Map: Screen plot of world map shows areas experiencing daylight, darkness, moonlight. Eclipse Map: Accurate data for solar-eclipse paths and graphical plots of paths on earth map. Calendar Conversions: Converts among Julian, Gregorian, and Jewish calendars, giving Julian Day numbers and moon phases. (Apple only)

K & W ASTRONOMICS, POB 2275, Orange, CA 92669. Programs to calculate coordinates of solar system objects and Messier objects. (Apple, VIC-20, Timex Sinclair, others)

MICROTECHNIC SOLUTIONS, POB 2940, New Haven, CT 06515, (203) 389-8383. Astro Positions: Provides solar, lunar, planetary, and stellar positions in geocentric, heliocentric, or topocentric coordinates. (Disk $49.95 U.S.) (Commodore 64)

ROBERT MOLER, 5999 Secor Rd., Traverse City, MI 49684. Programs simulating travel at relativistic speeds, rotation of spiral galaxies, comets, and other solar system coordinates. (Timex Sinclair)

PRENTICE-HALL INC., Rte. 9W, Englewood Cliffs, NJ 07632. The Astronomy Disk: Sheridan Simon provides 16 programs for simulating space travel, solar system and stellar phenomena. Thirty-eight-page handbook. (Apple II only)

PUBLIC DOMAIN SOFTWARE, POB 640, Stanley, NC 28164. Yale Catalog of Bright Stars: 9200 stars down to a magnitude of 6.5 with spectral, photometric, parallax, and proper-motions data. (Eight 8-inch CP/M single-sided single-density floppy disks)

SATURN SOFTWARE, R.R. 1, Box 673, Patterson, NY 12563. Galilean Moons: High-resolution simulation of Jupiter's moons. (Atari, TRS-80)

SCHAF SOFTWARE SYSTEMS INC., Suite 1068, 2111-M 30th St., Boulder, CO 80301, (303) 666-5353. TellStar II: Solar-system object position and time conversions for amateur astronomers. Plots sun, moon, and planets on star maps. Maps include Messier objects. (Apple, IBM)

BRAD SCHAPER, 7266 Volclay Dr., San Diego, CA 92119. Public-domain astronomy disk. Lots of good stuff in every category. Good educational item. Worth study by programmers new to astronomy. (Apple only)

SCIENTIFIC COMPUTING, POB 5091, Littleton, CO 80123, Astronomical Software 1: A menu-driven program providing date, time, and coordinate conversions. ($19.95 U.S.) (Timex Sinclair 1000, 64K)

STARSOFT, POB 2524, San Anselmo, CA 94960. Halley's Comet: Coordinates for Halley's comet plus graphic views of the comet in sky and in solar system. (IBM only)

S & T SOFTWARE, 13361 Frati Lane, Sebastopol, CA 95472. *Celestial BASIC* programs as listed in the book by Eric Burgess. (Apple, Sorcerer, Timex Sinclair)

SYNERGISTIC SOFTWARE, 5221 120th Ave. S.E., Bellevue, WA 98006. The Star Gazers' Guide: Crude sky and constellation charts with some tests about each constellation. The Planetary Guide: Rough planet positions plus "pictures" plotted on the high-resolution screen and text information. (Apple II only)

UNIVERSAL MICRO PRODUCTS, POB 8067, Rolling Meadows, IL 60008-8067. Eclipse prediction, telescope mirror analysis, ray tracing, comet and minor-planet ephemerides, etc. (Commodore 64 and VIC-20)

ZEPHYR SERVICES, 306 S. Homewood Ave., Pittsburgh, PA 15208, (412) 247-5915. Astrocalc: Time, calendar, and coordinate conversions along with coordinates for solar-system objects. Astro-Aid: Forty-four data conversions and utilities including Kepler's/Newton's laws, relativity, telescope design, solar-system data, and characteristics of nearest and brightest stars. Astrobase: Database of 300 deep-sky objects.

a degree away from the true pole, far enough to cause problems in aligning a telescope mount if not compensated.

The "Moon" section programs yield lunar positions, phases, and eclipse dates. The "Planets" programs yield positional data, distances, angular diameters, and, where applicable, phases and elongations of the planets. Rising and setting times of the sun, moon, and planets are generated with special attention to data that will help observers find Mercury and Venus in the morning and evening twilight. Skyset and Skyplt are a particularly impressive pair of programs that use high-resolution graphics to produce horizon star maps showing the visible planets, sun, moon, and stars for a specific date, time, and location on the earth. Since this program set is highly machine-dependent, it is given in two versions (Apple and Sorcerer). Also provided is a program called Plantf, which locates the sun, moon, and planets among the zodiacal constellations using plots composed of ASCII (American Standard Code for Information Interchange) characters on the text screen.

Among the "General and Tutorial" programs, the ones providing information on annual meteor showers and photo-exposure information for the planets are particularly useful. There is also a pair of programs to help beginners learn the constellations.

The programs in *Celestial BASIC* are written in Applesoft, Apple's variant of Microsoft BASIC. Burgess has taken some pains to avoid using the Apple's unique features in most programs, so it isn't too hard to get them running on other machines. We know of amateur astronomers who have had good results from some of the *Celestial BASIC* programs on TRS-80s, Commodore 64s, and Ataris, although they had to make some effort to translate Applesoft's way of doing things to their machine's BASIC. Burgess originally wrote these programs on an Exidy Sorcerer. In an appendix, Burgess gives three of the more interesting graphics-based programs in their Sorcerer versions. Since there is now a paucity of Sorcerer software, this book should be of special interest to Sorcerer owners interested in astronomy. *Timex/Sinclair 1000: Astronomy* is a new book from the same publisher as *Celestial BASIC* and uses similar programs that have been adapted to the T/S 1000.

The biggest advantage of *Celestial BASIC* is the open code. Burgess suggests ways to combine and modify the programs, and there is no better way to learn about something than to wade into its innards and modify it to your own purposes. In this respect, the *Celestial BASIC* programs are much better learning tools than most of the prepackaged software on the market.

While Burgess's programs are fine learning tools and information utilities for amateur astronomers, he doesn't discuss the source and quality of the algorithms in enough detail to satisfy a professional. Additionally, if you want similar programs in a language other than BASIC, trying to decipher the algorithms woven into Burgess's BASIC code can be tough going.

ASTRONOMY FUNDAMENTALS

Until recently there was no collected source for the fundamental algorithms related to time, the calendar, and the positions and properties of solar system objects. Jean Meeus has done both amateur and professional astronomers a great service by looking through a wide variety of ancient and obscure sources and bringing the best of the material together in his *Astronomical Formulae for Calculators*. Since *Celestial BASIC* was written around the same time as *Astronomical Formulae*, Burgess didn't have access to Meeus's fine algorithms. Instead, Burgess often used algorithms of lower quality and more limited range.

Regrettably, Meeus seldom gives his source for the algorithms. However, he provides a clear and definitive discussion of the formulae with implementation hints and sample runs for Hewlett-Packard calculators. Meeus provides the formulae and general

(continued)

computational methods, rather than Hewlett-Packard listings, so these algorithms are equally accessible to everyone who can program. This book really opens the way for amateur astronomers to proceed into computational astronomy and is equally useful to the professional who needs to compute temporal, calendric, or solar system phenomena.

Many of the algorithms in *Astronomical Formulae* can be implemented in a few lines of code. However, those that yield good positions for the sun, moon, and planets can grow into complex monstrosities. Roger Sinnott, proprietor of Cosmic Computer Works, an astronomical software house in Belmont, Massachusetts, has implemented these algorithms in a very elegant program called Planets. At $25 (last time we checked) the program is a bargain, and its open code is well worth a careful examination. Sinnott supplies Planets and a number of other superb programs in BASIC on disks or cassettes for Apple, TRS-80, and North Star computers.

Planets yields the celestial position and apparent size, brightness, and phase (if applicable) of the sun, moon, and planets. When the user supplies the latitude and longitude, the program provides altitudes and azimuths—a handy feature, since astronomers are frequently called upon to provide solar altitudes and azimuths for other professionals. We have used Planets to provide this kind of data to architects building solar-collection features into houses, satellite-dish installers, weather scientists, and lawyers.

In addition to very well organized and structured code, Sinnott has taken great care to avoid the pitfalls presented by the limited-precision binary floating-point numbers common to most BASICs. For example, he splits Julian Day numbers into their integer and fraction parts to effectively provide double precision. In addition, he traces the fundamental constants given in the Meeus algorithms to their sources and compares the results of the program with the standard mainframe-generated tables to verify their validity over a range exceeding 3000 years. This is one of the few really well documented astronomy programs available.

REFERENCES FOR COMPUTATION

Compact Numerical Methods for Computers by John C. Nash. Adam Hilger Ltd., Techno House, Redcliffe Way, Bristol, England BS1 6NX. A good section on machine and number characteristics precedes a concise discussion of problems in linear algebra, matrixes, nonlinear equations, and other topics. Helps to select methods appropriate for micros.

Computer Approximations by John F. Hart, E. W. Cheney, Charles L. Lawson, Hans J. Maehly, Charles K. Mesztenyi, John Rice, Henry G. Thatcher Jr., and Christopher Witzgall. John Wiley & Sons Inc., 605 Third Ave., New York, NY 10158. A lot of authors, but they all deserve credit for providing the fundamental source of polynomial approximations for the standard trigonometric and mathematical functions.

Floating-Point Computation by Pat H. Sterbenz. Prentice-Hall Inc., Rte. 9W, Englewood Cliffs, NJ 07632. Good functions require a good underlying system of arithmetic. A must for language writers teaching machines to add, subtract, multiply, and divide.

"Improved Trigonometric Functions for CBASIC-80" by Robert Lurie. *Microsystems*, vol. 4, no. 12, December 1983, pages 130–132. Uses algorithms from *Computer Approximations* to fix CBASIC-80's very poor trigonometric functions.

Pascal User Manual and Report by Kathleen Jensen and Niklaus Wirth. Springer-Verlag New York Inc., 175 Fifth Ave., New York, NY 10010. The fundamental source for Pascal users.

Software Manual for the Elementary Functions by William J. Cody and William Waite. Prentice-Hall Inc., Rte. 9W, Englewood Cliffs, NJ 07632. Implementation notes for *Computer Approximations* with FORTRAN test programs and comments on the quality of the algorithms.

"Transcendental Functions" by Hal Hardenbergh. DTACK Grounded no. 16, January 1983, and no. 18, April 1983, *Digital Acoustics*, 1475 E. McFadden Street, Suite F, Santa Ana, CA 92705. Uses the algorithms in *Computer Approximations* to implement the standard functions to 14 digits of precision on a 68000 microprocessor.

STAR AUTHORITY

In Canada, Great Britain, and the United States, the official source of astronomical data is the *Astronomical Almanac*. The compilers of the *Almanac* provide two publications that are a gold mine for advanced programmers. The *Explanatory Supplement* discusses in great detail, with a complete list of sources, the methods used to generate the book's superbly accurate tables. The *Almanac for Computers* is designed to help users of small computers generate positions for the sun, moon, and planets with accuracy comparable to the tables in the *Astronomical Almanac*. There is a penalty for this extreme accuracy. The equations have limited range, typically a month for the planets and five days for the moon. A different set of coefficients must be provided for the equations for each period, so programs using these equations must store quite a bit of data. Like the *Astronomical Almanac*, the *Almanac for Computers* is published yearly, and each year the data it provides for each object must be updated in the programs. However, this is the way to go if you require *Astronomical Almanac* accuracy and you don't want to flip through all the pages. In addition, the *Almanac for Computers* offers the best discussion and method for calculating sunrise and sunset that we've seen.

In the microcomputing world, a directory like the one we provide (see the "Astronomical Software Resources" text box on page 240) can go out of date rapidly. Fortunately, John Mosly of the Griffith Observatory (2800 East Observatory Rd., Los Angeles, CA 90027) maintains a current list of astronomical programs. To obtain the Griffith list send him a legal-size, self-addressed envelope with two first-class stamps. He has reviewed a number of these programs in an article entitled "The Universe on a MicroComputer," published in the October 1984 issue of *Griffith Observer* (vol. 48, no. 10, available from the observatory for 75 cents plus postage). The article is illustrated with graphics and screen dumps from several of the programs along with a good discussion of their features.

The best way to stay in touch with the world of astronomy is through *Sky & Telescope* magazine. The BYTE of the astronomical community, it serves both professionals and amateurs. *Sky & Telescope* advertisements list new software, and Roger Sinnott conducts a fine monthly section called "Astronomical Computing." He frequently provides short utility programs in BASIC that are very carefully crafted and discussed, and he takes care to use a version of BASIC that can be adapted to a wide variety of machines. Frequently, the "Gleanings for ATMs" (amateur telescope makers) section of the magazine, also under the direction of Sinnott, has good hardware articles about applications like the microprocessor control of telescopes or image processing.

Astronomy is another good magazine, directed more to an amateur and beginning astronomer audience than *Sky & Telescope*. *Astronomy* is a fine place to look for software ads, and it frequently publishes useful BASIC programs that have been very carefully crafted to be friendly to newcomers to both astronomy and computing.

Whether they're used to control a telescope, output a graph, or chart the position of a celestial object, microcomputers are changing the way amateurs and professionals alike are approaching the study of the sky. The accompanying text boxes will give you ample information to start with.

Welcome to astronomical computing. ■

ASTRONOMY SOURCES

BYTE would like to thank the following authors for their contributions to this listing: Richard Bochonko, David S. Dixon, Russell M. Genet, and William T. Peters.

Astronomy magazine. Milwaukee, WI: AstroMedia Corporation.
Superb artwork and illustrations. Easy reading for students and beginners yet satisfying to old hands. AstroMedia offers a wide selection of books via mail order.

Ball, John A. *Algorithms for RPN Calculators*. New York: John Wiley & Sons, 1978.
An astronomer's collection of general-science and astronomical methods arranged for the HP-45 and other HP calculators.

Bate, Roger R., et al. *Fundamentals of Astrodynamics*. New York: Dover Publications, 1971.

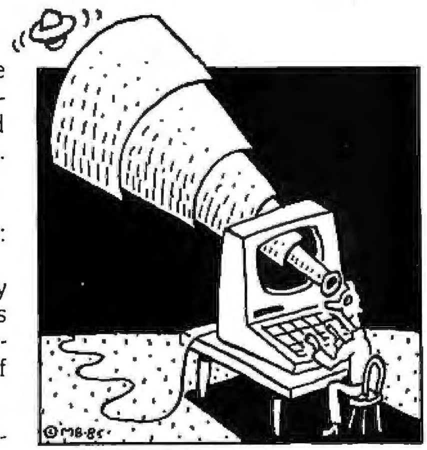
Burgess, Eric. *Celestial BASIC*. Berkeley, CA: Sybex Inc., 1982.
A fine selection of BASIC programs. Especially good for those new to astronomy and computing. Disk with programs listed in the book is available from S & T Software (13361 Frati Lane, Sebastopol, CA 95472).

Burgess, Eric, and Howard J. Burgess. *Timex/Sinclair 1000: Astronomy*. Berkeley, CA: Sybex Inc., 1984.
BASIC programs for the Timex Sinclair microcomputer. Adapts material similar to that in *Celestial BASIC* to the Timex Sinclair.

Crawford, D. *Instrumentation in Astronomy*, vols. I, II, III, IV, and V. Bellingham, WA: SPIE.
Extensive series on instrumentation instruction including the use of mini- and microcomputers.

Dickinson, Terence. *Nightwatch*. Scarborough, Ontario, Canada: Firefly Books, 1983.
Not a computing book, but an excellent guide to the night sky and the world of astronomy if you need a place to start.

Duffett-Smith, Peter. *Practical Astronomy with Your Calculator*, 2nd ed. London, England: Cambridge University Press, 1981.



A good selection of simple algorithms that are useful when you want quick, limited-precision results.

Genet, Russell M., and Mark Trueblood. *Microcomputer Control of Telescopes*. Richmond, VA: Willmann-Bell Inc., 1985.

Genet, Russell M., ed. *Microcomputers in Astronomy*, vols. I and II. Fairborn, OH: Fairborn Observatory, 1983 and 1984.
Telescope control, instrument control, data logging, and other applications. A collection of papers devoted to automatic telescope control and photometric data collection.

Genet, Russell M. *Real Time Control with the TRS-80*. Indianapolis, IN: Howard W. Sams & Co., 1982.
Data logging, instrument control, and analysis for the Radio Shack TRS-80.

Ghedini, Silvano. *Software for Photometric Astronomy*. Richmond, VA: Willmann-Bell Inc., 1982.
Reduction and analysis programs in HP BASIC. Just the thing if you want to seek meaning in the slowly varying light of pulsating or eclipsing variable stars. The HP BASIC may be a bit tough, however, to convert to other machines. Good explanations.

Hall, D., and R. Genet. *Photoelectric Photometry of Variable Stars*. Fairborn, OH: Fairborn Observatory, 1982.
Small observatory guide to photometry with some data logging and instrument control.

Henden, Arne A., and R. Kaitchuck. *Astronomical Photometry*. New York: Van Nostrand Reinhold, 1982.
Well-rounded book on photometry including some software and interfacing.

Institute of Theoretical Astronomy. *Ephemerides of Minor Planets*. Moscow, USSR: USSR Academy of Sciences through Mezhdunarodnaja kniga, 1980, 1982, 1984.

James, M. L., et al. *Applied Numerical Methods for Digital Computation with Fortran and CSMP*, 2nd ed. New York: Harper & Row, 1977.

Jones, Aubrey. *Mathematical Astronomy with a Pocket Calculator*. New York: Halsted Press, 1979.
Keystroke sequences in both algebraic and RPN notation for problems related to time precession, proper motion, positions of solar system objects, and orbits of binary stars. Good appendix with sophisticated HP-25 and HP-67 programs mainly contributed by Jean Meeus. Methods are readily adaptable to other machines since formulae and sample problems are presented.

Klein, Fred. *Pocket Computer Programs for Astronomers*. Los Altos, CA: Klein Publications, 1983.
Handy programs for use right at the telescope. Methods for finding objects using setting circles on Dobsonian and other altazimuth-mounted telescopes. The next best thing to an automated telescope.

Marsden, Brian G. *Catalog of Cometary Orbits*. Hillside, NJ: Enslow Publishers, 1983.

Meeus, Jean. *Astronomical Formulae for Calculators*, 2nd ed. Richmond, VA: Willmann-Bell Inc., 1982.
Classic reference on the topic. There are many others, but Meeus is authoritative. The best single compendium of algorithms. Available from *Astronomy* magazine, *Sky & Telescope* magazine, and Willmann-Bell Inc.

Minor Planet Center. *Minor Planet Circulars*. Cambridge, MA: Smithsonian Astrophysical Observatory.

The Observer's Handbook. Toronto, Ontario, Canada: The Royal Astronomical Society of Canada (RASC). Issued annually.
The standard set of tables for amateur stargazers. Many programs

ILLUSTRATED BY MICHAEL BARTALOS

seek to replace the table or offer the same type of information in a more versatile way. However, the *Handbook* is much easier to stuff into a jacket pocket than an Apple II. And its "ink-on-paper display" does not disappear at −40°C as does a liquid-crystal display.

Ottwell, Guy. *The Astronomical Calendar.* Greenville, SC: Department of Physics, Furman University, 1983. Issued annually.

The same basic type of information as the RASC *Observer's Handbook* conveyed with Ottwell's own deep sense of appreciation for all things cosmic and their connections to our terrestrial realm. Superb hand-drawn illustrations by the author. A children's version called *The View from Earth* is also available.

Sky & Telescope magazine. Cambridge, MA: Sky Publishing.

A source for many of the books listed here.

Tattersfield, D. *Orbits for Amateurs with a Microcomputer.* Somerset, NJ: John Wiley & Sons (distributor), Halsted Press (publisher), 1984.

BASIC programs for orbital computations with supplemental explanations.

United States Naval Observatory, Nautical Almanac Office. *The Almanac for Computers.* Washington, DC: U.S. Government Printing Office. Available annually.

High-precision polynomial approximations for the positions of major solar system objects. Helpful introduction and discussion, though no programming examples are given. Excellent source for precise formulae for basic astronomical calculations.

United States Naval Observatory. *The Astronomical Almanac.* Washington, DC: U.S. Government Printing Office, and London, England: Her Majesty's Stationery Office. Available annually from 1981 to 1984.

Includes the standard tables referenced by astronomers and others in need of precise-time and celestial-position data. Some explanations, but refer to *The Explanatory Supplement* for all details.

United States Naval Observatory. *The Explanatory Supplement to the Astronomical Almanac.* Washington, DC: U.S. Government Printing Office, and London, England: Her Majesty's Stationery Office.

Explanations of how the official tables are made. A gold mine, but not all of the methods are adaptable to a microcomputer, and some of the explanations are hard to understand even for a professional. A scholarly work with detailed references.

Wolpert, Robert C., and Russell M. Genet. *Advances in Photoelectric Photometry,* vols. 1 and 2. Fairborn, OH: Fairborn Observatory, 1983 and 1984.

Data logging, instrument control, and some analysis.

An Astronomy Glossary

Celestial Sphere: Astronomy uses a coordinate system for the sky that is directly analogous to the earth's system of latitude and longitude. The celestial equator is coplanar with the earth's equator. The declination (latitude) ranges from +90 degrees (north pole) to −90 degrees (south pole). The celestial equator crosses the ecliptic (q.v.) at the two equinoxes. The vernal equinox serves as the prime meridian (0-hour or 24-hour) for the right ascension (longitude) of the system.

Ecliptic: The plane containing the earth's orbit around the sun, defined with respect to the first point of Aris (the vernal equinox). The ecliptic changes each year.

Ephemerides: A table of position coordinates versus time for a celestial body.

Obliquity of the Ecliptic: The angle between the plane containing the earth's equator and the ecliptic. The obliquity is a cyclically changing value centered on approximately 23 degrees, 27 minutes.

Orrery: A mechanical model of the solar system that shows the relative positions and motions of the various bodies.

Osculating Orbital Elements: The Keplerian values for the theoretical orbit of a body; that is, the two-body path of an orbit. In any case where there are more than two bodies interacting in a system (such as in the solar system), the osculating orbital elements are only an approximation of the true orbital path.

Parallax: The difference in the apparent position of a celestial body due to the earth's orbiting around the sun. The major scientific argument against the Copernican model of the solar system was that there was no such observable difference in the apparent positions of stars during the year. It was not until the development of photography in the nineteenth century that the effect was measurable.

Parsec: Parsec, which stands for parallax second, is a unit of astronomical distance. It is defined as the distance that a celestial body would have to be from the sun in order for an earthly observer to see a one arc-second change in its apparent position (parallax) between the vernal equinox and the autumnal equinox (or any two orbital antipodes). The value is approximately 3.26 light-years.

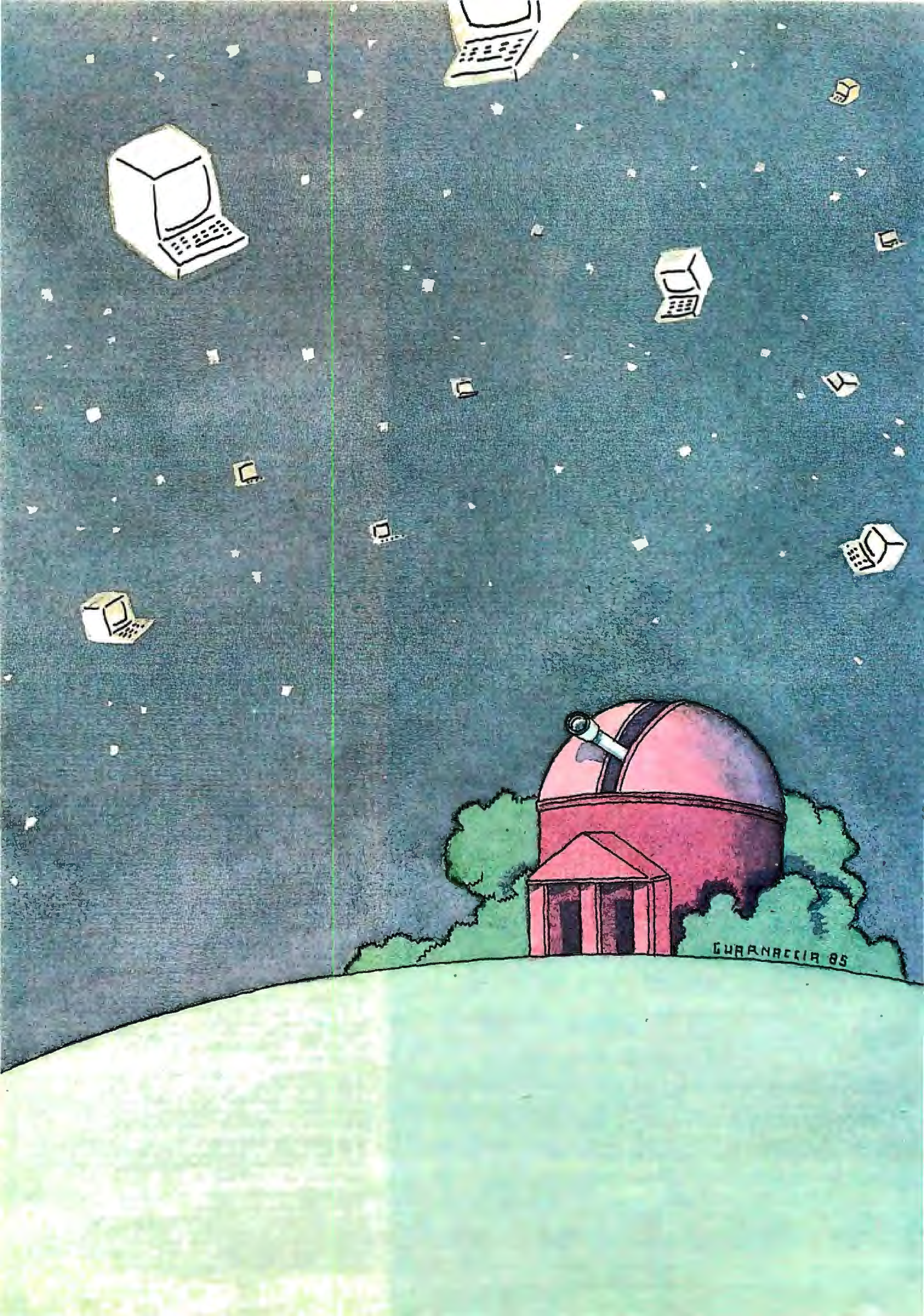
Right Ascension and Declination: See "Celestial Sphere."

Setting Circles: Calibrated disks that attach to the axes of a telescope. Setting circles are an easy way to locate stars quickly. The right-ascension (see "Celestial Sphere") circle is marked in hours and minutes; the declination circle is marked in degrees. To locate a star, look up its coordinates in right ascension and declination and rotate the telescope axes to the star's indicated position.

Sidereal Time: Sometimes called star time, sidereal time is based on the time of the earth's rotation compared to any star other than our sun. A sidereal day is divided into 24 hours, but each day is about 4 minutes shorter than a solar day. Sidereal and solar time coincide only at the instant that the sun crosses the equator at the autumnal equinox.

Star Classification: Stars are commonly classified by spectral class as O, B, A, F, G, K, or M in order of decreasing temperature. The star's spectrum is compared to spectra in the Yerkes *Atlas of Stellar Spectra* to determine its class.

Universal time: Another name for Greenwich Mean Time.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Reviews

ONE OF THE NEWER MEMBERS of Texas Instruments' Professional Computer line is a portable called the Pro-Lite. This briefcase-size machine uses an 80C88 processor and MS-DOS. It also features good communications capability and a number of expansion options available from TI. Richard Grehan and Eva White, two of BYTE's technical editors, team up to show you what the Pro-Lite can and cannot do.

Our other system review this month studies the NCR Personal Computer Model 4, an IBM PC-compatible that is *not* portable. You can buy the NCR in one of six configurations, choosing the one that best suits your needs. It comes bundled with several tutorial programs and features the enhanced speed of a RAM disk. Author Elaine Holden concludes that this rugged machine is a good value.

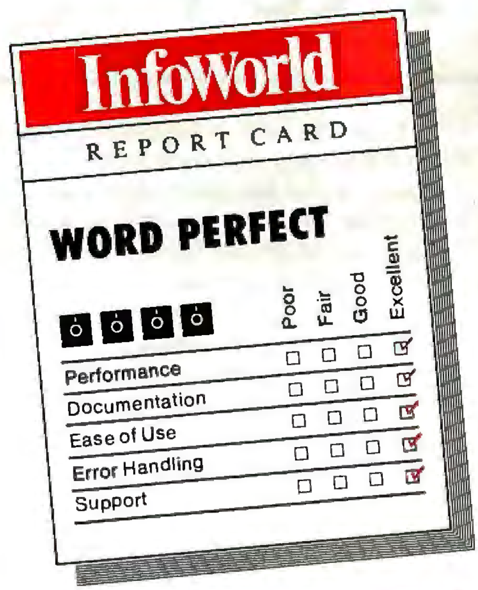
In keeping with our "Computers and Space" theme and in time for the return of Halley's comet, John E. Mosley has evaluated three comet-tracking programs. The first two packages, Starsoft's Halley and S & T Software Service's Halley's Comet, include information specific to the most famous of comets. The third program, Cosmic Computer Works' Ephemeris, is more general and very accurate. Any of these programs will give you the opportunity to practice for tracking Halley's comet this winter.

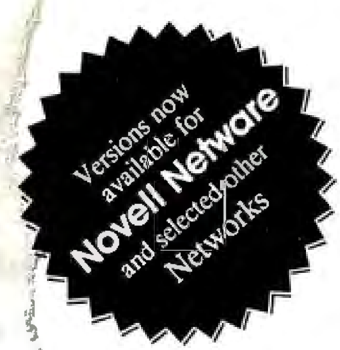
If you prefer to imagine yourself actually in space, you'll be interested in Benjamin Bernar's review of two space-flight simulation programs. Your goal in both Rendezvous and Saturn Navigator is to meet with a space station already in orbit. The decisions you have to make in these simulations mirror the complexities of space travel.

William Hershey follows up his June overview of idea processors with a review of MaxThink, an outline processor for the IBM PC. MaxThink's Thought Processing Language (TPL) is a powerful feature that lets you create programs to use as you develop a writing project.

In the communications area, our review of Anchor Automation's Signalman Mark XII indicates that this modem is not entirely Hayes Smartmodem-compatible. Although it surpasses the Smartmodem by accepting commands in upper- and lowercase and recognizing telephone signals, the Mark XII has fewer LEDs than the Hayes, no DIP switches, and only 6 of the Hayes's 17 software-loadable registers. Author George V. Kinal gives you the details.

WordPerfect 4.0. Our highest marks yet.





A perfect report card. It wasn't necessarily our goal when we added the most recent enhancements to WordPerfect. We were more interested in responding to the suggestions of our users and dealers.

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When optical character recognition (OCR) equipment first came out, it was the kind of item everybody wanted to take seriously. It just seemed the next logical step. No typing, no manual input of any kind. All you had to do was pass a document over the right kind of camera and words were read from paper into memory. After that, document manipulation and output would proceed with normal electronic ease. The major problem has been the very high price of most OCR hardware/software systems. That, along with reports of poor reliability and limited capabilities for recognizing type fonts, kept relegating OCR to the wish list.

With a little luck, we may be seeing a change in the availability of lower-cost, more functional OCRs. Datacopy Corporation of Mountain View, California, showed us its new flatbed-scanner–based Model 700 Word Image Processing System (WIPS). The $4000 unit has, as a $695 adjunct, OCR—or CIR (character image recognition)—capabilities.

Whole pages from letters, books, or magazines (including pictures) can be entered as images into the computer in much the same way as making ordinary photocopies. You can then "edit" them in a variety of painting-program ways. This is fine if what you want to do is capture and store relatively static information. Anything that needs true editing requires an interface to a word processor; in the Datacopy product, this is where the CIR option comes in. It converts text portions of scanned documents to standard ASCII that you can then manipulate with word-processing software. The WIPS/CIR software handles pages that contain both images and text by creating windows for the text and letting you convert just the contents of the windows to ASCII. Initially, the $695 CIR package comes preprogrammed to recognize only the Courier 10 and Prestige Elite 12 typefaces. The company says that about 10 additional typeface-recognition modules for the software can be bought for $195 each. The company also says that another option will be available later this year. This one, called CIR-2, will be preprogrammed for the same two fonts but is scheduled to have font-learning capabilities that will let you train it to recognize additional typefaces.

So, with the $4000 cost of the hardware/software WIPS, the $695 minimum investment in CIR software, either a laser printer or an Epson printer (FX/RX series or LQ-1500), and the required IBM PC XT or AT or equivalent, Hercules Graphics Card, and Mouse Systems PC Mouse, this is not something you'll be buying just to try it out. On the other hand, at a scanning rate of 30 seconds per page, the capability to use your own word-processing software, and a relatively good resolution of 200 dots per inch, it could win a good deal of support. A lot will depend on whether it works as well as it did in a demonstration the company gave us.

—*Glenn Hartwig, Technical Editor, Reviews*

Software Avalanche Forces New Policy

Much as we love new software, we have finally reached our limit for handling unsolicited software packages. We try as many packages as we can, but that is a small percentage of what we receive. We receive so many unsolicited packages, in fact, that we can no longer be responsible for returning them unless they are accompanied by a prepaid return envelope. We regret the need for this change in policy, but the demands on our clerical time have become burdensome, and the shipping costs are high.

We will continue to welcome press releases and other descriptive materials about new software. We will give serious attention to any literature sent. If the written information convinces us that the software described would appeal to BYTE's readership, we will send a formal written request for a review copy of the software.

We will continue to return at our own expense all the software packages we solicit. If we are unable to review a piece of solicited software, we will return it as soon as we arrive at that decision. If we review the package, we will return it as soon as the review is ready for publication.

When packages arrive unsolicited and unaccompanied by prepaid return envelopes, we will acknowledge receipt of them but will not return them. We will do our best to find time to use them but can make no guarantees. If we do not review unsolicited packages, we will store them for approximately one year and then destroy them. If at any time we receive a prepaid return envelope for an unsolicited software package in storage, we will return the software as soon as possible.

S·Y·S·T·E·M R·E·V·I·E·W

Texas Instruments' Pro-Lite Professional Computer

A briefcase-size computer compatible with the TI Professional

BY RICHARD GREHAN AND EVA WHITE

Texas Instruments has a new addition to its TI Professional family, a briefcase-size computer called the Pro-Lite (see photo 1). Designed as a compact MS-DOS computer, it comes with an 80-column by 25-line LCD (liquid-crystal display) screen, 256K bytes of RAM (random-access read/write memory), an internal 3½-inch floppy-disk drive, a keyboard, and a parallel printer interface. This standard unit costs $2995. The Pro-Lite's processor is an 80C88, which is a CMOS (complementary metal-oxide semiconductor) version of the 8088 for low power consumption, running at 5 MHz. It also boasts a wide variety of expansion options and some remarkable communication abilities.

Closed up, the Pro-Lite is a gray molded-plastic box measuring 2¾ by 11½ by 13 inches and weighing 10½ pounds. Some of the Pro-Lite's options add considerably to its dimensions and weight. The LCD also acts as the keyboard cover. Two slide latches on either side toward the case's front release the display, and you swing it up on a large hinge. This hinge was stiff on our machine, and opening and closing the display flexed the unit. The entire keyboard is mounted on a spring-loaded platform that tilts up when you open the unit so the keys are at a comfortable typing angle.

The power switch is near the front of the machine on the right. You slide it up to turn on the Pro-Lite. If you forget to turn the machine off when you close the top, a tab on the display's frame slips through a notch and forces the switch to the off position.

The Pro-Lite's AC/DC (alternating current/direct current) adapter lets you run the unit from an ordinary wall outlet, but it consists of an ungainly transformer box that is positioned along the length of the power cord in such a way that you have to make room for it on your desk.

THE DISPLAY

The LCD screen working area is 9¼ by 4 inches and the text is fairly readable, although, as with every other LCD screen we've seen, glare and reflection almost always overwhelm it. A contrast-control slider to the screen's right lets you adjust the intensity. Unfortunately, half of the slider's range produces a display that is too light to read.

Screen resolution is 640 horizontal by 200 vertical pixels, and an optional LCD graphics board enables bit-mapped graphics on the screen. The Pro-Lite's characters are 7 by 7 pixels right-justified in an 8- by 8-pixel grid. Thanks to the rectangular shape of the pixels (twice as tall as they are wide) the characters appear as they would on a CRT (cathode-ray tube) display. The character set comprises all the graphics (box-drawing), select Greek alphabet, and miscellaneous characters of the IBM PC's character set—including the normal and reverse-video smiling faces. Since the character definitions are downloaded into RAM from ROM (read-only memory) at boot-up time, you can define your own if you don't like the set provided.

KEYBOARD

Texas Instruments has packed many features into the Pro-Lite's 79-key keyboard (see photo 2). The top row includes 12 programmable function keys and some keys useful for text editing. On the right side of the keyboard, 18 keys double as an embedded numeric keypad that you enable by holding down the Shift and Num Caps keys; you disable it by pressing this combination again. An LED (light-emitting diode) on the Num Caps key glows green when the embedded keypad is enabled, glows red when the capitals are locked on, and is unlit (white) when the keyboard is in lowercase.

Some compromises have been made on the keyboard's arrangement. The space bar has been shortened to accommodate a row of cursor-control keys to its right and the single open-quotation mark (') and backslash (\ ) keys to its left. Also, Line Feed is on the top row with the function keys.

Richard Grehan and Eva White are technical editors for BYTE. *They can be contacted at* POB 372, *Hancock,* NH 03449.

The keyboard has a snappy and responsive feel. We found it comfortable to work with, although the Tab key is no larger than any other and we occasionally had to search for it. We were happy to find that the J and F keytops have tactile ridges for locating the home position.

A slot that runs the length of the keyboard platform just above the function keys will hold overlay strips as they become available. This slot is narrow, hardly ½ inch tall, and since each function key could be programmed to do three things (Shift-function, Alt-function, and Ctrl-function) it is hard to imagine an overlay that wouldn't be hopelessly cluttered. In an apparent attempt to alleviate this problem, the Shift, Alt, and Ctrl keys have been color-coded.

Behind Door Number 1 . . .

A plastic door on the machine's right side toward the back unsnaps and swings down to reveal the disk drive and parallel printer connector (see photo 3). The drive is a 3½-inch double-sided mechanism capable of storing up to 720K bytes per disk. The format is compatible with the proposed standard used by Microsoft for 3½-inch disk MS-DOS systems. We were able to read and write files on a disk created on a Data General/One.

The parallel printer connector is a 25-pin female D-type plug located directly below the disk drive. It will drive any printer with a standard Centronics interface. If you own a TI Portable Printer, a connector beside the parallel port lets you power your printer directly from the Pro-Lite.

Options

The Pro-Lite comes with a wide variety of options, most of which were unavailable at the time of this writing. They are divided into three groups determined by how they attach to the basic unit.

Identical to the floppy-disk cover door, but on the opposite side of the machine, is the option-module door (see photo 4). It opens to a chamber of two option-module slots, and each slot can hold either a 300-bps (bits per second) modem, an RS-232C communications interface, an external monitor interface, or a Solid State Software drawer.

The modem is equipped with a standard RJ11 telephone-line jack as well as a built-in connector for an acoustic coupler. It has auto-dial and auto-answer capabilities. The RS-232C interface module lets the Pro-Lite use a serial printer or an external modem.

The external monitor interface adds the video circuitry and extra RAM necessary for attaching an RGB (red-green-blue) color monitor to the Pro-Lite. Resolution on the external monitor is 720 by 300 pixels in eight colors.

(continued)

Photo 1: *The Texas Instruments Pro-Lite Professional Computer.*

Solid State Software drawer is another name for a ROM cartridge. In this case, a drawer can hold up to 256K bytes of ROM software.

Yet another door in the back of the Pro-Lite leads to the rear bus connector. Here you can attach a battery pack, a second 3½-inch floppy-disk drive, or a combination disk and battery. The second drive adds 3 more pounds to the system's weight and 5½ more inches to its depth. The battery pack provides up to eight hours of operation away from an AC outlet, depending on the options you are using. It adds 3 inches to the depth of the machine and 5½ pounds to its weight. You bolt these options to the main unit with two long flathead screws.

Photo 2: *The Pro-Lite keyboard. Note the embedded numeric keypad, the 12 programmable function keys, and the overlay slot for labeling the function keys.*

Photo 3: *Behind the door on the Pro-Lite's right side is the 3½-inch disk drive, parallel printer interface, and power connector for a TI Portable Printer.*

Photo 4: *Behind the door on the Pro-Lite's left are the two slots for plugging in options: an RS-232C interface, 300-bps modem, external color monitor interface, or Solid State Software drawer.*

Be warned: You can attach only one option to the rear bus connector. If you want to use the battery and extra floppy simultaneously, you must get the combination disk/battery module (8½ pounds). The battery is packaged inside the disk-drive case.

System options attach directly to the motherboard inside the Pro-Lite's casing, and they must be installed at the factory or by an authorized TI dealer. System options include up to three RAM expansion boards of 64K or 256K bytes each, an LCD graphics board, and an 8087 numeric coprocessor chip.

The standard unit comes with 256K bytes of RAM: 128K bytes on the motherboard and two 64K-byte expansion boards. If you want the Pro-Lite with all the RAM it can hold (768K bytes), get it that way initially. A 768K-byte Pro-Lite has three 256K-byte expansion boards (the motherboard RAM is disabled) and expanding up to it would leave you with two homeless 64K-byte expansion boards.

The LCD graphics board provides bit-mapped graphics on the screen with a virtual resolution of 720 by 300 pixels. In other words, although the LCD screen can only display 640 by 200 pixels at a time, the graphics option makes the screen a window into an imaginary graphics display of 720 by 300 dots. Holding down the Alt and Shift keys and striking the arrow keys scrolls this window around on the virtual display.

COMPATIBILITY

TI should get high marks for its efforts to keep the Pro-Lite compatible with the Professional Computer. (See "The Texas Instruments Professional Computer" by Mark Haas, December 1983 BYTE, page 286.)

The TI Professional uses three-plane bit-mapped graphics: one plane each for red, green, and blue. When you install the LCD graphics board option in the Pro-Lite, you are buying the equivalent of the blue video-memory plane. You can run graphics software on the Pro-Lite that was originally written for the Professional, with the

(continued)

AT A GLANCE

Name
Texas Instruments Pro-Lite Professional Computer

Manufacturer
Texas Instruments Inc.
Data Systems Group
POB 809063
Dallas, TX 75380-9063
(800) 527-3500

Size
2¾ by 11½ by 13 inches

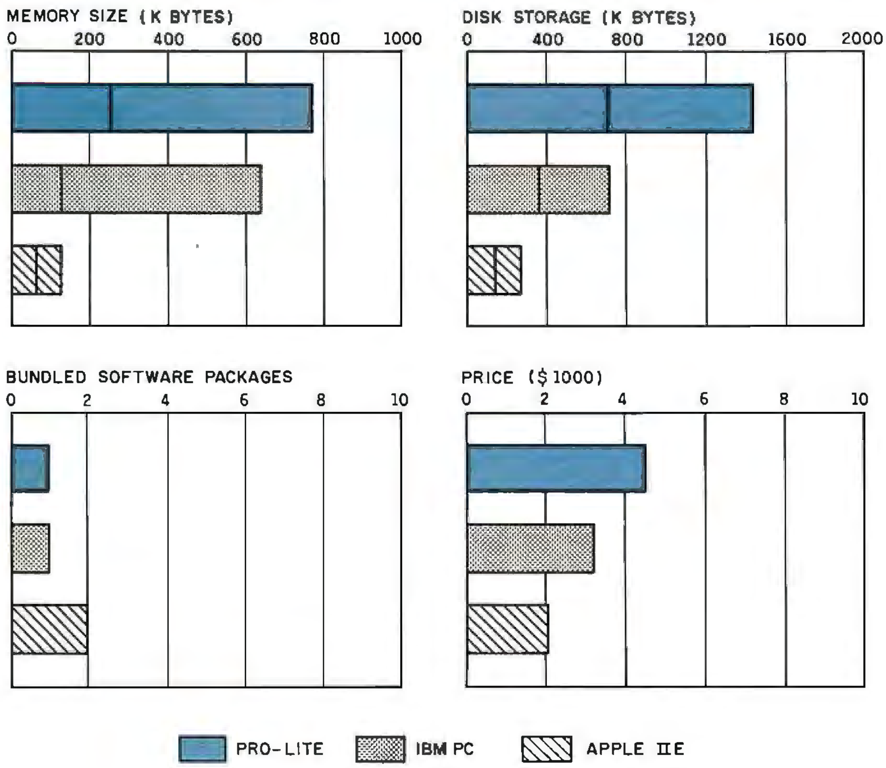
Components
Processor: 80C88, 5-MHz clock
Memory: 256K bytes
Mass storage: One 3½-inch double-sided disk drive, 720K-byte capacity
Display: 80 columns by 25 lines
Keyboard: 79 keys including 12 programmable function keys and an embedded numeric keypad, LED indicator for locked capitals
Expansion: Two option slots

Software
MS-DOS 2.13

Options
Add-on floppy-disk drive (with or without battery), battery pack, 300-bps modem, RS-232C interface, PC interface cable, 8087 coprocessor, 64K-/256K-byte RAM expansion boards, external color monitor interface, Solid State Software drawer

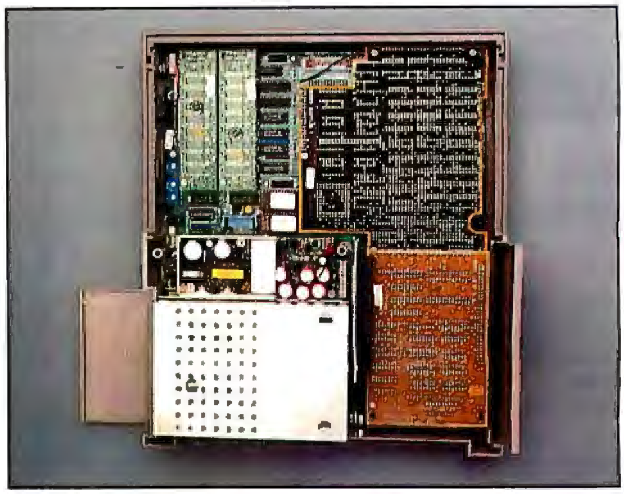
Price (suggested retail)

Pro-Lite standard configuration	$2995
Second disk drive	$595
300-bps modem	$300
External color monitor interface	$499
RS-232C interface	$225
Battery pack	$149
PC interface cable	$79
LCD graphics option	$150
64K-byte memory upgrade	$125
256K-byte memory upgrade	$595

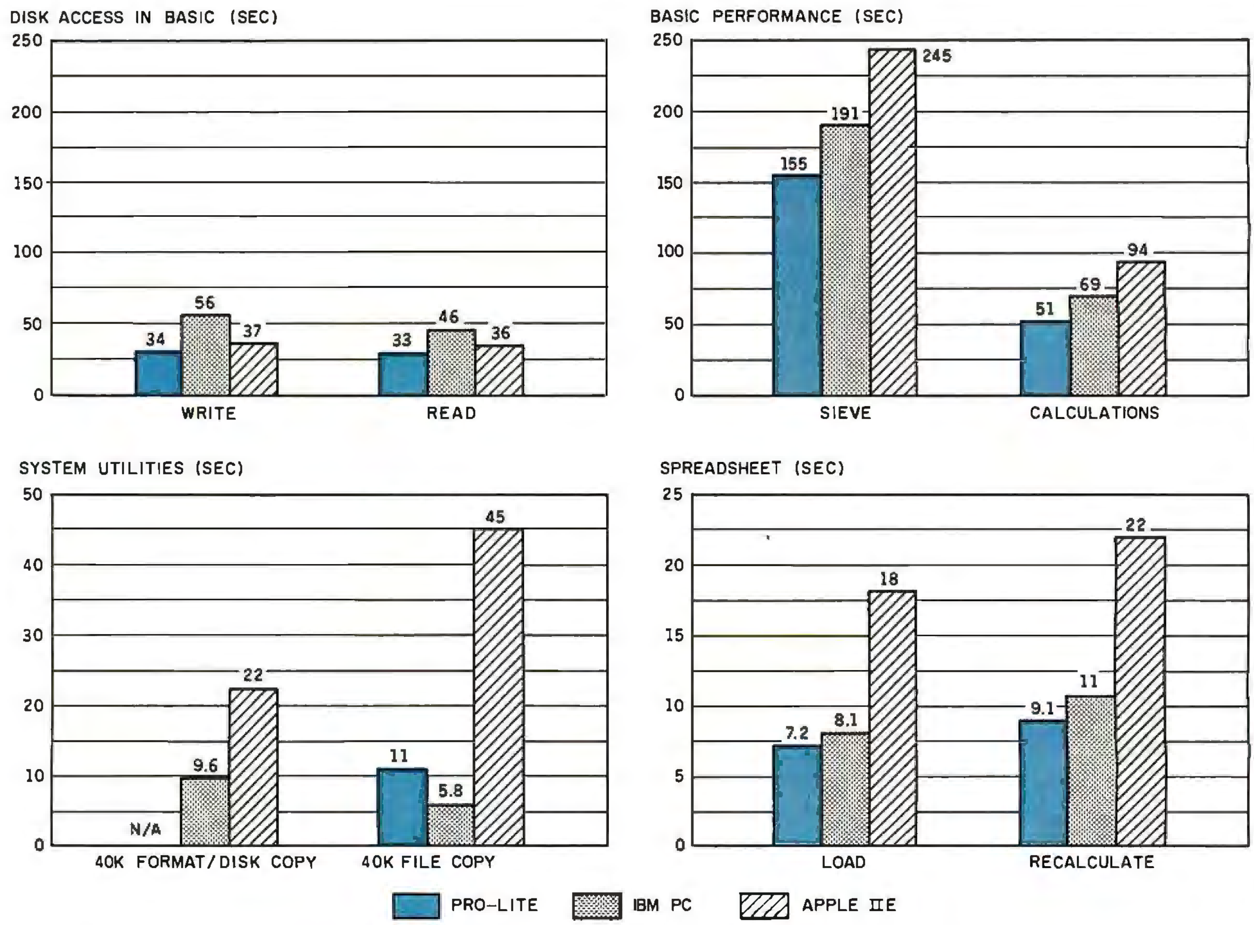


The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity of a single and dual floppy-disk drive for each system. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of a system with two high-capacity floppy-disk drives, a monochrome monitor (an LCD screen for the Pro-Lite), 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 and standard BASIC interpreter for each system.

The rear panel of the Pro-Lite. Note the connector in the lower left corner for the AC/DC power adapter and the silver door that leads to the rear bus connector.



A top view inside the Pro-Lite.



The graph for Disk Access in BASIC shows how long it takes to read this file. (For the program listings, see June 1984 BYTE, page 327, and October 1984, page 33.) The BASIC Performance graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. In the same graph, the Calculations results show how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. In the System Utilities graph, the Format/Disk Copy was not performed on the Pro-Lite since this requires a dual-floppy system. The File Copy results show how long it takes to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers take to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. The spreadsheet benchmark program is Multiplan. DOS 3.3 was used with the Apple II.

constraint that only the blue plane will be displayed on the LCD screen. (TI has modified the Pro-Lite's version of MS-BASIC so that anything drawn in a nonblack color will be displayed.)

Also, another price has to be paid for the Pro-Lite's compactness. Since a character cell on the Pro-Lite is 8 pixels wide, while a cell on the Professional is 9 pixels wide, a display generated on the Professional that contains mixed text and graphics will appear with the graphics out of place on the Pro-Lite.

Purchasing the external color monitor option gives the Pro-Lite full video compatibility with the Professional. This option includes all the memory necessary for the three video planes, as well as circuitry for displaying full Professional-size characters.

Additionally, every key on the TI Professional's keyboard has a counterpart on the Pro-Lite's keyboard. This is possible in spite of the Pro-Lite's space limitations thanks to its embedded numeric keypad.

Drive-Access Link

Getting information from one computer to another is always a problem, and you'd expect this to be especially true for the Pro-Lite with its 3½-inch drives in a 5¼-inch world. Normally, you would be faced with purchasing either the 300-bps internal modem option or the RS-232C interface option and transferring your files serially, probably over the phone lines. However, TI has taken care of this with a clever interface called the PC interface cable.

One end of the PC interface cable plugs into the rear bus connector. The other end plugs into the external drive connector found in the back of the TI Professional, the IBM PC, and some PC-compatibles. (The IBM PC's technical reference manual refers to this connector as the 5¼-inch disk-drive adapter external interface.) This drive-access link, as TI calls it, lets another PC control the Pro-Lite's floppy as if it were external drive C:.

When you use the drive-access link, the Pro-Lite's keyboard is disabled—you have what amounts to a very expensive 3½-inch floppy disk. However, the ease with which you can transfer files in this fashion beats a serial transfer any day; you simply use the standard MS-DOS Copy command. We used the drive-access link successfully with a TI Professional as well as an IBM PC.

Table 1: *The benchmark results for a word-processing test run on the Pro-Lite using WordStar. All times are in seconds.*

WordStar Test	Pro-Lite	IBM PC
Document load	6.6	9.9
Document save	21.3	24.2
Search	10.3	10.5
Scroll	9.6	41.2

The Pro-Lite's MS-DOS 2.13 normally formats its disks to 80 tracks per side. This is no problem for the TI Professional since its MS-DOS 2.13 is shipped along with the PC interface cable and can read this format. However, since the IBM PC expects the external drive to be formatted to 40 tracks per side, you should format the disk from the IBM PC. (The MS-DOS provided with the Pro-Lite can read disks of either capacity.) Of course, disks formatted with 40 tracks per side will hold only half the normal amount of data.

Also, a bank of DIP (dual in-line package) switches on the IBM PC's motherboard determines how many disk drives the system will recognize. Most PCs will have these switches set for only two drives so the IBM will not "see" an external drive. Before you use the drive-access link to connect the Pro-Lite to your IBM PC, you should refer to the PC's technical manual and make sure these switches are set appropriately.

Software and Documentation

The only operating system currently available for the Pro-Lite is MS-DOS 2.13, which comes bundled with the system. Third-party application software packages available include WordStar, Volkswriter, dBASE III, Framework, Multiplan, and many others. Generally, you can expect any packages available for the Professional to be available for the Pro-Lite.

We were even able to transfer some of the software for the Professional through the PC interface cable to the Pro-Lite and have it run successfully. You should check your software license agreement before doing this.

The benchmark results for the Pro-Lite (see the "At a Glance" box) show a significant improvement over the IBM PC for everything except system utilities. The word-processing benchmarks (see table 1) also show an improvement over the PC.

An Operating Instructions guide and two MS-DOS manuals are provided with the Pro-Lite. These manuals come in three-ring binders (8 by 9 by 2 inches) with a box to put them in. The operating guide seems geared for new users; it has clear explanations, diagrams of the computer's parts, and not too much detail to confuse a beginner. I found only one typographical error in the guide: On page 2-2 the screen, keyboard, and option-module slots' labels were interchanged.

Conclusion

The Pro-Lite performs as advertised. We found that it concealed no unpleasant surprises, and TI should be applauded for the variety of expansion options available. If you add the options that suit your needs, the Pro-Lite can be as powerful as most desktops, with the added advantage of portability. It is, however, priced noticeably higher than nonportables of comparable capabilities, and some people might find the cost of portability too high. Also, the Pro-Lite is a little awkward as a portable, especially if you add the floppy/battery option—no one wants to carry a 19-pound computer in his or her briefcase.

Systems like the Pro-Lite point in the direction of compact portable computers that are easy to use, have considerable power, and support as many options and peripherals as larger nonportables. The technology is getting there, but it hasn't arrived yet. ■

S·Y·S·T·E·M R·E·V·I·E·W

NCR *Personal Computer Model* 4

A sturdy IBM PC-compatible

BY ELAINE HOLDEN

The NCR Personal Computer Model 4 is definitely not a portable—it weighs 50 pounds and measures 18 inches wide and almost 15 inches high (see photo 1). But you couldn't find a more rugged computer. And NCR dealers provide dependable service. (Each dealer has a technician trained to handle any repairs. If you're not near a dealer, you can use NCR's mail-in service.)

The NCR computer comes in six variations. Choices include monochrome or color screen, one or two double-sided double-density floppy-disk drives, or a half-height 10-megabyte Winchester drive in place of the second drive.

It is a pleasure to find the on/off switch and the volume and brightness controls located on the front of the unit. The quality of sound is excellent.

SOFTWARE

Like all other IBM Personal Computer (PC) clones, the NCR Personal Computer cannot have BASIC in ROM (read-only memory) as it is in the IBM PC. In order not to violate copyright restrictions, an IBM PC-compatible BASIC must be on a floppy disk. The NCR version of GW-BASIC is easy to use, and the documentation provides excellent support. But the need to have BASIC on a disk almost necessitates the use of two drives; constantly switching disks can be annoying.

I was impressed by the exceptional compatibility of the NCR with the IBM PC. I was able to run Lotus 1-2-3, the Leading Edge word processor, and other packages for the IBM without any problems.

The software that comes with the NCR computer includes self-teaching programs: NCR Tutor, NCR Pal, and an on-disk help facility, NCR Help. I found these programs to be well designed. The disks provide examples of spreadsheets, word processing, games such as blackjack (I'm into the machine for five grand), program-development software (editors, compilers, etc.), and system software (operating systems, run-time interpreters, and utilities). NCR-DOS 2.11, part of the same package, boots easily and is operationally compatible with MS-DOS and PC-DOS systems found on other personal computers. A good feature for novice users is the control placed on the master disk. NCR has designed it to be copied only and not ever used. Once you make the copy, you store the original master and use the copy. This is excellent insurance against accidental loss of the master disk and also gets the user comfortable with making backup copies.

RAM DISK

Another interesting piece of software provided by NCR is the RAM (random-access read/write memory) disk utility. While not to be confused with a plug-in card with lots of memory and the software to use the memory as a disk, this program is an attempt to use internal memory for the same function. Basically, the RAM-disk utility lets you partition the RAM and use part of it for information or programs normally stored on the floppy disk. The information or the program is kept completely in internal memory and can thus speed the functioning of the computer because it has to reference only the information held in RAM rather than go to the external floppy. It is like having a third, very fast, disk drive.

Other microcomputers have lacked this convenience, and it does increase the speed considerably. And when using a word processor, the machine processes directly through the RAM disk and saves time by not referring constantly to the floppy disk for program instructions. The only drawback I see is the need for a large amount of memory to begin with. In order to fully utilize this feature, you would need almost all the memory NCR has to offer.

If you have less than maximum memory in your Model 4, you will have to take my or the company's word for the feature since the RAM Disk Demo does not perform well

Elaine Holden (22 Elm St., Peterborough, NH 03458), formerly an assistant professor of computer science, is doing advanced graduate work at the University of Lowell.

with less memory. The example included with the documentation clocks the time it takes to run a multiplication table with and without the RAM disk. Nice benchmark test—only they both took the same amount of time (11 seconds): no difference noted with only the 128K bytes or up to 256K bytes of memory.

DISPLAY

I found the monochrome display to have excellent resolution, competitive with any on the market. The green-phosphor screen has an 80-character by 25-line display. All characters are clear and easily read. I was equally impressed with the clarity of the color display. This 16-color screen also has a display of 80 by 25 and 640 by 200 pixels.

KEYBOARD

Weighing in at 4½ pounds, the keyboard tilts forward or lies flat (see photo 2). NCR sells the keyboard separately. It's plug-compatible with the IBM PC and the Compaq Deskpro. The keyboard connection is easily accessible at the back of the unit. Layout is compatible with the IBM PC, but NCR designers have added a separate cursor-control pad as well as separate Control, Page Up, Page Down, Delete, End, and Insert keys to the numeric keypad. I found this convenient because I could control functions in word processing while the numeric keypad was still on. Business users will find this a most important feature when jumping from one application to another.

LED (light-emitting diode) indicators on the Caps Lock and Num Lock keys are also an improvement over the standard IBM keyboard. They are not distracting but serve as gentle reminders.

PROCESSOR BOARD

The NCR Model 4 is controlled by an Intel 8088 microprocessor. This unit functioned well through all the benchmarks.

Standard for the NCR is 128K bytes of RAM, expandable to 640K bytes. Expansion from 128K bytes to 256K bytes is accomplished by adding extra chips to the main board in increments of 64K bytes. This board is located behind the adapter boards. To add memory, you remove the back of the machine and all of the boards and insert the chips one at a time. If your fingers have been genetically programmed to resemble needle-nose pliers, you won't have any problem. However, I suspect the workspace may be cramped for the larger-handed members of our species.

Another step in the process calls for the resetting of toggle switches located at the very top of the main board. I did not have a problem with this task, but I suspect that a novice user might, especially since the documentation is insufficient here. NCR should provide a clearer explanation and a set of diagrams.

(continued)

Photo 1: *The* NCR *Model* 4 *with two vertical disk drives.*

You can further expand the system to the full 640K bytes of RAM by inserting a 384K-byte memory board. But if you want extra memory by using the memory board, the 128K-byte expansion chips must first be in place. Once again you have to reset the toggle switches and then replace the boards.

This unit has five third-party-compatible expansion slots and three ports: keyboard, integrated RS-232C asynchronous interface, and a Centronics parallel interface for the printer.

Disk Drives

The NCR Personal Computer is available with one or two 360K-byte double-sided double-density floppy-disk drives. An optional 10-megabyte Winchester drive can also be added in place of one of the floppy-disk drives, an obvious advantage for business users who demand extensive external storage. The 5¼-inch TEAC drives are positioned vertically to the right of the screen. This makes disk exchange very convenient. Initially, though, these drives seemed noisier than those on any of my other computers.

Maybe the positioning of the drives is to blame, though vertical positioning should not be a factor in more noise or vibration. Engineering of either horizontal or vertical disk drives provides for proper bearing placement and counterbalancing of the read/write head, which would preclude any extra noise.

Rather than condemn vertical drives in general, I would rather say these particular drives are noisier. This may be related to the choice of manufacturer; some companies *do* make noisier drives, particularly if they use metal drive bands. When I dismantled the computer I noted that the drives' magnetic-head carriage is moved along the guide shafts by a motor controlled by a steel belt. The drives are secured to a metal housing by three screws (two on the top and one on the bottom), and they rest on a metal plate that may act inadvertently as a sound board. Future engineering changes should deal with the source of the extra vibration and perhaps eliminate the sound board or cushion the assembly with a gasket to absorb more of the vibration encountered by the drive movement.

Documentation

The documentation for the Model 4 is, for the most part, excellent. Since setup is not complicated, a first-time user will feel at once comfortable and in control. The manuals are accurate, and they provide material ranging

(continued)

Photo 2: *The keyboard, sold separately by* NCR, *is plug-compatible with the* IBM PC *and the Compaq Deskpro.*

AT A GLANCE

Name
NCR Personal Computer

Manufacturer
NCR Corporation
1700 South Patterson Blvd.
Dayton, OH 45479
(513) 445-5000

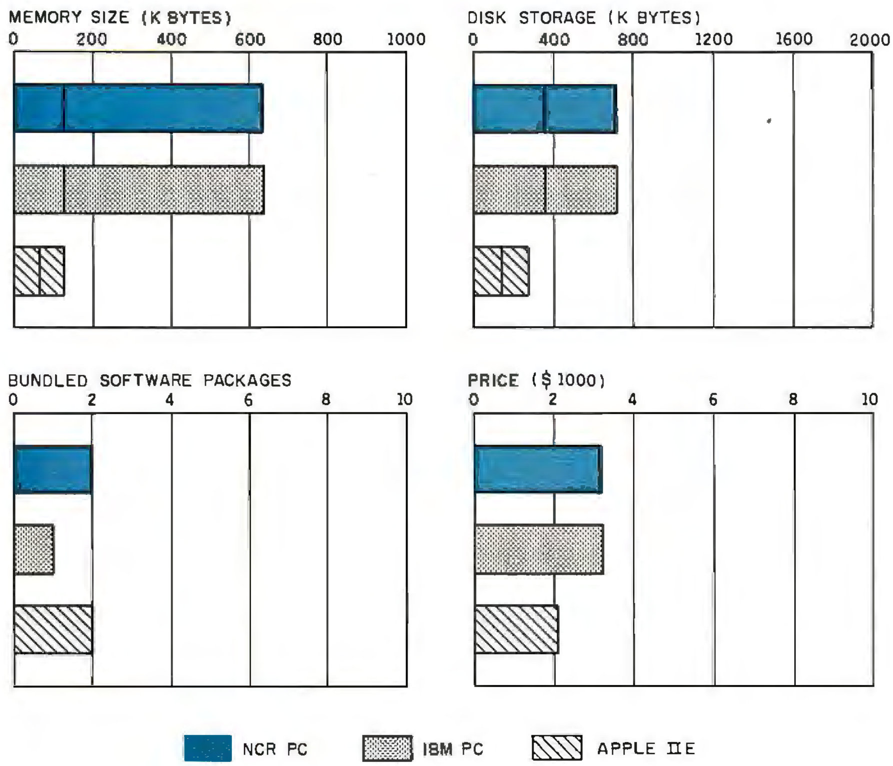
Size
14.8 by 14.6 by 18 inches;
50 pounds

Components
Processor: Intel 8088, 4.77 MHz
Memory: 128K system memory, expandable to 256K; board expansion to 640K
Mass storage: One or two 360K double-sided double-density 5¼-inch TEAC floppy-disk drives; optional half-height 10-megabyte Winchester hard-disk drive or dual 8-inch flexible-disk drives
Display: 80 characters by 25 lines, monochrome green (optional color), 640 by 200 pixels
Keyboard: IBM PC-compatible, plus separate cursor-control pad
Expansion: Three IBM PC-compatible slots available in dual-disk system
I/O interfaces: RS-232C port, parallel printer port

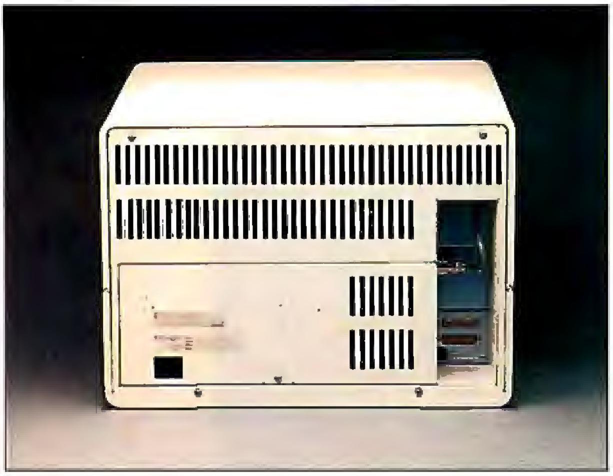
Software
GW-BASIC, NCR-DOS 2.11, NCR Tutor, NCR Pal, NCR Help, diagnostics

Documentation
Owner's manual, GW-BASIC manual, NCR-DOS manual

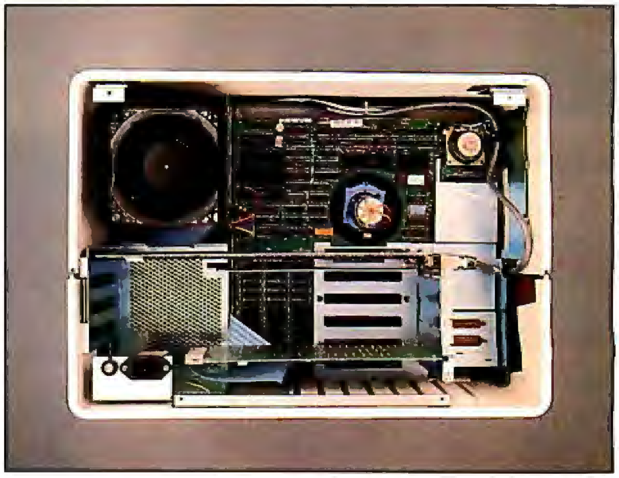
Price
Monochrome screen, one drive, and 128K RAM, $2400;
second drive, $425;
64K RAM, $90;
128K RAM, $180;
parallel or serial printer cable, $45;
10-megabyte hard disk, $2195



The Memory Size graph shows the standard and optional memory for the computers under comparison. The Disk Storage graph shows the highest capacity of one and two floppy-disk drives for each system. The Bundled Software Packages graph shows the number of packages included with each system. The Price graph shows the list price of a system with two high-capacity floppy-disk drives, a monochrome monitor, graphics and color-display capability, a printer port and a serial port, 256K bytes of memory (64K for 8-bit systems), the standard operating system for the computers, and their standard BASIC interpreters.

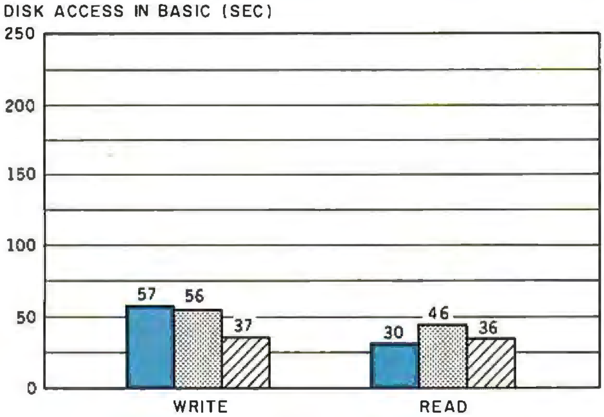


The rear of the NCR PC Model 4. The power supply is at left, the RS-232C and parallel ports are at right.

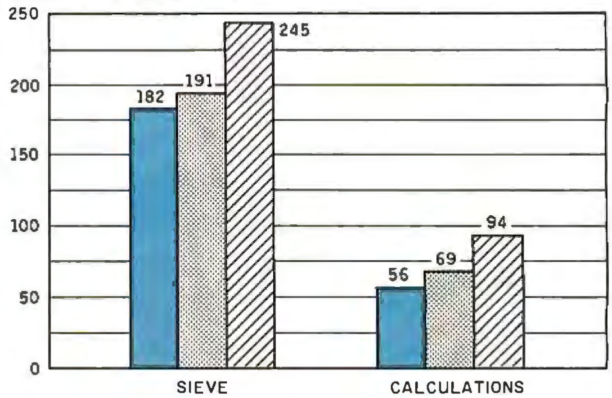


Inside the Model 4. The main CPU board is visible behind the expansion slots.

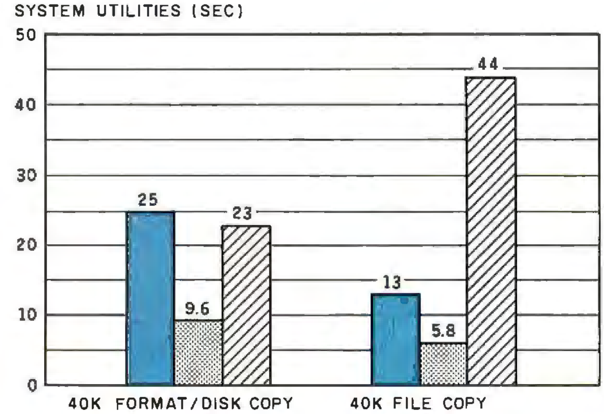
DISK ACCESS IN BASIC (SEC)



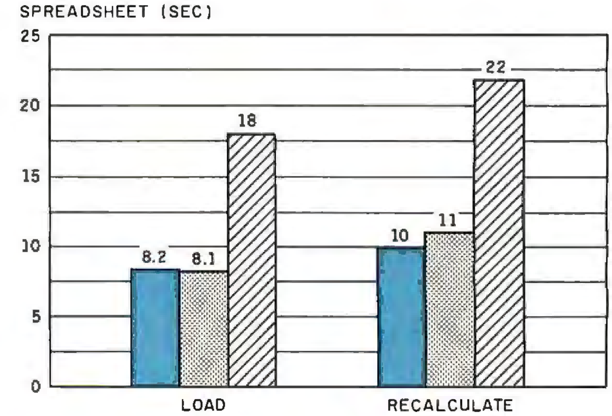
BASIC PERFORMANCE (SEC)



SYSTEM UTILITIES (SEC)



SPREADSHEET (SEC)



NCR PC IBM PC APPLE IIE

In the Disk Access in BASIC graph, a 64K-byte sequential text file was written to a blank floppy disk and then read. (For the program listings, see June 1984 BYTE, page 327, and October 1984, page 33.) In the BASIC Performance graph, the Sieve column shows how long it takes to run one iteration of the Sieve of Eratosthenes. The Calculations column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted time for 40K bytes of disk data) and to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers take to load and recalculate a 25-by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. The spreadsheet program used was Microsoft Multiplan. The tests for the Apple IIe were done with the ProDOS operating system (except for the spreadsheet test, which was done with DOS 3.3). The IBM PC was tested with PC-DOS 2.0.

The technical manual is impressive with its detail. The only section that could use revision is the one on installtion of additional memory.

from a history of computers to the sort of technical information appreciated by long-time computer users. The technical manual is impressive with its detail. Again, the only area that could use revision is the section that describes installation of additional memory.

Support from the company is also notable. All dealers are trained to provide technical assistance and troubleshoot. The manuals, tutorials, and integrated help package should get you through most crises. The manuals make frequent mention of contacting the local dealer if problems arise.

CONCLUSION

Although the NCR Personal Computer is not very portable and has the few imperfections I mentioned, it is still a good value. Ease of setup, documentation, tutorials, company backing, and solid engineering make this machine worthwhile. Other features include the choice between two excellent displays, terrific graphics, a RAM-disk utility that runs programs faster than most IBM PC-compatibles, and moderately easy memory expansion.

Having taught computer science to college students, I know the punishment that hardware must withstand. After giving the Model 4 the same type of rough treatment, I can say it is built like a tank. For heavy computer use and business purposes, this durability is a very important consideration. ■

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S·O·F·T·W·A·R·E R·E·V·I·E·W

Monitoring Halley's Comet

Three programs for tracking the celestial visitor

BY JOHN E. MOSLEY

In 1910 Halley's comet swept past the earth. People everywhere marveled at this heavenly visitor. The comet will be back this winter, and of course we'll all want to see it. Some of us will view it from our yards only; some of us will lug a telescope or newly purchased "comet hunter" binoculars to the dark countryside; and some of us will pay a month's wages to take a cruise to the "land down under" to see the comet high and bright in the southern sky. Some of us are already watching it on little green monitors.

It's fun to keep track of what is happening in the sky and be able to anticipate celestial events. The motions of objects in the solar system, Halley's comet included, are generally too slow to perceive except by looking at them night after night. However, with a computer you can control what you see; you can speed up time and peer into the future (or past), you can see celestial motions graphically and from different perspectives, and you can find relationships that printed tables do not show. Of course, the important thing is to see Halley's comet with your own eyes—nothing else counts—and with a microcomputer and some clever programs, you can be an informed participant as well as an enthusiastic observer.

Although you could create microcomputer programs that would tell you how and where to observe the comet, people have already done the work for you and made their programs commercially available. Some are surprisingly sophisticated, and we're fortunate that such software exists—just in time for Halley's return visit.

Of the three good comet programs available, two are tailored specifically to demonstrate a variety of aspects of Halley's coming appearance. There's also a new book on how to calculate comet orbits.

HALLEY

The most sophisticated of the three programs is named after the English astronomer, Halley. It's distributed by Starsoft and is available on disk for the IBM Personal Computer (PC). The program has four main parts. The first part plots the comet as it moves through the solar system from an imaginary vantage point high above the circling planets. It displays the sun and up to all nine planets at a scale you select. This allows you to see how the comet moves relative to the earth and other planets and how it accelerates as it approaches the sun and passes the inner planets.

The second part of the program plots Halley's comet on a standard rectangular star chart and shows how it moves through the constellations. These two parts of the program show not only the comet but the length and orientation of its tail—a fairly tricky feat.

The third part is numerical rather than graphical and calculates Halley's celestial coordinates and distances from the earth and the sun on a given date or series of dates, allowing you to plot it accurately on a star chart and find it with a telescope even while it is still relatively faint. The accuracy is surprising: positions are to within 1 minute of arc (one-thirtieth the diameter of the moon). The final part of Halley lets you change the orbital parameters and substitute values for any other comet (or any object that orbits the sun) and plot the motions of new comets as they are discovered. You can use the disk beyond 1986, which is especially valuable because several comets are discovered each year.

The first three parts in Halley can show the comet during the coming months as well as any appearances back to ancient times, although with decreasing accuracy as you travel backward. Using the program, you can see why the comet's appearance in A.D. 732 was so spectacular (on this occasion, it came to within 4 million miles of the earth), how it appeared on the eve of the Norman conquest of England in 1066 (when it inspired terror in the English

(continued)

John E. Mosley works at the Griffith Observatory (2800 East Observatory Rd., Los Angeles, CA 90027), where he produces the planetarium show and is in charge of educational activities.

AT A GLANCE

Name	Halley	Halley's Comet	Ephemeris
Type	Astronomy program	Astronomy program	Astronomy program
Distributor	Starsoft POB 2524 San Anselmo, CA 94960 (415) 453-1372	S & T Software Service 13361 Frati Lane Sebastopol, CA 95472 (707) 874-2352	Cosmic Computer Works 243 White St. Belmont, MA 02178
Computer	IBM PC	Apple, Commodore 64, TI Professional	Apple, TRS-80
Format	5¼-inch floppy disk	5¼-inch floppy disk	5¼-inch floppy disk
Price	$34.95	$49.95	$25

defenders), and how it will look when it returns in 2061.

HALLEY'S COMET

Eric Burgess, author of *Celestial BASIC* (both the popular book and the disk), has created a new comet-tracking program called Halley's Comet. The package, distributed by S & T Software Service, is for Apple, Commodore 64, and Texas Instruments Professional computers.

Like Starsoft's Halley, Burgess's package is an ambitious integrated suite of short and simple programs that attempts to cover its subject thoroughly. It offers more text and options than Halley, but it's less accurate.

The first three programs in the package provide a limited amount of background, much of it historical, and include a reference list of previous appearances. Only in the fourth program, Orbit Plots, does the computer begin to make calculations. It also shows a solar system display similar to the first program in Starsoft's Halley, with the comet, Venus, Earth, and Mars as they looked at the time of any appearance since the year 1000. You can select a year and let the orrery run or select a specific date and see a static display for that date while the comet's coordinates and distances from the earth and the sun are provided numerically.

The fifth program shows the path of the comet through the constellations during its 1985–86 visit and provides a tabular printout of its positions. The entire sky is shown as it would look on a standard star chart; however, with only about 200 stars plotted, the constellations are difficult to identify.

The last program offers observation information for a specific location on the earth's surface. You enter longitude, latitude, time, and date and are told the comet's altitude and azimuth and twilight times; you are then shown a display of the comet, complete with tail, in the appropriate part of the sky. The computer selects the proper direction to face, outlines the constellations in sufficient detail for the major constellations to be recognized immediately, and even includes the moon and planets.

Although the accuracy of Halley's Comet is limited and the displays rudimentary, it has enough clever features and options to keep a person busy for several nights. Another strength is that you can get inside the five programs and customize them to your liking. The program is ambitious, educational, and certainly worth the money.

EPHEMERIS

A third good comet program is Ephemeris by Roger Sinnott. It's available for Apples and TRS-80s. This relatively short (one-tenth of a disk) and inexpensive program was written several years ago, when Halley's comet was still distant. Apparently Sinnott didn't think to capitalize then on the comet's return.

Ephemeris is a simple but surprisingly accurate program that requires you to enter the orbital elements of the object you are interested in—there are no default values. It then gives you, for the dates you specify between A.D. 1800 and 2100, a printout of that object's celestial coordinates, distances, angular distance from the sun, and magnitude. The program has no graphical displays or other options, but it is straightforward and solid.

DO IT YOURSELF

People who like to write their own programs will be interested in a new book, *Orbits for Amateurs with a Microcomputer* by D. Tattersfield. This book tells you in a no-nonsense manner all you need to know to calculate a comet's ephemeris from the orbital elements, the elements from three observations of the orbit, and how to take into account perturbations and make differential corrections. It is clearly organized and includes all necessary formulas and tables, but it is not for the casual observer of the skies.

CONCLUSION

When Halley's comet last visited in 1910, household electricity was a novelty and science fiction authors dreamed about futuristic airships. Buck Rogers was still a generation away. Few people who saw Halley's comet then would have guessed that the next time it returned, people around the world would use undreamed-of computing power to follow its progress on little green monitors. ■

For a list of books and periodicals on astronomy, see the "Astronomy Sources" text box on page 244.

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Inquiry 313

S·O·F·T·W·A·R·E R·E·V·I·E·W

Space-Flight Simulators

Rendezvous with a space station or travel to Saturn

BY BENJAMIN BERNAR

Computer simulations of space flight have until recently been done only on mainframes and minicomputers. In this review, I'll discuss two programs that simulate space flight on a microcomputer.

RENDEZVOUS

Rendezvous is a collection of simulations written by Wes Huntress, who, according to the program packaging, is a Ph.D. in chemical physics currently working for the California Institute of Technology's Jet Propulsion Laboratory. The goal of these simulations is to rendezvous with a space station in a 1990-mile circular earth orbit. The mission is divided into four flight phases, each of which you can run independently and in any order. Animated color graphics is used to display the progress of the flight, which you control with the keyboard or joystick.

Booting the Rendezvous disk brings up the mission menu and its options: earth lift-off, orbital rendezvous, approach, and alignment and docking.

The documentation describes the requirements for completing each of these flight phases as well as the space-shuttle-type vehicle you use for this simulation.

Like NASA's space shuttle, the Rendezvous vehicle has two solid rocket boosters (SRBs). A big difference is in their burn time of 90 seconds as opposed to 132 seconds for the real thing. The main engines of the space shuttle are part of the orbiter and typically burn for about 510 seconds. They augment the thrust of the SRBs during the lift-off. The main engines of the Rendezvous vehicle are attached to the external tank instead of the orbiter and are jettisoned with it. The main engines are also turned on with the SRBs and only burn for an additional 200 seconds. Like in the space shuttle, the engines of the orbital maneuvering system (OMS) in the orbiter usually provide for the final orbit-injection velocity. Unlike the OMS engines in the shuttle, they have enough additional fuel to reach an orbit almost three times higher than the shuttle can reach.

Control of the Rendezvous vehicle during the launch phase is limited to attitude control in the pitch axis and to on/off operation of the OMS engines. The orbiter OMS engines are available after the external tank is jettisoned. You cannot control the throttle on any engine or the launch azimuth or orbit inclination. If an orbit is successfully achieved, it will be a polar orbit.

The earth lift-off option presents in the right half of the display an outside view of the launch vehicle on the pad. The lower left displays a profile of the flight path. The bottom of the screen presents flight data and a prompt for ignition to initiate the launch. The upper left is unused.

Huntress has made some simplifying design decisions in the launch simulation. Since the final orbit is polar, you don't have to worry about the launch azimuth or the effect of the earth's rotation on final vehicle velocity. One thing that does have to be determined for flight planning is the orbital altitude.

The documentation suggests a minimum altitude of 119 miles. An orbit below this altitude could decay within one or two revolutions. In fact, the launch simulation won't permit orbit injections below 119 miles; a low-altitude warning is displayed, and either you get the vehicle up by turning the OMS engines on or you lose altitude and are destroyed by aerodynamic forces.

An upper limit on orbital altitude is related to vehicle performance and mission requirements. In Rendezvous, this value is somewhere in the neighborhood of the location of the space station (1990 miles). Higher altitudes are possible, but you have to use more energy to get into them. Since the goal of these flight simulations is to rendezvous with another spacecraft, you need to get into the same orbit as the space station and time it so that the station is nearby when you match orbits. In principle, you could meet these requirements with a

(continued)

Benjamin Bernar received a B.S. in geology from Ohio University in 1976. His work with computers has led from uranium exploration in Wyoming to his current involvement with the space shuttle at Lockheed Space Operations. He can be reached at 201 South U St., #59, Lompoc, CA 93436.

direct injection into the station orbit from a ground launch; in practice, however, such an approach is not used. The launch could not tolerate any error in the flight profile, and constraints on the time of launch, the so-called launch window, would be extremely tight.

The usual procedure is to get into a parking orbit above or below the target and maneuver from there. The extra energy used to reach a higher orbit has to be dumped anyway, so parking altitudes below the target are typically chosen for efficiency.

The documentation states a value of 17,550 miles per hour (mph) as the minimum horizontal velocity (VELH) required for orbit injection. This corresponds to a local circular velocity altitude of 65 miles. The 17,550-mph value seems to be a limit in the launch program since you aren't permitted to do an injection at speeds below this, regardless of your altitude. When you reach the altitude of the space station, your VELH value is 14,533 mph.

Having selected the orbit, you are ready to plan a flight profile and get off the pad. The two forces to overcome are gravity and atmospheric drag. Of the two, gravity is by far the more important, so you want a flight path that curves as quickly from vertical as possible, becoming horizontal at the orbit-injection point. You must maintain a vertical or near-vertical attitude (as well as moderate velocities) in the lower, denser portion of the atmosphere. There is a region in the flight profile where aerodynamic loads on the structure of the vehicle are largest. If the vehicle is manned, you need to keep accelerations below 8–10 G (a unit of acceleration equal to the standard acceleration of gravity, 9.80665 meters per second per second) by throttling the engines down in the terminal portion of the flight when vehicle weight is just a fraction of the launch weight.

In the transition from vertical to horizontal vehicle attitude, you should avoid having a zero angle between the thrust vector and the horizon at any time other than orbit injection. If your ship is horizontal, all propulsion energy is used to increase VELH, and none is used to oppose gravity. In other words, you're falling, and the only time you're supposed to be falling is in orbit.

In a typical space-shuttle flight, the vehicle goes into a roll shortly after clearing the launch tower and pitches down slightly so that the crew is flying heads-down over the Atlantic. The vehicle reaches Mach 1 (about 708 mph) about 50 seconds into the flight; at SRB separation 82 seconds later, the vehicle is at an altitude of 28 miles and traveling at about Mach 4.5. During this part of the ascent, the main engines are throttled down to as low as 60 percent of their rated thrust to limit aerodynamic loads and to keep accelerations below 3 G. The main engines are turned off at an altitude of about 70 miles. The OMS engines take you the rest of the way to the first orbit-injection point, about 12.5 minutes from lift-off.

The Rendezvous vehicle can't be rolled, so when you pitch away from vertical you are flying heads-up. The pitching of the vehicle is allowed only in one direction and to a maximum of −90 degrees (pointing straight down). SRB separation occurs at an altitude of about 25.8 miles and a speed of about Mach 4.8, which is similar to the space shuttle. The Rendezvous shuttle can handle the aerodynamic loads of a reasonable flight profile without throttling the main engines. The effect of the atmosphere has been realistically modeled in the launch phase, varying as a function of velocity, attitude, and altitude. Fly too fast and too low and you'll lose the ship. Since you can't throttle the main engines, you can't control the G-forces on the crew.

Hitting some kind of an orbit is not difficult with the Rendezvous launch simulation. After playing with various flight profiles for a while, it becomes rather easy. Hitting a parking orbit suitable for a transfer to the space station is something else, though.

EARTH ORBITS

If you select the option of orbital rendezvous from the main menu, you are

AT A GLANCE

Name	Rendezvous	Saturn Navigator
Type	Space-flight simulator	Space-flight simulator
Publisher	Edu-Ware Services Inc. POB 22222 Agoura, CA 91301 (213) 706-0661	subLogic Communications Corp. 713 Edgebrook Dr. Champaign, IL 61820 (217) 359-8482
Computer	Apple II+ with 48K or Atari home computer with 48K and Atari BASIC; joystick optional	Apple II+ with 48K
Documentation	20-page operations manual	19-page user's guide
Price	$39.95	$34.95

prompted for a starting orbital altitude and a position relative to the space station. If you've successfully achieved some sort of an orbit in the launch phase, Rendezvous automatically switches to this option. In either case, the simulation presents a view of a nonrotating earth along the equatorial plane showing the western hemisphere. The orbital paths of both the Rendezvous vehicle and the space station are plotted, and both revolve around the planet in a counterclockwise direction. The bottom of the screen presents data about the current and projected vehicle orbits, such as energy remaining in the OMS engines and apogee/perigee altitudes. All flight-parameter input is through the keyboard.

Entering the orbital-rendezvous option through the mission menu puts you in a circular orbit at whatever altitude you choose. Selecting low-altitude orbits leaves the largest OMS fuel reserves for maneuvering. The maximum you can start with corresponds to changes in vehicle velocity of up to 2000 meters per second (m/s). At this point, one of the reasons for choosing such a high space-station altitude becomes apparent. A circle representing the earth is 7972 miles in diameter, and a low earth orbit of 250 miles produces a circle of 8222 miles in diameter. The high-resolution graphics mode is just barely able to differentiate the two circles.

Having 2000 m/s to play with and starting from a circular orbit, it's pretty easy to rendezvous with the space station. More interesting is trying it from the weird elliptical orbit you may have gotten into from the ground after burning most of your fuel. Many times, a partial orbit is achieved that intersects the atmosphere. These orbits have to be circularized or transferred from before you hit the atmosphere. Elliptical orbits can be circularized manually, but this is difficult. It's easier to set this up for the computer and let it do the worrying. Orbital maneuvering by the space shuttle is done exclusively through the onboard computers; manual control by the crew occurs only during approach and docking, with the rendezvous target visible.

Retrograde burns are available for orbit transfers from altitudes higher than the space station and for deorbit. At 250 miles, the space shuttle performs a deorbit burn that changes orbital velocity by 90 m/s (about 200 mph). Compare this to the 17,263-mph orbital velocity and you'll see that it doesn't take much to bring one of these things back down. The Rendezvous vehicle at this altitude will deorbit with 65 m/s or more, but the simulation doesn't provide for landings, so Huntress destroys you in the atmosphere.

You can rendezvous with the space station in many ways. But, as in the launch phase, you have to do it with enough fuel remaining for the approach and docking phases. A successful orbital rendezvous brings up the approach option automatically, or you can select it from the menu.

The display is a star field with a cross representing the Rendezvous vehicle. The data display presents velocity and range data relative to the space station and remaining maneuvering energy. You control the flight through the keyboard or joystick.

In an approach, you're in an almost identical orbit with the space station, either ahead of or behind it. There may also be some residual velocity along the approach vehicle's own internal x- and y-axes that needs to be reduced to some minimal value. Since you're still in an orbit around the earth, firing an engine along the orbital path to approach the station from behind increases your altitude and actually slows you down. In the early 1960s, this effect caused some difficulty for the Gemini program and the Soviet space program when rendezvous techniques were being perfected. The solution is to successively raise apogee in a series of translational burns, each time coming closer to the target. Since Rendezvous does not model this situation, it uses a direct approach for the simulation.

For a successful approach, you have to get within 1.2 miles of the space station and reduce velocities along the three spatial axes to 20 m/s or less (with respect to the station). Accomplishing this takes you to the last part of the Rendezvous simulation: alignment and docking.

In the alignment and docking phase, the screen presents an animated, three-dimensional representation of the space station. Flight data available to you includes a graphical presentation of your vehicle position and the station position in case you lose sight of it on the screen; other data includes range, velocity, and vehicle rotation rates. In this part of the simulation you have control over rotation around the three vehicle axes: yaw, pitch, and roll. You manipulate this, along with translational motion, with the keyboard or joystick.

Translational and rotational maneuvering is required to position your-

(continued)

The documentation does not describe the ship, but it probably has some kind of nuclear-fission propulsion system like the Discovery *in 2001 and 2010.*

self in front of the space-station docking port. Arriving inside the port without hitting anything ends the simulation.

SATURN NAVIGATOR

Saturn Navigator, also written by Wes Huntress, was originally sold as an add-on program requiring subLogic's A2-301 graphics package to run. It is now available as a stand-alone program running under Apple DOS. Saturn Navigator is a collection of simulations. The goal is to rendezvous with a space station in orbit around Saturn. The mission is divided into four flight phases: interplanetary transfer orbit, Saturn approach and orbit injection, orbital maneuvering, and rendezvous with the Saturn space station.

The program uses animated color graphics to display the flight; particularly effective is a three-dimensional wire model of Saturn and its rings during mid-course corrections and approach and orbit injection. You interact with the simulation through the keyboard.

Each flight phase is run in order; unlike Rendezvous, there is no provision for independent use of the individual programs. The documentation describes the options in the command menu for each flight phase as well as the general requirements for completing each part of the mission. Starting the simulation brings up a nice graphic of Saturn and one of its moons. Next on the screen comes some explanatory text and a prompt for the velocity of the Saturn transfer orbit.

The documentation for Saturn Navigator does not describe the ship, but considering its performance capabilities, it probably has some kind of nuclear-fission propulsion system like the *Discovery* in *2001* and *2010*. In setting up a transfer orbit to Saturn, you are presented with a plan view of the sun, Earth and its orbit, and Saturn and its orbit.

When you input a transfer velocity, the program calculates and plots a trajectory that intersects Saturn's orbit at that planet's location on the orbital path. It then provides the length of the flight in days, and you can request a view of the planet on approach for this trajectory or select a new transfer velocity.

Saturn Navigator lets you play with the relationship between travel time and fuel. The most economical way to go is the Hohmann transfer orbit, but this is also the slowest. (A Hohmann transfer orbit is an elliptical, heliocentric orbit that tangentially intersects the orbits of two planets. In terms of energy, it is the cheapest way to travel from one orbit to another.) Inputting the Hohmann transfer velocity to the program produces the correct transfer orbit, one that just intersects the orbits of Earth and Saturn; however, the calculated travel time is a bit off. A ship on a Hohmann transfer to Saturn would require 6 years for the flight; Saturn Navigator comes up with 5.8 years. The fastest transfer orbit you can select will get you there in 1.7 years, but you'll be left with precious little fuel for orbit injection and maneuvering.

Once you've committed the ship to a trajectory, another text screen comes up suggesting that you consult the documentation for a review of mid-course maneuvering. The screen also displays a countdown, which delays the start of the flight until Earth and Saturn are properly aligned for the transfer. I suppose this adds to the

(continued)

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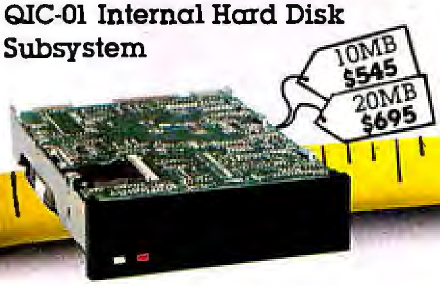

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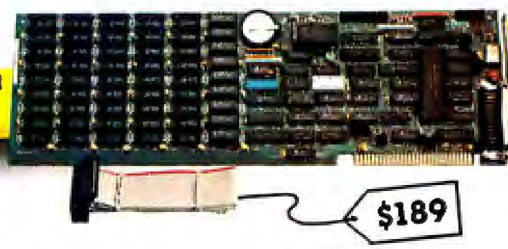

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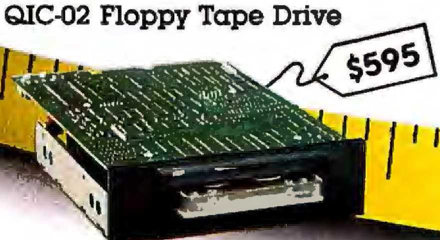

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realism, but I found it annoyingly long after the first few flights.

An animated display of the sun, Earth, Saturn, and the ship is presented after the transfer–orbit injection burn. Time into the mission in days and a plot of the ship's current position along the flight path are also displayed. At several points during the flight, you can make mid-course corrections of the flight path.

On a close approach to Saturn, that planet's gravity acts to "draw" you into a hyperbolic path around the planet. There is a point on this hyperbola where an appropriate engine burn causes the spacecraft to enter a closed orbit around the planet, a prograde orbit that doesn't hit the planet or the rings and leaves enough fuel for the orbital maneuvering required to rendezvous with the space station in an equatorial orbit around Saturn. You use mid-course maneuvering to target your approach so that you hit this point.

At each mid-course opportunity, Saturn Navigator puts up a three-dimensional view of the planet on approach along with a plot of the targeting point. Data about this point, such as the resulting orbital inclination and periapsis (of the trajectory), is also presented. You use this information to move the targeting point as required for the desired final approach. Once you've found and committed to a suitable target point, the computer initiates a burn to adjust the flight path to the new target point. The display returns to a plot of spacecraft and planetary positions. Final approach occurs two days out from the planet and automatically moves you into the approach and orbit-injection routines in the simulation.

Using Saturn's gravity to help capture your spacecraft expends far less energy than would be needed to circularize an orbit at Saturn's "altitude" from the sun. On approach and orbit injection, the screen displays the effect of gravity on the flight path and an overhead or polar view of the planet and ring system. This part of the simulation also allows views from the equatorial plane and changes in approach velocity or the initiation of the orbit-injection maneuver. Once you commit to an orbit insertion, a nice animated view of the approach appears on the screen. This is particularly effective in high-inclination approaches.

When you reach the point of closest approach, the computer does the orbit-injection burn. You can either manually initiate orbital maneuvering or complete half of the orbit for automatic transition. Maneuver sequences are loaded to the computer to change the orbit shape and size for immediate execution from circular orbits or delayed execution from elliptical orbits. This delay is to time the engine burn for either apoapsis or periapsis in a Hohmann-type fuel-efficient orbit transfer. You can also change orbit inclination.

As soon as you have maneuvered

Personal computers can provide a feel for the problems of space flight.

into some kind of an orbit inside the inner ring and have an inclination of 0 degrees, you are allowed to manually move into the final part of the simulation—the rendezvous with the Saturnian space station, which is in a circular orbit of 4125-mile altitude. The rest of the simulation is almost identical to Rendezvous except that you aren't required to handle approach and docking and you don't get a look at the station.

CONCLUSION

Personal computers and simulations can provide a feel for the problems and techniques involved in space flight that is obtainable in no other way save direct experience (an option not yet open to most of us). Books and equations dealing with orbital mechanics and rocket flight are very important, but they just can't provide the interaction necessary for an intuitive grasp of space travel. Even the lucky few with flight opportunities spend an awful lot of time with computer-based flight and mission simulators. Until that day when the rest of us get to join in the fun, personal computers can serve as our space vehicles. ■

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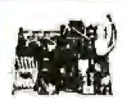

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MaxThink

An outline processor that has its own programming language

BY WILLIAM HERSHEY

Many software developers are entering the field of "idea processing," a name that is often too presumptuous for their products' capabilities. MaxThink from MaxThink Inc. is a well-conceived program for the IBM PC that begins to live up to the term. Of course, programs do not process ideas; people do. But MaxThink has the proper tools to help you process your ideas and a well-written manual that goes beyond the mechanics of the program. The manual is so good that you don't even need the program to apply many of its thinking and writing techniques. MaxThink's developers obviously thought a great deal about how people organize thoughts.

MaxThink is an outline processor similar to ThinkTank and the outlining features in Framework (see references 1 to 3). In this review I'll focus on MaxThink and use ThinkTank and Framework as points of reference. Like its predecessors, MaxThink can handle information in the form of lists, outlines, and paragraphs of text, but the underlying structure is the outline.

Most thought processors include three types of commands: viewing commands that let you look alternately at the outline's various levels of detail; moving, copying, and sorting commands for restructuring the outline; and editing commands for entering and changing text. Of lesser importance are commands for formatting the printed outline and handling files.

MaxThink handles an outline as a hierarchy of lists, showing only one list on the screen at a time. Moving from one place to another in the outline is easy. The biggest differences between MaxThink and the Framework and ThinkTank programs are in the restructuring commands. Framework's commands for restructuring are consistent and easy to use. ThinkTank's are less so. MaxThink best addresses the restructuring of outlines by simplifying common sequences of Move commands and offering several ways of executing them.

Unfortunately, cursor movement in MaxThink's editor is sluggish. And you must access editing commands through an edit menu, which might seem backward to people who are used to conventional word-processing programs. The program's formatting and file-handling commands are better than ThinkTank's but not as powerful as Framework's. You might want to use MaxThink to produce a first draft, then transfer the text of your draft into your favorite word processor for polishing.

An especially powerful feature in MaxThink is its Thought Processing Language (TPL) that lets you write executable programs for handling outlines. (Framework has a programming language, but ThinkTank does not.)

MaxThink is a versatile tool. The manual illustrates progressive uses of the program through three stages of thinking and writing. In the early "perception" stage of thinking about a subject, you can use list structures to collect facts, possible concepts, and tentative approaches. At the second "processing" stage you use the outline structure to organize, categorize, and analyze the information, showing hierarchical relationships between the lists and their component units of information. In the final "integration" stage you fill in the structure with paragraphs of text to develop your insights and solutions into a sequential, coherent, polished presentation.

Following the above prescription is easier said than done. However, I have found that MaxThink holds a slight edge over Framework and a clear advantage over ThinkTank throughout the stages of a writing project. Also, at $59.95 MaxThink is priced far below what you would expect to pay for its capabilities.

OUTLINES

To get a better idea of MaxThink, you have to examine how it works. MaxThink commands, prompts, and messages appear on

(continued)

William Hershey is a systems engineer with a B.S. in engineering from Princeton and an M.A. in computer and communication sciences from the University of Michigan. He is also an instructor in computer literacy at the University of Maryland's University College. You can contact him at MITRE Corp., 1820 Dolly Madison Blvd., McLean, VA 22102.

the screen's bottom four lines. Your document occupies the rest of the screen. MaxThink encourages you to develop an outline as a hierarchy of lists. Each item in a list is called a "topic," and MaxThink numbers them sequentially for you. The screen displays a single "parent" topic at the top and an indented list of its direct descendants below. You use the up- and down-arrow keys to move a selection arrow from one topic to another. Highlighted or underlined topic numbers indicate the existence of deeper levels, as do ThinkTank's plus signs or Framework's triangular flags.

By pressing the right-arrow key you can zoom in on a selected topic with its subtopics. Conversely, the left-arrow key takes you to the outline's next higher level. Again a parent topic will appear at the top of the screen followed by an indented list of its topics. At the highest level, the "root" topic (i.e., the outline's title) appears.

MaxThink's display of a list hierarchy is slightly different from the methods used in ThinkTank and Framework. These programs maintain an outline view of your headings (topics) on the screen and let you expand any heading in the outline to any deeper level. (Framework also offers a frame-based view of the document's hierarchy.) Like MaxThink, the other programs let you view any outline level as a list of headings, but you might need several steps to collapse or expand parts of the outline to show the desired list without subheadings. MaxThink maintains the list format automatically. An improved version of MaxThink, which the publisher says will be available by the time you read this, will use a function key to toggle between list and outline views of a document.

MaxThink offers you a great deal of flexibility in the ways you can use topics. A topic can be one word or several lines long. When you reach the end of a line, the text wraps to the next line as it would in most word processors. The second and succeeding lines become the "annotation."

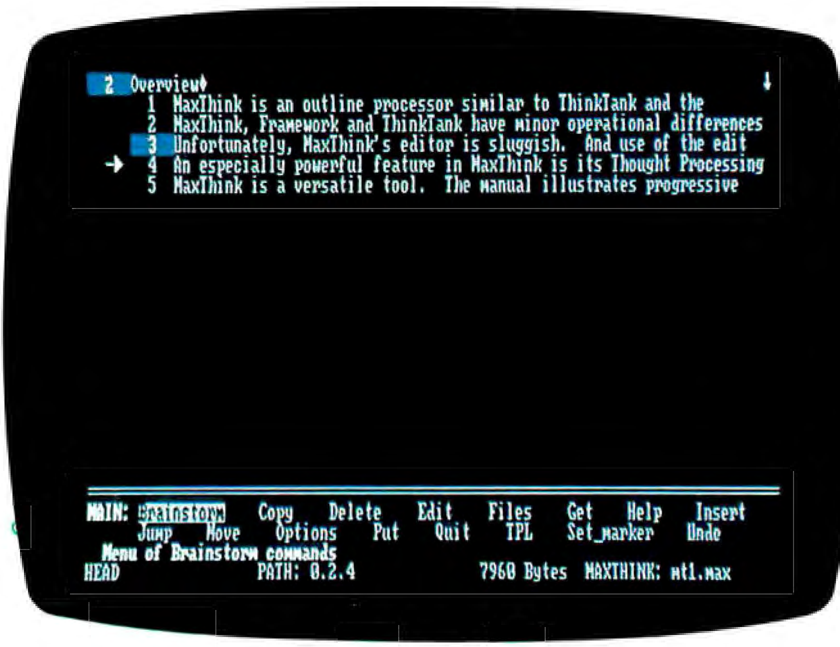

Photo 1: *A sample list of topics in MaxThink. A topic can be a heading or the first line of a paragraph. In this case topic 2 is a section heading and its subtopics (2.1, 2.2, etc.) are the first lines of paragraphs. The word* HEAD *at the bottom left corner of the screen indicates that only the first lines of topics are displayed. The* F2 *key toggles between this display and the one in photo 2 showing full paragraphs.* Highlighted *topic numbers indicate that subtopics exist. At the bottom of the screen is MaxThink's main menu. Other information at the bottom includes the amount of memory remaining, the filename, and the "path" designation for locating the topic targeted by the topic-selection arrow.*

You can thus format a topic either as a section heading or simply as the first line of a paragraph. I've found this flexibility especially helpful in the integration stage when I'm transforming an outline to a series of paragraphs. ThinkTank and Framework maintain outline headings and the paragraphs beneath them as independent entities. With these programs it is more awkward to retain some headings to serve as formal section headings and replace others with paragraphs.

The F2 function key toggles between two views of a given list of topics. You can look at the topics alone, each of which could be a section heading or the first line of a paragraph (see photo 1). The alternate view shows the annotations along with the topics, revealing all your paragraphs (see photo 2). This feature lets you move easily within your document and can be a handy editing tool. For example, in writing this review I replaced the first several topics in my initial outline with paragraphs and pressed F2 to get an overview. The topic-only view revealed that I had begun five out of the first six paragraphs with the name MaxThink. I quickly made some adjustments to add variety.

BRAINSTORMING

The Move command is fundamental in word processing. Without it you might as well go back to scissors and tape. The ability to move the elements in a list or an outline is perhaps even more important than moving sentences or paragraphs in a text document. If you are really processing ideas, you have to be free to experiment with different ways of relating them to each other. Framework's Move command is easy to use. ThinkTank's is awkward except in the Macintosh version. MaxThink goes beyond conventional Move operations. In MaxThink you select the Brainstorm option in the main menu. This calls the "structure editor" into action.

The structure editor is merely a handy collection of commands for putting a list in a new order or for moving groups of topics from one level in your outline to another. These commands thus fall into two classes: ones that change the order of your topics in a list and ones that change the hierarchy.

The commands that change the order of topics include Prioritize, Randomize, and Sort. Prioritize inserts a separator line of pluses and the word PRIORITIZE at the top of your list. You then point to the topics with the cursor and press the Enter key to move them, one by one, from below the marker to above the marker. When you finish, the separator disappears. Randomize simply puts your list in a random order to give you a fresh perspective on the topics. The Sort command sorts the topics in your list in ascending or descending order, starting at the column you specify. Because you can specify the sort column and sort-string length, you could impose a tabular structure on a list of topics and sort on any column or field as though the list were a mini-database.

Commands that affect the hierarchy of topics include Binsort, Divide, Join, Fence, Categorize, and Levelize. Binsort is just a manual sort. It lets you group topics into higher-level bin topics. You simply enter a bin number for each of the topics to be moved (see photo 3).

The Divide command splits a topic into new topics for each word, line, sentence, or paragraph according to your instructions. The Join command combines multiple topics into single ones by lines or words.

The Fence command adds fences or boundaries to a list that is already in correct order. It provides an alternative to Binsort. After you insert horizontal fence separators into your list, each with a label, you can use the Categorize command to convert the fences to topics, with the other topics in the list subordinate to them. The Levelize command can reverse the effect of Binsort or Categorize by con-

(continued)

Photo 2: A *view of MaxThink paragraphs. Each contains a topic, or first line, followed by an annotation, which in this case is the remainder of the paragraph. This display was obtained by pressing function key* F2. *Also note that the edit mode has been selected from the main menu. The edit menu appears at the bottom, and a cumbersome Insert command is necessary before you can enter text at the cursor position.*

Photo 3: *Binsort is one of the Brainstorm commands that make it easy to restructure MaxThink outlines. Binsorting is the manual process of assigning topics to groups or bins. You designate any number of bin topics (in this case two), and MaxThink inserts the Binsort separator line beneath them. You then point to each of the other topics and type the number of the bin where you want to put it as a subtopic. You could accomplish the same result with the Move command but not as quickly.*

AT A GLANCE

Name
MaxThink

Type
Outline processor

Manufacturer
MaxThink Inc.
230 Crocker Ave.
Piedmont, CA 94610
(800) 227-1590
In California, (800) 642-2406

Format
One 5¼-inch floppy disk

Computer
IBM PC (or compatible) with 256K bytes, one drive, PC-DOS 2.0
(Macintosh and CP/M versions available soon)

Features
Outlining, organizing, text editing, programming (Thought Processing Language), advice systems

Documentation
Tutorial, reference guide, programming guide, thinking techniques, writing techniques

Price
$59.95

Audience
Writers and others who need to plan and organize ideas

Comments
The program has a cumbersome editor but is otherwise very well thought out with a good manual and a great price

verting subtopics into topics.

MaxThink also has the more conventional Move, Copy, and Delete commands, and even an Undo command. The Brainstorm commands, however, greatly simplify restructuring of lists and outlines.

EDITING, FORMATTING, AND FILE HANDLING

The text editor is MaxThink's weakest component. It uses the cursor, Delete, and backspace keys conventionally and offers both insert and overtype modes. It executes several functions (like block copy and move) better than the ThinkTank editor but does not come close to the editor in Framework. The version I reviewed lacked niceties such as tabs and word deletion. Also, it is slow. I was not able to outtype the MaxThink editor, but autorepeated cursor movement with the arrow keys was very slow in long passages of text. I suppose the key is to keep your paragraphs small and to avoid putting too many of them beneath a topic. Neil Larson of MaxThink Inc. advises not to scroll through paragraphs but to jump from one to the next at the list level. He claims it is easier to keep track of your thoughts this way. Because of this slowness, you must also be careful when deleting characters; it is easy to go beyond the part you wish to delete. For deleting large blocks of text, use the Delete command in the edit menu.

If you are accustomed to WordStar or other word processors that put you directly into edit mode and expect control commands for most other operations, the MaxThink edit menu (at the bottom of photo 2) will seem backward to you. From the main menu, it takes two steps to begin editing: Edit, which invokes the menu, and Insert, which lets you type. You must return to the menu (with Esc) to perform block operations or Find/Replace commands. Deleted blocks go into a buffer, and you can copy them to other parts of your document. The Put command copies blocks from the buffer to the document. The Get command copies a block into the buffer, as Delete does, but leaves the block intact in your document. The Put command will also work from the main menu.

The editor does not format your text on the screen as it will appear on paper, but the program does give you control over margin settings and other parameters. You can view your outline on the screen before printing if you wish.

The Format command offers 22 format settings for controlling the format of a printed document. Many of these, such as indentation settings, are specific to outlines. You can even set the multilevel numbering scheme for the topics in your outline to any combination of upper- and lowercase Roman numerals, Arabic numerals, and upper- and lowercase letters. One option lets you save a document in a format that WordStar can read.

In addition to standard commands for printing, loading, and saving outline files, MaxThink gives you access to five DOS-like commands for copying, erasing, and renaming files, and for setting the system date and time.

THOUGHT PROCESSING LANGUAGE

Potentially the most interesting feature of MaxThink is its programmability via the Thought Processing Language. TPL programs can access the same commands that are in the MaxThink menus. When put into the format required for TPL, the commands are said to be in MaxMode format. A program of TPL commands is an outline, and you can switch easily between your program outline and your text outline while editing.

It is possible to specify any position within an outline by using what MaxThink calls a "path." For example, the path for the second subtopic of the third topic of an outline would be 0.3.2. Most spreadsheet programs give you the alternatives of pointing to a cell with the cursor or specifying that cell's row and column coordinates as a letter and a number. Similarly, MaxThink provides the path specification as an alternative to mov-

(continued)

In a comparison against two other popular outline processors, MaxThink ranks highest on the most important features.

ing the selection arrow in an outline. TPL, like formulas in spreadsheets, uses the path to reference a given topic in an outline.

Each topic of a program outline can be a MaxThink command, a comment line, a blank line, data, or a TPL directive. Some directives affect the sequence of operations, the construction of menus, and statement branching. Others affect messages displayed, help screens, movement of data between the text and program outlines, and program execution. TPL has nearly 30 directives. The TPL menu that is accessible from MaxThink's main menu provides commands for creating, loading, running, and testing TPL programs.

I have written only a few simple TPL programs, so I can't claim to know how to take advantage of all of TPL's features. One thing is clear, however: it is a macro language, not a full programming language. The manual says that you can program MaxThink to provide advice, information, or customized help for applications that require listing and outlining capabilities. MaxThink can be programmed to branch through an outline on the basis of user responses, so the manual claims you could use TPL to develop CAI (computer-aided instruction) applications and portions of expert systems. These claims are a bit overblown. TPL's menu-handling commands are nice, but the language has no arithmetic capabilities, and tests for conditional branching are limited to simple string and path matching. I wrote a program to give a multiple-choice test, but I could not use TPL to add up the number of correct responses.

Documentation and Support

The MaxThink manual is undergoing extensive revisions even as I type, so the version you see will almost certainly be different from the one I have been using. However, I can report that the manual I saw was well written and makes learning the program easy. Mine came in a loose-leaf binder with attractive artwork. The publisher says that the final format will be a paperback book.

The documentation includes thorough introductory, tutorial, and reference sections and a programming guide for TPL. The program also incorporates an on-line help feature that uses a 60K-byte help file. You might find the supplementary sections on writing and thinking most valuable of all. These provide some good techniques for collecting, organizing, and conveying information.

Conclusion

Table 1 ranks MaxThink against the two other popular outline processors. The five summary features of the programs appear in order of their importance for idea processing, so MaxThink ranks highest on the most important features.

Table 1: *Ratings of three outline processors and the convenience of their outline-processing commands. The highest rating is a 1; the lowest is a 3.*

Summary Feature	MaxThink	Framework	ThinkTank
Restructuring	1	2	3
Viewing	1	2	3
Editing	3	1	2
Formatting	2	1	3
Manipulating files	2	1	3

Along with the manual, the program itself is currently undergoing improvements. MaxThink keeps your entire outline in memory, and the current limit is about 38K bytes. The publisher is removing that limit to let your outline occupy as much memory as is available in your machine.

I had some anxious moments when MaxThink garbled the directory of the disk I was using to save this article. In fact, it also garbled my backup disk. The DOS CHKDSK utility saved me from retyping the whole article. The programmer at MaxThink said I had experienced a file-allocation problem related to the current limitation on memory. Another problem was that the program sometimes chopped off carriage returns at the ends of paragraphs during Load operations. A fix is in the works, but I advise you to be cautious with this program until its record is proven. Large files seem to cause the majority of problems right now.

MaxThink's copy-protection scheme has undergone several changes. The publisher plans to provide a version that can be transferred onto a hard disk and used directly, so it won't be necessary for you to have the master floppy disk handy.

Aside from the trauma of nearly losing this review, the limitations of the editor, and the minor inconvenience of the copy-protection scheme, I am enthusiastic about MaxThink. The publisher seems eager to provide a quality product and the support to go with it. The price of MaxThink is one indication of his sincerity; for $59.95 you can't go wrong. ■

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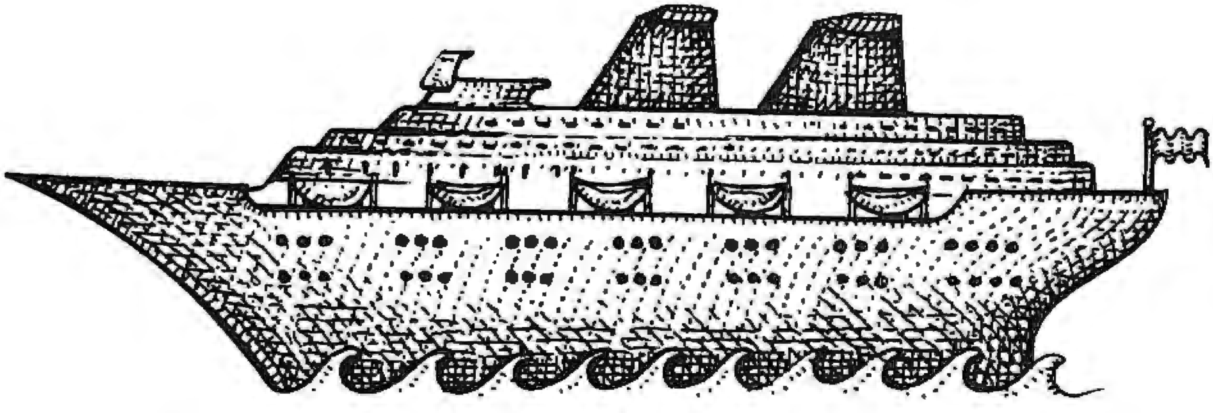
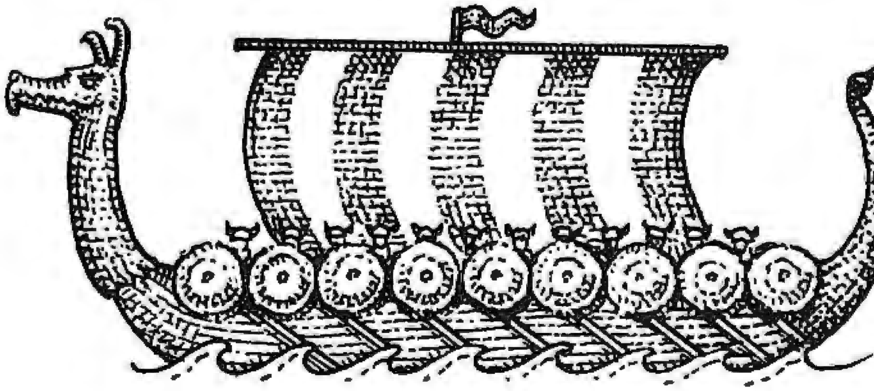
1. Hershey, William R. "ThinkTank." BYTE, May 1984, page 189.
2. Hershey, William R. "Idea Processors." BYTE, June 1985, page 337.
3. Jadrnicek, Rik, John Markoff, and Ezra Shapiro. "Framework." BYTE, August 1984, page 121.



M2SDS



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The Anchor Automation Signalman Mark XII Modem

The Mark XII incorporates interesting features, yet lacks full Hayes compatibility

BY GEORGE V. KINAL

If imitation is the sincerest form of flattery, Anchor Automation's Signalman Mark II modem is a compliment to the Hayes Smartmodem 1200. But, like many imitators, this product isn't entirely faithful to the original.

The Anchor Mark XII supports the 300-bps Bell 103 mode and the full-duplex 1200-bps Bell 212 mode. It operates in originate and answer modes. It can auto-answer an incoming telephone call and will auto-dial in either pulse or tone modes. The Mark XII has no switches except on/off; all programming is through the RS-232C interface. It adjusts its mode and data transmission rate to match that of an incoming caller (modem), or you can set the data rate desired on an outgoing (originated) call.

The modem has a gray plastic case, 6 by 9 by 1 inches. It uses an external power supply and a plug-in (RJ11) telephone cable. Unlike most other modems, which have a female DB-25 connector for the RS-232C connection, the Anchor has a 1-foot ribbon cable, on the end of which is a male DB-25 connector. You can plug this connector directly into the female DB-25 that most computers have, except the IBM PC. (You can purchase more recent versions of the Mark XII with either a male or a female connector.)

The Mark XII has a jack for your telephone so you don't need to buy a two-jack adapter if you want the modem and the phone on the same line. Thus, you might be able to save both the cost of an RS-232C cable and the adapter, which would be required with most other modems. The modem consumes less than 1 watt of electrical power and stays cool.

COMPATIBILITY

The Mark XII is advertised as a Hayes Smartmodem 1200 work-alike. As I previously mentioned, it comes with the cables and two RJ11 telephone jacks, unlike the Hayes. The Anchor has a few extra features not available on the Hayes, but it also lacks some of the Smartmodem's features.

The Mark XII recognizes all of its commands in upper- or lowercase; the Hayes must have the initial AT in uppercase. More significant, the Mark XII recognizes the dial tone and most busy signals and sends appropriate messages back to your computer. This is an advantage with certain communications software packages and so-called macros.

The disadvantages are that the Mark XII has fewer LEDs (light-emitting diodes) on the panel, and no DIP (dual in-line package) switches. The only one of the LEDs that I miss is OH (off hook). Both products have the HS (high speed) and CD (carrier detect) indicators. Where the Hayes has separate lights for send and receive data, the Mark XII uses one for both (SD/RD).

Hayes has 17 software-loadable registers, and Anchor has only the first 6. For example, in the Hayes you can change the duration and spacing of the touch tones. In the Mark XII, these parameters are preset to values like those to which the Hayes defaults.

The Mark XII will not produce dial tones for the * or # buttons, which are not really necessary for public telephone networks. Anchor apparently has made design choices in deleting some of the Smartmodem's features, but most users will not notice the omissions.

One rather significant technical difference might make the Mark XII unsuitable for some users. The modem will not pass on the so-called Break signal in 1200-bps operation, only at 300. The Break is not an ASCII (American Standard Code for Information Interchange) character. Instead, it is a sustained (75 to 300 milliseconds) transmission of the Space signal. (When not sending specific ASCII characters, the interface and modem are sending the Mark signal.)

Many mainframe computers use the Break as an indication to interrupt whatever

(continued)

George V. Kinal (636 South Carolina Ave., Washington, DC 20003) is a communications systems engineer specializing in satellite data communications.

AT A GLANCE

Name
Anchor Automation Signalman Mark XII Modem

Type
300/1200-bps modem for data communications (Bell 103 and 212 standard)

Manufacturer
Anchor Automation Inc.
6913 Valjean Ave.
Van Nuys, CA 91406
(818) 997-7758

Size
6 by 9 by 1 inches

Weight
13 ounces

Power Requirements
12-volt DC, 60 mA, from 110-volt AC adapter supplied

Necessary Hardware
Any computer or terminal with asynchronous serial (RS-232C) interface

Necessary Software
Dumb terminal firmware or software sufficient, communications software with macros desirable

Features
Auto-answer, auto-dial smart modem (all functions commanded via data interface); low power consumption, two-year warranty

Documentation
29-page manual, 5 by 8½ inches

Price
$399

is going on. For example, you might temporarily halt transmission of a long file to save the already received portion to disk. Some computer systems have been modified to respond to XOFF (usually a Control-S). The remote database/network services all accept XOFF, as do almost all microcomputer bulletin boards.

The Mark XII will respond to commands of any parity but will not send back result codes with 8 bits and no parity (8N1). This has led some people to believe that the modem cannot handle 8-bit data, which is not the case.

Finally, the Hayes has a speaker so you can hear what is going on; the Mark XII does not. You can check on the results of a dial attempt by picking up the telephone handset (with pulse dialing, you must wait until the dialing sequence is finished).

USER EXPERIENCES

I have tested the Mark XII on the Apple II and IIe with a wide variety of serial interface cards. I also substituted it for a Hayes Smartmodem 1200 on an IBM PC. Software used included ASCII Express-Professional, Transend II, MODEM7—a public-domain program, a homebrew program called COMTERM based on the TAFT program (see "TAFT: Terminal Apple with File Transfer" by Tom Gabriele, June 1982 BYTE, page 410), BLAST on the Apple and the PC, and PC-Talk. The modem performed satisfactorily and was functionally identical to the Hayes.

Surprisingly, 300-bps operation was less than perfect. When I called a local bulletin board, the Mark XII showed an occasional tendency to garble the received data. This was apparently caused by its inability to tolerate signals that were stronger than normal. If you take the telephone off the hook during the session, the garbling is almost completely eliminated. Other owners of the Mark XII reported the same problem when making a local call. The people at Anchor insist that a firmware change repairs this problem, but a replacement PROM (programmable read-only memory) they sent failed to cure it.

A colleague tested the Mark XII using Hayes Smartcom II software on the IBM PC (certainly an acid test of the claim to Hayes compatibility). Again, 1200-bps operation was flawless. However, at 300 bps, in addition to the garble problem, the Anchor did not always reliably hang up upon completion of a session.

Another problem is that if the data carrier is suddenly dropped (the other end hangs up, for example), the modem won't respond to your commands. You can restore function only by turning the power off momentarily. This flaw makes the current version of the Mark XII unsuitable for auto-answer applications such as bulletin boards.

The biggest problem with the Mark XII seems to be the difficulty in getting it operating. The interface-card manual, the software manual, and the modem manual each give different connection instructions. The typical RS-232C interface does not expect to receive data until the carrier detect is high. But the modem manual says that when you send the AT command to the modem, you should see the response OK. Without carrier detect, you see nothing and assume that the new modem isn't working. Even worse, some interface cards for the Apple present a DCE instead of the DTE interface convention, so a crossover cable or null modem is required. But the standard null modem does not strap the carrier detect high. These difficulties are not the fault of the modem design but can be frustrating.

DOCUMENTATION

As for documentation, the Mark XII manual is no match for the thorough Hayes manual. It has barely enough information to install and use the product. However, producers of modems that might be used with many different computers, terminals, and interface cards are in a situation similar to that faced by printer manufacturers a few years ago. It is impossible to provide enough information in

(continued)

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The Anchor's low power-consumption design contributes to long-term reliability.

a short manual to cover all the possibilities.

A key phrase appears in the manual: "Minimum to operate are pins 7, 2, and 3." In other words, the modem is perfectly happy with only these three wires of the RS-232C interface connected. But in most cases, the interface (computer) probably will not work. Most people are able to get the Hayes working, perhaps by trial and error, because of its Force DTR true and Force CD true switches. Anchor should do what Epson and Okidata did: print a separate booklet showing the interface requirements for all popular computers and interface cards.

CONCLUSIONS

The Mark XII's operation is good at 1200 bps, except for the firmware's intermittent refusal to reset properly. A signal-level sensitivity problem occurs at 300 bps. Since the modem comes with a two-year warranty, perhaps these flaws will be corrected by the manufacturer in due course.

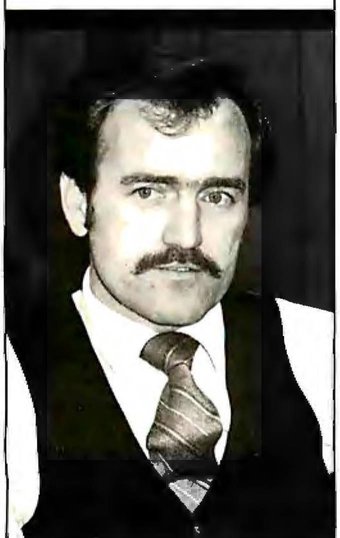
For about 90 percent of the potential applications, the Mark XII's lack of LEDs, DIP switches, and registers doesn't matter. The provision of two RJ11 jacks and the male DB-25 on 1 foot of cable can save the customer a few more dollars. Also, the Anchor's low power-consumption design should contribute to long-term reliability.

If you need RJ12/13 capability or the flexibility that the additional registers in the Hayes give you (for example, the ability to force the modem to transmit in the absence of received carrier), the Anchor is not for you. And before you consider the Mark XII, make sure that you can get along without the Break capability. ■

"...it is impossible to lead in the development of new technology when your entire system design is dedicated to following."

[This is one of a series of design philosophy discussions with Rod Coleman, President of Stride Micro™ formerly Sage Computer]

RC: In the rush to gain instant marketshare, the concept of good microcomputer system design has been forgotten by many man-



ufacturers. The worst abuses are among those who think that system design is deciding what color to paint your PC clone.

Q: So you're referring to the compatibles?

RC: They're the worst offenders, but lack of attention to system design is present at all levels. The IBM™ PC itself, as first designed and introduced in 1981, was a failure. They sold relatively few of their original cassette-based systems. It was the floppy diskette option that made the product more reasonable and allowed the PC to dominate the market.

Likewise, the success of the hard disk model is more a credit to the innovators and second-source vendors who first provided Winchester disk add-ons. The XT is a tribute to independent ingenuity, not any system design work by IBM in Boca Raton.

Of course, the pure imitators are the worst. Some companies would have you believe that system design is determining which version of Apple or IBM to clone. The perversion here is that it is impossible to lead in the development of new technology when your entire system design is dedicated to following.

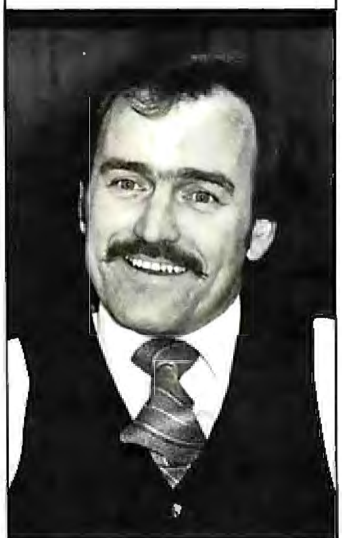
Q: How would you change that?

RC: Current practices aside, the correct way to approach design is to first define the problem or market need. Standards *should* be followed wherever possible. However, if technology is significantly advanced, the system design should never be unduly biased by fear of incompatibility.

Our work on the NOD™ cursor control device is a good example of this theory in practice. In looking at the mouse as a method of directing cursor movement, we recognized the problems of having to remove the hands from the keyboard and the requirement of having additional clear desk area.

This design began with the generalization of "what are we trying to do?" instead of looking for mouse re-designs or spinoffs like "foot mice."

"...system design should never be unduly biased by fear of incompatibility."



Q: Where did that lead?

RC: It allowed our engineers to be creative. We examined human factors such as what muscle groups have the finest control and the general aversion to having any wires attached to one's body. Then we matched those objectives against available technology, and our answer was something totally different: a cursor control system that tracks head movement using light rays. It's similar to the technology of a television remote control device. Today we offer it as a development product to innovative software engineers, tomorrow its potential is unlimited.

The point here is that whether it's the NOD individually or our system design in general, we seek the best solutions, whether they're standard or not. The goal is providing the best answer, not just the usual answer. Maybe the philosophy is best summarized in Stride's tagline: "Performance By Design.™"

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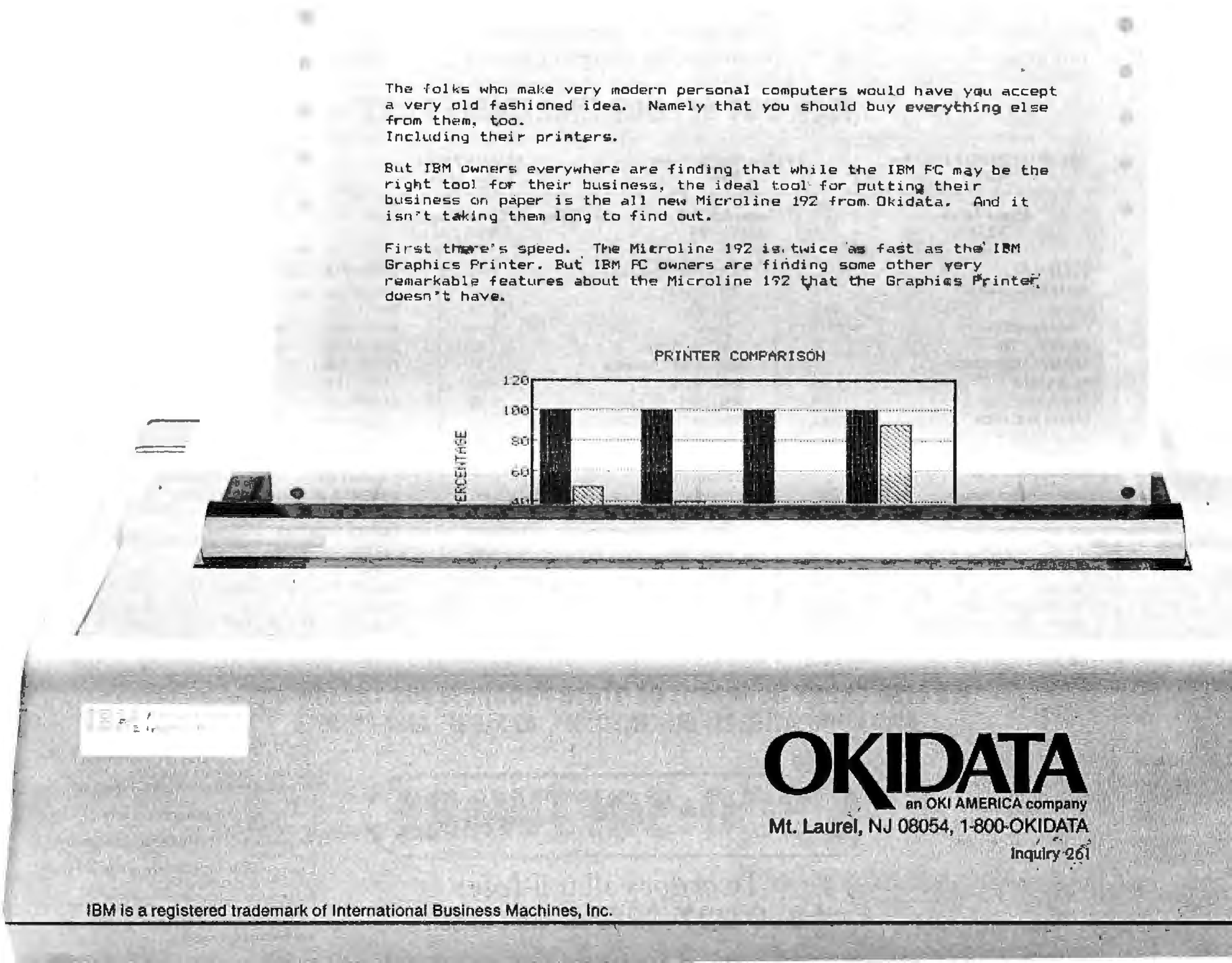

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MODULA-2/86

We would like to clarify some important points regarding the review of Logitech's Modula-2/86 by Kevin Bowyer (February, page 311).

Three months prior to the review's publication, Logitech released a new version of Modula-2/86. Release 1.1 provides significant enhancements and modifications to 1.0.

Modula-2/86 1.1 no longer requires an 8087 numeric coprocessor chip. In addition to 8087 in-line code, the system now provides software emulation for real data-type operations and exception handling for real operations.

A utility program called LOD2EXE is now available as part of Modula-2/86's utilities package. This utility merges the run-time support (M2.EXE) with a .LOD file to produce one DOS-executable file (.EXE) so you can execute Modula-2/86 programs directly from PC-DOS. Modula-2/86 requires 256K bytes of RAM and is now compatible with MS-DOS 3.0.

The overall speed of compiling and linking has been improved by a factor of 10 to 40 percent.

A symbolic run-time debugger is available and sold as a separate package. The user interface of the new postmortem debugger, included in the base package, has been improved and made compatible with the optional symbolic run-time debugger. The run-time debugger is sold as a separate package.

The messages displayed during compilation have been changed to be more descriptive. And Modula-2/86 for MS-DOS is compatible with generic MS-DOS and therefore runs on a variety of machines other than the IBM PC.

CHRISTOPHER R. CALE
Logitech
Redwood City, CA

EASYLINK AND MCI MAIL

We believe that Wayne Rash's review of EasyLink and MCI Mail (Feburary, page 317) contained some misleading impressions. Also, several features added to EasyLink shortly before the issue was published make the service easy to use and inexpensive.

EasyLink's major new features are prompting, two-hour express-document and overnight delivery of letter-quality documents, and session control. The prompting feature leads users step by step through creating and sending a message or retrieving information from the mailbox. To activate prompting, users type / Prompt and Enter. Once EasyLink users become familiar with the system, they can bypass prompting.

Two-hour express-document delivery is available for $20 to most major U.S. metropolitan areas, with overnight delivery service available for $7.75 to the entire country. Both services, which are provided by DHL Worldwide Courier Express, are less expensive than the MCI alternative.

The session-control feature lets EasyLink users move directly from EasyLink to another service (such as FYI) and back during the same phone call. Session control features menus to lead users through the switching process.

Your review states that from the information you had, the two software packages are functionally equivalent. But Instant Mail Manager from Western Union offers features superior to those in the package offered for MCI Mail, including a text editor, address-list maintenance, local-filing (message-management) capability, and easy communication with other hosts.

While your review employs a few comparisons that show EasyLink to be more expensive than MCI Mail, it can just as easily be shown that EasyLink is less expensive. Since the majority of business correspondence contains fewer characters than the MCI ounce, EasyLink would be less expensive in most cases.

MEL WEBSTER
Miller Communications
Boston, MA

JANUS/ADA

The review of Janus/Ada by Mark J. Welch (February, page 295) was based on a version that was almost a year old. Mr. Welch had problems with several nonstandard features of Janus/Ada. The latest version, 1.5.1, contains a standard, full Ada grammar. Any program written in Ada will be accepted by Janus/Ada as syntactically correct (with some features marked as unimplemented). The "empty parentheses" problem does not exist in version 1.5.1; function calls have been updated to match the current Ada standard.

The new version also comes with an Ada-standard (subset) text__io module. The get__line routine is Ada-standard. No get__line routine in Ada takes a single parameter, so Mr. Welch's program wouldn't have worked anyway. The Ada get for strings is the same as a loop that reads a fixed number of characters, so it is useless for interactive input.

The Janus/Ada code generator, particularly local-variable access, has been improved in version 1.5.1. The BYTE prime-number benchmark (as a subprogram, not a package) now runs in 18.44 seconds on an IBM PC XT. You can get a further improvement to 15.80 seconds by using the stand-alone optimizer provided in the tools. The optimizer was previously a separate product.

The prime-number benchmark is somewhat misleading since an Ada main program is a normal procedure. Unlike other languages, in Ada you can call a main program recursively. Thus the data contained in it must be allocated on the stack, rather than in memory. That makes Ada slower than most other languages in benchmarks, no matter how good the compiler.

Ada does not have an unsigned integer type, so I see no reason why the reviewer expected one. The Fibonacci benchmark, which expects 16-bit unsigned integers, is unfair to any language that does not have them (including Pascal).

Long__integer is not a predefined type in Janus/Ada; it is an optional Ada type. We have been providing notes about the use of long__integer for a long time; perhaps Mr. Welch did not get them. We have revised Janus/Ada's manual to eliminate problems like the erroneous mention of long__integer as a predefined type. We also renumbered the sections to match the 1983 ANSI Ada standard. The new version of Janus/Ada has floating-point software and can use the 8087 chip. We generally recommend using the floating-point capabilities rather than the long__integer routines.

The version 1.5.1 compiler completely

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implements exceptions and exception handlers, including those on blocks and packages.

Last, the prices mentioned in the article changed at the beginning of 1985. We no longer directly sell the CP/M version of Janus/Ada, but it is still available through Workman & Associates (112 Marion Ave., Suite 3B, Pasadena, CA 91106, (818) 796-4401). The C-Pak (the compiler, linker, and Ada-standard libraries), which is mainly intended for education, is available for $99.95. The D-Pak, which includes the C-Pak, the tools, and the full set of libraries, is now priced at $900. The S-Pak, which includes the D-Pak, our Pastran Pascal-to-Ada translator, and the source code to the libraries, is $1500. The D- and S-Paks are intended for software development.

RANDALL L. BRUKARDT
RR Software Inc.
Madison, WI

I am glad that RR Software has updated its compiler to handle Ada's current syntax. My impression as I finished the review was that the new version had not yet been released. I will be pleased to update the review when RR loans me the compiler's new version; they have promised to do so.

Mr. Brukardt is correct about get_line. Ada does not have a single-parameter get_line procedure (get_line also returns a natural integer for the length of the string). My intent was to point out that get_line had not been implemented as a procedure, something that has presumably been fixed in the new version.

Regarding BYTE benchmarks, I used the standard BYTE Sieve of Eratosthenes prime-number benchmark in Ada (January 1983, page 288); BYTE does not normally review the performance of optional optimizers or of rewritten benchmark programs, since these defeat the purpose of benchmarks. If the optimizer is now a standard component of Janus/Ada, an updated review should include its performance. Anyone who can suggest a better compiler benchmark that can be fairly translated across all languages should let me know.

I realize that Ada does not have an unsigned integer type. My point was that you cannot run the Fibonacci benchmark in Janus/Ada because the language cannot handle numbers that large without overflowing the stack or heap. I wasn't faulting the compiler or language as much as explaining why I couldn't provide a value for this standard benchmark. Since the maximum and minimum values for integer are not specified in the reference manual, other Ada compilers might be able to execute this benchmark.

I am happy to hear that the compiler's price is now $99.95. If, as Mr. Brukardt reports, the compiler now matches standard Ada 1983 syntax, Janus/Ada is a bargain and a must for hobbyists trying to learn Ada.

—MARK J. WELCH
Staff Writer

ALTOS 586

I agree with Greg Corson's review of the Altos 586 with the XENIX Development System (March, page 247). However, we have managed to circumvent some of the problems he mentions.

We are using two Altos 986-40s with Altos Worknet, 10 terminals, two high-speed printers, two modems, and six local screen printers. The modem communication problem was solved by purchasing M-Link. This communication program lets us control communication protocol rather than rely on the standard Altos output.

The XENIX Development System is amazing; much like CP/M, you understand XENIX from other authors' articles and books, not from the original documentation. However, we are using programs written in COBOL, FORTRAN, C, and MS-BASIC interchangeably and without knowing which program is written in what language.

With the advent of XENIX 3.0 and Worknet 3.0, the documentation is now in 13 manuals covering 20 inches of shelf space. Both the hardware and the XENIX system are superior, but liaison between hardware and software becomes extremely confusing.

RICHARD C. LOFBERG
Teaneck, NJ

ATARI 800XL

I was pleased to see Jon Edwards's review of the Atari 800XL (March, page 267). The 800XL is a superior machine for the money. For $300, a computerist can get a disk drive and a 64K-byte 6502C machine.

Literally thousands of programs are available for the Atari, and two magazines devoted entirely to the machine do an outstanding job.

Also, the Action! compiler works faster than any I have seen, and it produces good, tight machine code. It is highly structured, complete with subroutines,

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global variables, local variables, and arguments. I wish someone would tell computer teachers in elementary schools how cheaply they could teach structured programming instead of BASIC.

J. RAY WOOD
Benton, IL

JUKI'S TRACTOR FEED

John J. Williams's letter in Review Feedback (March, page 303) found sympathetic readers: We experienced the same difficulty with the tractor feed. Since we have four Juki printers, we felt we had bought into a lemon factory until we hit on what appears to be an inexpensive solution.

The paper path from the underside of the tractor, around the platen, and back again through the top is too long and allows for paper slippage. This isn't too bad unless you need some form of double-printing. We finally found a method to take up the slack that gets rid of the wandering without causing gear-stripping friction.

The steel rod just below the paper-out bail is mounted to each end plate. We could remove only the left screw, but this was enough to access one side of the rod. We took polyethylene spiral wrap for harnessing cables and worked it on over the steel rod. The size we used was ⅜ inch outside diameter, but ½ inch would probably be easier to work with. A light touch of silicon lubricant helped it slide more easily, and any residue that made it to the outer surface of the wrap probably reduced the paper friction.

This slight addition to paper-path length worked wonders for us. The spiral wrap should be available locally, but several electronics mail-order catalogs carry it too.

JOHN J. NEVILLE
Onamia, MN

TECMAR'S JRCAPTAIN

In Glenn Hartwig's review of jrCaptain (March, page 299), he remarked about the cosmetics of the keyboard, the limitations of a single disk drive, and the need for more memory. In home use, I have found none of these problems insurmountable.

When you spend a lot of time with a PCjr, you find two less obvious problems, one major and one relatively minor. The minor one is the limited keyboard buffer. The serious problem is lack of direct-memory access (DMA): Everything stops when you read or write to disk. Almost every PCjr owner I meet has problems downloading files from remote host computers. There is a crying need for software that will support flow control for receiving ASCII files, as well as XMODEM for binary files.

I assume that expansion units like Tecmar's do not provide DMA but do get around these problems by providing a virtual disk in RAM. Are reliable file transfers possible this way? Is that also possible without the memory expansion? In other words, is there a RAM-disk program that is compact and will fit 40K or 50K bytes of storage into the PCjr above the communications program?

P. M. MORETTI
Stillwater, OK

Perhaps other PCjr owners can offer suggestions.

—GLENN HARTWIG
Technical Editor, Reviews

Glenn Hartwig could not find the data sheet for an 8314 memory chip on Tecmar's jrCaptain because it does not exist. The number 8314 is a date code representing the 14th week of 1983 when the part was manufactured. Almost all semiconductors are branded by the manufacturer with its logo, a part number, and a date code for lot traceability. Off-brand or retested parts will have the manufacturer's logo obliterated or removed but will generally leave a generic part number such as 4164 and the date code.

DAVID W. THOMSON
Highlands Ranch, CO

MICROSOFT BASIC

Manly W. Mumford, commenting on Microsoft BASIC in Review Feedback (March, page 303), made the same observation my students do at first: It seems crude compared to BASICs on lap and home computers because it lacks a full-screen editor and a Clear Screen statement.

The problem is that MS-DOS and CP/M provide software with only a simple service to print ASCII characters to the screen. When Microsoft designed MBASIC to run, without changes, on any computer (that is, working strictly through the system), this limited cursor movements to the directions provided by ASCII or the system. Since ASCII was designed around Teletype terminals using paper, text display can proceed only to the right and down except for backspacing along the current line. This rules out the possibility of a full-screen editor.

For similar reasons, ASCII, MS-DOS, and CP/M do not provide for clearing the screen. To provide these services to soft-

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ware, terminals recognize escape sequences—sequences of two or more ASCII characters, often beginning with the Escape character—as special commands to move the cursor, erase lines, clear the screen, and so on. Unfortunately, each terminal maker uses different sequences. To clear my Osborne 1's screen, I print Ctrl-Z; on my employer's DEC Rainbow 100, I print seven characters: Esc [2 J Esc [H.

Microsoft provided an Install program that lets the user adapt MBASIC to any terminal. You can solve your editing problem by saving your MBASIC program in ASCII form and using your favorite text editor. On my Osborne 1, I set up two function keys that transfer my work back and forth between MBASIC and the WordStar-like (but faster) public-domain editor VDO; the transfer takes only seconds in either direction. Mr. Mumford should be able to use MemoMaker on his HP 110 in this way.

Similarly, his terminal manual should describe a sequence that clears the screen. If such terminal-specific sequences are always written as subroutines or defined functions, MBASIC programs can be ported to other terminals by changing only those subroutines. I hope those moving up to MBASIC from home computers will notice the improvements, especially the ability to use up to 40 characters in truly descriptive variable names.

ALAN T. CHATTAWAY
Vancouver, British Columbia, Canada

NEWWORD

In John Heilborn and Nanci Reel's review of NewWord (February, page 291), I was shocked to read: "The R command. . .is missing from NewWord, and NewStar Software has no plans to add it to NewWord's vocabulary." Our household has two Morrow MD3s that came bundled with NewWord 1.19 and NewWord 1.32; both include the R command, which I use frequently. In addition to formatting blank disks, running the program STAT.COM allows maintenance of disk data.

Photo 1a in the review is clearly the introductory screen from a demonstration program, so perhaps the R function was deleted from the demo or perhaps the statement in the review pertains only to the MS-DOS/PC-DOS versions of NewWord (1.19 and 1.32 are CP/M versions).

ROBERT C. BROOKS
Nashua, NH

GENEVA PX-8

I have some comments on Rich Malloy's review of the Epson Geneva PX-8 lap com-

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REVIEW FEEDBACK

puter (February, page 302).

The reviewer describes the connectors on the Epson as DIN connectors. However, the DIN connectors you can purchase in Radio Shack and from other sources are not compatible with these plugs. The usual DIN connectors are ½ inch in diameter; the Epson connector is something like ⅜ inch.

The review concludes that the PX-8 would make a good second computer. Most people with two computers want them to be able to talk to each other. The PX-8 comes with two programs, TERM and FILINK, for this purpose. TERM does not allow the transfer of binary files, only ASCII text files, and consequently isn't of much use; you can't transfer programs or WordStar text with TERM. Serious communication between your desktop computer and the PX-8 should be carried on through FILINK. If your first computer is an Epson QX-10, you have no problems since the QX-10 will talk to the Epson FILINK protocol. Everybody else is out of luck. In the vast documentation supplied with the PX-8, Epson neglected to describe the protocol used by FILINK. You can write or buy some other communications program, but this is counterproductive in a portable computer with extremely limited storage space.

The PX-8 comes with a version of WordStar. The review says: "The only features lacking are certain printing capabilities." The PX-8 WordStar will print only on an Epson or compatible printer. It's not a question of only being able to use fancy features with an Epson printer; the PX-8 WordStar appears to be deliberately configured to make its output impossible to use on any other printer.

Finally, the review commends the PX-8 documentation. In terms of user orientation, I agree. However, the PX-8 CP/M manual keeps referring to something called *PX-8 System Essentials* whenever a technical question arises. This document is not provided with the PX-8.

I cannot recommend the Geneva PX-8 to average users because, for the price, it has too many things wrong with it and not enough right.

GREGOR OWEN
Port Jefferson Station, NY

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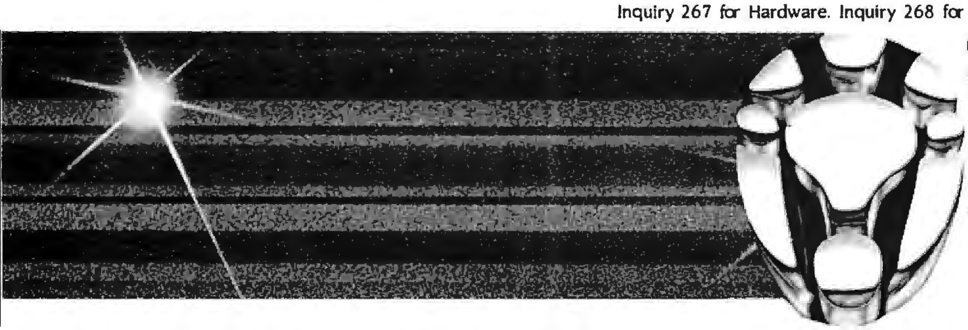

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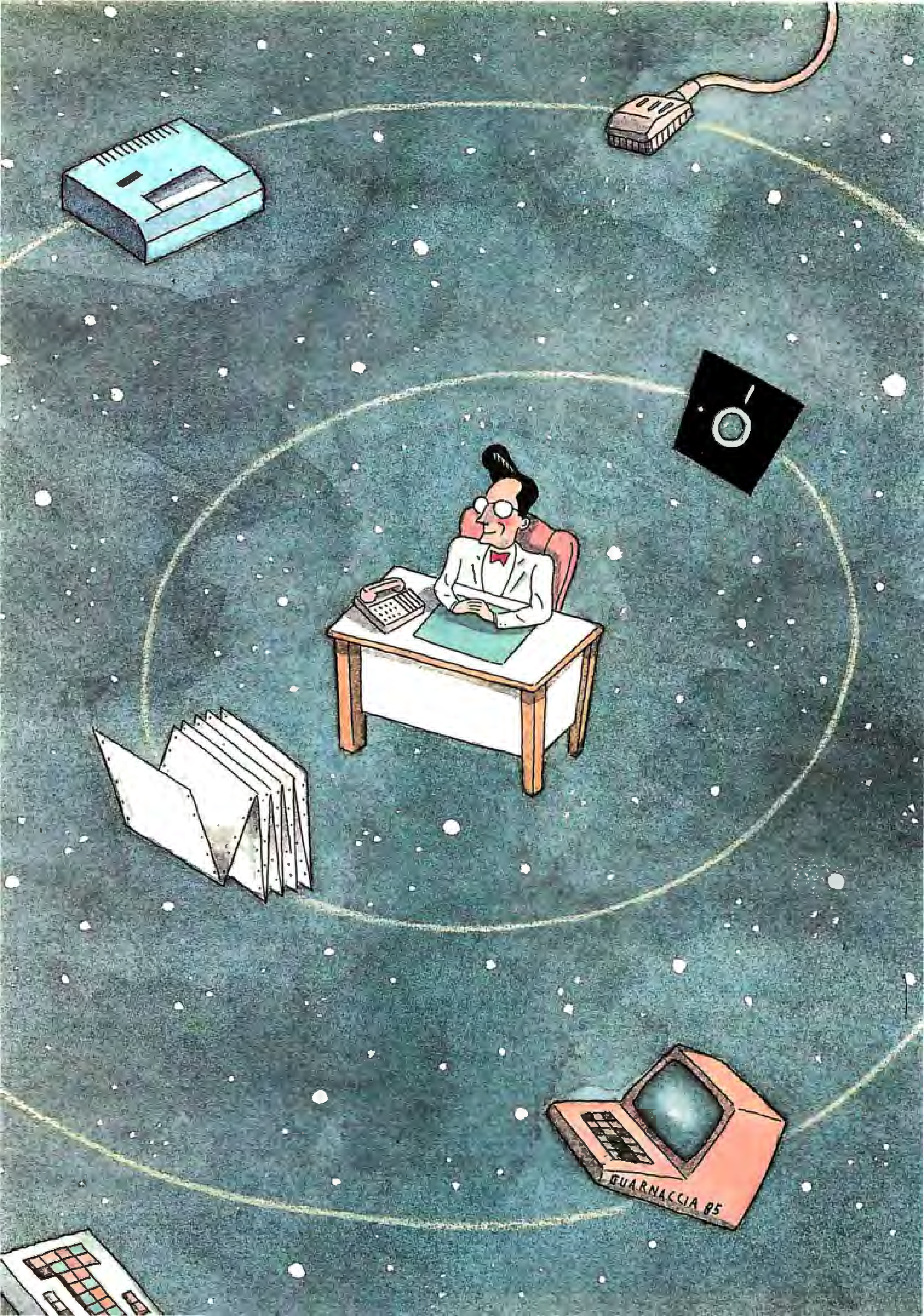
GUARNACCIA 85

Kernel

The renovation at Chaos Manor is nearing completion, but it was still chaotic enough for Jerry to spend much of his time on the road, making visits to the Stride Faire, Texas Instruments, and the MacFaire. At the Stride Faire he had a chance to meet Niklaus Wirth; at the MacFaire he discovered that the flood of software for the Macintosh has finally begun. In addition to his travels, he also spent some time answering readers' letters.

On the West Coast this month, Ezra Shapiro, BYTE's West Coast bureau chief, talked to Ralph Griswold about SNOBOL4 and his new language, Icon.

Dick Pountain reports from London on Andrew Hollis's Ormada Observatory in northern England and on the application of the Sinclair Spectrum microcomputer in measuring the brightness of celestial objects.

From Japan, Bill Raike reports on the Silver-Reed EB50, Fujitsu's new erasable optical-disc technology, the ongoing battle of memory chips in that country, and on two new personal computers.

This month sees the debut of a new column. According to Webster is another vehicle that will let us provide informed commentary on new products. This column, taken in conjunction with Computing at Chaos Manor, will help us better cover the many products that are appearing on the market. The author, Bruce Webster, knows the computer industry. His introductory column deals largely with Macintosh products.

In Mathematical Recreations, Bob Kurosaka presents a BASIC program that turns a system of equations into something a computer can deal with.

And finally, Steve Ciarcia provides a brief sampling, in Circuit Cellar Feedback, of the numerous letters he receives each month, and Sol Libes offers more news and speculation on the personal computing industry in BYTELINES.

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C·O·M·P·U·T·I·N·G A·T C·H·A·O·S M·A·N·O·R

Come to the Faire

The Stride Faire
Niklaus Wirth
Micro Modula-2
The Nod
ScenicWriter
Lilith CAD System
The MacFaire
MegaMac
Mac Software Galore

BY JERRY POURNELLE

I've just been upstairs to look at my new office suite. The floors are still bare plywood, the electricity isn't hooked up, and the windows haven't been installed; but the walls are up, the ceiling beams are in, and I can see what it's going to look like. It's magnificent. Of course, it's not done. Half the house is folded into the other half, I'm still crammed into the living room, and everything I own is in boxes. One more month. Sigh.

Fortunately, I was able to spend a good part of my time away from home. While the contractors drove our housekeeper, my staff, and my wife nearly out of their minds, I was able to get to the Stride Faire, visit Texas Instruments in both Dallas and Austin, and go to the MacFaire in San Francisco. Clever, no?

STRIDE FAIRE

I still think of it as the Sage Faire, but they can call it anything they want to: it's one of my favorite computer shows, and this year there was a special treat. Thanks to Stride Micro I got to have lunch with Niklaus Wirth of the Swiss Federal Institute of Technology in Zurich, one of the genuine heroes of the computer revolution. I'm not usually at a loss for words, but when he told me he reads these columns I think I actually stammered a bit.

In my judgment, Stride Micro is still the leading outfit developing low-cost usable micro systems based on the Motorola 68000 chip family.

I now have a problem: longtime readers know what I mean by "chip family." Newer readers won't, and why should they? I'll take a moment to explain.

Chip family: the micro is built around the "computer on a chip." At the heart of any micro is a single chip called the central processing unit (CPU). There are four main families of microcomputer chips: the 8088, 8086, 80186, 80286 family from the Intel Corporation used in PClones and upgrades; the Motorola 6500, 68000, 68010, 68020 family used in Apple and Stride computers, etc.; National Semiconductor's 32016 and 32032 family which has yet to be adopted by a major manufacturer; and the Zilog Z80, which dominated the 8-bit market (I'm writing this on Zeke II, a CompuPro Z80) but whose upgrade, Z8000, has yet to catch on.

Now back to the 68000 family. Stride continues to stay on top of new developments in computer hardware. The new Stride machines are built around the VME bus and are designed with upgrades in mind; when superchips such as the 68020 and beyond become common, Stride will be right there.

Stride does have a rival, Pinnacle Systems. So far I haven't seen any Pinnacle equipment, but people I trust, including Carl Helmers, have been impressed. One day perhaps I'll do some comparisons; meanwhile, the 68000 machines get more useful and more powerful all the time. Now that 256K-byte chips are available in quantities, even the smallest Stride can have 2 megabytes of memory and can run at 12 megahertz. That's *fast*.

QUO VADIMUS?

The mainstream of the micro community still looks as if it's flowing from Intel and the 8086 family. IBM certainly thinks that's the mainstream.

Then there's National Semiconductor with the 32016 (which used to be known as the 16032 and don't ask me why National changed the name); a lot of knowledgeable enthusiasts, including Dr. William Godbout, are highly impressed with its architecture.

A lot of top people ignore the Motorola 68000 family. Even so, it always happens: when I get among enthusiasts for the Motorola 68000 chip, and especially when I get around Stride Micro's president, Rod Coleman, I begin to wonder. Add Jack Brown, Motorola engineer and product manager, and the enthusiasm is catching.

According to Brown, the 68000 is the best thing in general use, while its follow-on

(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.

68020 is a better chip "than anything out there." In fact, the 68020 is faster than available memory, although that's changing rapidly. Machines using the 68020 can economically put the equivalent of a VAX at every workstation. Brown says Motorola will ship 75,000 of the 68020 chips this year.

Of course, the 68020 will become cheaper, just as all chips do. Brown put it this way: "If GM could do what we in the semiconductor industry can do, a Cadillac today would cost less than a thousand dollars. It would also be about a foot long . . ."

The 68020 is very much upward-compatible with the 68000, and all 68000 programs ought to run in 68020 machines without problems.

As I listened to different speakers tell of the virtues of the 68000 series, I kept wondering: Why isn't this the mainstream? Why hasn't the chip caught on better in the micro community?

THERE'S THE RUB

I suppose the big problem with the 68000 family has been the operating system. The only popular one is the Lisa/Macintosh system developed by the folks at Apple, and not only are they not interested in standardization, they seem to fight it. Apple wants to sell Apple hardware. It's a policy that helps IBM more than Apple, but I don't expect the Apple strategists to understand that. More on the Macintosh when I get to the MacFaire.

There was also the Fortune-32 system using UNIX. That never caught on. Meanwhile, the Sage—introduced at the same West Coast Computer Faire as the Fortune-32—came out with SofTech's p-System as its major operating system. This tied Sage/Stride to a company whose marketing philosophy seemed to me a combination of the worst features from Apple and AT&T: arrogance, indifference to customer complaints, and total unwillingness to make any changes. SofTech's attitude seemed to be "We have this wonderful product, and if you're too stupid to realize just how wonderful it is, then you don't deserve to use it."

Understand, there was much to like about the p-System. It was too slow, but at first that wasn't much of a problem because the 68000 chip was so fast. Later, though, rival hardware got faster, but the p-System didn't. Indeed, as the rest of the micro world raced ahead, the p-System didn't. Meanwhile, Digital Research didn't do any better with CP/M-68000. I confess I had thought Digital would develop CP/M-68K into a new standard compatible with CP/M-86, after which CP/M would move forward to dominate the 16-bit world as thoroughly as CP/M-80 dominated the 8-bit micro universe. Boy, was I ever wrong.

There were a few other rather interesting operating systems, such as the British-developed Metacomco system, but none of them really caught on. Like it or not, the Sage's destiny was intertwined with the UCSD p-System.

Things may be different now. First, SofTech has reorganized, and the SofTech people assure me they've had a great change of heart. "We know we acted strangely," one of their reps told me at the Stride Faire. "It really is a good system, though, and we're working to make it better. We're working with the users groups, and we're open to suggestions from anyone." They've improved their relations with USUS, the p-System users group. Another visible sign of their change of attitude happened three days ago: an enormous box of SofTech products arrived at Chaos Manor. In the past, they not only wouldn't send review copies, they didn't even answer their mail.

Second, SofTech's p-System doesn't have to stand alone. Modula-2 has arrived.

VIOLATIONS AND VOLITIONS

I first got interested in Modula-2 through the enthusiasm of Rod Coleman, and my first experiences with the language were on the Sage II. Naturally it ran under p-code. The Modula-2 implementation was developed by Volition Systems of San Diego. This was a typical start-up company with a small staff and little capi-

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tal; everyone worked in hopes of developing a best-selling product. It was likely that they'd do that. They were sharp troops, and many of Volition's people came from the University of California at San Diego and had thus worked on UCSD Pascal, from which grew the UCSD p-code that later became SofTech's p-code.

The best introduction to Modula-2 I've yet encountered was the Volition Modula-2 documentation. That was written by Richard Gleaves (generally called Glitch) and has since been published by Springer-Verlag. Alas, it isn't a beginner's book; it assumes you know something about programming in general and Pascal in particular. However, if you like Pascal, get Glitch's book; it will probably make a Modula-2 convert of you, and at the least it will show how easily Pascal programmers can learn Modula-2.

After Volition's people developed the p-System's Modula-2 compiler, they set to work on a native-code compiler for the 68000 chip. This was a product sorely needed, and the first company to bring out a reasonably bug-free compiler would get big sales. They might not do quite as well as Borland International did selling Turbo Pascal, but the potential market was large and growing.

Alas, Volition didn't focus its effort. Moreover, as often happens in small start-up companies, personality conflicts developed. Some of the original founders went away to work elsewhere. They retained ownership rights and promises that when Volition struck it rich they'd be paid for back salaries owed. Meanwhile, those who remained to work on the compiler were working for little to no pay.

This went on far too long. When the compiler was not quite finished, things came apart. Tensions had already developed between those who had left and those who stayed behind. Once the compiler was in sight, the tensions worsened. Reorganizations were announced. Proxy fights developed. The management team changed. Equipment was sold off. Volition went from healthy to

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struggling to near death.

Meanwhile, a few test versions of the compiler drifted about the micro community. One landed in the hands of Erik Smith of Scenic Computer Systems Corporation, a firm you'll hear more about shortly. Erik cleaned up most of the remaining bugs and worked on the documents. His improved version went to Stride Micro. The Stride people did some more work, with the result that they have, in house, a Modula-2 compiler that works splendidly with the Stride computers; works so well, in fact, that Stride wrote their 68000 assembly language in Modula-2.

The Volition Modula-2 compiler uses the p-System for the editor and file manager, and the compiler runs under the p-System; but once you have compiled the file, it is a true native-code program that has only minimal interface with the p-System. Volition Modula-2 programs don't have the 64K-byte limit on code size that p-System programs have; and they're very fast compared to p-code.

The new Stride Micro computer systems have *great* graphics capabilities. Stride now uses Wyse terminals, and they've done nearly incredible things. They can repaint a screen instantly, faster than Zeke II manages with memory-mapped video. The nice part is that Modula-2 is very nearly the perfect language for exploiting Stride's graphics. It is also a great language in which to develop a text editor. I've got a couple of colleagues working on doing just that. So, I suspect, does Stride.

Moreover, Modula-2 was explicitly designed as a language you can use to write an operating system. After Niklaus Wirth wrote Pascal, he spent a sabbatical year at the Xerox Palo Alto Research Center (PARC). Alan Kay was also at PARC. Much of the Macintosh operating system is no more than an implementation of Kay's ideas. Wirth left PARC with many of those ideas and went home to Zurich to write Modula-2. As a consequence, the Modula-2 operating system strongly resembles the Mac's. A

(continued)

Modula-2 operating system for the Stride could have most of the better features of the Macintosh without the limitations.

So far there's no Modula-2 operating system for the Sage, but that will change. Meanwhile, I did see demonstrations of Volition Modula-2 programs working within the p-System, and they were *fast*. The Stride, unlike the Macintosh, can handle lots of memory, extra disk drives, tape backups, and the other peripherals one expects microcomputers routinely to make use of. I'd already thought that Modula-2 and the Sage, oops, Stride Micro machines were made for each other; seeing what they'd done using the Volition compiler, I was absolutely sure of it.

Arbitration, Anyone?

There was one big problem. The Volition compiler was all tied up in lawsuits and acrimony. There was no way any publisher could get an unclouded license to market it.

I'd heard bits and pieces of the Volition controversy before going to Reno for the Stride Faire. It had seemed unfortunate; but now that I'd seen the compiler working on a Stridé, it was tragic. Stride was arranging to trade my Sage IV for a Stride 440—but they couldn't let me have the Modula-2 compiler.

Representatives from most of the major factions in the Volition dispute were present at the Faire. It wasn't hard to get each to give his version of the problem. When I'd heard them all, I wanted to cry. We had here a classic case of a failure to communicate, with serious complications caused by an awful lot of wounded pride.

Certain facts stood out. First: there were no villains here. Sure, each side could persuade itself that the others—or at least one of the others—was a villain, but objectively it just wasn't true.

More important, though, from what each told me he wanted, it was obvious they aren't even very far apart. It may well be that their lawyers have made needless claims—lawyers tend to do that—but from what the principals to the dispute told me, they'd *all* be better off if they *all lost*. That is: if in order to get the compiler on the market they agreed that each side would get no more than the other was willing to concede, and some random stranger, or the government, took all the rest, *all* of the factions would still be better off than they are now. The potential sales of the compiler—provided that it gets out there while it has a chance to grab some market share—are large, while the potential return from liquidating the company is small.

The image I get is a farm: the goose is dead, but there's one unhatched

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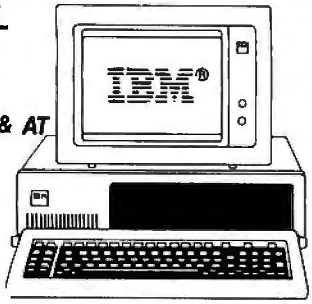

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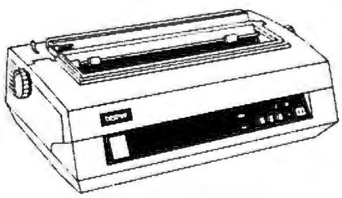

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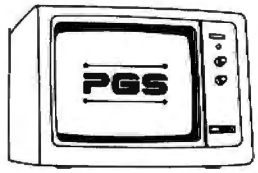

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Inquiry 96

Many of the language's limits were imposed by the machinery Wirth had available, and they might be changed in later revisions.

egg. All the heirs to the farm are standing in the nest fighting with sledgehammers.

It seemed a perfect situation for arbitration. I spent a good part of my time at the Stride Faire trying to persuade all parties of that. Now, it's a truism that the best way to make enemies is to stick your nose in other people's quarrels—but damn all, this isn't just their fight. Anyone interested in the future of the 68000 chip family has an interest in the outcome. As a result, I not only tried to persuade them to submit this mess to arbitration, but I even offered to get involved if that would help. So far no one has taken my offer; but I do understand there's a good chance they can come to sufficient agreement to get the compiler on the market.

Last-minute flash: it looks like they have. Stay tuned.

MOSYS

It's almost an *embarras de richesses*. Until recently, there wasn't a good operating system for 68000-based computers. Now there are several based on Modula-2. One that I saw at the Stride Faire was MOSYS, which comes from the British firm Robinson Systems. I've known Brian Kirk, managing director (sort of like president) of Robinson for some time, and I'm always astonished at what his people can accomplish.

MOSYS is a full operating system and comes with an editor, document-processing program, and Modula-2 compiler. You also get quite a lot of source code. I saw it work on Stride systems, and I have the documents: a bit dry but thorough. I anticipate no problems with MOSYS. A copy will come with my Stride system; full report Real Soon Now.

THE MASTER SPEAKS

I liked last year's Faire, but the big attraction for me this year was Dr. Niklaus Wirth, certainly one of the most influential leaders of the micro revolution. On my way to Reno I tried to imagine what Wirth would be like. I had a few clues: there's a famous story about his reply when asked how to pronounce his name.

"You can call me by name, or you can call me by value," he is supposed to have answered. "If you call me by name, it is 'VIRT.' If you call me by value, it is 'Worth.' "

I can't confirm that Wirth ever actually said anything like that. I think I do not know another pun that exploits three languages (German, English, and Pascal). Certainly the man I met would have been capable of it. He has a puckish sense of humor and speaks excellent English, as does his wife. Frau Wirth found Reno fascinating. During lunch she kept making one-dollar keno bets on numbers that mathematicians would find interesting; at last count she was about $50 ahead.

After lunch Dr. Wirth gave a talk on Modula-2. He said too much for easy summarization; I expect I'll be cribbing pieces of it for a year. He managed, in a bit more than an hour, to say more interesting things about compiler design than I've learned in five years. I don't find Wirth a good writer; but he's a fascinating speaker.

Because I am a staunch Modula-2 enthusiast, a number of readers have asked me, more or less politely, to explain some of the curious aspects of the language. Why has Wirth done this? Why has he left that out? After hearing Wirth's lecture, I can make this generalization: when Wirth designs a compiler, there are no "accidents." There's a good reason for everything he does.

Wirth begins with a philosophy: keep it simple. "There should not be a compiler that takes 100,000 lines of source code and requires experts and armies of programmers to maintain. Such things should not exist." Compilers should be simple and consistent. There should be no surprises. When Wirth mentions Ada, he grows contemptuous. "They put in exception handling. They don't know how to program."

Of course, not all omissions and inclusions grow out of high philosophy. "If you are at a university and have only a few students to help you, you better don't do vast projects." At Wirth's university during 1975-76 he had only one machine, a PDP-11 with 56K bytes of storage. "This set definite limits to the size of programs, including compilers."

Of course, many people cannot distinguish between a language and their implementation of it. After Pascal's success showed the need for a follow-on language, Wirth developed Modula-2; but he had only a little time—part-time one summer—to write an implementation of it. The idea was to keep the compiler small and comprehensible and get it running. Once a Modula-2 compiler existed, it could be used to write a better compiler.

His first Modula-2 compiler took 25 minutes to compile itself. By working recursively, he was able to develop a version that would compile itself in 2 minutes. "As you see, you can gain not only by making fast hardware." The speed was not done at the sacrifice of comprehension.

Many of the language's limits were imposed by the machinery Wirth had available, and they might be changed in later revisions. On the other hand, Wirth is contemptuous of programmers who read through the language report and call for extensions before they have even tried to use the language. He has special scorn for those who insist that a language have exception handling.

"If you are deep inside nested structures, it can be good to raise your hand and shout 'Help!' But could not

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'Industry needs standards much more than universities. Even so, there is such a thing as too much standards.'

that problem have been handled before? Rather than build exception structures—surprises—into the language, is it not better to raise flags and check them later?"

Wirth also commented on what he called the "urge to standardization. I appreciate the need of industry for standards. Industry needs standards much more than universities. Even so, there is such a thing as too much standards." Programmers must be clever enough *not* to explore the language and find "features" not described in the language report, or else they will later clamor that those "features" be in the language—yet there may be a very good reason why they should be left out. "A language report should not only be taken for what it says but for what it does not say."

Wirth finds one omission serious. "I will probably introduce forward definitions, but I do not like it. In general, you should not add complexities to handle a few pathological cases. If there were a trivial fix to the problem of forward declarations, I would have done it already."

There was a great deal more; enough that I'm still digesting his lecture while rethinking some of my objections. I'll admit it: I was one of those who clamored for certain extensions and changes to the language before I did much programming in it. On reflection, I find that a particularly silly form of hubris and a mistake I don't intend to continue. When we get Chaos Manor rebuilt and I have my machines set up again—at the mo-

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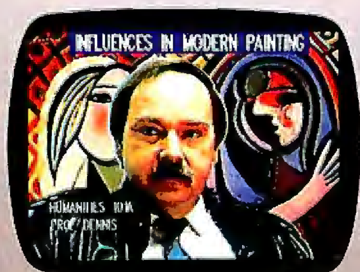

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Inquiry 76

CHORUS Data Systems, Inc., 6 Continental Blvd., P.O. Box 370, Merrimack, New Hampshire 03054 ment there's only room for Zeke II, and he's crowded into the living room—I'll do some more exploration.

How Do We Really Do It?

After Wirth's lecture, there was a panel on the Modula-2 language. Alas, whether due to the hour or the speakers, I slept through much of it.

There were a few interesting points. Jon Bondy, former officer of USUS, talked about Modula-2's seeming simplicity. "At the end of a month I thought I knew all about the language, but then I feel this way every month." The real value of Modula-2 is that big projects can be broken up into meaningful parts for different people to work on—and it really works.

Tom DeMarco commented on programming philosophy and gave the opinion that Modula-2 is a major step toward developing a "standard software bus," which all of us, professionals and amateurs alike, can make use of.

One of the major advantages of Modula-2 is that it is truly possible to use teams of programmers to work on large projects. Modula's, er, *modular* structure allows projects to be broken apart and keeps the interfaces between pieces thin; according to the panelists, thinner than with any other language. Bondy told of some recent projects he'd worked on. "We wouldn't be finished without Modula-2."

All the panelists agreed that programmers think too little and begin writing code too early. "It's the APL-FORTH philosophy," Bondy said. "Don't think about the problem, just start hacking at it."

With Modula-2 you needn't do that. In fact, if you have a team of programmers, you can't do that. Instead, you must spend time breaking things apart and looking at logical divisions of the work. In Modula-2 you can write code that describes what a program part does and what variables it uses without showing *how* that's to be accomplished. These "definition modules" can be passed back and forth, and once agreed on, they can be fixed even though the implementation modules that actually do the work are changed. This is the way to proceed.

I listened to all this and nodded agreement, but then I began to wonder. It all reminded me of how English teachers tell us we ought to write. Do outlines. Think of what you want to say. Get it all organized. Most people start writing too early. Don't. Wait until you know where you're going . . .

I don't know any professional writers who do that. Certainly I don't. If English teachers follow their own advice, it's no wonder that so few of them can support themselves by writing. It's perfectly true that badly organized material reads badly; but it's not necessarily true that the best way to do well-structured writing is to sit and think and outline forever. If I had to do that, I'd get so discouraged that I'd never write anything at all.

Most writers I know simply start hacking at the problem, writing whatever comes to mind. Get it down and written; then, later, when there's something to organize, you can work on the structure. That's what's so wonderful about writing with computers: it makes reorganization so easy. In the old days I had to use scissors and paste.

For me, at least, the big problem of writing is getting the thoughts down on paper. (Well, in my case, on disk.) The easiest thing I can find is a good reason why I should think about my essay or story rather than writing it. In fact, the best way I know of to get writer's block is to insist that first-draft stuff be presentable.

I find programming much the same. It's a lot easier to sit and think about structures than it is to hack out code. Now it may be that programming is a fundamentally different kind of

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creative activity from writing and different rules ought to apply; but I don't believe it. I'm not a professional programmer, but I have written some pretty complicated programs, including the accounting system I use; and I find that the best way to get a program done is to treat it like an essay. Think about where you want to go; look at what must be done to get there; and start working on the parts that look the most interesting. It will all get reorganized later.

Most programmers I know work that way. Get something running; that's work, but it's also rewarding to see progress. When you're tired of writing code, stop and think again. It's a recursive process. Of course, programmers can, if not careful, get into a blind alley and be faced with throwing away a lot of work or hacking up some particularly horrible kludge; but that's also true for writers and only goes to prove that courage is indispensable to programmers and writers alike.

Books written in collaboration need more organization than those written solo, of course; but once again, there's a strong motivation factor. Larry Niven and I have written five novels (the latest, *Footfall* from Ballantine Books, ought to be in your local bookstore right now) together; and the hardest part of it is when we have to work alone. When we get together and I see text I didn't write, or improvements in something I thought was pretty good to begin with, the result is a flurry of work. It's often necessary to sit at the conference table and work on an outline; but the real inspirations come when the words begin to flow.

Now, I am willing to concede the value of good organization and of thinking things out in advance; but just as good writing requires rewriting and editing, so, I think, does good programming. It would be remarkable if my first cut at organizing an essay turned out to be optimum; and though I have less experience at programming, I suspect it's no different there. In fact, I'm tentatively putting it forth as one of Pournelle's laws: in any large programming effort, the outline will change when coding begins.

For all that, the panelists were agreed that Modula-2 makes it easier to do proper organization, as well as to compensate for organizational mistakes, whether you're working solo or as part of a team; and I believe that.

JUST TURN YOUR HEAD...

Some love them, some hate them, but many users have strong feelings about mice. Touch-typists find mice sometimes useful but are annoyed by machines that have no arrow keys and thus make you take your hands off the keyboard. In my own case, my desk is always covered with papers: not only is there no place to operate the mouse, but often I can't even *find* the silly thing.

Alternatives to mice include foot-controlled mice—sometimes called rats—joysticks, trackballs, thumb balls, and touchpads. Comes now the new Stride "spot," which they call The Nod. That is: Stride's engineers have mounted a small infrared source and detector on the screen. The operator takes a circle of silvered tape about the size of a quarter and mounts it on his head. You can stick it on your forehead, on your glasses, or on the end of a pencil to stick behind your ear. It doesn't matter. You can now control the cursor by moving your head.

This works. Naturally there are a number of control features. You can program in the slewing rate and that sort of thing, and there are various ways to enable/disable it. I don't know how I'll like it, because due to the construction here I don't have mine set up yet; but I had no trouble using the one on demonstration in Reno, and I rather like the idea. My new Stride

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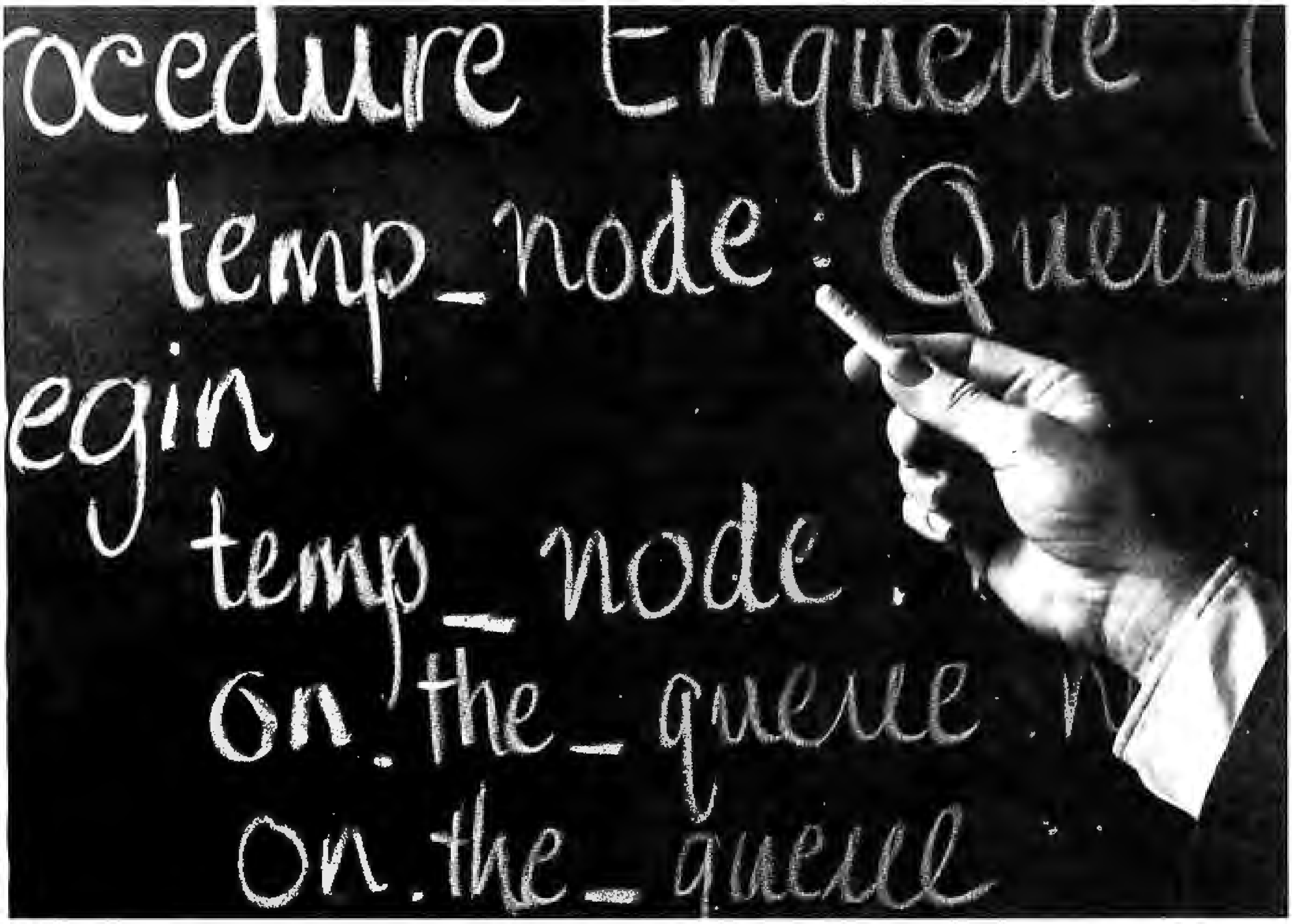

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SCENIC

If you're interested in computerized typesetting, you need to talk to the people at Scenic Computer Systems Corporation of Redmond, Washington. They've developed a number of typesetting/formatting programs, including the one used to set type for Glitch's Modula-2 book. Their original ScenicWriter programs were in various languages, including assembly languages, but now they're working seriously with Modula-2. ScenicWriter can do a *lot*, and once it's in Modula-2 it will be even easier to add special features. It will also be more portable.

Their system takes the output from a text editor—nearly any text editor—and formats it for a variety of printers, including the HP LaserJet and the new Apple laser printer. I was fascinated by all the things they can do with the LaserJet making use of the various font cartridges available from HP. Erik Smith, their vice president for engineering whom I mentioned above, is impressively informed about both typesetting and computers. He tells me that the LaserJet is very nice. Those who do fancy printing may find Apple's LaserWriter is worth the extra money, but LaserJet is darn good.

This is a show report, not an evaluation: I'll have more on ScenicWriter when I get the Stride 440 set up in my new quarters. Meanwhile, I liked what I saw, and if you're in the fancy text-formatting business, look at ScenicWriter. You may like it a lot.

SIGN OF THE TIMES

A quick note: I now have review copies of three different commercial programs written in Logitech's Modula-2 for the IBM PC. They work. The language has come of age, and I expect to see many more Modula-2 programs in the coming year.

SUPERPRACTICAL LILITH

The Lilith computer is a wonderful Modula-2 programming environment, and I don't hesitate to recommend it for anyone seriously interested in writing big programs in that language. It's not likely to catch on as a mass-market machine, so I haven't in conscience been able to recommend it to anyone but Modula-2 programmers.

That's all changed.

If your business involves laying out and taping circuit boards, you need to call Richard Ohran at Modula Corporation. He has turned the Lilith into a superbly practical engine for generating circuit-board templates.

The CAD (computer-aided design) software is designed for use by technicians who know something about taping boards and don't want to become computer jocks. The system can be learned in two days. The conversion is simple because Ohran's system is designed to be easy for computer neophytes to learn. After a couple of days' experience with the Lilith, board designers can take a complex multilayered board from circuit diagram to photo templates in a week or less.

Dr. Ohran had Lilith set up in his hotel room, and we went up after the Saturday dinner show—the MGM puts on the San Francisco Quake twice nightly, and it's still one of the best dinner shows I've ever seen—for a demonstration. I watched Ohran playing about with the system. He drew lines. Called in circuit components. Rerouted lines. Changed layouts. Marked chunks to be enlarged, worked on them, and changed their scale. "That's as good as I've seen on a Symbolics machine," I said.

Ohran didn't even chuckle. "Symbolics isn't as fast."

He was dead serious, and I'm sure he's right. I've seen *nothing* as fast for manipulating circuit elements. The

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Lilith CAD system uses the mouse to draw circuit lines, chip-mount pads (the little wide spots that chips or chip sockets would be soldered to), and the other stuff that goes onto circuit boards. Elements, such as pads, can be built up into larger units, as large as you want. Since each is an element in the file, changes can be made at any level. For example, if you change the design of one of the chip-mount pads at the lowest level, then *every* instance of that particular pad, hundreds of them, will change instantly. Alternatively, you could change one of them at the highest level of abstraction and only that particular one would change.

The system has a real mode and a quick mode. In quick mode the corners aren't exactly rounded, and there are other subtle shortcuts; but it's very fast, recalculating hundreds of images and redrawing them nearly instantaneously. Real mode is slower but shows on screen exactly what you'd get if you made printouts and templates. Real mode does size and shape and scale changes fast enough to work with; it's slow only in comparison to quick mode.

The Lilith will certainly raise productivity. One Santa Monica outfit has a Lilith CAD system with a slightly flaky hard disk. Dr. Ohran keeps urging them to ship the unit back to him for repair; but they say they can't spare the machine even for a couple of days. They'd rather keep lots of backups than be without the unit. "One of these days I'll have to ship them a loaner," Richard Ohran says.

The Lilith system is about $21,000 with software, which is a bit beyond the price range I usually review. Still, I'm no great expert on CAD systems for making circuit-board templates, but I'd be much surprised if there's anything this effective at anything like its price. Anyone in that business should certainly find out about it.

MacFaire

The Macintosh Faire was held in San Francisco's Brooks Hall the 22nd and 23rd of February. I had a long-standing dinner engagement with Frank Herbert for the night of the 22nd, leaving nothing for it: I caught an airplane to San Francisco at 0700 Saturday the 23rd. This was unlikely to put me in a good mood for looking at MacProducts.

It didn't matter. Besides being in Brooks Hall, where the West Coast Computer Faire was held for so many years, the MacFaire had something else in common with the early West Coast Faires. There was an almost electric air of excitement. The MacFaire was full of people who *like* small computers. Whatever else I might think about the Macintosh, I give it full marks for bringing the fun back to the

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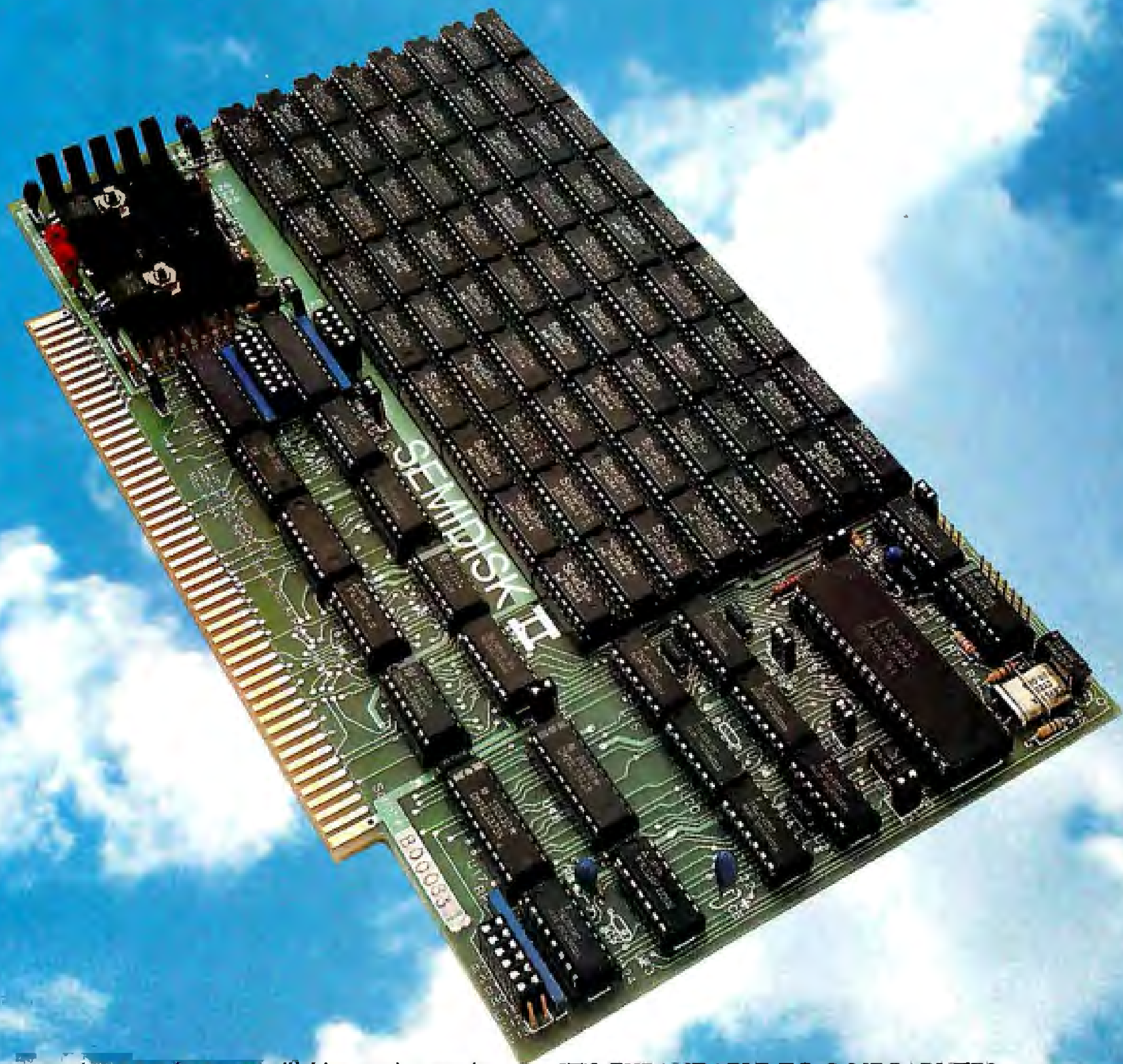

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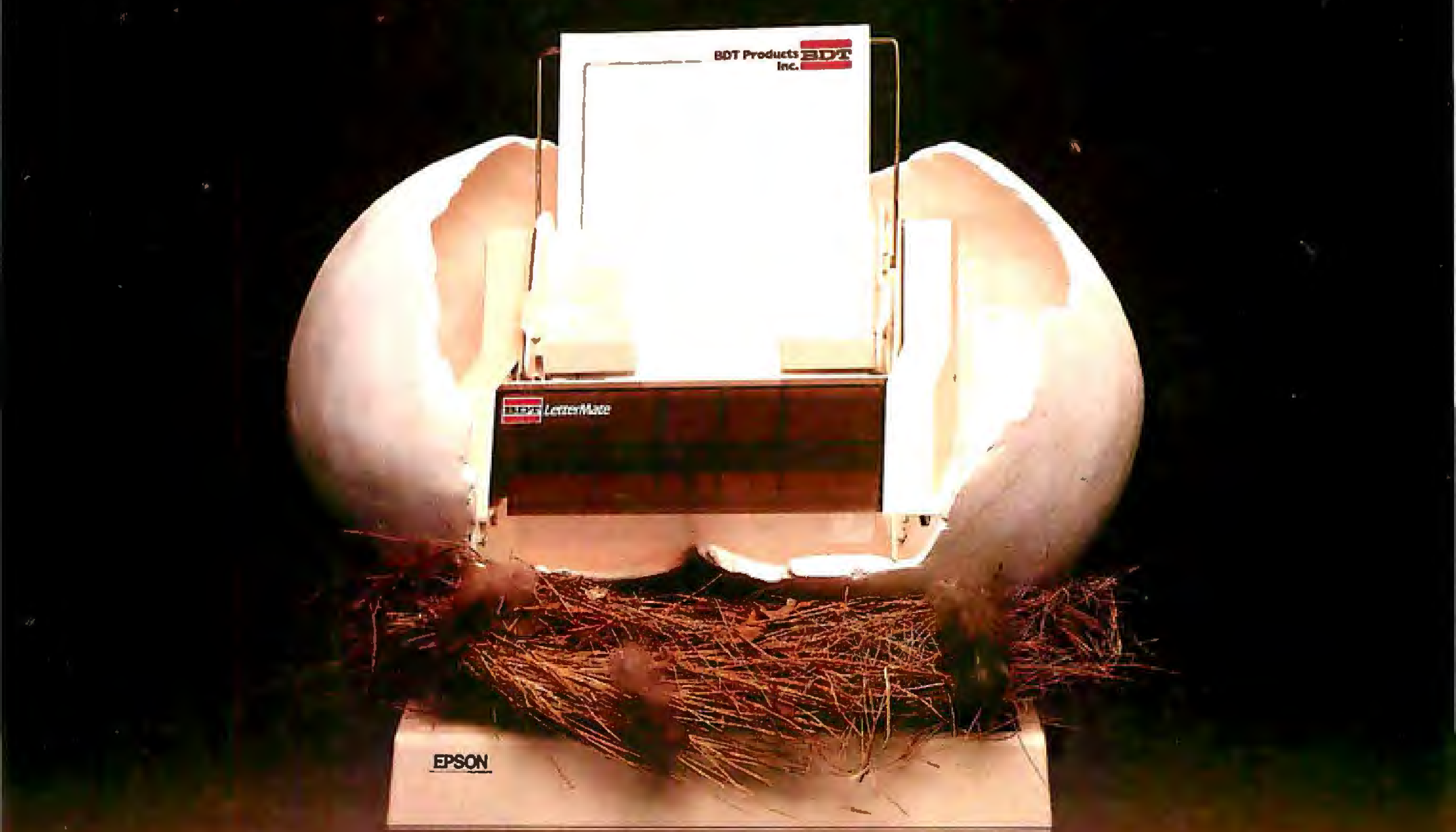

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small-computer game.

Moreover, there's no question about it: useful MacSoftware is beginning to appear. It's now possible to use the Macintosh as a serious business machine—and still have some fun while doing it.

Before a number of you write me triumphant letters saying "I told you so," let me hastily add that just about all that new software is for the 512K-byte Macintosh; the 128K-byte Mac still has severe limits. When the Mac first came out, I advised readers not to get one. Those who took my advice saved a lot of money; now you can get a Fat Mac for less than you'd have paid for the thin one a year ago. During that year the 128K-byte Mac might have been a good companion for

(continued)

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FAST FINDER $100
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LASERJET $3495
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Sunnyvale, CA 94086
(800) 367-4772

HYPERDRIVE (for Macintosh)
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for 128K-byte Macintosh . . . $2795
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512K bytes $2795
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Cupertino, CA 95014
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LILITH CAD SYSTEM $21,000
LILITH COMPUTER $8000
MACMODULA-2 . . . . $150
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Provo, UT 84604
(801) 377-3598

MACNOSY $50
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Menlo Park, CA 94025
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MEGAMAC $1395
Micrographic Images
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Woodland Hills, CA 91367
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MODULA-2 (for Stride) $500
SCENICWRITER $995
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p-SYSTEM IV.2
(SofTech's liaison) $250
STRIDE 440 . . . . starts at $5900
THE NOD
(available as a development
tool) $400
with cable
Stride Micro
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TECHFONTS (for Macintosh)
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Del Mar, CA 92014

UNDERWARE COLORPENS $14.95
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The Modula Corporation now has a working Modula-2 compiler for the Macintosh.

those trying to grow a beard or making a study of wristwatch icons, but serious users would have gotten a lot more mileage out of something else.

The Mac is a better buy now. Of course, the documents still are inadequate in my judgment; even the $150 "Inside Mac" package you can buy extra—do you know of any other company that sells you photocopied loose-leaf sheets in lieu of providing real technical documentation?—isn't very complete.

HACKING YOUR MAC

The day I returned from the MacFaire I packed up my Macintosh and shipped it off to General Computer. Eight days later it returned with 512K bytes and the internal hard disk they call Hyperdrive. It's fast and works fine.

I also ordered another 128K-byte Mac. That one will go to Janek Kaliczak, president of Micrographic Images Corp., the outfit that did many of the House of Dracula special effects for the Universal Studio tours. Janek and his people demonstrated the MegaMac at the MacFaire. This is a package that can be installed by dealers in 20 minutes for less than $1500; and it puts a full megabyte of memory at the MacUser's disposal. The Micrographic Images people did some clever work integrating the MegaMac into the Macintosh operating system, but even so the Macintosh can't make full use of more than 512K bytes of memory. However, the other 500K bytes in the MegaMac isn't wasted. It's used as a RAM (random-access read/write memory) disk. That lets the Mac swap screen images faster than I'd have believed. Every time I went past the MegaMac display, Janek was surrounded by huge crowds fascinated by the Mac's new-found speed.

When it came time to integrate memory into the Mac, Janek used a VAX to disassemble the Macintosh ROMs (read-only memories) and operating system into source code. There's another way now. One of the programs demonstrated at the MacFaire was MacNosy, a disassembler that can be aimed at the Macintosh ROMs or any other Mac program. I haven't used it yet, but I have looked at the documentation. As you may suspect, you need to know something about 68000 assembly language and how disassemblers work. Given that and determination, though, you can find out a lot about what's happening in the Mac; more than Apple tells in its overpriced "developer's" documentation.

Anyway, my second Mac will become a MegaMac, after which the Corvus people will install their new hard disk, Omnidrive. I'll then be able to compare that system against the Fat Mac with Hyperdrive. It should prove interesting.

MACMODULA-2

The Modula Corporation now has a working Modula-2 compiler for the Macintosh. The compiler was announced last summer, but it took a while to deliver. I don't recommend the 128K-byte Mac for any but the most patient users, but amazingly the compiler will even work with that. A story goes with that.

Richard Ohran got his Ph.D. from the Swiss Federal Institute of Technology in Zurich. Niklaus Wirth was his sponsor. Ohran believes he understands Modula-2. Moreover, the Modula Corporation has developed a perky little board for the Apple II that lets you write good Modula-2 programs and run them on that venerable machine. (The board speeds up the Apple II to be faster than a Macintosh. Apple owners ought to look into it.) Consequently, Dr. Ohran thought little of promising a Modula-2 compiler for the 128K-byte Mac even though he hadn't done much work on it.

"It almost ruined the company," Ohran told me. "They say it's a 128K-byte machine, but they use chunks of memory for everything. The screen, the operating system, clipboard, you name it. There's not more than 60K bytes of usable memory in the 128K-byte Mac."

"Agreed," I said. "But why didn't you just abandon the effort and wait for the 512K-byte Mac?"

"Because I'd promised to do the 128K-byte compiler."

There are still people who believe a promise made is a debt unpaid. Richard Ohran is one of them.

In the 128K-byte Mac, the compiler is still more curiosity than useful. Don't get me wrong. You can use Modula-2 to write useful programs for the small Mac; it will just take you a while because the compiler is slow. Of course, it takes a long time to write programs for the 128K-byte Mac in *any* language. Once compiled, Modula-2 programs run as fast as anything else. On the 128K-byte Mac that isn't very fast, but many find it adequate—or say they do.

However, MacModula-2 really shines in the 512K-byte Mac. The Fat Mac is no Lilith, nor yet even a Stride; but it's plenty good enough to learn Modula-2 with, and in the learning you can write some really powerful—and useful—programs.

Ohran's MacModula-2 is complete. It gives you access to the Mac Toolbox and QuickDraw. There's an editor, a linker, and a run-time system to execute programs.

There's also an excellent manual. This documentation is more than complete, comprising not merely a manual on how to use Modula-2 with the Macintosh but a darned good introduction to the Modula-2 language. The manual explicitly states that it does not contain enough information for you to learn the Modula-2 language without additional source materials, and I suppose that's true; but anyone at all familiar with Pascal will have little trouble writing programs in MacModula-2, especially if they have Glitch's *Modula-2 for the Pascal*

(continued)

Concertware is a music program that simulates different instruments and explains harmony.

User at hand. There's plenty of information tucked into the MacModula-2 manual's 540+ pages. It also has an index *and* an analytical table of contents. I wish every software publisher would get a copy and study it; the MacModula-2 manual could serve as a standard for the rest of the industry to shoot for. Sure, I can find some things to gripe about, but there's not a lot out there this good at this price.

Modula Corporation's MacModula-2 will do for the Macintosh what Borland's Turbo Pascal did for the IBM PC. If you're a Macintosh enthusiast, make haste to get a copy. You'll be glad you did.

AND STILL MORE...

There was a lot more excellent Macintosh software. Given that I'm running out of space, I think the best thing I can do is list some of what impressed me and promise full reviews for later.

Paragon Courseware has some wonderful technical fonts for the Mac. If you're into doing circuit diagrams, op amps, or complex math, look at what Paragon offers. It's great.

In previous columns I've mentioned Blue Chip Software's stock market simulation game Millionaire; now they have Tycoon, the commodity market game, and Baron, the real estate game, for the Macintosh. The PC versions of these games are quite enjoyable, but the Mac versions are even nicer than that. These games will teach you a lot about real-world finances. They're also a lot of fun. Recommended.

Concertware from Great Wave Software is a music program that I'm still fooling around with. It simulates different instruments, explains harmony, and in general taught me more about music than I thought I'd ever learn. Highly recommended.

Diversions Inc. has added UnderWare Colorpens to their UnderWare line. UnderWare is a ribbon for the Mac Imagewriter that will put iron-on transfers on a sheet of normal bond paper. The idea is to use the Mac to create a T-shirt design; flip it to a mirror image; and print it on normal paper. You can now take the Under-

(continued)

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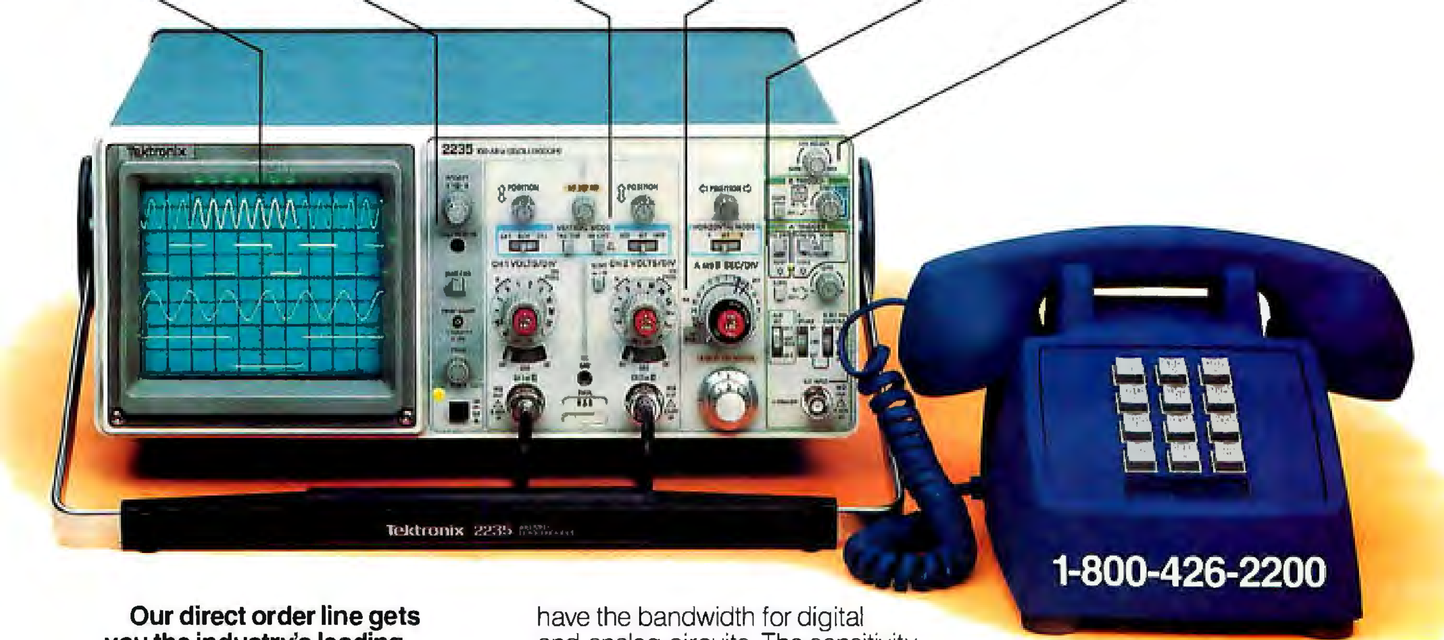

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If you're looking for something to put on your T-shirt, Miles Computing (Suite 212, 7136 Haskell Ave., Van Nuys, CA 91406, (818) 994-7901) has a treasury of clip art called Mac the Knife; this is a whole bunch of patterns, new fonts, and illustrations from *Star Trek* and *Star Wars* (R2D2 and the *Enterprise* are both here); Liberty Enlightening the World; fancy borders; international symbols; U.S. and world maps; the Illuminati Pyramid and Eye; and lots of other fun stuff. It's obviously useful for more than T-shirt design, but I intend to use it with UnderWare to produce something for the next science-fiction convention I go to. Recommended.

I also picked up the latest version of Mike Lehman's Fast Finder, a program I reviewed in the March issue. It's much faster than the standard Finder and highly recommended for anyone trying to do program development on the Mac. I am told by insiders that the new official Macintosh Finder—not released as I write this—corrects a lot of the original Finder's defects, so that Fast Finder is not quite as vital as it once was. On the other hand, I don't have the new Finder, so I can't compare. I do know that Fast Finder is fast, allows batch commands, works, and is in production.

There was a lot more Mac software. The flood has begun.

Winding Down

I haven't even mentioned my trip to Texas Instruments in Dallas and Austin. TI has a corporate center for human factors where they're developing a keyboard that will knock your eyes out. I can hardly wait until they have an experimental model.

They're also doing fantastic things with artificial intelligence and natural-language interfaces. I've got some of their programs for Big Tex, our TI Professional; alas, given the construction I've been unable to do justice to what TI has wrought. Next month for sure.

I've also got a huge pile of Hewlett-Packard software and hardware, including the HP 110 lapboard portable. I'm quite impressed with the 110. Like Percy, my NEC PC-8201 lapboard, you can't lose text by turning the machine off. Alas, although I find the HP 110's electronics, keyboard, and on-board programs (Lotus 1-2-3 and WordStar in ROM already) really nice, I *cannot see* the electronic-crystal display. I know such displays can be made visible, because I have no trouble adjusting Percy for almost any angle and light condition; but the 110 needs strong light and I have to hold my head right, else I find myself squinting at the display. It may just be me. I have no trouble recommending the HP 110—I've now taken it on three trips, and while it's a bit heavier than the NEC it's no more trouble—for those who've examined it and don't have visual problems; but for heaven's sake try it before you buy one!

I also have a pile of new fonts for the HP LaserJet; Tony Pietsch has yet another version of WRITE, my favorite text editor, with print drivers to use the LaserJet's true proportional spacing and other such goodies. My love affair with the printer continues unabated.

The book of the month is Ben Wattenberg's *The Good News Is the Bad News Is Wrong* (Simon and Schuster, 1984). It doesn't have much about computers, but it tells why we'll live to enjoy the computer revolution. There's no game of the month. What with the house construction and the annual school play, neither the boys nor I had time.

Next month we'll be upstairs in the new quarters, the Good Lord willing and the San Andreas don't let go. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE *Publications,* POB 372, *Hancock,* NH 03449. *Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.*

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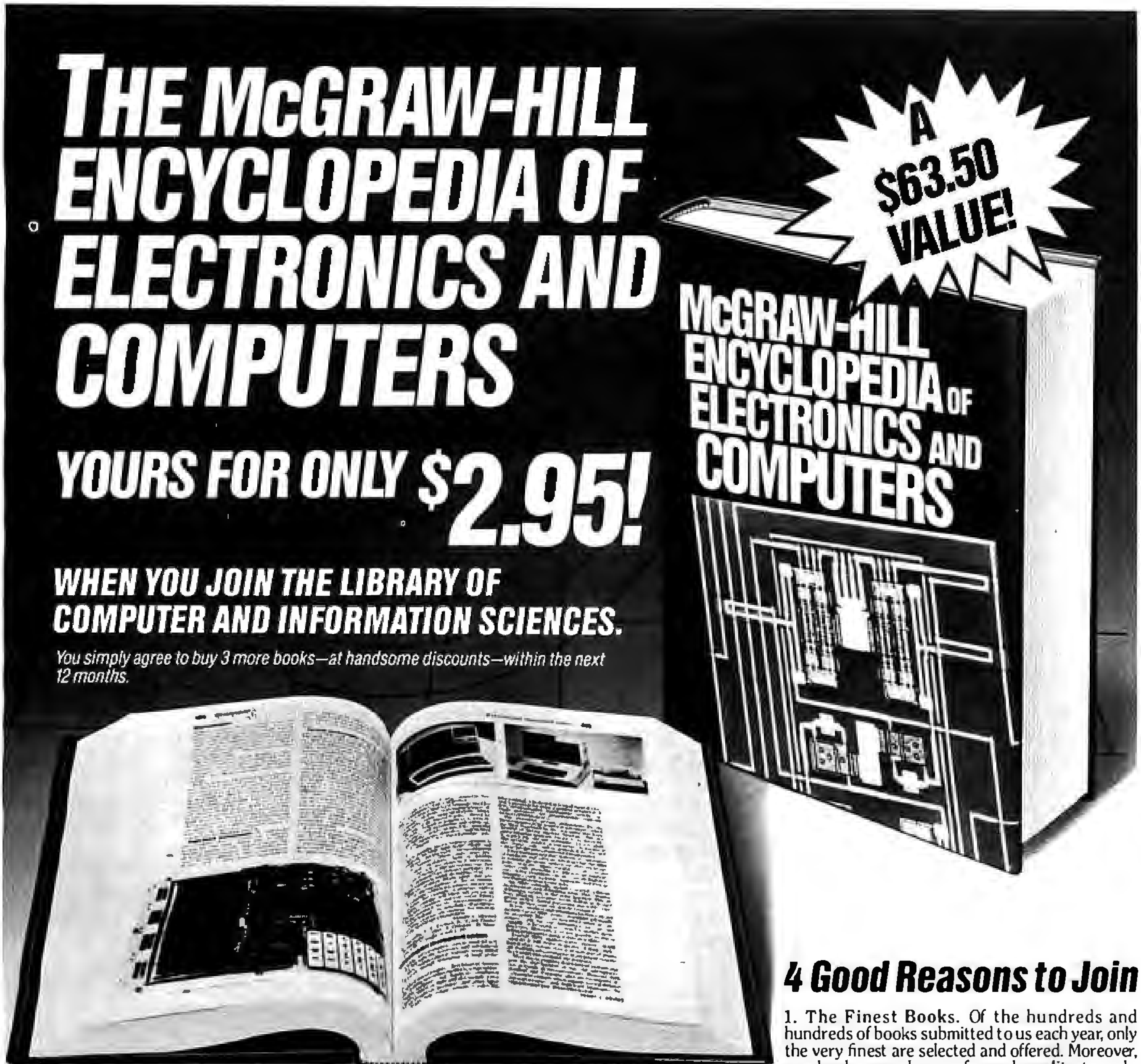

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RAM Disks and Calendar/1

Dear Jerry,

In the February BYTE, you rightly condemn those authors and publishers who hurry to put out "junk" computer books and thereby reap quick and cynical profits; because, in your words, "newcomers to the computer field are desperate for books," making them ripe for rip-off. I agree, and I also agree with your implied argument: that if newcomers were greeted with real information and patient instruction, not with mysticism and condescension, they would become knowledgeable and able to pick out the good from the bad.

I was distressed to read on page 340: "A RAM (random-access read/write memory) disk, *for those few who tuned in late* (my emphasis), is . . ." If I said that from the pulpit, I would be condemned for putting down newcomers, to my church or to computers, and that condemnation would be just and justified. Later (page 352) you explain: "96-tpi (tracks per inch) . . ." If you need to explain "tpi" to your readers, why condescend to those who haven't learned what "RAM disk" means?

On another subject, I finally (after some anxious inquiry as to compatibility) bought Calendar/1 from Clear Systems. You praised it highly; I can testify that your praise was not loud enough. For me, and I think for anyone who works with non-uniform schedules for several-to-many persons or groups, this thing is worth its weight in platinum. That's *not* what I want to tell you about Calendar/1, though.

What I want to tell you is that the folks at Clear Systems have one of the better license agreements I've seen. I think you will smile rather than frown at it. Parts read like this: "Clear Systems grants . . . license to use the software in *any computer belonging to the customer* . . . the customer *may modify or make copies of any part of the software,* provided . . . [that only 5 copies are made and that they are labeled with Clear Systems' trademark and copyright notices, and that they aren't sold or given away]" (all emphasis mine). And further, in an accompanying letter from Barbara Like (propitious name), product manager, I was told, "We're very nice about refunding money if the program isn't compatible with a mysterious (to us) computer," and there follow hints and encouragements about making Calendar/1 run.

Run it does on Zaccheus my Z-100, to my delight; and delighted I am, also, to meet some nice, courteous, and (on the evidence) competent software people. Calendar/1 and its folks are (famous phrase): Recommended.

John Carl Bowers
Bronx, NY

It's a real dilemma: although most of my readers have read one or more of my columns before, and many will have read quite a few of them, BYTE is a growing magazine, and thus inevitably there will be a fair number of readers who have never read my stuff at all.

I can't claim to have discovered RAM disks, but I was one of the earliest to write about them, and I've covered the subject in at least a dozen columns. I grow weary of explaining what a RAM disk is, but of course I must lest I lose someone just starting to read BYTE. Thus my "for those few who tuned in late," meaning (I thought) for those who just began reading my column. Since I hadn't explained tpi—or certainly hadn't as often as I'd explained RAM disk—I saw no need to think of a tag for that.

You're saying my tag was terminally cute. Perhaps you're right. It's still a problem: What do I say when I must, for the benefit of those who have just begun reading BYTE, explain something yet once more?

Glad you had pleasant experiences with Clear Systems. One of the satisfactions of writing this column is discovering small companies that my readers like. Best.—Jerry

Terminal Recommendation

Dear Jerry,

I saw the letter from Kaye Caldwell in the September Chaos Manor Mail (page 385) and wanted to add my praise of the Wyse WY-50. I have had mine for six months and couldn't be more pleased. Everything in that letter is true, especially about the feel of the keyboard and the location of the keys. Although it was not advertised, mine came with the function keys programmed for WordStar, but that can be deselected and the functions programmed any way you want. The list price may be $695, but it is available for much less (I got mine for less than $500 from Computer Warehouse in Phoenix).

The only criticism I have is with the little user's manual that comes with it. It is sufficient to hook up and use the terminal, but there are no explanations or definition of terms, as if every buyer is an expert on terminals. The reference manual ($25) and maintenance manual ($50) are extra, but don't expect to get them fast. It took three letters to Wyse just to get a response saying how much they were.

Nevertheless, the WY-50 is quite a bit of terminal for the money.

Charles D. Hamilton
APO New York

Stride Micro (Sage) has recently adopted the Wyse as its standard terminal. I saw a bunch of them at the Stride Faire and liked them. I was particularly impressed with the way they can communicate with the host computer at 38,400 bits per second; that's effectively as fast as my memory-mapped video!

However, two Wyse users told me that Wyse terminals have an intermittent keyboard-bounce problem. Shades of TRS-80 Model I! I gather it's not prohibitively severe, but it can be annoying. We're getting a Wyse; more when I know more. Thanks.—Jerry ■

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SNOBOL *and Icon*

Language designer Ralph Griswold looks at his language

BY EZRA SHAPIRO

During the course of 1984, three implementations of SNOBOL dialects appeared on the microcomputer language market (see page 350). SNOBOL, a convoluted acronym for "string-oriented symbolic language," emerged from Bell Laboratories in the mid-1960s and has been a staple of the mainframe and minicomputer environments ever since. It's a unique language with an unusual syntax, geared to text processing and string pattern matching. Because SNOBOL is unlike any other programming language, it is still taught in many computer science departments. It has also spawned a loyal community of users who find it the easiest way to solve programming problems involving nonnumeric data. However, because the language has never been sold commercially, it has remained something of an oddity . . . although it has refused to die. The most widespread version of the language, SNOBOL4, has changed little since its release to the public domain in 1968.

One of SNOBOL4's authors, Ralph E. Griswold, now teaching at the University of Arizona, has gone on to create a new language called Icon that combines many of SNOBOL's facilities for string analysis with more traditional control structures—although its philosophy and operation are anything but traditional. Icon is not yet available for personal microcomputers in any commercial form.

Early this year, Bruce Webster and I got a chance to chat with Griswold about SNOBOL, Icon, and computer languages in general. We found him to be charming, outspoken, and bemused by the sudden spurt of interest in SNOBOL.

BYTE: *It's funny, when you look at the "hot new languages" and start looking back at SNOBOL4, you notice that a lot of the concepts—things like list processing, goal-directed programming, and object orientation—have always been a part of SNOBOL.*

Griswold: Part of the reason for that is the philosophy we had at the time we developed SNOBOL4; we tried to find things that would make life easier for the programmer—not necessarily for the implementor. We kind of let ourselves freewheel with SNOBOL4. We didn't know a lot of computer science; we weren't constrained by knowledge. We were more concerned with facility than efficiency at that time. We thought that human beings were more valuable than computers, which is something people forget.

I think a lot of things in SNOBOL4—list processing, so-called object-oriented processing, even a strong coherent system for string processing—have not been in later languages because of concerns about implementation.

I'll give you an example. In SNOBOL4 a string is a data type; it's not an array of characters. It's a type in its own right; a string is a data object. That's a concept that's still not generally accepted in programming languages. Even in C a string is essentially still an array of characters, and there's a difference, a substantial difference as far as the user is concerned.

But those ideas were going on back then. They're not really new ideas; they've just achieved a level of public acceptance that they didn't have then.

BYTE: *Has the major interest in SNOBOL over the years been in the humanities community, for things like syntactic analysis?*

Griswold: Well, that's a major component of it—people doing research in the humanities have always been SNOBOL fans. PL/I took over at some point as being the predominant language because many of these people were at IBM mainframe facilities, and SNOBOL4 is not officially supported by IBM. SNOBOL4 became the language of choice for computing in the humanities in Europe, more so than in this country, because they have so much textual material to process. There's always been a substantial user community there.

But people using SNOBOL4 cover every application imaginable except perhaps business applications. Systems programmers use it a lot when they have data-processing jobs to do—processing compilers, reformatting things. There's a lot of scientific programming; people working in molecular

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genetics or areas where the data is naturally nonnumeric do a lot of work with it. For a long time there was (and maybe still is) a fair amount of use of it in the federal government in classified departments—particularly for cryptography. The CIA and the NSA used it quite a bit for some time.

The major use of the language has been in academic institutions. It's a traditional part of the curriculum in courses in comparative programming languages at upper division levels and lower graduate levels, as a language that's sufficiently different to be interesting from an intellectual standpoint.

BYTE: *Availability is always a critical factor.*

Griswold: That's true. The success of SNOBOL4—to the extent that you would call it successful—is due to its availability, the fact that it's in the public domain, it's been supported for a great deal of time, it's essentially free in most of its implementations.

What usually makes a language available is when a computer manufacturer supports it officially. For very good reasons, computer manufacturers don't want to support a wide range of products, particularly those that are out in left field somewhere, because it's a very expensive process to support products like that—distribution, documentation, the maintenance burden. Something has to be really in demand before somebody will officially support it. If a company decides to make something available, then it comes into widespread use no matter how bad it is.

SNOBOL4 has never been officially supported by any organization. It's always been unofficial. Even at Bell Laboratories it was unofficial. There was never an official SNOBOL project there; it was done as a by-product of other work. It was never budgeted, it was never officially acknowledged. It was released but not marketed.

With the personal computer community and the computer networks, software is becoming more readily available, and that's going to change things. Sometimes it takes longer than one expects for the change to occur. In the case of SNOBOL4, the three PC implementations all came out within a few months of each other. After years and years and years of people talking about it and saying it couldn't be done, all of a sudden three of them came out. Until they did, I wasn't sure anybody would ever do it.

BYTE: Is SNOBOL *going to go through another round of evolution at this point?*

Griswold: I've talked with the implementors and know the pressures they feel on both sides, the advantage of remaining compatible with existing programs versus the desire to take advantage of the nature of the computing equipment and facilities that

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'Icon is competition for SNOBOL4; it's a successor to it in a sense. Most people prefer it to SNOBOL4.'

are available at the present time. I've advised them to make compromises. Maintain the integrity of the language, but not at the expense of making it awkward and out of date or out of kilter with the computing context in which people are using it. That includes things like input and output, memory use, and so forth.

There's another point that inhibits them besides the desire to be compatible. They're working from existing implementations; they're not starting from scratch. They're taking generic implementations, the original SNOBOL4 implementation, called the SIL implementation, which was done in the 1960s, and Macro SPITBOL, which was done in the 1970s. Those are portable, generic systems, and all but one or two implementations of SNOBOL4 work from them.

I don't think anybody's going to do a language redesign for several reasons. It's not a language that most people will be able to implement starting from scratch. People learn in compiler courses how to write implementations of Pascal; there are a lot of tools for this—it's conventional knowledge. SNOBOL4 is complicated, difficult, sophisticated, the algorithms are not obvious, the implementation techniques are arcane. Very few people have attempted to implement it from scratch, and many of those have failed to implement the most important features of the language. It's a lot of work. I don't think there's enough motivation for anyone to undertake that; not that people don't exist that can do it, but it's not something an average programmer can sit down and do. A person who can write a C compiler might not be able to implement SNOBOL4.

And I think there's enough wrong with the language that changing it represents a very substantial problem, not just in the implementation, but in deciding what to do with the things that are wrong with it.

What does happen is that people write preprocessors for SNOBOL4 to make it look more palatable to the user. I've done that myself with some success. But that's not quite the same as redesigning the language.

The other thing is that it's got competition. Icon is competition for SNOBOL4; it's a successor to it in a sense. It wasn't designed to replace it, but it's a product of the same work. Most people prefer it to SNOBOL4. So there's enough competition there that I think that someone would be reluctant to invest the person-years of effort it would take.

BYTE: *Tell us about Icon. Where did it start?*

Griswold: It didn't start anywhere really; it sort of crept up behind us.

SNOBOL4 was developed at Bell Laboratories by a small group of people who needed a tool for doing something. We weren't language designers and we weren't computer scientists; we had some text to process (symbolic mathematics, in fact). So we just sat down and wrote something because we didn't have anything else. It was so successful we turned from solving the problem to becoming language designers.

FORTRAN was a tremendous triumph in terms of language design, but the designers had available to them a repertoire of mathematical notation, operations, and syntax and semantics that people were used to. There was nothing like that for string processing; I mean, nobody processed strings seriously until computers came along—it's too much trouble. Short of algebraic operations, there wasn't any accumulated body of knowledge on which to base the linguistic facilities—and they're hard to implement, especially on conventional architectures that aren't de-

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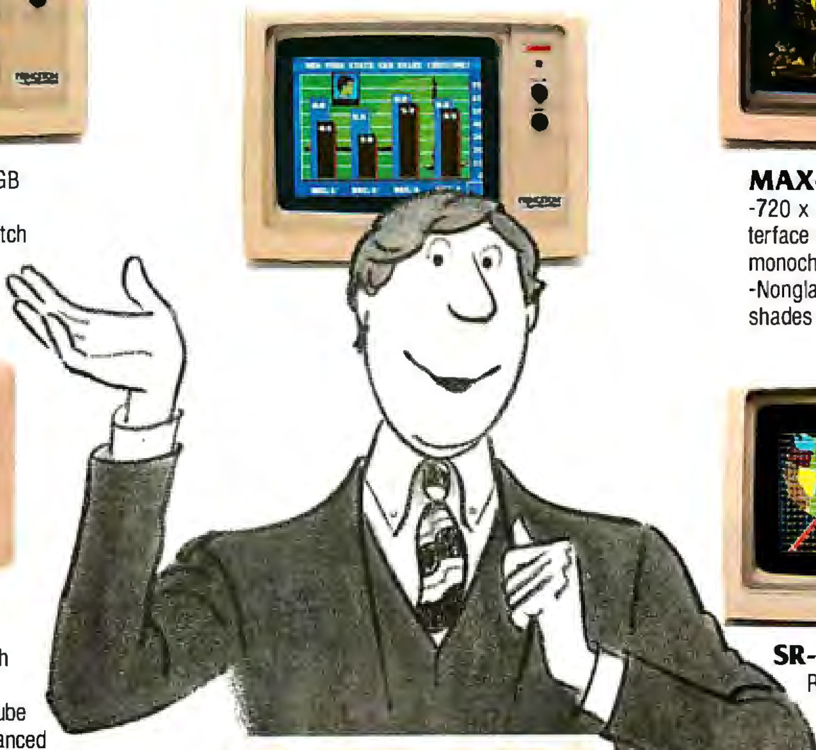

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signed for this kind of thing. We became interested, from a research point of view, in linguistic facilities for string and list processing, and in implementational techniques.

I came here to the University of Arizona in 1971 from Bell Laboratories and got funding from the National Science Foundation, and it's been funded since then. That's 15 or 16 years of continuous funding in this area. We've been working on developing programming languages for processing nonnumerical data and techniques for implementing them—the two going hand in hand.

This is a research project; it's not designed to produce another programming language—there are too many of them already—or a commercial product, but it's nice when your research can produce a by-product that's useful in the computing community. Every so often we've gotten to the point where the results of the research needed to be embodied in a working programming language; we've implemented it and made it available to the computing community.

There was a language called SL/5 following SNOBOL4. SL/5 stood for "SNOBOL Language 5"—I think we were kind of embarrassed by the name SNOBOL, which was originally intended to be a joke and then caught up with us. At some point we realized that we had a conceptual breakthrough in the area of programming-language facilities and we set SL/5 aside and started working on a new linguistic context that became Icon.

Icon looks a lot like SNOBOL4 in some respects, but it looks very different in others. I use both of them indiscriminately, although I prefer Icon. I've taught both of them; I prefer to teach Icon because some of the things in SNOBOL4 date back to a time when our ideas about programming were very different from what they are now, and it's kind of embarrassing. Fun, but embarrassing.

In one sense Icon can be looked at as just what you were talking about, an attempt to keep the good features of SNOBOL4 and replace the bad ones with better ones. It's not an entirely accurate characterization, but it's one way of looking at it.

BYTE: *What do you see as some of the special features of Icon?*

Griswold: In the first place, it carries some of the features of SNOBOL4 that were attractive to begin with—attractive for certain kinds of uses, for certain kinds of people. It tries to make programming easy, at the possible expense of efficiency. It tends to support the programmer. It's also good for one-shot programs. You can write an easy program that's quick and dirty—use it once and throw it away—very much like SNOBOL4.

The thing that's most intellectually interesting about it and most potentially significant in its influence on programming languages of the future is that expressions can have more than one value. This is a carryover from SNOBOL4 string pattern matching where patterns could first match one thing and then match another.

What motivated Icon really was the recognition that this didn't have to be limited to pattern matching; it could be a general feature of programming, not just string processing. Expressions in Icon are capable of producing a sequence of results. This works

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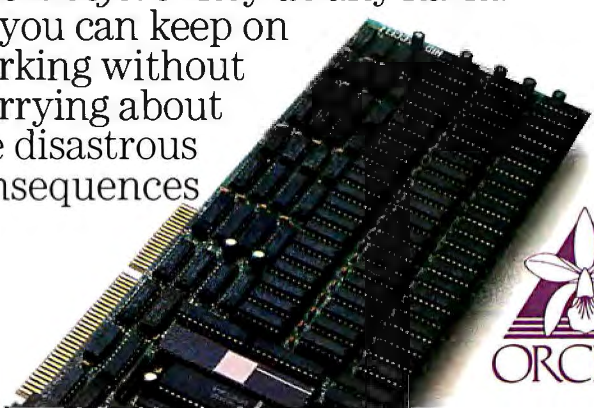

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'SNOBOL lets people write really simple, compact, natural code instead of crazy loops, nested things, and so forth.'

just as well in numerical domains and list processing as in string processing. It makes very simple and natural some kinds of formulations that are contorted and difficult in other languages.

Expressions may produce an infinite number of results. In that sense, Icon is a superset of ALGOL-like languages where you evaluate one expression and you get one result, period, no matter what. In Icon you may get zero results, which corresponds to failure in SNOBOL4; you may get one, which corresponds to normal computation; or you may get a lot of results if the surrounding context needs them to arrive at a solution. There's a flavor of logic programming in Icon; you can see logic programming as a subset of it. There's logical conjunction and disjunction. It all fits into a uniform theoretical framework that the programmer may never have to see but which has the nice feature that you can see generalizations.

This is what turns people on; they can find new ways of expressing things they couldn't have before. You can iterate overall solutions. There are several programming languages that have iterators, going back to IPL-V, and more recently Alphard, CLU, and SETL, but they're all limited to specific kinds of structures or contexts over all the elements of a set. In Icon you can just have a lot of expressions that produce a lot of results and you can iterate the results overall. You can produce sequences; you can manipulate sequences. Those were all inherent in SNOBOL4 but they were limited to a very small context, and the programmer couldn't get his or her hands on them. Now it's been generalized, and that is what I think is going to appeal to people.

That, I think, is the most significant thing. In fact, it surprised us; we didn't expect that to be the result. That's what really excites people; they can write really simple, compact, natural code instead of all these crazy loops and nested things and so forth. It looks like it ought to look and it produces the results it ought to produce.

Icon produces interesting programs, and it's fun—which can't be knocked. Programmers are, after all, human beings.

BYTE: *What Icon implementations are out there right now?*

Griswold: There are several versions. The one that is current, and maintained and supported, is version 5, which is the UNIX-based system. It's written mostly in C. It's available on PDP-11s, VAX-11s, Sun workstations, AT&T 3B20s, Onyx. . . . We have it running on PC/IX now—it's not ready for release, but the full language is running. And there's a VAX VMS implementation. There are 80 or 90 VMS systems out that we know of, most of those in educational environments.

There are probably two dozen implementations of Icon for various kinds of processors in progress, but what will become of them I don't know.

We've decided to go with C as an implementation language and UNIX as an environment. It's not easy to implement this in assembly language. Implementing Icon from the start is considered to be a research project. How you implement the expression-evaluation mechanism efficiently is not something that's obvious. It's incompatible with stack-based implementations of languages like ALGOL-68 or Pascal. So again, the implementations come from a generic one, and that limits its availability.

BYTE: *Do you see a specific group of people using Icon?*

Griswold: There is an academic group again. It's being taught in comparative

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programming languages as a replacement for SNOBOL4 here at the University of Arizona, and at Carnegie-Mellon, Illinois Institute of Technology, Duke, and a few other places. That's probably because Icon is more cosmetic from a computer science point of view, even if you think of it as SNOBOL4 embedded in Pascal, which it isn't, but even if you think of it that way.

People in industry are using Icon for VLSI (very large scale integration) layout. They're using it for utility programming; we have quite a few utilities written in it here. It's good for all kinds of things, from producing nicely centered labels for mailing lists to random-sentence generators, linguistic analysis, all those unusual things that other languages don't do well. It fits into the humanities very nicely; we're getting a lot of people really looking at Icon in the humanities now. Icon tends to be a catchall like SNOBOL4 for all those applications that other languages are not designed for.

It's still fairly young; SNOBOL started in 1962 and SNOBOL4 came out in 1968. Icon wasn't available to anybody outside the University of Arizona until about 1978 or 1979, and the current version, the UNIX version, is quite a bit more recent than that.

I don't think Icon will develop an identifiable user community. I think it will be a tool that some people use by preference or other people use for special purposes.

BYTE: *Why the name "Icon"?*
Griswold: No reason. You need a name when you want to talk about something.

One of my colleagues was into one-character names at the time, C being the current attraction, but there were languages called A and B before C. He wanted to call the language S, because it's short. Well, that doesn't look very good when you're writing—it looks like you've made a typo. C is bad enough and S is worse.

So we sat around for a long time trying to think up names. I personally am not very enthusiastic about acronyms or naming languages after famous or infamous people, but you need a name.

I'm responsible for the name. You can find some thread, in the sense that the language development of which it's a by-product has been rather iconoclastic. But that's not why we picked the name; it's just an excuse I can give you for it.

In hindsight, I think the unfortunate thing is that it's caused some confusion because of the use of the word "icon" to mean a symbol in programming systems—the Lisa and so forth—which came after Icon was developed and published. Every so often we get a request for Icon because somebody thinks he's going to get some kind of screen-manipulation package. But we couldn't have anticipated that, I don't suppose.

We chose not to call it SNOBOL6 because that sounds like it's just another revision, and it's so substantially different. It's as different as PL/I is from FORTRAN.

It's a problem, picking names. You pick a name and later on you wish you hadn't.

BYTE: *Where do you think microcomputers are taking us?*
Griswold: I've been in computing for about 25 years. When I first got into it I thought, "Gee, wouldn't it be great if I could have my own computer! But what happens when I retire because the machine is an IBM 360/50 and costs a million dollars and it's as big as this room?" One of my colleagues said that was his ambition—to have a 360 in his basement. Now, of course, I run UNIX on an IBM PC XT and have at my fingertips essentially the kind of computation that used to be too expensive for even a whole organization to own, at a price I can afford. And I don't think we fully understand what the impact of that is going to be.

BYTE: *In the next few years, we'll be seeing microprocessors that can address gigabytes of memory. There are very few languages or programming concepts out there now that can't be done in that kind of space.*
Griswold: Someone will invent one. Someone *always* invents one. Given that amount of space, they'll find a reason. ■

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Griswold, R. E., J. F. Poage, and I. P. Polonsky. *The SNOBOL4 Programming Language*. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, 1971.

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For information on Icon, contact the Icon Project, Department of Computer Science, University of Arizona, Tucson, AZ 85721.

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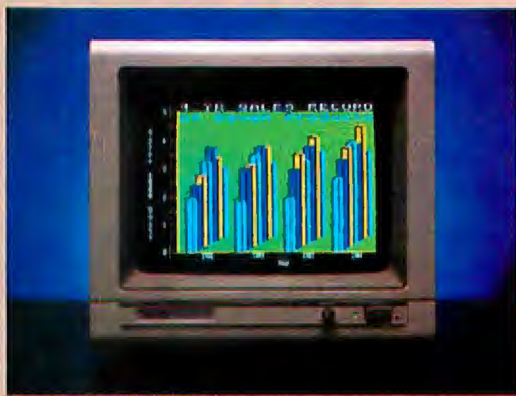

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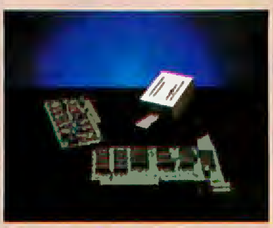

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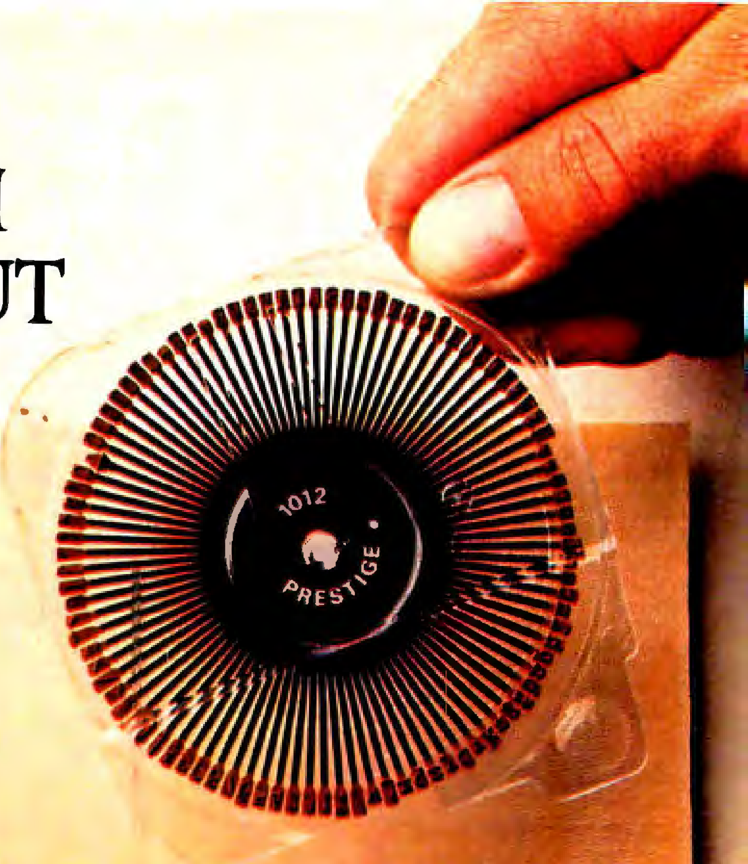

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Starlit Spectrum

Using the Sinclair Spectrum to collect and process astronomical data

BY DICK POUNTAIN

The subject of this month's column is the prominent U.K. amateur astronomer Andrew J. Hollis. He uses a low-cost Sinclair Spectrum microcomputer to perform data capture and processing on observations obtained by photoelectronic photometry (the electronic measurement of the brightness of celestial objects).

Mr. Hollis, who is a chartered engineer by profession, runs the Ormada Observatory from the garden of his house in the northern England country village of Cuddington in Cheshire.

He became interested in astronomy in 1957 when his parents showed him the comet Arend-Roland through a pair of opera glasses; from this beginning he went on to join the British Astronomical Association (B.A.A.) and build his own 8-inch reflecting telescope in the late 1960s. Though his interest in astronomy is broad, he is particularly interested in variable stars and in the asteroids (more properly called the *minor planets*) and is now director of the minor planets section of the B.A.A.

No science (with the possible exception of ornithology) is as open to contributions by "amateurs" as astronomy. Indeed, the term "amateur," which has acquired faintly derogatory overtones in this century, seems barely adequate to describe their efforts. There is certainly nothing "amateurish" about the activities at Ormada Observatory. Therefore, I shall intend the term in its original sense of one who works for love of the subject. The results obtained by Mr. Hollis and his coamateurs are often significant enough to be published in the B.A.A. and other astronomical journals.

The advantage of a large telescope is that it collects more light, hence it can measure fainter objects that smaller telescopes can't detect. Since the giant telescopes are almost always dedicated to the inspection of the most remote objects beyond our galaxy, it's not uncommon for professional astronomers to actively solicit the participation of serious amateurs when an event of interest like an eclipse occurs in this solar system. The combined small telescopes of amateur observers around the world add up to a formidable instrument.

Time on the large telescopes at major observatories must be booked many months in advance and is tightly rationed. An observer whose allocated slot comes up is then at the mercy of the weather; if conditions are bad, the whole session may be fruitless. Consequently, a professional observer who wishes to study a particular variable star or minor planet may get only 16 or so hours of observation a year. Hollis reckons that he can get in at least 50 hours per year because he is in a position to observe from his garden observatory any time the weather is fit.

PHOTOELECTRONIC PHOTOMETRY

The study of both variable stars and asteroids depends in part upon measuring their brightness. In the case of a variable star, the aim is to chart the changes in brightness over time. The shape of the light curve so produced can help to answer several questions about the star system that produced the stars: Is it a binary or ternary system of stars orbiting each other? What are their relative sizes? Do they have extensive atmospheres? Are they exchanging matter?

Andrew Hollis spends much time measuring such light curves to derive the times of minima (those points in a star's cycle when the brightness is at its lowest level). He acquires further information by taking accurate measurements of the period of variable stars, i.e., the time between minima. If this is done to sufficient precision, long-term fluctuations can be distinguished, as some stars appear to slow down or speed up over years or decades. Mr. Hollis also measures the brightness of asteroids and plots this against their progress in orbit around the sun. These measurements yield details about their shape and orientation.

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, POB 372, *Hancock,* NH 03449.

Before the advent of electronics, brightness was estimated visually using the magnitude system. Certain important groups of stars were classified into groups of similar brightness, and these groups were then ranked in magnitudes—first magnitude being brightest and so on in order of decreasing brightness down to the limits of visual discrimination at the sixth magnitude.

To estimate the brightness of an object visually, you use a star map to identify a nearby star of known magnitude, compare the object with it, and decide whether the object is more or less bright in the telescope than the nearby star. Choose another known star and repeat. By making numerous comparisons of this sort you can assign a magnitude to the object, interpolating if necessary between the two nearest known values. Though it may sound rough, skilled observers can in fact produce remarkably accurate estimates this way. However, it lacks the degree of precision necessary to follow fine variations in variable stars.

Photoelectronic photometry replaces this visual ranking method with a direct measurement of the light entering the telescope from the object. (To accommodate this, the magnitude system has been refined into a more quantitative logarithmic scale that permits fractional magnitudes extending down to the 20th magnitude and below.)

Some kind of photoelectric detector is placed at the prime focus of a telescope so that the image of the star falls on it. The current or voltage produced by the detector must be in some way proportional to the amount of light falling on it. The telescope is not used to magnify the image of stars, as we do with terrestrial images, but merely as a light collector.

The telescope collects light from a more or less large region of sky (determined by its aperture), not merely from the desired star. To narrow this field to the object of interest, a diaphragm plate with a tiny hole in it is placed at the focus and the star image is positioned (by eye) over this hole, thus excluding surrounding stars. A further refinement is to take a second light reading with the telescope focused on a region of empty space. This reading can be subtracted from the first to eliminate the residual effect of background light and the spurious dark current produced by most detectors.

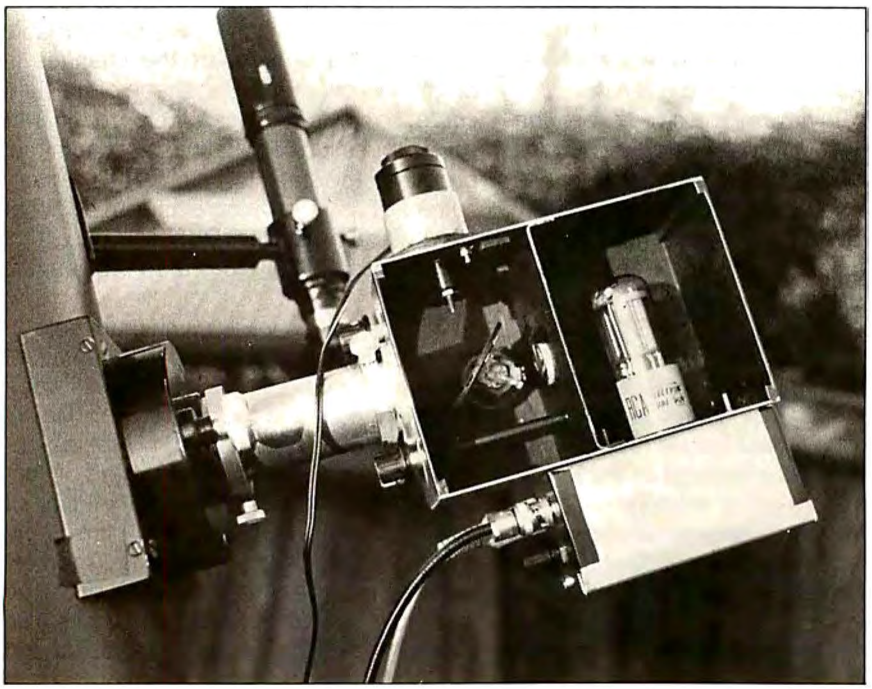

Photo 1: *The photodetector subsystem attached to the telescope has a flip-up mirror in the left-hand compartment that directs light to the eyepiece on top.*

Photodetectors typically respond to a broad band of wavelengths in the starlight. Astronomers are interested in certain wavebands and so will usually interpose filters between telescope and detector, allowing only certain bands to pass. Hollis works in three widely studied bands known as the UBV, for ultraviolet, blue, visual.

Readings taken straight from the photodetector bear a most indirect relation to the magnitude of the star, and it is here that a computer can be used to make the necessary conversions.

The Hollis System

At the time of my visit to Ormada in February, Andrew Hollis's own 300-millimeter telescope was away being rebuilt, and his photometry system was mounted on a borrowed 135-millimeter telescope (it sits on a German equatorial mounting, powered by a synchronous electric motor from a home-built power supply).

At the heart of the system is a side-window photomultiplier tube (RCA 1P21) that does the actual detecting—it looks like those vacuum tubes used in old radios. Photo 1 shows the detector mounted in its enclosure on the telescope—the eyepiece and flip-up mirror allow visual positioning of the star image onto the diaphragm plate.

Inside the evacuated glass envelope of the photomultiplier tube are nine metal anode chambers. At one side is a window through which light passes and falls onto a photocathode, dislodging a few electrons.

A DC voltage of around 1000 volts accelerates these electrons to the first anode. On striking the anode, each electron dislodges more electrons, which accelerate to the second anode, etc. This snowballing effect results in a huge amplification, with around 1 million electrons arriving at

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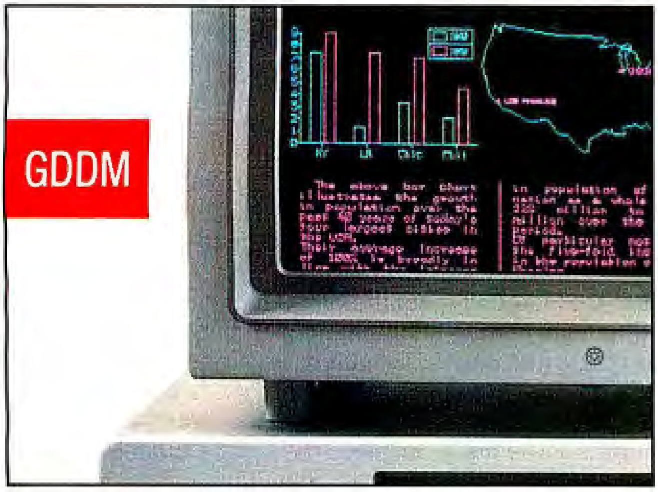

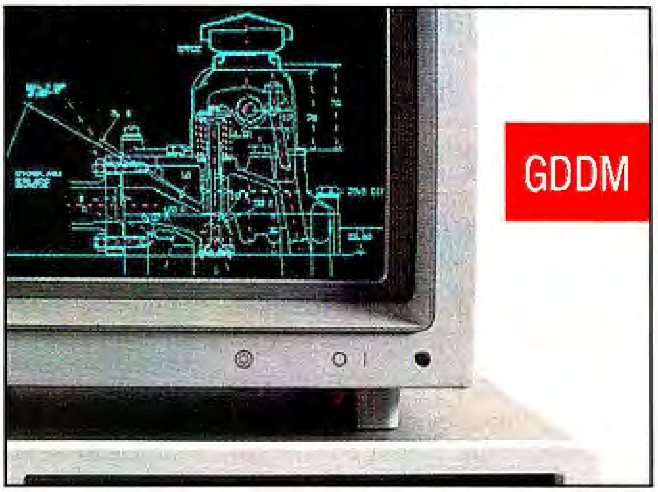

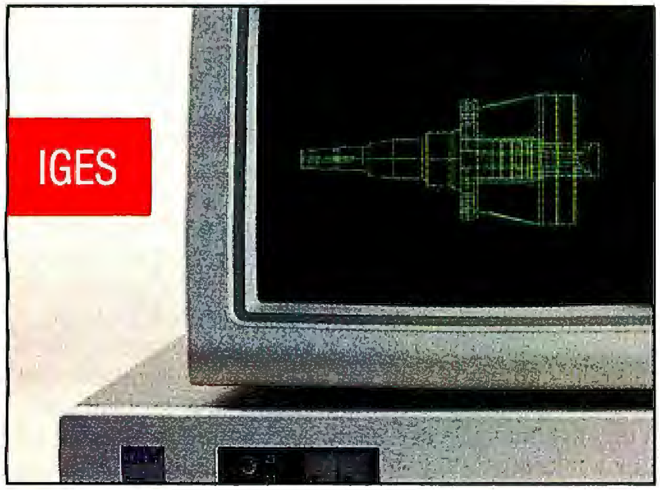

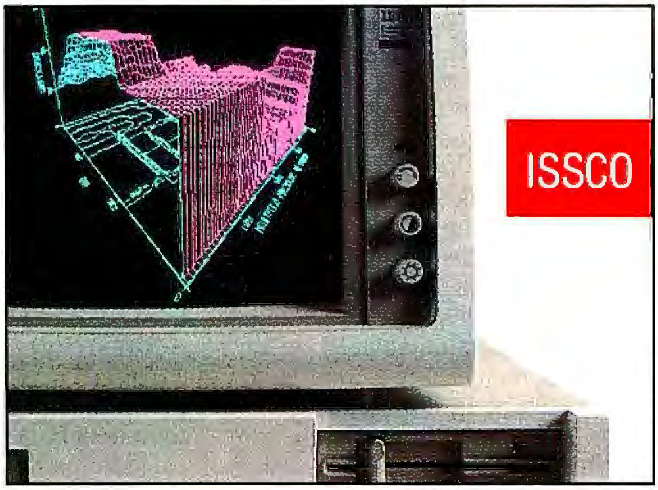

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The interface program is written to use interactive printer output, much like the old days of the Teletype.

the final anode for every electron initially dislodged by a photon.

The end result is a tiny burst of current, measured in nanoamps or even picoamps, proportional to the original amount of light. To increase efficiency, the star image is actually defocused by a lens after passing through the diaphragm aperture, so that it covers more of the photocathode; only the total amount of light is important, not the image itself.

The processing of this tiny signal begins immediately when it is passed to a high-gain current-to-voltage amplifier. (Hollis uses an Intersil ICL7650 chopper stabilized op-amp on a single chip.) The output is now a DC voltage in the range of 0–10 volts. However, it varies during each observation, and reading it directly would involve messy averaging calculations. Consequently, Hollis passes this signal to another chip, a Teledyne 9400CJ voltage-to-frequency converter, which outputs either a stream of pulses or a continuous square wave whose frequency is proportional to the input voltage.

This can now be sent to a pulse counter and the count read off from a calculator-style visual display. By recording for a fixed period of time, the number of pulses counted will be a measure of the light received integrated over that period.

Hollis finished his basic system in 1983 and began recording observations manually from the pulse-counter display. Each observation requires at least three readings: two from the star (which are averaged) and one from the background sky (to be subtracted). Sometimes readings must be repeated because some stray event lights up the sky and causes a bad reading.

To obtain standard star magnitudes, these readings must be performed on both the object of interest and a comparison star of known magnitude. Then these two readings need to be reduced using various mathematical formulas to convert them from instrumental magnitude to the Standard UBV Magnitude. One formula calculates the differential air mass (i.e., the distance the light had to travel through the earth's atmosphere) according to the stars' heights above the horizon, another corrects for instrumental scale factors, while others convert from geocentric to heliocentric time.

Finally, subtracting these results yields the differential magnitude of the object of interest; a long, timed series of such differential magnitudes is required to show the variation in brightness, and thence the time of minimum.

COMPUTERIZED DATA ACQUISITION

It quickly occurred to Hollis that this whole rigmarole, including the initial capture of data from the instrument, could be performed by a microcomputer with considerable savings of effort and increase of reliability. He selected the Sinclair Spectrum because of its low cost, availability, and its large volume of add-on circuitry published in the electronics hobby press.

The Spectrum, Britain's largest selling computer, was sold for some time in the U.S. (in a slightly modified form as the Timex 2000). For those who are not familiar with it, it's a Z80-based machine with 48K bytes of RAM (random-access read/write memory) and a highly individual BASIC in ROM (read-only memory). It is supplied with no standard I/O (input/output) ports (e.g., RS-232C or Centronics) but has a parallel expansion socket, using a proprietary bus, and cassette port. Internally it is a low chip-count design, with all the peripheral activities controlled by a single ULA (uncommitted logic array, or gate array as it is commonly called in the U.S.).

Hollis built his own interface box to fit onto the bus-expansion connector. This contains the high-gain amp and voltage-to-frequency converter chips and a Z80A-PIO (parallel I/O) chip.

Instead of taking the pulse output from the voltage-to-frequency converter to a counter, the alternative square-wave output is taken to the first data pin of the PIO. The PIO is configured in mode 3, or control mode, with no handshaking. The net effect is that the central processing unit sees the first bit of an 8-bit port toggling on and off at the frequency of the square-wave signal.

Hollis realized that Sinclair BASIC would be too slow to read this port—a sampling rate of at least 6500 reads per second is required. He wrote a short machine-code subroutine that counts the number of changes of state of the single bit that is input over a variable integration period, typically 10 seconds, and returns the answer in the Z80's BC register to the main interface program, written in BASIC.

Hollis doesn't like to take a television set out into the confined and often damp environment of the observatory, and so the interface program is written to use interactive printer output, much like the old days of the Teletype. Data can be inspected immediately on the Sinclair printer, a tiny low-cost device that prints electrostatically on rolls of 4-inch metallized paper and takes its power from the Spectrum. Any reading that is clearly wrong can be deleted and taken again. Satisfactory readings can then be stored on cassette tape for further processing by other programs.

To further simplify the business of gathering data, Hollis has built a remote-control unit to operate the Spectrum. This is made from an off-the-shelf 5-key cursor keypad mounted in an alloy box and connected by a long lead to another interface box on the bus-expansion port. It allows Hollis to take readings without leaving the telescope.

After an observing session the

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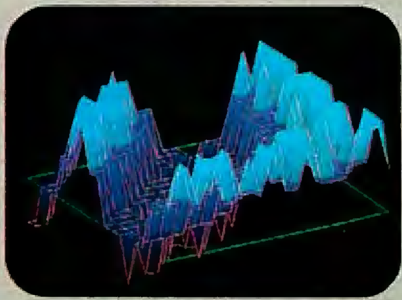

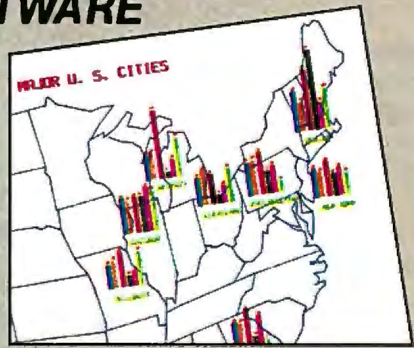

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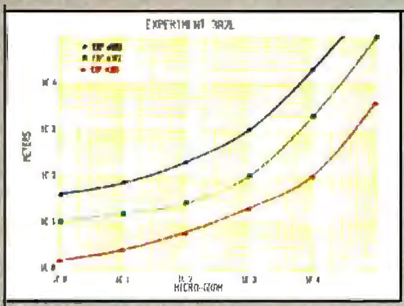

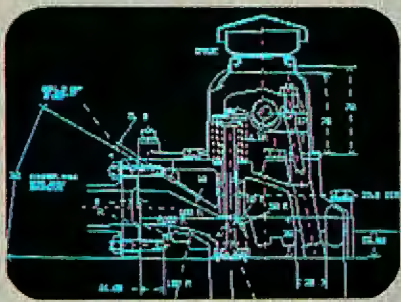

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Spectrum is taken back indoors and the results are reduced by a second program that applies all the various corrections, converts the date and time to the required Julian calendar, and finally prints out the time of minimum of the variable star under study, together with statistical certainty estimates. This program works on a TV screen as well as the printer.

A third program is used to predict the time of minima. This contains a database of the periods of 67 selected variable stars, gleaned from the *General Catalog of Variable Stars*. It calculates and prints out a list of the times of all the minima for a given night, allowing Hollis to plan his evening viewing efficiently.

A home-brewed graphing program for the diminutive Sinclair printer produces neat and highly presentable scatter graphs of light curves. Figure 1 shows a typical light curve for the asteroid VW Cephei.

TIMING MATTERS

The Spectrum has proved itself highly competent and cost-effective for the sort of work that Hollis requires. Its main limitations are the lack of double-precision floating-point arithmetic and a real-time clock. The relatively slow BASIC and cassette storage are no problem and are only noticeable in the Minima Prediction program.

Precision is not too serious a matter as the 10 significant figures of the Spectrum's BASIC are well beyond the inherent accuracy of the photometer readings. The only problem involves the representation of Julian dates, in which the time and date are combined to give the time in fractional days since noon on January 1 of the year 4713 B.C. These numbers have seven figures before the point and up to six places after it, if you're measuring to fractions of a second (I'm writing this word at approximately 2446123.57540). Hollis gets around this by dropping the initial 24 in internal calculations, which is unlikely to cause any problems for a century or two.

Timing is a more serious problem. The Spectrum uses interrupts for its I/O, causing the software clock to stop during printing and cassette operations. At first, Hollis tried timing the printing operations and adding a correction factor, but he was soon looking for a proper real-time clock.

He found a suitable design published in an electronics magazine and built it. It has battery backup and is based on an MM 58174 clock chip with its own 2K-byte static RAM into which the Spectrum can write key parameters such as the latitude and longitude of the observatory and the year (which the chip's designers inexplicably left out). This clock card stacks onto the bus-expansion connector at the back of the Spectrum, making quite a pile of hardware.

There is a scheme afoot, however, to provide even more precise timing. Hollis intends to move into new areas of observation, including studying the orbits of Jupiter's moons and the occultation (i.e., hiding) of stars by asteroids. This requires high-speed photometry using the highest possible sampling rate.

For a slowly changing variable star, integration of the light received over a 10-second period is satisfactory, but to resolve detail in the occultations occurring over a few seconds, the light needs to be sampled at subsecond intervals.

To time such observations, Hollis has built a radio receiver that can pick up a time signal called MSF, broadcast on 60 Hz from Rugby in the Midlands. Fortunately, there's no need to synchronize the readings with the transmitter (which would be a major programming problem); it is sufficient to merely record the time "pips" alongside the data like the time base on an oscilloscope.

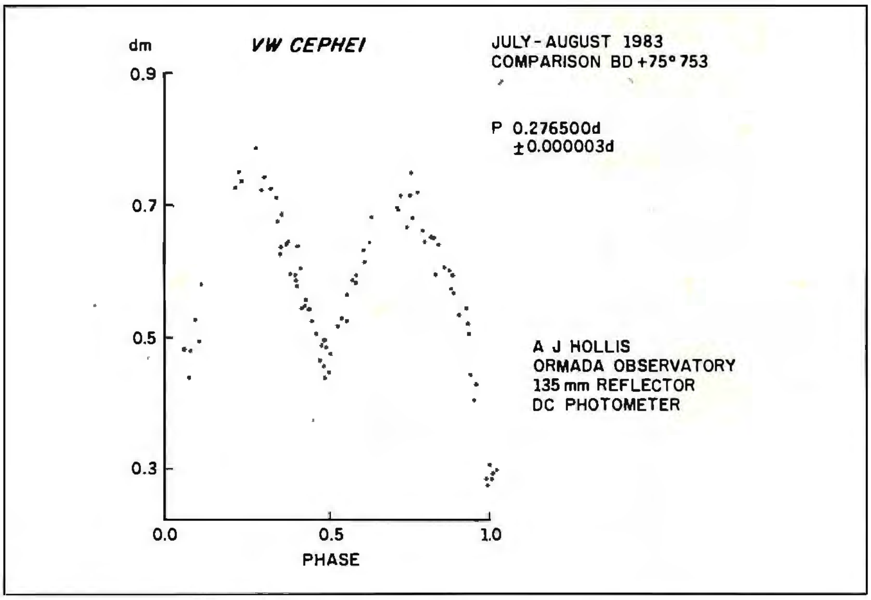

Figure 1: A *typical light curve for the asteroid* VW *Cephei.*

LIGHT DETECTORS

There is now a small community of astronomers like Andrew Hollis using the comparatively cheap side-window photomultiplier tube as a light detector. By experimenting and exchanging their findings they have extended the limits of its performance in quite unexpected ways.

One drawback of the device is its comparatively large and variable dark current (i.e., the signal produced even when no light is falling on it). Hollis and confederates have discovered that this dark current can be drastically reduced and made more constant, not by cooling as is often done with photodetectors, but by drying the environment in which it operates.

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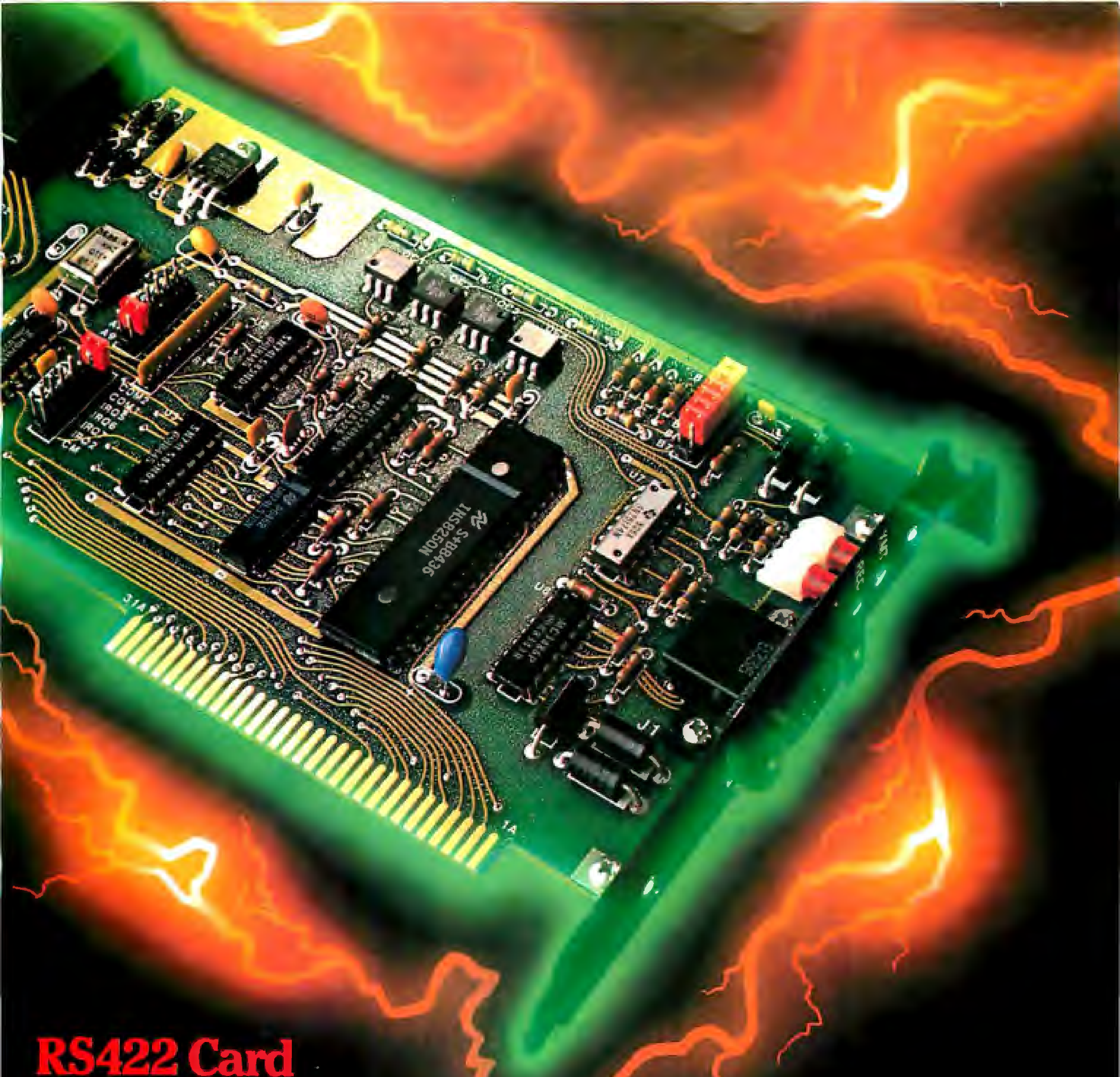

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No one knows for certain why it works, but Hollis's theory is that adsorbed moisture on the insulating base of the tube creates variable resistive paths between the high-tension pins (up to 1000 volts). Drying the moisture raises the resistance of such paths.

Hollis is also trying out other types of photodetectors. When I visited, he showed me an experimental setup that uses a photodiode, though so far the results from it have been unsatisfactory.

CONCLUSION

I was impressed by the simplicity and effectiveness of the system Andrew Hollis developed. Excluding the telescope, the hardware costs less than £600 (about $760 at the current exchange rate) and yet can produce results with a certainty of ±0.01 magnitude, or around 1 percent error. It's also gratifying to see one of the humblest of home microcomputers serving science in such a competent fashion.

Interestingly, Hollis denies that he is in any way a computer buff; he has learned only enough about computers to get the job done, with astronomy always being most important. It's rather sobering to think that the amount of computing he had to learn would probably qualify him as a computer design engineer; we are still living very much in the frontier days.

During my visit to Ormada, a fond hope that I once entertained was revived: that the spread of personal computers might do for computer science what cheaper telescopes have done for astronomy and encourage amateurs to make significant contributions. ■

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Peripherals, Chips, and New Computers

Erasable optical-disc coating from Fujitsu and more new Japanese products

BY WILLIAM M. RAIKE

In the past month at least two new personal computers have appeared on the market here; the battle of the memory chips continues with the major contenders evidently undaunted by the slump in the chip market (both Toshiba and Hitachi have introduced new large-scale memory chips); Fujitsu announced a new erasable optical-disc technology; there are glimmers of hope that the dismal situation in the Japanese software industry may be headed for improvement; and I discovered the Silver-Reed EB50, a battery-powered lap-size portable four-color printer/plotter/typewriter/thingamajig that's just plain neat.

TAKE YOUR GRAPHICS ALONG

It's hard to know just what to call the Silver-Reed EB50. It looks like a briefcase-size portable electronic typewriter, but there's no print element. Instead there are four ballpoint pens (black, red, blue, and green) mounted in a little drum that draws the characters you enter from the keyboard (alphanumeric or katakana) in any of three sizes, in either Courier or italic type, either vertically or horizontally. You can also draw four-color graphs in any of 12 styles, including various kinds of pie charts, bar graphs, and broken-line graphs, complete with labels and axes. A 15-character liquid-crystal display helps you orchestrate all this from the keyboard.

The EB50 has a built-in serial interface, so it only needs paper and an RS-232C cable to turn it into a four-color plotter. A hard carrying case with a handle is standard, and the total weight, including batteries, comes to 5½ pounds. I still don't believe the list price; it's only about $200. However, I don't have any idea whether the company is planning to export the EB50.

NEW FUJITSU OPTICAL-DISC MATERIAL

Optical discs, like videodiscs and compact digital audiodiscs, store large amounts of data; you read the data by scanning the discs with a laser beam. But you can write data on the newer types of optical discs with a computer, something you cannot do to videodiscs and compact discs. The two main types of optical discs are DRAW (direct read after write), on which you can only write once, and erasable, on which you can write, erase, and rewrite a number of times.

Fujitsu has just developed a new coating material for optical discs that allows data to be written by creating holes in the coating with a laser beam. Then this material can be partially melted by a lower-power laser beam that effectively erases the data. It also overcomes one of the main drawbacks of earlier materials: it is thermally stable, which makes long-term data storage practical. The new material, a thin crystal layer of selenium, indium, and antimony, also resists corrosion and oxidation better than the exotic tellurium used in other optical-recording materials.

To record data, you shine a 5-milliwatt laser beam on the surface for 100 nanoseconds; the surface reflectivity of the resulting hole ends up being about 30 percent higher than the surrounding area. When a half-power laser beam heats up the same spot for several microseconds, the hole is smoothed out, reducing reflectivity by about 20 percent and effectively erasing the data.

Existing optical-disc units store about 1 gigabyte per 20-centimeter disc, but according to BYTE's Japanese sister publication, *Nikkei BYTE*, which featured optical discs in a recent issue, 5¼-inch units are on the way and promise to open up new applications. We should start to see commercial products within the next two years.

LET THE CHIPS FALL...

Just about all the Japanese electronics giants got into the chip act in recent weeks. First, there was NEC's announcement of a new superfast Josephson-junction inte-

(continued)

William M. Raike, who has a Ph.D. in applied mathematics from Northwestern University, has taught operations research and computer science in Austin, Texas, and Monterey, California. He holds a patent on a voice scrambler and was formerly an officer of Cryptext Corporation in the United States. In 1980, he went to Japan looking for 64K-bit RAMs. He has been there ever since working as a technical translator and a software developer. He can be contacted c/o BYTE, POB 372, Hancock, NH 03449.

grated circuit (IC). In the U.S., IBM abandoned Josephson-junction research and development as impractical about two years ago; NEC obviously thinks it's not that impractical. Josephson-junction devices use superconductors cooled to −269 degrees Celsius and are capable of the fastest operations currently known. Logic gates based on Josephson-junction technology can operate in times as short as 5 picoseconds, and speed will be a crucial factor in future supercomputer projects. NEC's latest IC, an experimental device, was a multiplier circuit; it could multiply a pair of 4-bit numbers in only 280 picoseconds, several times faster than previously possible. The whole circuit is on a chip only 2.7 millimeters square, and it contains 862 Josephson junctions arranged to form 249 logic gates.

Meanwhile, Toshiba claims to have developed the fastest 1-megabit dynamic RAM (random-access read/write memory) chip. It has an access time of only 60 nanoseconds. Like many new ultralarge-scale ICs, it's based on CMOS (complementary metal-oxide semiconductor) technology, which means low power consumption; the new 1-megabit memory requires only three-quarters of the power of the 256K-bit dynamic RAM chips being sold now.

Speaking of 256K-bit dynamic RAM chips, I spotted some Hitachi 150-nanosecond memory chips on sale in the electronics bazaar in the Akihabara district of Tokyo just a few days ago. The cost is now down to about $4.60 per chip; last year the first units were selling for over 10 times that amount.

Recently Hitachi also made a tantalizing announcement: It has developed a "multilevel slant-cell dynamic RAM." According to the company, with this new technique you can store four times as much information with no change in the dynamic RAM structure; instead of holding 1 bit of data, each cell holds 4 bits (represented by a 16-level staircase-voltage signal). The speed of this new type of memory, 1 to 2 microseconds, is slow compared with conventional dynamic RAM chips, presumably because of some type of analog-to-digital conversion. Nevertheless, it's not hard to think of applications where the speed penalty wouldn't be important. There was no word from Hitachi on when it might be possible to buy a multilevel slant-cell dynamic RAM, or what the cost for such a chip might be.

JAPAN MOVES TO IMPROVE SOFTWARE QUALITY

Japanese computer manufacturers and software houses are aware of the low productivity and questionable quality of much software-development activity in Japan; one software company here, Reed Corporation, is dealing with the problem by commissioning over a dozen U.S. software firms to develop custom software, linking minicomputers in Tokyo with the U.S. companies via a satellite hookup.

The Japanese government, through MITI (the Ministry of International Trade and Industry) and its subagency, the Information Technology Promotion Agency (IPA), is concerned about the software problem, which is projected to get worse with time because of the increasing shortage of software specialists. MITI started the Sigma Project this past April in cooperation with domestic and foreign software firms. Combined government and private spending on the project will be almost $12 million the first year and $100 million over the next five years; the objective is a fourfold improvement in software productivity and a dramatic improvement in reliability and modularity, particularly in the area of business software.

As hardware costs decrease and computing power increases, software for personal computers and low-priced office computers is certain to be a major factor in the success, and even the survival, of computer manufacturers. Part of the dramatic success of the NEC personal computers stems from the company's efforts to encourage and attract independent software houses to develop and sell software products specifically designed for NEC machines. Some other Japanese manufacturers are providing monetary incentives to software developers to encourage them to design and develop software that runs only on their hardware. This could help counter the reluctance of many software firms to invest heavily in the development of general-purpose software for wide distribution; those firms currently rely on orders for high-priced custom software.

THE NEW IBM 5540 AND THE OKI IF800/60

Last year IBM Japan Ltd. announced its JX personal computer; it was too little too late—basically an IBM PCjr-compatible at IBM PC prices. It was greeted with thundering silence at the cash registers. On the other hand, IBM's 5550 workstation achieved a limited popularity as an office computer, despite its $4000-plus price tag and extreme sluggishness in recognizing Japanese-language kanji input.

Now IBM has introduced the 5540. In a nutshell, the 5540 is yet another computer based on the 8086 microprocessor, but not much else. Even the kanji ROM (read-only memory) isn't standard; you have to buy it as an option. You get either one or two 5¼-inch 720K-byte floppy-disk drives—not particularly impressive when you consider the 1-megabyte drives in the Fujitsu FM-11BS and FM-16β, or in the newest version of NEC's market-dominating personal computer, the PC-9801M2. (See the May BYTE Japan, page 355, for more information.) Standard memory is 256K bytes, expandable to 640K bytes. The IBM 5540 has no color-display capability; other than that, it can run all the 5550 software, which amounts to a tiny fraction of the software available (for example, for NEC's PC-9801 machines). This lackluster bundle costs about $1450 for the single-drive version and $1700 for the two-drive version—about the same as for either the Fujitsu or NEC machine, but it has far fewer capabilities and a much narrower choice of software.

The newest machine from Oki Electric, the if800 model 60, is far more likely to win the hearts and minds of the computer-buying public than the IBM 5540. Despite having very little software written specifically for it, the if800/60 comes with Japanese-language MS-DOS 2.11, so owners have access to the mass of generic MS-DOS software on the market. Interestingly, Oki has developed its own windowing software, called SuperView, which runs hand in hand with MS-DOS on the new machine. SuperView also has standard 720- by 512-dot color-graphics capability supported by 512K bytes of graphics video RAM in addition to the 512K bytes of standard main RAM. That's more than double the memory of the NEC PC-9801M2 and better graphics capability than the new Fujitsu FM-16β. Like the NEC machine, the new Oki if800/60 runs an 8-MHz 8086-2 microprocessor; the Fujitsu FM-16β uses the faster 80186 processor and a video coprocessor. All three of these machines include two 1-megabyte 5¼-inch floppy-disk drives; on the Oki you can fit an optional 10-megabyte hard disk into the main unit along with the two floppy disks. The list price for the if800/60 is about $1750; unlike most other Japanese computers, the Oki's price includes a high-resolution monochrome display, so it actually ends up costing a few hundred dollars less than either the NEC or the Fujitsu machine, and discounts of at least 20 percent are inevitable in this highly competitive market.

COMING UP

In next month's column I'll report on the first-ever COMDEX in Japan and on several of the products on display there, including a Fujitsu lap-size portable, the NEC PC-8401A, and more. ■

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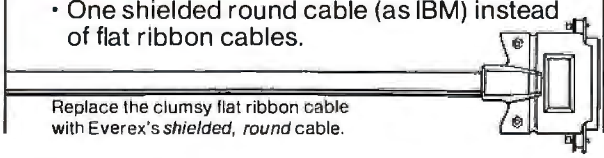

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BY BRUCE WEBSTER

As you probably know, the period of time after a product is released until a review shows up in BYTE can be pretty long. Our editorial staff is all too aware of that delay. According to Webster is an attempt to close that gap a little. Its goal is to look at what's new in software and hardware and to comment on the industry itself. We can't bring you the latest news; our three- to four-month editorial lag time just won't permit it. But we can—and, we hope, will—bring you reasoned, informed commentary.

A WORD ABOUT THE AUTHOR

You're probably wondering who I am and why I am writing this. I'm a semiretired professional software engineer who has decided to pursue writing full-time for a while. My educational background includes a B.S. in computer science (BYU, 1978) and some graduate work at the University of Houston. My professional background includes work at General Dynamics, the Lunar and Planetary Institute, and Monitor Labs. Perhaps more significant is that I spent two years working for a microcomputer software house. While there, I helped bring two products to market. I wrote about 5 percent of the first one and 95 percent of the second. Both received many glowing reviews, both have been commercially successful, and both are still on the market—so I'll refrain from identifying them or the firm I worked for.

I don't bring this up to pat myself on the back; I just want to point out that I don't fall into the second category of "those that can, do; those that can't, teach/review/critique/etc." I know firsthand all the headaches and difficulties in developing a product, putting it on the shelves, and supporting it. On the other hand, I know the shortcuts, the excuses, the temptations to cheat, and the song-and-dance routines that the customers get. Of course, this doesn't mean that I used them . . . at least, not very much. It does mean that I know the difference between problems inherent in the application and problems caused by sloppiness or corner-cutting.

While I am no longer developing commercial software, I still spend most of my time in front of computers. I currently own three, all paid for out of my own pocket. The first is a Compaq, which I use mostly for word processing and telecommunication. When I'm not using it, I run a bulletin board on it. The second is a Macintosh, which is used for word and outline processing, software development, and other tasks. The third is an Apple IIe, which right now isn't used for much of anything. And, of course, I have various chunks of hardware and software floating by from time to time.

Which brings us back to this column and why I am writing it. Some of you are probably asking yourselves, "If he's such a hotshot programmer, how come he's writing this?" The truth is, I burned myself out finishing an updated version of product #2. I had been writing articles part-time for several years, so I decided to try it full-time. BYTE graciously offered me the chance to write this column, and the rest, as they say, is history. I still do software development; in fact, I spend more time writing code than prose. The difference is, I'm doing it for my own pleasure and entertainment, nobody else's.

Enough about me. As mentioned above, the idea is to cover the latest in software and hardware. Unfortunately, I've got several months' accumulation of "the latest," so it's going to take a column or two to clear things out. Not only that, but most of it is for the Macintosh. Those of you who aren't Mac fans can skip to the section entitled "And Now for Something Completely Different." The rest of you can read on.

MACINTOSH REDUX

In my review of the Mac (August 1984, page 238), I stated that the 128K-byte one-drive Mac was "an amazing machine but not

(continued)

Bruce Webster is a consulting editor for BYTE and a charter member of the PMS Commandos. He can be reached c/o BYTE, 425 Battery St., San Francisco, CA 94111.

really a powerful one" and that a 512K-byte Mac with two drives "is both amazing and powerful." This, of course, was conjecture on my part, since the 512K-byte Mac wasn't available when I wrote that. As you all know, that changed last September. A few months ago, Apple lent me a Fat Mac so that I could test the truth of my statement. It's true: a 512K-byte Mac with two drives is both amazing and powerful. A 512K-byte Mac with a hard disk is even better. You shouldn't even consider buying a 128K-byte machine; it just isn't worth the aggravation.

More significant has been the dramatic drop in prices. At the time of the review, a 512K-byte Mac with two drives and an Imagewriter printer would have cost $4500, which doesn't compare very well with the $3000 I paid for my Compaq (512K bytes, two 360K-byte drives, Epson RX-80 printer). This week I saw two computer stores advertising that exact Fat Mac system for $2795. Since $2795 is the current official list price for a Fat Mac, those stores are effectively throwing in the printer and extra disk drive for "free." By contrast, my Compaq system has barely dropped in price; it would cost me about $2800 today. Coincidentally, $2800 is almost exactly what I spent on my 128K-byte single-drive Mac (with Imagewriter) a year ago. It shows what a difference a year can make, but most of you already knew that.

Though it's old hat as I write this, I have to comment on Apple's 512K-byte upgrade policy. The initial $1000 cost (it dropped to $700 in January) was in my opinion atrocious and inexcusable, especially since other firms are now offering $300–$400 Mac upgrades. Apple's price was designed to make money, which I'm sure it did. Unfortunately, Apple squandered a far more precious resource: the goodwill and loyalty of tens of thousands of Mac users who were patiently putting up with a crippled machine while waiting for the upgrade to come out. Almost every Mac user I know expressed disgust or disappointment at finding that upgrade priced pretty much out of his or her reach. Apple users are known for their zeal and fervor; in many Mac users, that's been replaced with caution and cynicism. And I don't even know if Apple people realize what they've lost.

MacWorld Exposition

I spent two days at the MacWorld Exposition in San Francisco in February. The show wasn't overly large; it didn't quite fill up all of Brooks Hall, the underground portion of the Civic Center. On the other hand, as Guy Kawasaki of Apple noted in a talk, had the show been held a year earlier, only three exhibitors would have been

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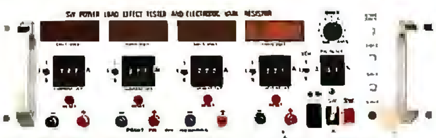

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ACCORDING TO WEBSTER

> A 512K-*byte* Mac *with a hard disk is a nifty system.*

there ... and two of those would have been showing carrying cases.

There were a lot of start-up companies, firms that were banking their whole future on the success of the Macintosh. Indeed, the Mac appears to be attracting companies who believe that the IBM market is overcrowded and tends to be dominated by a few major companies. They see the Macintosh as a chance to get in on a ground floor that the IBM market passed three years ago. Others, most notably software developers, follow the Mac because they find it a more interesting and challenging machine than the IBM PC. Yet others, such as Hayden, see the Mac as a chance to get back into an industry that they've been slowly squeezed out of. And, of course, we must remember that all these firms must (and want to) make money. Most are still waiting to see if the Mac helps them to do just that.

There wasn't much new at the show, unless you knew where to look. Several hard disks were announced, although most won't be ready to ship for a while. Infosphere showed two products that didn't appear all that flashy, but they could be very important to increased acceptance of the Macintosh. XL/Serve is a program that turns a Mac XL (aka Lisa) into an AppleTalk file server. This means that AppleTalk is an immediate reality. What's more, it runs in "background" mode, so that the Mac XL can still be used for other tasks, although performance is degraded. MacAide is a Z80-based board (designed mostly for OEMs) that serves as a bridge from AppleTalk to just about anything else: SASI, serial, IEEE-959 bus, even another AppleTalk network. The Infosphere people had an $800 Xybec hard disk (10 megabytes) talking to a Mac through a MacAide card. Keep an eye on this product.

Other interesting products were shown. For die-hard hackers, Steve Jasik was selling MacNosy, a disassembler that lets you rip the Toolbox ROM (read-only memory) and other programs apart. (Incidentally, Jasik, who has looked at all the ROM routines, had harsh things to say about the quality of some of the code therein.) Professional Data Systems showed an external video adapter for the Mac, along with a large (23 inches) high-resolution monochrome monitor and a high-resolution video-projection system. Large crowds gathered to look at the Hyperdrive, a 10-megabyte hard disk that mounts inside the Mac. Everyone wants one, but they're leery about letting someone mess with the innards of their Macs. Large crowds also flocked to the Odessa booth, where they were displaying Helix (which is finally shipping). And the Apple booth itself attracted many people.

The award for "Most Original Boot-up Sequence" goes to Silicon Beach Software, which was previewing its arcade game Airborne. If you boot Airborne on a 512K-byte Mac, it plays 20 seconds of Wagner's "Ride of the Valkyries." We're not talking about the four-voice chamber music found in MusicWorks—this is a full orchestral rendition. Turns out the folks at SBS took the excerpt from an actual symphonic recording, digitized it using a VAX, and then downloaded it to the Mac. The file takes up 138K bytes, which is why it plays only on the Fat Mac. The game itself isn't terribly original—a cross between Sabotage and Choplifter—but the sound effects are nice.

The show was enjoyable and manageable. It will be interesting to contrast it with the West Coast Computer Faire. Look for comments here in a few months.

MASS STORAGE

As mentioned above, a 512K-byte Mac with a hard disk is a pretty nifty system. The extra storage and faster response time do much to overcome the limitations of the basic Mac sys-

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tem. For the last month or so, I've had the pleasure of working with two mass-storage devices for the Mac: the QC-10 from Quark and the Mac Bernoulli Box from IOmega.

The QC-10 is a nice piece of hardware with good software support. It's a 10-megabyte hard disk that can be used with the Macintosh, the Apple II, and the Apple III. What's more, you can use one disk with all three systems. The QC-10 Volume Manager software lets you allocate chunks of the disk for the Mac, DOS, ProDOS, and SOS. (Software to support Apple Pascal is under development.) For example, the unit I had on loan (and have since, regretfully, returned) had a 2-megabyte SOS volume, a 2-megabyte ProDOS volume, and four Mac volumes, two of 1 megabyte and two of 2 megabytes. Each Mac volume acts like a floppy disk, with its own volume name and directory. Using the Volume Manager, each volume can be mounted or dismounted, and each can be selected for automatic mounting on boot. Yes, you do have to boot off a disk.

As many hard disks do, the QC-10 makes chirping noises during read/write operations, but they are by no means annoying. Most important, during a month of heavy use, I never had a single problem with the QC-10: no crashes, no lost files, nothing. Note, though, that all my QC-10 use was with a 512K-byte Mac. A friend who has been using the QC-10 with a 128K-byte Mac has reported some problems. I can't verify that since I no longer have the QC-10 here, but be warned.

The QC-10 plugs into the Mac's external drive port. It has a matching port on back, but you can't plug an extra Mac drive in there (yet). However, if you're using it with an Apple IIc or a IIe with a DuoDisk, you can indeed plug your drives into that port. For example, to hook the QC-10 up to my IIe, I would plug it into the DuoDisk controller, then plug the DuoDisk unit into the QC-10. A special cable is provided to connect it to a regular Disk II controller. You use two rocker switches to tell the QC-10 just what it's talking to. All the cables needed are provided, along with a tiny screwdriver (very thoughtful), and, of course, Mac, DOS/ProDOS, and SOS versions of the Volume Manager software.

The speedup on the Mac was nice, although it was not as great as I would like. However, the same appears to be true of most hard disks and is largely due to the Mac system software. Apple knows this and is apparently taking steps to correct it. A press release handed out at the Apple shareholders' meeting in January stated that ". . . during 1985 we will enhance the Macintosh user interface and file system to significantly improve Macintosh performance, particularly with hard disks." I hope so.

If you're considering getting a hard disk for your Mac (or Apple II or Apple III), you should take a good look at the QC-10. If you have two or more of those models, you should look very closely.

Question: What looks like a hard disk, acts like a hard disk, but isn't a hard disk? Answer: a Bernoulli Box. Built by IOmega Corporation, the Bernoulli Box has been around for some time as a mass-storage device for the IBM PC. Instead of using rigid platters, it uses a flexible disk inside a removable plastic case. In other words, it's like a very fat floppy-disk drive. How fat? From 5 to 10 megabytes per disk. I've been intrigued with the Bernoulli Box ever since it came out, so I was pleasantly surprised to spot a Macintosh version at COMDEX last November. It holds "only" 5 megabytes per disk, but since you can buy disks at $60 a pop, your total storage is limited only by your wallet.

I received a loaner unit in December, about a month sooner than expected. It was one of the first ones off the assembly line and, as might have been expected, was D.O.A. Actually, it would power up and everything; it just wouldn't format any disks. A few weeks later, an IOmega representative visited me and replaced a ROM, fixing the problem.

The Box plugs into the modem port

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I can recommend both the QC-10 and the Bernoulli Box if you are adding mass storage to your Mac.

and looks like a single disk drive to the Mac. Unfortunately, the Mac Finder has problems supporting more than 128 files on a single drive; if you create too many files on the drive, the system crashes. Since a 5-megabyte drive can easily hold two or three times that many files, it's hard to make full use of the disk space. IOmega has just released software to let you make the drive look like several disks; look for a follow-up next month.

The Bernoulli Box is noticeably faster than the QC-10; at least, I noticed the difference when I returned the QC-10 and went back to using the Box. It's also much quieter. The disk-drive emulation is consistent and thorough. You can "eject" the current disk; the drive door actually does pop up, and you can remove the disk and insert another one. You can swap disks, transfer files, and generally treat the Box like another disk drive.

The real advantage of the Box is that you can set up different mass-storage environments. For example, I have two disks: Development and Write/Paint. The Development disk has MacAdvantage (UCSD Pascal), MacASM (68000 assembly language), Microsoft BASIC, MacFORTH, Copy II Mac/MacTools, IconEdit, Resource-Editor, other utilities, and numerous program source files. The Write/Paint disk has Microsoft Word, Think-Tank-512, MacWrite, MacPaint, Multiplan, Dollars and $ense, and Hayden: Speller, along with numerous documents. And I have plenty of room on both disks for more. In other words, I've replaced a few dozen disks with just two. When I want to program, I plug in the Development disk and everything I need is right there. If I need to write or paint, I eject the Development disk, plug in the Write/Paint disk, and go to work.

An ideal use for a Bernoulli Box would be on a Mac shared by two or more people. Each person would have his or her own 5-megabyte disk with all the programs and data files that he or she needs. No problems with security, no need to worry about accidental (or deliberate) alteration or deletion of files, and no fighting for space.

Aside from the initial ROM problem and the limit on number of files, the Bernoulli Box has been almost as solid as the QC-10. I say "almost" because at one point some of my development software started acting flaky, and I wasn't entirely sure if the problem was with the Box or with the 512K-byte Mac (which has had a few hardware problems of its own). I copied all my program files off, reformatted the disk, put everything I needed back on it, and it's been solid ever since. Since the Mac is on 12–18 hours each day, the Box, like the QC-10, has gotten plenty of work. Also, I have worked with the Bernoulli Box hooked to a 128K-byte Mac, and I have run into a situation where I can't eject the Box's disk via the regular method, forcing me to reboot before ejecting. Recommendation: If possible, upgrade to a 512K-byte machine before (or soon after) getting the Box.

Besides the partitioning software, IOmega is also planning to release a slave drive (also 5 megabytes) for the Box. It would be smaller and cheaper and would plug into the pass-through RS-422 port in the back of the Box. Among other things, this would let you do quick backups, doing a complete disk-to-disk transfer. I have no idea when this will be available or how much it will cost.

I can recommend both the QC-10 ($1995) and the Bernoulli Box ($1895) for anyone adding mass storage to their Mac. Each has its own strengths and weaknesses; you need to consider how each might (or might not) meet your needs. And again: If you are considering getting any hard disk for your Mac, you should first upgrade your Mac to 512K bytes. Heck, you should upgrade to 512K bytes even if you aren't considering getting a hard disk, but that's already been discussed.

PRODUCT OF THE MONTH: CHIPWITS

When I first saw the Macintosh, I thought about how it would be to develop a graphical programming language for it, i.e., a language that used graphical images instead of text. At the Consumer Electronics Show, I was startled and pleased to see that someone had taken a stab at it. Doug Sharp and Mike Johnson (of Discourse Inc.) have come up with a delightful game called ChipWits. The game resembles a cross between two classic Apple II programs: Robot Wars and Rocky's Boots. Your goal is to design a robot to get through a given environment, i.e., a collection of rooms connected by doors. The robot must avoid obstacles; refuel by finding and picking up coffee and pie; avoid (or destroy) dangers such as electrocrabs, bouncers, and bombs; and gain points by collecting "good items" like oil cans and disks. Eight different environments are included, each with its own mix of objects and overall goal.

If that were all there was to ChipWits, the game would be merely nice. What makes it remarkable is the icon-based programming language, IBOL, that Doug and Mike have implemented. To program your robot, you position and connect icons on a grid (6 by 10) of rectangles. Program flow starts in the upper left corner of the grid (which always has a "green light" icon). Each icon points to the next one to be executed. A number of icons make tests and have TRUE and FALSE arrows that show which way to go based on the test. A "return to start" icon always takes you back to the green light, as does an empty rectangle. And it has subroutines: seven additional grids that you can call from the main grid. Like the main grid, each subgrid starts with a green light icon

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in the upper left; a special "boomerang" icon returns you to the main grid. What's more, you have three different stacks to use (values, objects, and directions), which lets you do things like set up loops or pass parameters to subroutines. On top of that are single-stepping and trace functions that let you observe the icons, the stacks, and other variables while watching the robot run around. Figure 1 shows one of my creations.

This may all sound complicated; it isn't. I sat down my 8-year-old daughter (who has never programmed) in front of it. Within 10 minutes, and with only a little help from me, she had built a pretty good beginning robot. More than that, she knew why it was doing what it was doing—she understood the program that she had written. One of the advantages of IBOL is that it is impossible to write a program with a syntax error in it. All programs run and run in predictable ways. This makes it an ideal language to introduce programming to nonprogrammers, because *anything they write will run*. The robot may not do very much—indeed, it may even hasten its own destruction—but the program will at least run.

The only real weakness in ChipWits is the documentation (which wasn't written by Doug and Mike, though it probably should have been). I had a very hard time finding the information I wanted, either because it was stuck in some obscure location or because it just wasn't in there. On the other hand, the IBOL quick-reference card tells you most of what you really need to know. I did find one or two minor bugs in the program itself, but they were truly minor; I passed them on to Doug and Mike, and I'm sure they'll have been corrected by the time you read this.

Even with the poor documentation (did I mention the ugly packaging, also?), ChipWits is a program that every Mac owner should have. It really shows the strength of the visually oriented approach that the Mac promotes. Plus it's a lot of fun. Get it.

TWO PASCALS FOR THE MAC

When the Macintosh was first released, you had to buy a Lisa (since renamed the Macintosh XL) to develop software for it. This, understandably, was a sore point with many developers, since the Lisa 2/10 cost two to three times as much as a Macintosh. In the last year, the situation has changed dramatically. A growing assortment of development systems that run on the Mac itself have appeared, aided by the release of the 512K-byte Mac and various hard disks.

Two Pascal development systems for the Mac are available. Both are from SofTech Microsystems, and both use a p-code interpreter. The first to come out was the Macintosh p-System, a full-fledged port of the p-System onto the Macintosh. Instead of using the Mac interface (mouse, desktop, pull-down menus), it uses the standard p-System menu and utilities (filer, editor, etc.). If you've done any p-System development on another computer, as I have, you'll feel right at home here. However, if you want to bring up a Mac-like application, you're pretty much out of luck. A small graphics library supports sections of QuickDraw and the Event Manager, but that's about it.

The basic Pascal Development System costs $195 and includes the operating system, compiler, editor, filer, and some other odds and ends. It also includes a few manuals, which are general to the p-System, and a supplement specifically for the Macintosh. If you're going to do any serious programming, you'll also want to get the Advanced Development Tool Kit ($150), which has a 68000 assembler, a native-code generator, some other advanced utilities, the source code (both Pascal and 68000) for the graphics library given in the basic package, and a few more manuals.

I have mixed feelings about this Pascal implementation. My big software project was done with a version of the p-System, and since it had its own user interface, I think I could have converted it to the Mac in a relatively short time using this package. But that's something of a rare case. Most people who want to write software for the Mac want to make some use of the Mac interface; this package doesn't let you do that. On top of that comes the problem of SofTech's li-

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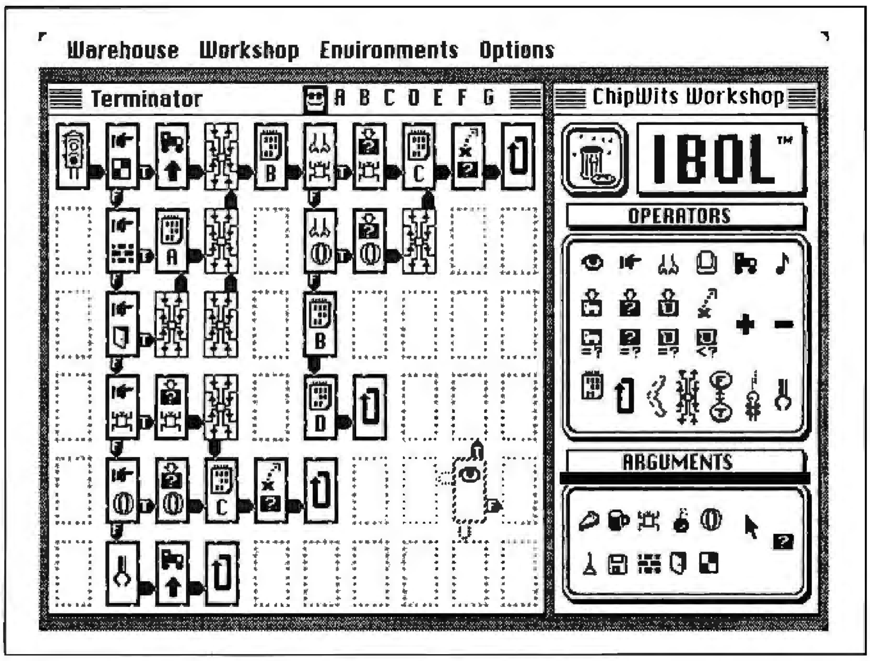

Figure 1: *A portion of one of the author's* IBOL *robot-control programs in the game* ChipWits *for the Macintosh.*

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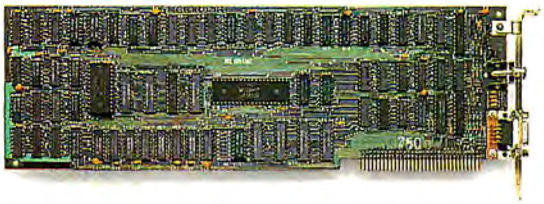

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Mind Prober has a personal flavor. Its purpose is to help you find out what makes people tick—why they do what they do.

censing fees, which involve a per-copy fee, some of which ($2000–$6000) has to be paid in advance. This actually represents a dramatic improvement over the fees that SofTech used to charge (which required as much as $50,000 up front), but it puts this product at the very high end of Mac licensing fees. Unless you have a product that's closely tied to the p-System, and unless you don't want to use the Mac interface, you really shouldn't consider this package for software development.

SofTech's second package has the unwieldy name of MacAdvantage: UCSD Pascal. That's the only unwieldy thing about it. MacAdvantage is a UCSD Pascal development system that runs under the Mac operating system, i.e., the Finder. With this system, you can point, click, and drag, just as with other Mac applications. More important, you have access to more than 95 percent of the Toolbox routines, which means that you can create Mac-style applications that also let you point, click, and drag.

The editor, developed by Bill Duvall of Consulair Corporation, is a nice MacWrite-like program editor. It is disk-based, so your programs don't have to fit into memory all at once. You can open up to four files at the same time, which makes it easy to move chunks of code between programs. You can even open the same file more than once, which lets you look at one part of the program (such as global declarations) while editing another part. It has an auto-indent option for easy formatting of your Pascal programs.

Another feature of MacAdvantage is a little (4K bytes) program called Executive. When you run it, it clears the desktop and changes the menu bar to reflect the development environment (editor, compilers, utilities, run, etc.). This is helpful because it takes only a second or two to go from, say, the editor back to Executive, while it takes 10 to 15 seconds to go from the editor back to the Finder. You can move quickly through the development cycle (edit, compile, run), avoiding the constant, agonizing redrawing of the desktop.

Yet another asset of MacAdvantage is the resource compiler, RMAKER. With it, you can set up your resources (menus, windows, icons, cursors, and so on) in a separate text file and compile them into a resource file. When you compile your Pascal program, these resources are copied into the resulting code file.

The Pascal compiler does produce p-code, but you never have to be aware of this. When you double-click a code file, it automatically loads in the interpreter and run-time library, then runs the program. Only two real disadvantages arise when you have p-code files. First, they execute more slowly than machine-code files (those produced by Lisa Pascal and the various C compilers). Second, you can't produce a stand-alone program to distribute; the interpreter and the run-time library have to go with it. You used to have to pay an annual licensing fee, but no more. As of 1 July, SofTech dropped that fee. SofTech also dropped the price of MacAdvantage from $295 to $119.

The abolition of the licensing fee represents a growing trend in development software. Creative Solutions Inc., maker of MacFORTH, has lowered the price of its Level III development system from $2500 to $499 and has dropped the per-copy fee altogether. Likewise, Modula Corporation has eliminated all licensing fees connected with its MacModula-2 product.

Most notable are the various C compilers, which produce fast stand-alone code and have never had any fees. Because of that, C is becoming the standard Mac development language. This is ironic since Apple wanted to make Pascal the standard; however, Apple's inability (or unwillingness) to come out with a true compiled Pascal for the Mac has dimmed the chances of that happening. SofTech's efforts help but may be a case of too little too late.

MIND PROBER

Human Edge Software Corporation specializes in "mind-reading" software, products to give some sort of edge in dealing with others. Most of these are business-oriented (sales, negotiations, etc.); however, Mind Prober has more of a personal flavor. Its purpose is to help you find out what makes someone else tick—why they do what they do.

Mind Prober works by asking you to give a little information on the subject (male/female, over 18/18 and under) and then asking you to choose AGREE or DISAGREE for a long list of attributes (CHARITABLE, PRECISE, SELF-BLAMING, SPONTANEOUS). When you've finished, you can then ask for a report on that person, to be sent either to the screen or to the printer. The report attempts to describe the subject, talking about his or her feelings and actions with regards to work, sex (or, if he/she is under 18, school), relationships, stress, personal interests, and so on. The reports discuss both reactions to situations and underlying motivations. You are then supposed to use this information somehow.

My wife and I separately ran the program on each of us. It was interesting to see how accurate many portions of the report were, while noting the different ways we view ourselves as opposed to how we viewed each other. We then tried a "committee" run on myself. In other words, we both sat and together answered the questions, with some discussion (and arguing). The result was not accurate at all.

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Attempts to fine-tune the report by changing answers didn't help much. Our conclusion was that the program worked best if you didn't think too hard or long about the answers.

A psychologist, Dr. Irene Brennan, then took the program and our Mac for a week. She ran Mind Prober on her family and some of her clients. Her conclusion: Mind Prober does indeed help to reveal information about us. She also thought it was fun.

We did encounter several limitations with the program. First, after doing a number of reports, the same sentences start to appear over and over again, which makes the program lose some of its "oracle" aura. Second, when the report didn't match exactly, we tended to tweak the answers to get a more accurate report. This implies that the program is always right and that we had just answered the questions wrong. This, of course, is not necessarily the case. Third, we wondered how useful the program would be if we didn't know the subject that well. Changing just a few answers often had a dramatic effect on the report; if we were forced to guess about that many answers, the possible reports that could come out would diverge wildly.

Keeping these limitations in mind, Mind Prober is an interesting and entertaining program. In fact, I've seen it used at a few parties as sort of the modern version of Mad Libs. Just be sure not to take the report too seriously.

SOFTWARE FROM VIDEX

Videx has released a number of software packages for the Macintosh: a desk accessory and several games. The desk accessory, MacCalendar, isn't really worth getting. Some public-domain calendar desk accessories function almost as well; and if you need something more powerful than those, you should probably look at Front Desk (from Layered).

AND NOW FOR SOMETHING COMPLETELY DIFFERENT

Well, not quite. If imitation is the sincerest form of flattery, the folks at Apple can feel honored indeed. I spent two days this month at the GEM seminar put on in Monterey by Digital Research Inc. GEM is a Mac-like environment that DRI hopes to support on a number of machines, most notably the IBM PC (and clones) and the Atari ST (Jackintosh) series. The similarities to the Mac are striking: textured desktop; windows that you can drag, size, scroll, and make go away; icons that you can click (or double-click); mouse-oriented system; drop-down menus (not to be confused with pull-down menus, for various legal reasons); alert and dialog boxes; and so on. Much of the terminology is un-

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AHH. IT'S LONELY AT THE TOP.

abashedly borrowed from *Inside Macintosh*, and, for that matter, why not? It would have been annoying and confusing for DRI to have come up with brand-new names for everything. There is also a desktop program to replace the MS-DOS interface with a Mac-like display.

GEM actually has some striking improvements over the Mac operating system. First, of course, is that the IBM PC version supports several graphics cards (three from IBM, the Hercules card, etc.), so you can have a Mac-like environment with glorious color. The response time on the IBM PC AT was very quick, and it didn't seem all that much slower on the PC XT. An ingenious object definition allows everything to be linked together in a tree-based structure. This can make for some sophisticated graphics manipulation on the screen. Best of all is the amazing Resource Construction Set, which lets you graphically lay out menus, dialog boxes, windows, etc., and which then generates the necessary resource code for that item. This last tool had a lot of Mac developers in the audience drooling, and I wouldn't be surprised to see some Mac versions of that appear in the near future.

As impressive as GEM looks, anyone who has done Mac development starts to see gaps and barriers. A number of arbitrary limits crop up: only eight windows open at one time, and only four of those can belong to the application; a maximum of six desk accessories (and that limit can be further constrained by RAM). Text-editing and memory-management routines are primitive. And so on. The result: GEM requires more work to get generally less effect.

The most serious limit announced at the seminar nearly caused a riot among the software developers (300 or so). In the last session, the DRI marketing people announced that the MS-DOS version of GEM would run only on IBM equipment and not on any of the compatibles . . . at least, not until each manufacturer of a compatible machine had paid an OEM fee to DRI. The developers immediately saw the headache of having to either maintain a separate version of their product for each compatible (bundling GEM in) or else release the product without GEM bundled and hope that the end users would buy GEM so that they (the end users) could run the product. In the session, in the lobby, in the taxis and limos, at the crowded Monterey airport, and on the planes, the single topic of discussion was this deliberate crippling of GEM. And the consensus was nearly universal: DRI was making a big mistake.

Digital Research got the message.

ITEMS DISCUSSED

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Silicon Beach Software
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San Diego, CA 92126
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BIG MAC MONITOR SYSTEM $1995
PROJECT-A-MAC SYSTEM $4495
Professional Data Systems
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Mill Valley, CA 94941
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CHIPWITS $39.95
Brainpower
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Calabasas, CA 91302
(818) 884-6911

GEM DEVELOPMENT SYSTEM $500
Digital Research Inc.
60 Garden Court
POB DRI
Monterey, CA 93942
(408) 649-3896

MAC BERNOULLI BOX $1995
IOmega
1821 West 4000 South
Roy, UT 84067
(801) 776-7330

MACCALENDAR $89
Videx Inc.
1105 Northeast Circle Blvd.
Corvallis, OR 97330
(503) 758-0521

MACFORTH
Level I $149
Level II $249
Level III $499
Creative Solutions Inc.
4801 Randolph Rd.
Rockville, MD 20852
(301) 984-0262

MACINTOSH (512K bytes) . . . . . $2795 and falling
Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95104
(408) 996-1010

MACINTOSH p-SYSTEM $195
MACADVANTAGE: UCSD PASCAL . . $119
SofTech Microsystems Inc.
16885 West Bernardo Dr.
San Diego, CA 92127
(619) 451-1230

MACNOSY $50
Jasik Designs
343 Trenton Way
Menlo Park, CA 94025
(415) 322-1386

MIND PROBER $49.95
Human Edge Software Inc.
2445 Faber Place
Palo Alto, CA 94303
(415) 493-1593

QC-10 HARD DISK $1995
Quark Peripherals Inc.
2525 West Evans, Suite 220
Denver, CO 80219-5554
(800) 543-7711

XL SERVE $195
MACAIDE . . . . OEM pricing
Infosphere
4730 Southwest Macadam Ave.
Portland, OR 97201
(503) 226-3620

The following week, a call came from Tom Byers at DRI. He said that the marketing people at DRI had reconsidered and that a patched version of GEM that would run on all the major compatible machines was being distributed to all the developers. This should greatly increase the chances of GEM being accepted by both hardware and software developers. Whether or not GEM itself catches on remains to be seen.

IN THE QUEUE

I still have many packages on which to comment, but I haven't been able to wring them out quite as much as I'd like, and I hate to pass judgments based on 5 minutes' worth of playing around. I hope to clear out the backlog of Mac software next month and get to more recent releases. Items planned for commentary next month include several packages from Hayden, a company that threatens to dominate the Mac software market; Copy II Mac, which has no problems copying most of the protected software out there; ThinkTank-512, which I used to outline this column; Microsoft Word for the Mac; MacASM from Mainstay; MacModula-2 from Modula Corp.; and some other odds and ends. I hope to include some MS-DOS products as well and even up the mix a little more.

GETTING IN TOUCH

I'm a firm believer in feedback and discussion. Please feel free to contact me with comments, questions, rebuttals, and whatever else you have. I am an avid telecommunicator, spending two to three hours each day maintaining my own bulletin board and checking on other systems. Because of that, you stand a much better chance of getting a quick reply if you contact me electronically. One obvious option is to write to me via BIX, BYTE's electronic conferencing system, which should be up and running by the time this sees print. You can reach me there by joining the conference "ask.webster." Other addresses include CompuServe: 75166,1717 (in MAUG, BOR, GAM); MCI Mail: 138-5892; ARPANET: crash!bwebster @ucsd; uucp: {ihnp4, cbosgd, sdcsvax,noscvax}!crash!bwebster; USPS: c/o BYTE, 425 Battery St., San Francisco, CA 94111.

Note well that the last address is the least reliable and has the longest turnaround time. Also, because of demands on my time, I must regretfully reserve the right to limit my responses—I enjoy talking (and writing) too much and might find myself spending six to eight hours a day on the modem. See you on the bit stream. ■

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Parsing and Solving Linear Equations

Set up and solve simultaneous linear equations

BY ROBERT T. KUROSAKA

Mary has \$1.10 in nickels and dimes. She has a total of 12 coins. How many of each coin does she have?

John is 5 years younger than Bob. Next year, John will be two-thirds of Bob's age now. Find their present ages.

$$x + y = 5$$
$$x + \tfrac{1}{2}y = 2x + 1$$

Look familiar? Of course they do. You've been required to solve systems of linear equations ever since your first course in high school algebra. This month's column is about teaching computers to solve them.

With computers, as with students, the hard part is teaching them how to set up the equations. Solving the system is easy. I wouldn't know how to write a program to set up the two story problems I began with, but I have written a BASIC program to turn the system of equations into something the computer can deal with (that is, to *parse* the expressions). That doesn't seem as if it should be difficult to do. When we write BASIC programs, we commonly write code that looks a lot like algebra already—$x=y-7$ or $x=x+1$ (oops!). So the first thing I want to do is clarify the difference between what BASIC means by x and what algebra means by x. The key is in that funny BASIC statement $x=x+1$.

In an algebraic expression like $1/6x + 1/12\,x + 5 = x$, x has some numerical value or set of values. The function of algebra is to determine what those values are. In a BASIC expression like $x=x+1$, on the other hand, x is the name of a memory location. The function of BASIC is to modify the contents of that memory location in the way specified by the expression. Put differently, algebraic expressions state facts; BASIC expressions specify operations. The value of x in BASIC is always known (at least by the computer), while the value of x is the object of our inquiry in algebra. How then do we solve a system of linear equations?

We have a variety of methods for solving systems of linear equations: matrix methods (by normalization of the matrix or by inverse matrices), by determinants (Cramer's rule), and many more. I will use the normalization method. Two considerations make this an attractive choice. First, consider the situation where we have four equations for two unknowns, and three of the equations are equivalent. The system is soluble, and we want our method to handle it in a straightforward manner. Second, consider an incomplete or inconsistent system. In that case, the system will be insoluble. We want our program to tell us that without the program hanging because of something like a divide-by-zero exception.

I will use the equations in table 1 to illustrate the way this program will solve systems of linear equations. The equations in table 1a create the matrix shown in table 1b, with the constant terms occupying the zeroth (leftmost) column in the matrix and the other columns filled by the coefficients of the alphabetically ordered variables. In equations that do not include a given variable, a 0 coefficient is entered. That is, each column corresponds to one—and only one—variable. Two row operations are needed for as much normalization as is necessary to solve the system. They are (1) multiply or divide a row by any nonzero constant, and (2) add or subtract a nonzero multiple of a row to another row.

To begin our procedure, we locate the first nonzero coefficient, or *pivot*, in the matrix. In our example, the first pivot is the "2" at the (1,2) position. Set the pivot term equal to 1 by dividing the entire row by the pivot value (table 1c). (R1)/2 means divide each element of row 1 by the number 2.

Use that pivot to create zeros elsewhere in its column. That is, eliminate the "1" and "2" below the pivot. The "1" is removed by subtracting row 1 from row 3 [(R3)−(R1)], and the "2" is removed by subtracting twice row 1 from row 4 [(R4)−2(R1)]. Of course, we need not do anything to row 2. The

(continued)

Robert T. Kurosaka teaches mathematics in the Massachusetts State College system. He invites your correspondence c/o BYTE, POB 372, Hancock, NH 03449.

Table 1: *Steps in solving simultaneous linear equations.*

$2y-z=1$ $2x+z=3$ $x+y=2$ $2x+2y+3z=1$	$\begin{array}{c\|ccc} & x & y & z \\ 1 & 0 & 2 & -1 \\ 3 & 2 & 0 & 1 \\ 2 & 1 & 1 & 0 \\ 1 & 2 & 2 & 3 \end{array}$	$\begin{array}{c\|ccc} & x & y & z \\ 0.5 & 0 & 1 & -0.5 \\ 3 & 2 & 0 & 1 \\ 2 & 1 & 1 & 0 \\ 1 & 2 & 2 & 3 \end{array}$	$\begin{array}{c\|ccc} & x & y & z \\ 0.5 & 0 & 1 & -0.5 \\ 3 & 2 & 0 & 1 \\ 1.5 & 1 & 0 & 0.5 \\ 0 & 2 & 0 & 4 \end{array}$
a: the system of equations	b: the matrix from (a)	c: (R1)/2	d: (R3) − (R1), (R4) − 2(R1)
$\begin{array}{c\|ccc} & x & y & z \\ 0.5 & 0 & 1 & -0.5 \\ 1.5 & 1 & 0 & 0.5 \\ 1.5 & 1 & 0 & 0.5 \\ 0 & 2 & 0 & 4 \end{array}$	$\begin{array}{c\|ccc} & x & y & z \\ 0.5 & 0 & 1 & -0.5 \\ 1.5 & 1 & 0 & 0.5 \\ 0 & 0 & 0 & 0 \\ -3 & 0 & 0 & 3 \end{array}$	$\begin{array}{c\|ccc} & x & y & z \\ 0.5 & 0 & 1 & -0.5 \\ 1.5 & 1 & 0 & 0.5 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 \end{array}$	$\begin{array}{c\|ccc} & x & y & z \\ 0 & 0 & 1 & 0 \\ 2 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 \end{array}$
e: (R2)/2	f: (R3) − (R2), (R4) − 2(R2)	g: (R4)/3	h: (R1) − 0.5(R4), (R2) − 0.5(R4)

```
ENTER EQUATION 1 ? 2y-z=1
ENTER EQUATION 2 ? 2x+z=3
ENTER EQUATION 3 ? x+y=2

THE STANDARD FORMS OF THE EQUATIONS ARE

y -0.5z = 0.5
x +0.5z = 1.5
x + y = 2

TOO FEW INDEPENDENT EQUATIONS
```

Figure 1: *Screen dump of the program's response to an underdetermined system. Notice that adding the standard forms of equations 1 and 2 gives equation 3.*

```
THIS PROGRAM'S LIMITATIONS INCLUDE

(1) IT WILL HANDLE ONLY "LINEAR EQUATIONS". THAT IS, INEQUALITIES AND
    VARIABLES MULTIPLIED OR DIVIDED BY VARIABLES WILL CAUSE ERRORS.

(2) 2y IS WRITTEN AS SHOWN, NOT AS 2*y OR 2xy. SPACING IS OPTIONAL.

(3) YOU MAY NOT USE THE LETTERS d OR e AS VARIABLE NAMES.

(4) YOU MAY USE ONLY ONE EQUAL SIGN IN AN EQUATION, I.E., x=y=z IS
    NOT ALLOWED.

(5) PARENTHESES CAN BE USED ONLY IN VARIABLE NAMES, I.E., -(-2x) IS
    NOT A VALID TERM, BUT --2x(1) IS.

(6) MIXED FRACTIONS (E.G., 1 1/2 x), TRAILING COEFFICIENTS (E.G., x/2), AND
    SCIENTIFIC NOTATION (1 e-2 x, 1x10-2 x) WILL CAUSE ERRORS.

(7) IF THE SYSTEM OF EQUATIONS CONTAINS MORE THAN 10 VARIABLES, IT
    WILL CAUSE A SUBSCRIPT OUT OF RANGE ERROR.

ENTER THE NUMBER OF EQUATIONS IN THE SYSTEM (MAX. 10)?
```

Figure 2: *Screen dump of the program's limitations.*

result is table 1d. In table 1e our second pivot (2,1) has been set equal to 1 [(R2)/2]. Note that row 3 has gone to 0 in table 1f. If equations 1 through 3 were the only ones in our system, the set would be underdetermined, i.e., insoluble (figure 1). If all of row 3 except for the constant (zeroth term) went to 0, the system of equations would be inconsistent.

Since row 3 is all zeros, we skip over it and find the last pivot in row 4. In table 1g we have set the pivot term equal to 1 by (R4)/3. We then eliminate the z-term from rows 1 and 2 by (R1)−0.5(R4) and (R2)−0.5(R4). The final result is table 1h. The solution set for our system is thus $y=0$, $x=2$, and $z=-1$.

As I mentioned earlier, the hard part is not solving the system of equations but getting from table 1a to table 1b. How do we do that? Consider the expression $3x-x+1=x+2$. We want to begin by collecting terms. In a linear equation, a term is separated from the next term by "+," "−," or "=." Let's limit our attention to the left-hand side of the equation for now. Clearly, we want to combine the "$3x$" term and the "$-x$" term. We add the coefficients, 3 and −1, to get $2x$. The third term, "1," is on the "wrong side" of the equation. So we want to change its sign to minus and save it as a constant. Now we can deal with the right-hand side. We see that "x" is on the wrong side. We must change the sign of its coefficient and add it to the other "x" term, giving a total of $1x$. The 2 should be added to the constant term, leaving 1. Thus, our collected expression is $x=1$.

If that looks like a lot of work, you don't know the half of it. Consider the expression $x-y=0$. This is entered in BASIC as a string expression. I use the VAL operator to identify the coefficient. In our example, the VAL operator will return 0 for the value of each term. What we want returned are 1, −1, and 0, respectively. Again, $1x=\frac{1}{2}y$ will return 1 for the coefficient of each term. Clearly, the program needs to do a lot of bookkeeping.

Figure 2 is a screen dump of the first screen of the program I have provided

Parsing string data in BASIC requires a lot of bookkeeping.

for downloading on BYTEnet Listings at (617) 861-9774. As you can see, I left many potential problems unaddressed in the program. I invite you to alter the program to cover whatever limitations you think need to be eliminated. What I want to do here is just discuss what the limitations tell you about the program.

Limitation number 2 is rather typical. If you enter $2*y=1$ instead of $2\ y=1$, the parser will interpret the variable name as $*y$. If another equation is in the system, say $y-z=5$, the program will not treat the two ys as the same variable. The same is true for using $2xy$. It would be a small addition to the program to make the parser throw away all occurrences of "*," and the first problem would be overcome. The case of indicating multiplication by x is more problematic. There is no reasonable way to distinguish between an x used as a multiplication sign and an x used as a variable name or the first letter of a variable name.

Limitation 3 is kind of interesting. Consider the expression $2e+3f=4$. The VAL operator will return 2000 as the numerical part of the string because $2e+3$ is a valid BASIC way of saying 2000. If you change the e to a d, you just have a double-precision way of saying 2000. I eliminated the ambiguity by disallowing both e as a variable name and $2e+3$ as a coefficient (limitation 6). You could avoid limitation 3 by separating the "2" from the rest of the string before taking its VAL. As for scientific notation, it seems to me that such notation has too many different ways of writing numbers to be worth the effort of using.

In limitation 4 the variable on the right-hand side would be $y=z$ according to the parser. In limitation 5 the

(continued)

```
ENTER EQUATION 1 ? 0.05 NICKELS + 0.10 DIMES = 1.10
ENTER EQUATION 2 ? NICKELS + DIMES = 12

THE STANDARD FORMS OF THE EQUATIONS ARE

DIMES + 0.5 NICKELS = 11
DIMES + NICKELS = 12

THE SOLUTION SET FOR THE SYSTEM OF EQUATIONS IS

DIMES = 10
NICKELS = 2
```

Figure 3a: *Screen dump of the program's handling of the coin problem.*

```
ENTER EQUATION 1 ? JOHN'S.AGE = BOB'S.AGE - 5
ENTER EQUATION 2 ? JOHN'S.AGE + 1 = 2/3 BOB'S.AGE

THE STANDARD FORMS OF THE EQUATIONS ARE

BOB'S.AGE - JOHN'S.AGE = 5
BOB'S.AGE - 1.5 JOHN'S.AGE = 1.5

THE SOLUTION SET FOR THE SYSTEM OF EQUATIONS IS

BOB'S.AGE = 12
JOHN'S.AGE = 7
```

Figure 3b: *Screen dump of the age-problem solution. The period is used in the variable names for readability because the program removes all spaces.*

coefficient would be -1 and the variable name $(-2x)$. Both of these are avoidable without much trouble. The second one seems more interesting to me because you will commonly use linear expressions of the form $3(x+1)=4$. It would be useful for the parser to multiply through the parentheses rather than leave everything in parentheses uninterpreted. If you do this, be careful. You don't want to multiply through the parentheses on an expression like $3x(1)$; an expression like $3(x+1)$ should be multiplied through; and an expression like $x(x+1)$ should generate an error.

We've already discussed one aspect of limitation 6. The problem with 1 1/2 x is that the parser removes all blanks from a string. Otherwise, "x" and " x" will be two different variable names. Therefore, 1 1/2 x actually looks like $11/2x$, as does eleven-halves x. A different approach to parsing will avoid this if you want to. In $x/2$ the parser will treat the coefficient as 1 and the variable name as $x/2$. Avoiding this problem would be more work than it looks like and probably more work than it's worth.

Limitation 7 is simply a matter of having left all of the arrays undimensioned.

At least one more interesting situation can arise in the program. I'm not sure I want to call it a limitation. Consider the equation $x+y=x+3$. If you enter this equation by itself in the program, you will be told that it has too many variables for the system to be soluble, even though the program will also print out the standard form of the equation as $y=3$. Most of us would take $y=3$ as the answer. However, x is clearly underdetermined. If you want the parser to handle this kind of situation, the variable name x must be removed from the list of variable names in the expression when the coefficient of x goes to 0.

In closing, I have provided a screen dump of the program solving the two story problems at the beginning (figure 3). I hope you get a chance to download the program and that you enjoy playing with it. ■

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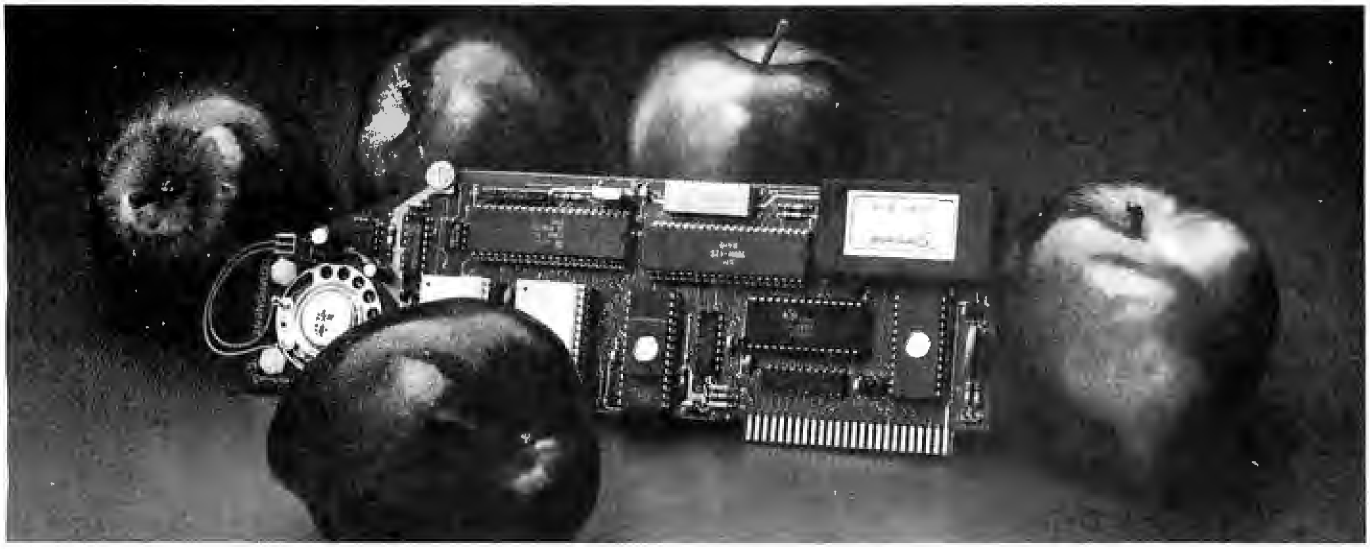

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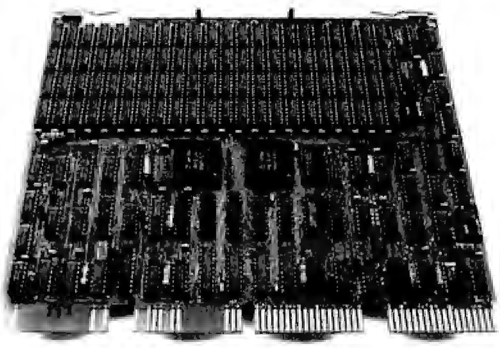

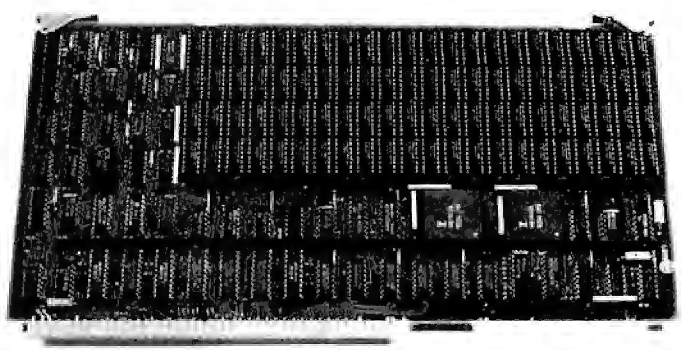

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Conducted by Steve Ciarcia

OFFER EXTENDED

Dear Circuit Cellar Project Builders,

In my November 1984 article on the Lis'ner 1000 voice-recognition board, I offered the software separately to Circuit Cellar project builders for $17 through March 1, 1985. Requests have poured in throughout the offering period, but the majority of foreign mail has just started to arrive. To give everyone time to properly evaluate the project and respond, I am extending the availability of the software through August 1, 1985. Thanks for your support.—Steve

TRUMP CARD AND NEC

Dear Steve,

In rereading some older issues of BYTE recently, I came across your Trump Card project (May and June 1984). Though I find it very intriguing, it raises several questions regarding its adaptation and use with my PC look-alike, the NEC APC III. I feel that I can overcome the minor problems with physical board-size differences but want to know what possible problems there would be with using the software mentioned under MS-DOS 2.11. Another issue is that of using 256K-byte RAMs rather than 64K-byte RAMs. I don't feel that the project would warrant consideration if the software mentioned could not be modified to run on the system.

My computer is currently configured with 256K bytes, dual 360K-byte disk drives, serial and parallel ports, graphics card (192K bytes), 102-key keyboard, and 640- by 400-pixel resolution color monitor. It is an 8-MHz 8086-based processor. I thought this additional information might be helpful in determining whether or not this project is feasible.

I would be interested in your thoughts on the design and adaptation of a RAM-disk board using 1-megabit bubble-memory modules instead of either 64K- or 256K-byte dynamic RAM chips.

OTTO BARTSCH
Plano, TX

The Trump Card was tested on several different systems running under MS-DOS 2.0 and operated without problems on these systems. Since the Trump Card project was presented, the software has been updated by Sweet Micro Systems. Any specific questions about the software interaction with a particular system should be addressed to Sweet Micro Systems Inc., 50 Freeway Dr., Cranston, RI 02920, (401) 461-0530.

If you change the memory chips in the Trump Card to 256K-byte chips, you should use chips with 150-nanosecond access times. You will also have to change the address decoding to accommodate the added address lines on the 256K-byte chips.

Bubble memory is still relatively high priced compared to other types of storage, especially with the prices of hard disks coming down as fast as they are. However, bubble memory still has a place in systems where the environment is not suited for hard disks and where the price is not a factor. If you are interested in building a bubble-memory system, you should read the two-part article by Louis Wheeler in the January and February 1984 issues of BYTE called "Bubbles on the S-100 Bus."—Steve

8749 PROGRAMMER

Dear Steve,

For some time now, I have wanted to experiment with the Intel 8749 single-chip microcomputer. On reading your November 1983 article ("Build the H-Com Handicapped Communicator"), I learned that you have used the Intel 8748, which is very similar to the 8749.

The only real problem I have is burning the code into the 8749. Can you please refer me to any articles that describe an 8749 programmer? Perhaps it can be connected to a few I/O ports of a personal computer.

NICHOLAS T. VASIL
Bridgeport, CT

Several companies advertising in BYTE offer EPROM programmers that are capable of programming the EPROM on the 8749 microprocessor. These programmers can be interfaced to any computer through an RS-232C serial port. For example, GTEK Inc. sells the Model 7128 EPROM programmer that will program 19 different types of EPROMs, 5 different EEPROMs, and 7 different microprocessors with on-board EPROMs. Contact GTEK Inc., POB 289, Waveland, MS 39576, (601) 467-8048.

If you intend to build a dedicated programmer for the 8749, you can obtain the programming voltage specifications and the programming timing sequence from the Intel Component Data Catalog. *You can obtain this catalog from Intel Corporation, Literature Department SV3-3, 3065 Bowers Ave., Santa Clara, CA 95051.*

For information on how to connect an EPROM programmer to an RS-232C serial port, see my article on page 104 of the February BYTE ("Build a Serial EPROM Programmer").—Steve

SPEECH AND THE VIC-20

Dear Steve,

While perusing some back issues of BYTE, I noticed that you have published several articles on speech synthesizers. I purchased a speech chip from Radio Shack to connect to my VIC-20, but I am unable to figure out how to interface it to my computer. Can you give me any help?

GARY W. TIDWELL
Killen, AL

The chip set that you got at Radio Shack was probably the General Instrument SP0256-AL2 Allophone Speech Processor with a special ROM chip containing encoded words for use as a talking clock. See "Build a Talking Clock Speech Synthesizer" by Ernest H. Piette (May BYTE, page 143) for details on interfacing the SP0256-AL2 to a variety of microcomputers, including the VIC-20.
—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.

Conducted by Sol Libes

Congratulations to Altos for being the first company to introduce a system using the Motorola 68020 microprocessor, a true 32-bitter. The Altos 3068 runs UNIX System V and will handle up to 30 users.

At the January Consumer Electronics Show, Atari's Jack Tramiel (chairman of the board) promised the company would ship 5 million of its new ST-series machines this year. In March, Atari's president, Sam Tramiel (Jack's son), cut the prediction to just over a million units. Rumors now are that Atari will not start shipping the ST in earnest until this month, which would make it difficult to achieve the revised goal. Meanwhile, Leonard Tramiel (another son) revealed that Atari plans an OEM version of the 68000-based machine as well as a local-area network for the system. It is expected that the LAN will use the ST's MIDI (musical instrument digital interface) port and operate at 31.25 kbps. This would make it slower than the AppleTalk net but faster than LANs using RS-232C interfaces.

Digital Research is expected to add an MS-DOS emulation feature to the GEM operating system running on the new Atari 68000-based computer, meaning that users may be able to run many of the programs written for the IBM PC.

Manufacturers of clones are moving from the IBM PC to the PC AT marketplace. Expect Tandy, Hewlett-Packard, Wang, Honeywell, Philips, Siemens, Ericsson, and AT&T (plus several Japanese, Korean, and Taiwanese companies) to introduce AT-compatible machines before the end of the year. Compaq, Xerox, NCR, Texas Instruments, Zenith, and Kaypro already have AT clones out. There are even rumors that Apple is seriously considering producing one. Most are expected to run faster than the AT and have display circuitry compatible with IBM's Enhanced Graphics Adapter (EGA). Chips and Technologies, a custom IC maker in San Jose, CA, is reportedly attempting to reduce the EGA from 150 to 23 ICs.

Also, rumors are going around that General Electric and AT&T have attempted to acquire Apple Computer.

IBM Rumors and Speculations

The long-rumored PC II is expected to be officially announced by IBM next month, with shipments to users starting in the fall. . . . Industry pundits expect that this fall IBM will bring out a more powerful and faster version of the AT running UNIX System V and handling up to 16 users. . . . Rumors say that IBM may put TopView into ROM on future PC products along with a new operating system being developed in-house. . . . Expect IBM to introduce a laser printer with much better dot density than current Apple and HP printers.

Future Computing of Dallas predicts that IBM will sell 350,000 ATs this year worth $1.6 billion. The people there estimate that in 1984 IBM shipped 90,000 ATs worth $500 million.

Expect IBM to shortly switch to 3½-inch floppies. IBM has ordered 1.5 million 1-megabyte disks from Toshiba, Alps, and Matsushita.

It is estimated that IBM, at the time the company announced it was ceasing production of the PCjr, had around 350,000 units in its warehouses. There are reports that IBM, in an attempt to move large quantities of the units, offered them to liquidation brokers for $80 each but did not get any takers. There are also reports that IBM, this spring, had as many as 600,000 XTs in stock. In an effort to move them out of warehouses, IBM reduced the XT price by 12 percent, included several software packages, and also began selling PCs with XT motherboards. The feeling is that the introduction of the AT last summer severely undercut sales of the XT. Further, IBM raised the price of the PC to discourage dealers from upgrading PCs to XTs using non-IBM components. In any event, IBM's overstocked warehouses appear to be the cause of the delay in the introduction of the PC II.

Some reports say that IBM is putting the squeeze on independent suppliers of software packages that it distributes. Currently, these companies give IBM 40 to 60 percent discounts. It is reported that IBM is now asking for 70 percent discounts.

Apple Bytes and Pits

First there was the Macintosh with 128K bytes of RAM, quickly followed by the Fat Mac with 512K bytes. Now, industry watchers expect Apple to soon introduce a 1-megabyte Mac. Apple already offers a 1-megabyte plug-in RAM card for the Mac XL (née Lisa 2).

The 1-megabyte Mac should improve performance, particularly for memory-hungry spreadsheets and font-generating programs. It would also encourage a RAM-disk operation to compensate for the Mac's slow disk access.

Several companies already offer do-it-yourself Mac memory add-ons of up to 2 megabytes, and we can expect these independents, when 1-megabit chips become available, to offer 4-megabyte RAM upgrades (the maximum addressing limit of the Mac). These upgrades require opening the Mac and soldering to the main processor board, a violation of Apple's warranty, and is not recommended for the inexperienced. Levco Enterprises (11568 Sorrento Valley Rd. #14, San Diego, CA 92121) and Beck-Tech (41 Tunnel Rd., Berkeley, CA 94705) offer such kits. Levco also offers a motorless, piezoelectric fan to cool the 2 megabytes of RAM.

I also hear rumors that Apple may introduce a new version of the Mac with a bus-expansion slot, a feature being asked for by value-added retailers. Also expected is a doubling of the ROM from 64K bytes to 128K bytes to improve and expand the operating system. The likelihood is that Apple will offer a new dealer-installed enhanced processor board for the 350,000 Macs already sold. However, Apple will have to figure out how to make this upgrade more popular than its $995 upgrade from 128K bytes to 512K bytes, which created a great deal of resentment among Mac owners, many of whom did not take Apple up on the offer.

Finally, Apple is expected to introduce an Apple II with the Western Design

(continued)

BYTELINES, *news and speculation about personal computing, is conducted by* Sol Libes, *the author of numerous books and articles on computers. He is the founder of the* Amateur Computer Group of New Jersey *and a coorganizer of the* Trenton Computer Festival. *He edits and publishes* Micro/Systems Journal, *a bimonthly publication for system programmers and integrators. He can be contacted c/o* BYTE, POB 372, *Hancock*, NH 03449.

Center 8-/16-bit 65816 microprocessor. Look for it to be introduced at Apple's January stockholders' meeting. There is some question as to whether Apple will provide an upgrade kit for the current 2.5 million Apple II users. If Apple doesn't do it, you can bet somebody else will!

MICROSOFT TO INTRODUCE MS-DOS 4.0

Late this year, Microsoft is expected to release version 4.0 of MS-DOS, the primary operating system for the IBM PC/XT/AT family of computers and compatibles. Version 4.0 should add multitasking and a virtual memory space in excess of 640K bytes. Multitasking is expected to improve the operating speed of Microsoft's Windows environment. Currently, the only way to get PC software-compatible multitasking on PC-compatible machines is with Digital Research's Concurrent DOS. The latest version of Concurrent DOS (4.1) also includes the GEM user interface.

Also, version 5.0 of MS-DOS is reportedly in development, designed specifically for the 80286 processor. It should execute programs in the 80286 protected virtual-address mode.

INTEL UNWRAPS 386

Intel is expected to shortly make a formal announcement of its new 80386 32-bit microprocessor. For the first time, Intel finds itself running behind National Semiconductor (already shipping production quantities of the 32032), Motorola (sampling for close to a year and ready to start 68020 production), and AT&T (selling its 32-bitter to OEMs). Production of the 80386 is not expected until next year. This means that the first computers using the device may be introduced by late 1986.

The 80386 is expected to be upward-compatible with the 80286 (used in the IBM PC AT), contain more than twice the number of devices, and be two to three times faster. It should have on-chip memory management, with a protection feature, to work with up to 4 gigabytes of physical memory and 64 terabytes of virtual memory.

MEMORY SIZES INCREASING

In Japan, large-volume pricing of 256K-bit RAM chips is already less than $4 each, with 64K-bit chips less than $1. Toshiba, NEC, Hitachi, and Fujitsu are expected to start sampling 1-megabit chips by year's end. Such chips should start appearing in equipment in 1987, earlier than previously expected, making the life of 256K-bit chips shorter than the 64K-bit and 16K-bit chips. The base RAM memory size in 1987 is expected to be 1 megabyte, compared to the current 256K-byte and previous 64K-byte standards.

ROM size is also growing. Several companies are sampling 1-megabit ROM chips organized as 128K 8-bit words or 64K 16-bit words. This means that the entire operating system for most personal computers can now be in ROM, allowing faster operation and freeing up valuable disk space. HP already has a UNIX portable machine with the operating-system kernel in 256K bytes of ROM. Further, plug-in application-software ROM cartridges will contain larger programs.

MICRO MARKET IN SLUMP

A definite slowdown in personal computer demand developed in the late spring of 1984, just as many manufacturers, carried away with the euphoria of the early 1980s, brought increased production facilities on line. This resulted in an inventory buildup for most manufacturers. (IBM reportedly had $1.8 billion of finished goods plus $300 million of parts in inventory.) Many companies attempted to cope with the situation with special promotions during the fall and Christmas seasons. IBM cut the price of the PCjr and included a color monitor and software, which brought the list price of a complete system down to less than $1000 (with a street price of substantially less than $900). Apple, Commodore, and Atari also offered special prices to move inventory out of warehouses. This policy proved effective in moving out a lot of systems, particularly during the Christmas selling season.

However, since the first of the year, manufacturer inventories have soared as demand fell off again. Some manufacturers have restored higher prices. For example, IBM raised the price of the PCjr to more than $1400 and saw demand for the unit shrivel to virtually nil.

Apple had such a buildup of inventory that it closed all its plants for a week in March and forced employees to take a vacation. Also, it offered dealer rebates of as much as $300 in an attempt to get Apple IIs and Macs moving again.

SINCLAIR GOING WSI

Sinclair Research, the British company that startled the industry with its inexpensive ZX80/81 microcomputer just a few years ago, is rumored to be planning a new breakthrough. It is expected to introduce late next year a portable system (tentatively called Proteus) using wafer-scale integration (WSI) and the flat-screen display currently being used in its pocket TV. WSI is expected to allow several megabytes of memory to be built on one wafer. Sinclair is now in the initial stages of constructing a factory to build an estimated 300,000 units a year.

A PC CLONE FOR LESS THAN $900

I just came back from attending the Trenton Computer Festival. This event held every April has the largest personal computer flea market in the country. With components I purchased at TCF, mostly from Taiwan, I was able to put together a very close copy of the IBM PC for less than $900. If you are looking for the best prices on microcomputer equipment, I suggest you check out computer flea markets held in your area. At TCF I also was able to buy supplies at incredibly low cost (e.g., DS/DD floppies for 70 cents each). If you want specific information on how I built my clone, send me a stamped self-addressed business-size envelope. Send it to POB 1192, Mountainside, NJ 07092.

ZILOG DELAYS Z80000 AND Z800

Zilog has again pushed back introduction of its Z80000 32-bit and Z800 super 8-/16-bit (Z80-compatible) microprocessors to the spring of 1986. If Zilog does manage to ship samples when promised, it will be a full six years since announcing it was developing the units.

Zilog, owned by Exxon, has shown a profit only one year in its 11-year life and recently cut 400 people from its payroll. Although a pioneer in microprocessor development, with its Z80 and Z8000 8- and 16-bit microprocessors, it has suffered from a reliance on microprocessor manufacturing, while competitors like Intel, Motorola, and National Semiconductor have used microprocessors as loss leaders to sell memory and other types of ICs.

RANDOM BITS

Novix, Cupertino, CA, has introduced a 16-bit microprocessor that directly executes the FORTH language. . . . A catalog issued by Markline Co., Belmont, MA, features a $39.95 electronic toaster using a microchip to assure uniform toasting. . . . For the first time, it appears that there will not be a waiting list for booth space at this month's National Computer Conference. . . . Hewlett-Packard, long a pioneer in the computer business (first to introduce the touchscreen, the 3½-inch disk, a UNIX portable, etc.), is expected to be the first company out with a computer optical-disc unit. ■

B·O·O·K·S R·E·C·E·I·V·E·D

ADVANCED LEVEL I DBASE: CONCEPTS FOR FIRST-TIME USERS, Alan Freedman. Englewood Cliffs, NJ: Prentice-Hall, 1985; 71 pages, spiral-bound, ISBN 0-13-011420-0, $6.95.

ADVANCED PROGRAMMING: A PRACTICAL COURSE, D. W. Barron and J. M. Bishop. New York: John Wiley & Sons, 1984; 300 pages, hardcover, ISBN 0-471-90319-1, $24.95.

THE ANALYSIS OF ALGORITHMS, Paul Walton Purdom Jr. and Cynthia A. Brown. New York: Holt, Rinehart & Winston, 1985; 560 pages, hardcover, ISBN 0-03-072044-3, $39.95.

ANIMATION MAGIC WITH YOUR IBM PC AND PCjr, Ron Person. Berkeley, CA: Osborne/McGraw-Hill, 1985; 256 pages, softcover, ISBN 0-88134-145-2, $15.95.

APPLE COMPUTER DIRECTORY: HARDWARE, SOFTWARE, AND PERIPHERALS—APPLE II/II+, APPLE IIE, MACINTOSH, LISA, APPLE III, APPLE IIC, Kelly-Grimes. New York: John Wiley & Sons, 1985; 496 pages, softcover, ISBN 0-471-87818-9, $26.95.

APPLICATION DEBUGGING, Robert Binder. Englewood Cliffs, NJ: Prentice-Hall, 1985; 382 pages, hardcover, ISBN 0-13-039348-7, $29.95.

ASSEMBLY LANGUAGE PROGRAMMING FOR THE VAX-11, Michael H. Pressman. Palo Alto, CA: Mayfield Publishing Co., 1985; 400 pages, hardcover, ISBN 0-87484-599-8, $28.95.

BASIC, Bijan Mashaw. Palo Alto, CA: Mayfield Publishing Co., 1985; 560 pages, softcover, ISBN 0-87484-692-7, $23.95. Includes instructor's manual (ISBN 0-87484-737-0).

THE BASIC ADAM: A SELF-TEACHING GUIDE, William Abikoff and Gary Cornell. New York: John Wiley & Sons, 1984; 536 pages, softcover, ISBN 0-471-80807-5, $14.95.

BASIC PROGRAMS FOR THE ATARI 600XL & 800XL, Timothy Orr Knight. Blue Ridge Summit, PA: Tab Books, 1984; 128 pages, softcover, ISBN 0-8306-1726-4, $8.95.

BEST MICROCOMPUTER HARDWARE, Chung I. Park, ed. Morton Grove, IL: Ad Digest, 1985; 64 pages, softcover, ISBN 0-939670-03-8, $3.95.

BEST MICROCOMPUTER SOFTWARE, Chung I. Park, ed. Morton Grove, IL: Ad Digest, 1985; 64 pages, softcover, ISBN 0-939670-04-6, $3.95.

C LANGUAGE FOR PROGRAMMERS, Kenneth Pugh. Glenview, IL: Scott, Foresman and Co., 1984; 206 pages, softcover, ISBN 0-673-18034-4, $17.95.

THE C PROGRAMMER'S HANDBOOK, M. I. Bolsky. Englewood Cliffs, NJ: Prentice-Hall, 1985; 88 pages, spiral-bound, ISBN 0-13-110073-4, $14.95.

CHARGED BODIES: PEOPLE, POWER, AND PARADOX IN SILICON VALLEY, Thomas Mahon. New York: New American Books, 1985; 352 pages, hardcover, ISBN 0-453-00487-3, $15.95.

THE CHIP: HOW TWO AMERICANS INVENTED THE MICROCHIP & LAUNCHED A REVOLUTION, T. R. Reid. New York: Simon & Schuster, 1985; 246 pages, hardcover, ISBN 0-671-45393-9, $17.95.

COMMODORE 64 BASIC MADE EASY, David A. Gardner and Marianne L. Gardner. Englewood Cliffs, NJ: Prentice-Hall, 1985; 256 pages, hardcover, ISBN 0-13-152067-9, $19.95.

COMMODORE 64 BASICS: A SELF-TEACHING GUIDE, Ann Harris. New York: John Wiley & Sons, 1985; 456 pages, softcover, ISBN 0-471-88008-6, $15.95.

COMMODORE 64 LOGO: A LEARNING AND TEACHING GUIDE, Peter Goodyear. New York: John Wiley & Sons, 1984; 204 pages, softcover, ISBN 0-471-81964-6, $14.95.

THE COMPLETE PFS: BOOK, Ralph Mylius. Plano, TX: Wordware Publishing, 1985; 200 pages, softcover, ISBN 0-915381-70-2, $19.95.

COMPUTER GENEALOGY: A GUIDE TO RESEARCH THROUGH HIGH TECHNOLOGY, Paul A. Andereck and Richard A. Pence. Salt Lake City, UT: Ancestry Inc., 1985; 304 pages, softcover, ISBN 0-916489-02-7, $12.95.

COMPUTER USABILITY TESTING AND EVALUATION, Richard H. Spencer. Englewood Cliffs, NJ: Prentice-Hall, 1985; 240 pages, hardcover, ISBN 0-13-164088-7, $27.50.

COMPUTERS AND APPLICATION SOFTWARE: AN INTRODUCTION, Wilson T. Price. New York: Holt, Rinehart and Winston, 1985; 582 pages, softcover, ISBN 0-03-000349-0, $26.95.

DBASE II: TECHNIQUES AND REFERENCE MANUAL, Jack E. Lohman. Milwaukee, WI: dTECHNIQUE, 1984; 146 pages, softcover, ISBN 0-9614034-0-3, $19.95.

THE DBASE DOZEN FOR DBASE II, Alan Freedman. Englewood Cliffs, NJ: Prentice-Hall, 1985; 71 pages, spiral-bound, ISBN 0-13-195967-0, $6.95.

THE DBASE DOZEN FOR DBASE III, Alan Freedman. Englewood Cliffs, NJ: Prentice-Hall, 1985; 71 pages, spiral-bound, ISBN 0-13-196288-4, $6.95.

THE DBASE QUERY LANGUAGE, Alan Freedman. Englewood Cliffs, NJ: Prentice-Hall, 1985; 72 pages, softcover, ISBN 0-13-196171-3, $6.95.

DEBUGGING BASIC PROGRAMS, David R. Cecil. Blue Ridge Summit, PA: Tab Books, 1984; 178 pages, softcover, ISBN 0-8306-1813-9, $9.95.

DEC MICROCOMPUTER DIRECTORY: HARDWARE, SOFTWARE, AND PERIPHERALS—RAINBOW, RAINBOW PLUS, DECMATE II, PROFESSIONAL SERIES, Kelly-Grimes. New York: John Wiley & Sons, 1985; 366 pages, softcover, ISBN 0-471-87822-7, $26.95.

DEFECT CORRECTION METHODS: THEORY AND APPLICATIONS, K. Böhmer and H. J. Stetter, eds. New York: Springer-Verlag, 1984; 256 pages, softcover, ISBN 0-387-81832-4, $20.

DICTIONARY OF MICROELECTRONICS AND MICROCOMPUTER TECHNOLOGY (German–English/Engish–German), Yvonne Hélène Attiyate and Raymond Shah. Philadelphia, PA: Heyden & Son, 1984; 460 pages, hardcover, ISBN 3-18-400652-2, $31.

DO YOU REALLY NEED A HOME COMPUTER? Derek Rowntree. New York: Charles Scribner's Sons, 1985; 160 pages, softcover, ISBN 0-684-18182-7, $6.95.

8086/8088 ASSEMBLY LANGUAGE PROGRAMMING, Bik Chung Yeung. New York: John Wiley & Sons, 1984; 280 pages, softcover, ISBN 0-471-90463-5, $19.95.

THE ELECTRONIC LINK: USING THE IBM PC TO COMMUNICATE, Lawrence J. Magid and John Boeschen. New York: John Wiley & Sons, 1985; 280 pages, soft-

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THIS IS A LIST *of books received at* BYTE *Publications. It is not meant to be exhaustive; its purpose is to acquaint* BYTE *readers with recently published titles in computer science and related fields. We regret that we cannot review all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.*

BOOKS RECEIVED

cover, ISBN 0-471-88382-4, $15.95.

ESSENTIAL PROGRAMS FOR SMALL BUSINESS PLANNING OF THE APPLE II/IIE/IIC, Michael Kilpatrick. New York: John Wiley & Sons, 1985; 272 pages, softcover, ISBN 0-471-80602-1, $46.90. Includes floppy disk.

EVERYTHING YOU NEED TO DO YOUR TAXES WITH LOTUS 1-2-3, Michael Kwatinetz, Joel Pitt, and Leonard Kwatinetz. New York: Sterling Publishing Co., 1984; 320 pages, softcover, ISBN 0-8069-7928-3, $14.95.

EVERYTHING YOU NEED TO DO YOUR TAXES WITH SUPERCALC, Michael Kwatinetz, Joel Pitt, and Leonard Kwatinetz. New York: Sterling Publishing Co., 1984; 264 pages, softcover, ISBN 0-8069-7932-1, $12.95.

FIRST BOOK ON UNIX FOR EXECUTIVES, Yukari Shirota and Tosiyasu L. Kunii. New York: Springer-Verlag, 1984; 170 pages, softcover, ISBN 0-387-70003-X, $16.

FORTH, W. P. Salman, O. Tisserand, and B. Toulout. New York: Springer-Verlag, 1984; 176 pages, softcover, ISBN 0-387-91256-8, $14.

FOUNDATIONS OF COMPUTER MUSIC, Curtis Roads and John Strawn, eds. Cambridge, MA: MIT Press, 1985; 736 pages, hardcover, ISBN 0-262-18114-2, $50.

GOING FROM BASIC TO C, Robert J. Traister. Englewood Cliffs, NJ: Prentice-Hall, 1985; 176 pages, softcover, ISBN 0-13-357799-6, $17.95.

GUIDE TO TELECOMMUNICATIONS WITH YOUR IBM PC, Greg Kearsley, Beverly Hunter, and Hal Hunter. Glenview, IL: Scott, Foresman and Co., 1985; 176 pages, softcover, ISBN 0-673-15944-2, $39.95. Includes floppy disk.

HOW TO REPAIR AND MAINTAIN YOUR IBM PC, Gene B. Williams. Radnor, PA: Chilton Book Co., 1984; 224 pages, softcover, ISBN 0-8019-7537-9, $12.95.

IBM PC COMPATIBLE COMPUTER DIRECTORY: HARDWARE, SOFTWARE, AND PERIPHERALS—COMPAQ, EAGLE, COLUMBIA, HYPERION, TI PROFESSIONAL, . . . AND MORE, Kelly-Grimes. New York: John Wiley & Sons, 1985; 608 pages, softcover, ISBN 0-471-87819-7, $26.95.

IBM PC COMPUTER DIRECTORY: HARDWARE, SOFTWARE, AND PERIPHERALS—IBM PC, PCJR, CS 9000, IBM PC/XT, Kelly-Grimes. New York: John Wiley & Sons, 1985; 590 pages, softcover, ISBN 0-471-87821-9, $26.95.

IBM PC 8088 MACRO ASSEMBLER PROGRAMMING, Dan Rollins. New York: Macmillan Publishing, 1985; 464 pages, softcover, ISBN 0-02-403210-7, $18.

THE IBM PC/XT: MAKING THE RIGHT CONNECTIONS, Martin D. Seyer. Englewood Cliffs, NJ: Prentice-Hall, 1985; 320 pages, hardcover, ISBN 0-13-449026-6, $24.95.

IBM PORTABLE PERSONAL COMPUTER USER'S HANDBOOK, staff of Weber Systems. Cleveland, OH: Weber Systems Inc., 1984; 316 pages, softcover, ISBN 0-938862-17-0, $15.95.

THE ILLUSTRATED LOTUS 1-2-3 BOOK, Thomas H. Berliner and David T. Reeves. Dallas, TX: Wordware Publishing, 1985; 304 pages, softcover, ISBN 0-915381-52-4, $17.95.

IMPROVING CAI IN BASIC, Sharon Burrowes and Ted Burrowes. Eugene, OR: The International Council for Computers in Education, 1985; 88 pages, softcover, ISBN 0-924667-08-7, $6.

INFORMATION MANAGEMENT WITH BASIC FOR THE IBM PC/XT, Tom Shoemaker. Reston, VA: Reston Publishing, 1985; 192 pages, softcover, ISBN 0-8359-3076-9, $14.95.

INTELLIGENT SYSTEMS: THE UNPRECEDENTED OPPORTUNITY, J. E. Hayes and D. Michie, eds. New York: John Wiley & Sons, 1984; 224 pages, softcover, ISBN 0-470-20139-8, $19.95.

INTRODUCTION TO ADA, 2nd ed., S. J. Young. New York: John Wiley & Sons, 1984; 404 pages, softcover, ISBN 0-470-20112-6, $29.95.

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INTRODUCTION TO NON-LINEAR OPTIMIZATION, L. E. Scales. New York: Springer-Verlag, 1985; 256 pages, softcover, ISBN 0-387-91252-5, $19.80.

INTRODUCTION TO NUMERICAL METHODS FOR PARALLEL COMPUTERS, U. Schendel. New York: John Wiley & Sons, 1984; 152 pages, hardcover, ISBN 0-470-20091-X, $21.95.

LEARNING ASSEMBLY LANGUAGE, Hugo T. Jackson and A. M. Fischer. New York: Harper & Row, 1985; 318 pages, softcover, ISBN 0-06-043247-0, $19.95.

LEARNING FORTH, Margaret A. Armstrong. New York: John Wiley & Sons, 1985; 226 pages, softcover, ISBN 0-471-88245-3, $16.95.

LEARNING MS-BASIC ON THE TI PROFESSIONAL COMPUTER, Donald W. Drury. Blue Ridge Summit, PA: Tab Books, 1984; 240 pages, softcover, ISBN 0-8306-1815-5, $15.95.

LEARNING WITH COMMODORE LOGO, Daniel Watt. New York: McGraw-Hill, 1985; 332 pages, spiral-bound, ISBN 0-07-068581-9, $19.95.

LOGICS FOR ARTIFICIAL INTELLIGENCE, Raymond Turner. New York: John Wiley & Sons, 1984; 128 pages, hardcover, ISBN 0-470-20123-1, $29.95.

MACGUIDE: THE COMPLETE HANDBOOK TO THE MACINTOSH, Leslie S. Smith. New York: New American Library, 1985; 288 pages, softcover, ISBN 0-452-25569-4, $14.95.

MACTELECOMMUNICATIONS, Jonathan Erickson and William D. Cramer. Berkeley, CA: Osborne/McGraw-Hill, 1985; 224 pages, softcover, ISBN 0-88134-155-X, $16.95.

MANAGING MICROCOMPUTERS IN LARGE ORGANIZATIONS, National Research Council. Washington, DC: National Academy Press, 1985; 160 pages, softcover, ISBN 0-309-03492-2, $13.95.

MASTERING YOUR COMMODORE 64 THROUGH EIGHT BASIC PROJECTS, Robert M. Tripp, ed. Englewood Cliffs, NJ: Prentice-Hall, 1984; 192 pages, softcover, ISBN 0-13-559543-6, $19.95. Includes floppy disk.

MICROCOMPUTERS AND MICROPROCESSORS: THE 8080, 8085, AND Z-80—PROGRAMMING, INTERFACING, AND TROUBLESHOOTING, John Uffenbeck. Englewood Cliffs, NJ: Prentice-Hall, 1985; 688 pages, hardcover, ISBN 0-13-580309-8, $31.95.

MULTIPLAN MADE EASY, MACINTOSH EDITION, Walter A. Ettlin. Berkeley, CA: Osborne/McGraw-Hill, 1985; 288 pages, softcover, ISBN 0-88134-153-3, $14.95.

OKIDATA PRINTER USER'S HANDBOOK, staff of Weber Systems. Cleveland, OH: Weber Systems Inc., 1984; 304 pages, softcover, ISBN 0-938862-19-7, $15.95.

OR ON THE MICRO, David Whitaker. New York: John Wiley & Sons, 1984; 208 pages, hardcover, ISBN 0-471-90083-4, $19.95.

THE PC SOFTWARE AND SYSTEMS DIRECTORY FOR COMPUTER-AIDED ENGINEERING, the editors of *CAD/CIM Alert* and *CAE Workstation Alert*. Brookline, MA: Management Roundtable Inc., 1985; 86 pages, spiral-bound, #002PC, $79.

THE PERSONAL COMPUTER INVESTMENT HANDBOOK, Jon Zonderman. Blue Ridge Summit, PA: Tab Books, 1984; 160 pages, softcover, ISBN 0-8306-1807-4, $11.95.

THE PLAIN ENGLISH MAINTENANCE AND REPAIR GUIDE FOR IBM PERSONAL COMPUTERS: IBM PC, PC XT, PCJR, AND COMPATIBLES, Henry F. Beechhold. New York: Simon & Schuster, 1985; 272 pages, softcover, ISBN 0-671-52864-5, $14.95.

THE PRINCIPLES AND PRACTICE OF COST/SCHEDULE CONTROL SYSTEMS, Chuck M. Slemaker. Princeton, NJ: Petrocelli Books, 1985; 440 pages, hardcover, ISBN 0-89433-227-9, $39.95.

PROGRAMMER'S GUIDE TO VIDEO DISPLAY TERMINALS, David Stephens. Dallas, TX: Atlantis Publishing, 1985; 336 pages, softcover, ISBN 0-936158-01-8, $30.

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Programming in IBM PC DOS Pascal, David M. Chess. Englewood Cliffs, NJ: Prentice-Hall, 1985; 240 pages, softcover, ISBN 0-13-730292-4, $14.95.

Programming Tips for the Commodore 64, David Highmore and Liz Page. New York: John Wiley & Sons, 1985; 112 pages, softcover, ISBN 0-471-81553-5, $14.95.

Recursion via Pascal, J. S. Rohl. New York: Cambridge University Press, 1984; 206 pages, hardcover, ISBN 0-521-26329-8, $34.40.

Research and Development in Information Retrieval, C. J. van Rigsbergen, ed. New York: Cambridge University Press, 1985; 450 pages, hardcover, ISBN 0-521-26865-6, $49.50.

Sanyo MBC User's Handbook, staff of Weber Systems. Cleveland, OH: Weber Systems, Inc., 1984; 340 pages, softcover, ISBN 0-938862-24-3, $17.95.

Serious Programming for the Commodore 64, Henry Simpson. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, softcover, ISBN 0-8306-1821-X, $9.95.

6502 Machine and Assembly Language Programming, Mike Smith. Blue Ridge Summit, PA: Tab Books, 1984; 322 pages, softcover, ISBN 0-8306-1750-7, $12.95.

Software for Amateur Radio, Joe Kasser, G3ZCZ. Blue Ridge Summit, PA: Tab Books, 1984; 304 pages, softcover, ISBN 0-8306-0260-7, $15.95.

Star Power: Mastering WordStar, MailMerge, SpellStar, DataStar, SuperSort, CalcStar, InfoStar, StarIndex, CorrectStar, StarBurst, ReportStar, & PlanStar, Paul Garrison. Blue Ridge Summit, PA: Tab Books, 1985; 320 pages, softcover, ISBN 0-8306-1742-6, $16.95.

Stock Selection: Modern Portfolio Management, IBM PC Version, Robert J. Bibbero. New York: John Wiley & Sons, 1984; 110 pages, 3-ring binder, ISBN 0-471-80550-5, $125. Includes floppy disk.

Systems Analysis, Design, and Development with Structured Concepts, Perry Edwards. New York: Holt, Rinehart and Winston, 1985; 526 pages, hardcover, ISBN 0-03-000142-0, $27.95.

Text Processing, A. Colin Day. New York: Cambridge University Press, 1984; 160 pages, hardcover, ISBN 0-521-24432-3, $29.95.

A User Guide to the UNIX System, 2nd ed., Rebecca Thomas, Ph.D., and Jean Yates. Berkeley, CA: Osborne/McGraw-Hill, 1985; 736 pages, softcover, ISBN 0-88134-109-6, $18.95.

Word Processing Cookbook, Glenn B. Stuart. Englewood Cliffs, NJ: Prentice-Hall, 1985; 304 pages, softcover, ISBN 0-13-963380-4, $18.95.

Word Processing for the IBM PC & PCjr and Compatible Computers, Carole Boggs Matthews and Martin S. Matthews. New York: McGraw-Hill, 1985; 248 pages, softcover, ISBN 0-07-040952-8, $18.95.

Word Processing Software for the IBM PC, Ronni T. Marshak. New York: McGraw-Hill, 1985; 208 pages, softcover, ISBN 0-07-056322-5, $15.95.

WordStar in 3 Days, Miranda Morse. Huntington, NY: Maple Hill Press, 1984; 216 pages, spiral-bound, ISBN 0-930545-02-8, $14.95.

WordStar Without Tears: A Self-Teaching Guide, Ruth Ashley, Judi N. Fernandez, and Robert Sansom. New York: John Wiley & Sons, 1985; 220 pages, softcover, ISBN 0-471-80540-8, $14.95.

Working from Home, Paul and Sarah Edwards. Los Angeles, CA: Jeremy P. Tarcher Inc., 1985; 432 pages, softcover, ISBN 0-87477-240-0, $11.95.

The ZX Programmers' Companion, John and Catherine Grant. New York: Cambridge University Press, 1984; 256 pages, softcover, ISBN 0-521-27044-8, $11.95. ■

(continued from page 32)

where the values of x_8 and x_9 are arbitrarily selected.

For example, if a magic number of 9 is desired and if x_8 and x_9 are arbitrarily selected to be 31 and 15 respectively, the values for the remaining boxes are

$x_1 = -15 + 6 = -9$
$x_2 = -31 + 6 = -25$
$x_3 = 31 + 15 - 3 = 43$
$x_4 = 31 + 30 - 6 = 55$
$x_5 = 3$
$x_6 = -31 - 30 + 12 = -49$
$x_7 = -31 - 15 + 9 = -37$

The derivation of this general solution is extensive. Solutions for larger squares (higher order of n) can also be obtained using this technique.

Listing 1 is a short BASIC program (written for the unheard-of IM-1 computer manufactured by the "late" APF Industries) that will calculate a magic-square solution using the equations described above. Except for the second line of code (which is directed to turning the audio off and clearing the screen), this program should work on virtually any computer that runs some version of BASIC.

ALFRED A. FRESSOLA
Fairfield, CT

Listing 1: A *program to calculate magic-square solutions.*

```
  5 DIM A$(1)
 10 POKE 24578,38: CALL 17046
 20 INPUT "ENTER MAGIC-SQUARE NUMBER",MAGIC
 22 IF INT (MAGIC/3)< >MAGIC/3 THEN GOSUB 300
 30 MAGIC= - ABS ( INT (MAGIC))
 40 PRINT "MAGIC-SQUARE NUMBER IS ",-MAGIC
 50 PRINT : PRINT "CHOOSE LOWER MIDDLE BOX VALUE": INTPUT X8
 60 X8= ABS ( INT (X8))
 65 PRINT : PRINT "LOWER MIDDLE BOX = ";X8
 70 PRINT : PRINT "CHOOSE LOWER RIGHT-HAND BOX": INPUT "VALUE ",X9
 75 PRINT : PRINT "LOWER RIGHT-HAND BOX = ";X9
 90 X9= ABS ( INT X9))
110 X1=-X9-2*MAGIC/3
120 X2=-X8-2*MAGIC/3
130 X3=X8+X9+MAGIC/3
140 X4=X8+2*X9+2*MAGIC/3
150 X5=-MAGIC/3
160 X6=-X8-2*X9-4*MAGIC/3
170 X7=-X8-X9-MAGIC
200 PRINT : PRINT : PRINT "MAGIC-SQUARE BOX VALUES FOR A": PRINT
    "MAGIC- SQUARE VALUE OF ";-MAGIC;" ARE"
205 PRINT : PRINT
210 PRINT X1,X2,X3
220 PRINT X4,X5,X6
230 PRINT X7,X8,X9
250 END
300 PRINT : PRINT : PRINT "FOR A WHOLE NUMBER IN EACH BOX"
310 PRINT "YOU MUST ENTER A MAGIC VALUE"
320 PRINT "THAT IS EVENLY DIVISIBLE BY 3."
330 PRINT : PRINT "KEEP THE PRESENT VALUE ?"
340 INTPUT A$
350 IF A$="Y" THEN RETURN
360 GOTO 330
```

MODEM MISMATCH

Since I am in charge of a laboratory computer system I needed a modem link to my home to save me trips into town to fix small problems that could have easily been handled over the phone. Our system already had a Racal-Vadic Model VA3455 modem (300/1200 bps) installed on it for remote diagnostics by our software vendor so I figured that I would use it. I bought an Anchor Automation Mark XII 300/1200-bps modem and hooked it up to my Model 4P at home. I thought I was all set.

What I discovered was that the two modems would not lock into each other. After a couple of phone calls I was told by Anchor Automation that its modem first checks at 1200 bps and then at 300 bps if it hasn't detected a carrier and that Racal-Vadic performs just the opposite. The two units were both switching data rates so that they would never lock in!

It appears to me that there is some degree of nonstandardization in the modem industry that should be made known to others. Since modems are becoming cheaper, smarter, and more prolific, I am sure that others will also run into this problem. The problem would not exist if the remote were a single-speed unit, but the problem seems to arise when two automatic two-speed units trying to establish a link continously shift gears in opposite directions.

I would be interested if others have had this same problem and whether something can be done to remedy the situation.

T. TED SCHWANINGER

SUPER HYPER

Thank you for publishing Richard B. Leining's "Factoring with Hyper" (March, page 396). The enclosed program (listing 2) was derived entirely from his equation (11) and considers right triangles instead of rectangular hyperbolas. Loop 1 factors quickly and exactly those numbers that can be factored directly without overflow, and loop 2 shrinks the remaining number to trigonometric ratios (between 0 and 1) that can be manipulated without overflow and then enlarged. The program requires the same number of iterations (always fewer than $n/12$) but factors 94,815,109 three times as fast and factors numbers with almost twice as many digits. My program (I call it BIGFAC) can factor 99,876,225,023 on my 12-digit computer in the blink of an eye, but it takes more than half an hour to determine that 999,983 is prime. When I get a multitasking computer (perhaps the Hewlett-Packard Integral) I can run BIGFAC simultaneously with a program that can factor any 12-digit number in half an hour (see Jim Horn's "Fast Factoring on the HP-75C," *Computer Journal of PPC*, November/December 1982).

To convert this HP BASIC program to Microsoft BASIC, you need to know that HMS$ converts elapsed seconds into hours, minutes and seconds, ! equals REM, @ equals :, and DISP is similar to PRINT. On a 16-digit computer one would want to lengthen L to 16 digits in line 80 and L9 to 15 digits in line 90.

GORDON D. KIRCHHEVEL
Chicago, IL

(continued)

Richard Leining replies:
Bravo! You've reaffirmed the progress begotten by publication. You've beaten the size of the numbers being juggled from N²/4 in Hyper to N in BIGFAC. That triangular simplification was really slick. It wouldn't have occurred to me in a long time. My efforts to fit right triangles to the origin, foci, and differences of a hyperbola, in search of some kind of Pythagorean triple, led nowhere. I was still glued to that hyperbola, while you were free of it.

The use of upper or lower numbers was neat; I'm just learning them. I looked for some w,r analogy to the key numbers used to find Pythagorean triples and primitive hypotenuses, without finding any. After all, one side of your triangle is irrational, whereas Fermat and Euler were obsessed with integers.

Your scaling down of the problem is a clever way to get the most out of limited-precision software. In the long run, there is more growth potential in working with arrays of integers. Their running times are an incentive to eliminate trial values of ϕ (or w) with a minimum of arithmetic.

Listing 2: *The* BIGFAC *factoring program.*

```
10 ! BIGFAC: factoring program
20 ! derived from
30 ! Richard B. Leining's HYPER
40 ! BYTE, March 1985, p. 396
50 ! written in Hewlett-Packard enhanced BASIC
60 ! for the HP-85A computer
70 ! with Advanced Programming ROM.
80 ! LET L=999999999999 ! Largest integer (on 12-digit computer)
90 ! LET L9=99999999999 ! Largest N to integerize r accurately
100 DISP "Number to be factored";
110 INPUT N@ T=TIME ! T is the starting time.
120 IF N<4 THEN BEEP @ DISP "Number too small." @ GOTO 100
130 IF L9<N THEN BEEP @ DISP "Number too large." @ GOTO 100
140 IF N\2*2=N THEN DISP 2;N/2 @ GOTO 360 ! N\2 = INT(N/2).
150 LET S=SQR(N)
160 LET W=IP(S) ! (IP(S)=INT(S)
170 IF N MODE 4=1 AND W MOD 2=0 THEN LET W=W-1
180 IF N MOD 4=3 AND W MOD 2=1 THEN LET W=W-1
190 IF W<S THEN LET W=W+2
200 LET W9=(N\3+3)\2 @ LET W5=MIN(SQR(L),W9)
210 ! Loop 1
220 IF W>W5 THEN 260
230 R=SQR(W*W-N)
240 IF FP(R)=0 THEN DISP W+R;W-R @ W=L ! FP(R) = R-INT(R).
250 W=W+2 @ GOTO 210
260 ! Exit loop 1
270 LET I=10^LEN(VAL$(N))-1 ! I is an "integerizer" as long as N. VAL$ =
    STR$.
280 ! Loop 2
290 IF W>W9 THEN 340
300 C=S/W ! Cosine of a right triangle whose sides are w (hypotenuse), r, and
    square root to N
```

(continued)

IBM-Interference Solution

There I was, typing away on my IBM PC and churning out copies of the world's greatest program on my Epson FX-80, when I received a phone call from my landlady.

She called to ask if I was using a computer. When I told her I was, she replied that a television repairman was at her place to fix her TV, which was suffering from terrible reception. Seems she had been throwing away one "bad" TV after another, until she finally called the repairman, who told her there was nothing wrong with the sets, there was just some jerk in the area who was operating a personal computer.

At first, I didn't believe I was the jerk. I turned off my computer. "Hey, my TV is working OK now," came the startled cry from my landlady over the phone. I turned the computer back on. "Ack. It just went bad again," she said.

I *was* the jerk.

I confessed to the crime, turned off my computer, and sank into a deep depression. Visions of being drummed out of the neighborhood by the FCC danced through my head. Human nature being what it is, I began experimenting.

(continued)

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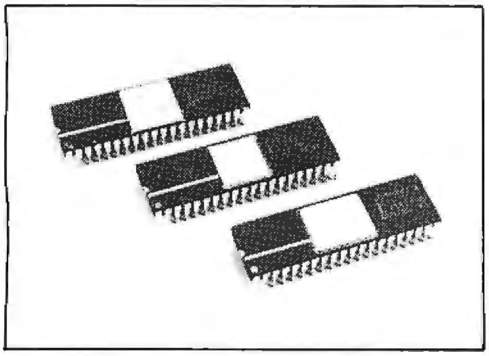

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[1]Requires RTOS or iRMX-86. All Intel compiler names and iRMX-86 TM Intel Corp.

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```
310 R=SQR(1-C*C)*W+I-I ! Converts cos to sin, solves for r and integerizes
     near-integer r's.
320 IF FP(R)=0 THEN GOSUB 390
330 W=W+2 @ GOTO 280
340 ! Exit loop 2
350 IF W<L+2 THEN DISP N;"is prime."
360 T2=TIME @ BEEP @ DISP HMS$((T2-T+86400) MOD 86400) @ DISP !
     Displays elapsed time.
370 STOP
380 ! Subroutine: Test product
390 BEEP @ P=W+R @ Q=W-R @ IF P*Q=N THEN DISP Q;P @ W=L
400 RETURN
410 END
```

It turned out that whenever I had the parallel printer cable connected to my computer, the interference was emitted. It didn't matter if the cable was connected to the printer, or if the printer was on. I was using an AST SixPak card as a parallel printer adapter, but I don't know if that had anything to do with the problem.

I called my dealer. He was out of town. His technical-support manager didn't know what to do but suggested I write to Washington for "a bulletin that gives hints." IBM told me to call my dealer. My friends told me to wrap the cable in several layers of aluminum foil (kept me off the streets for a night, but it didn't do a thing for the interference). I borrowed a shielded cable from work and tried it on my errant system. It didn't make an ohm of difference.

Then I saw a catalog from Moore Computer Supplies (Box 20, Wheeling, IL 60090), and there on page 31 was a picture of a cable that was like none other: "full tinned copper braid sleeve for highest degree of transmission shielding," a metal casing extending from the cable and onto the connectors "for total EMI/RFI protection," and a grounding lug!

Moore had a toll-free number for technical support, and it had Business Centers that stocked its equipment all over the country. There was one in San Diego, from which I ordered the cable. The cable that was sent had no grounding lug and didn't offer much improvement. I explained the problem to manager Gary Tuck, whom I found to be very helpful and courteous. He contacted the manufacturer, who said the cable was specially made for the IBM because of the very problem I was experiencing. Two days later, I had a new cable.

The cable made a remarkable difference. It cut out about 90 percent of the interference, and I trust the distance from my apartment to my neighbors' will take care of the rest.

BILL PARKER
Los Angeles, CA ■

a message to our subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

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NEW SYSTEMS

Talking Computer

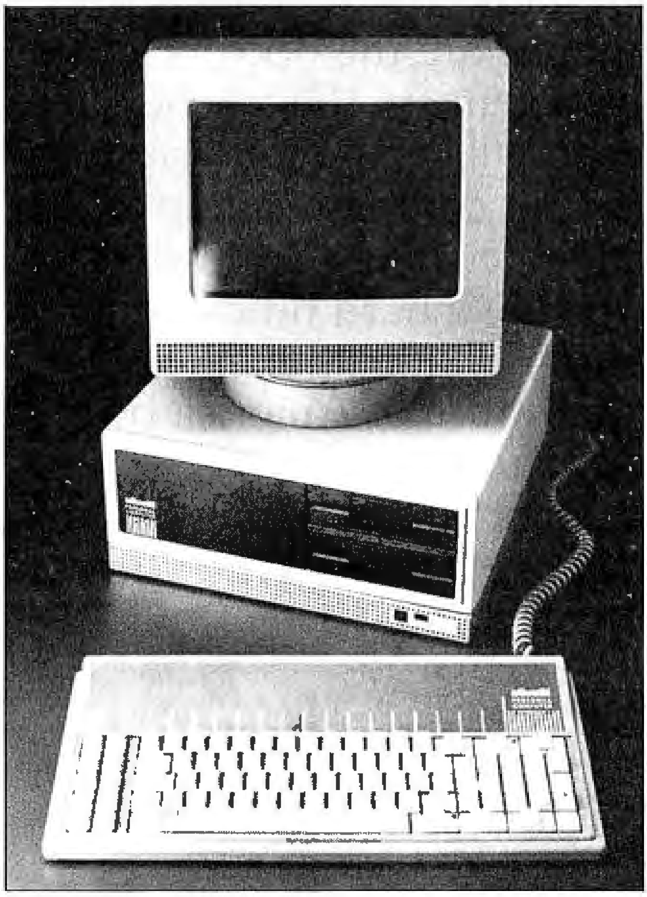
Computer Aids Corporation's Small Talk is a five-pound, battery-powered, talking computer. Small Talk is based on the Epson HX-20 notebook computer. The manufacturer uses the SSI-263 speech chip and a specially developed text-to-speech program to produce speech.

Small Talk contains a built-in dot-matrix printer and cassette storage. It has a speaker, a headphone jack, and two RS-232C serial ports for connecting external printers, modems, or braille devices.

A version of Computer Aids Corporation's Word-Talk word processor is built into Small Talk's firmware. Word-Talk vocalizes each key as it is pressed in a synthetic voice, and it provides spoken review of characters, words, lines, or entire documents.

Also in Small Talk's firmware are a scientific calculator and a clock/calendar. An optional terminal program is scheduled for release in the fall. Small Talk is completely programmable so the user can write her or his own BASIC programs.

With its carrying case and battery charger, Small Talk sells for under $2000. Contact Computer Aids Corp., 124 West Washington, Lower Arcade, Fort Wayne, IN 46802, (219) 422-2424.
Inquiry 620.



The Olivetti M24 IBM PC-*compatible.*

Olivetti M24 IBM PC-Compatible

Olivetti's M24 is an IBM PC-compatible personal computer that uses an 8-MHz 8086-2 processor and MS-DOS 2.11. Its standard features include 128K bytes of RAM (expandable to 640K bytes) on dual-disk models or 256K bytes of RAM (also expandable to 640K bytes) on hard-disk models, a 12-inch monitor with 640- by 400-pixel resolution, serial and parallel ports, a clock/calendar, a graphics card, and seven expansion slots.

You can choose your disk-drive configuration: two 360K-byte slim-line floppy-disk drives or one 360K-byte floppy disk and one 10-megabyte slim-line hard-disk drive. The 83-key keyboard has LED indicators and is detachable.

In its 128K-byte configuration with dual floppy-disk drives and monochrome monitor, the Olivetti M24 is priced at $2745. The same system with a color monitor is $3395. Contact Docutel/Olivetti Corp., 5615 Highpoint Dr., Irving, TX 75062, (214) 258-5400.
Inquiry 621.

IBM PC AT-Compatible Transportable

Corona Data Systems' Corona AT Transportable (ATP) computer is an MS-DOS machine that uses Intel's 80286 processor. It has a built-in color/monochrome video graphics card and can operate as a standalone system or a workstation for the IBM PC AT.

The Corona ATP runs at 6 MHz and supports the 80287 numeric coprocessor. It includes parallel printer and RS-232C serial ports and a built-in floppy-disk controller. The green-phosphor, 9-inch display has 640- by 400-pixel resolution. Three of the system's five expansion slots are AT-compatible; the remaining two are XT-compatible. The AT-style detachable keyboard features an IBM PC XT interface.

You can choose the ATP-6-QD or ATP-6-Q20 model of the Corona ATP. The ATP-6-QD has a 1.2-megabyte floppy-disk drive, a 360K-byte floppy-disk drive, and 512K bytes of RAM. The ATP-6-Q20 has a 20-megabyte Winchester drive, a 1.2-megabyte floppy drive, 512K bytes of RAM, and an AT-compatible hard-disk controller.

Suggested retail price for the ATP-6-QD is under $4500; the ATP-6-Q20 is priced under $5500. For more information, contact Corona Data Systems Inc., 275 East Hillcrest Dr., Thousand Oaks, CA 91360, (805) 495-5800.
Inquiry 622.

ADD-INS

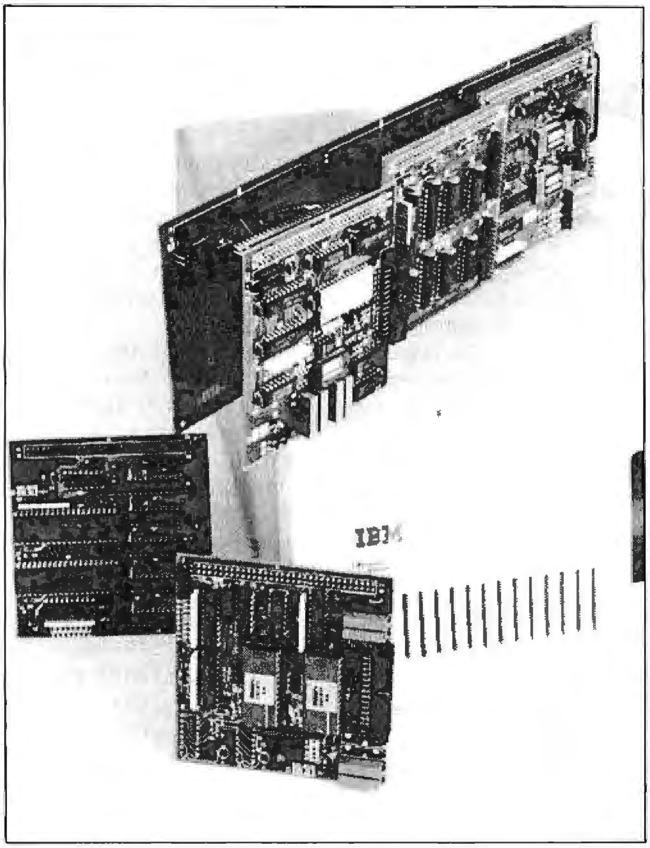
Instrument Modules for IBMs

PCI-20000 from Burr-Brown consists of a family of instrument modules and a bus-compatible carrier board for the IBM PC, PC XT, PC AT, or Compaq computer. The carrier board provides the computer interface, power supply, and intermodule communications, as well as inputs for three modules. An optional carrier configuration gives you 32 points of buffered, TTL-compatible, digital I/O.

The carrier bus is designed for data acquisition and measurement. It performs standard computer-bus functions and allows for chaining analog signals among the plug-in instruments. The bus lets sync and trigger signals pass among the modules.

Among the instrument modules available are a 16-channel, 12-bit accuracy, data-acquisition module; a data-acquisition expansion module; two types of analog-output modules; a digital-I/O module; and a counter/timer/pulse-generator module. Three different termination panels connect field signals to the PCI-20000 instrument modules.

Prices for the PCI-20000 system start at $295 each for carrier boards and $199 for each instrument module. Contact Burr-Brown Corp., POB 11400, Tucson, AZ 85734, (602) 746-1111.
Inquiry 623.



The PCI-20000 *instrument modules for* IBM-*compatibles.*

IBM PC AT Debugger

Atron's AT Probe is a hardware/software combination for the IBM PC AT that provides hardware-assisted debugging. The AT Probe intercepts signals to and from the processor and can trap and trace all occurrences in the system.

A 1-megabyte on-line symbol table, independent of PC AT memory, lets you debug large applications and facilitates source-level debugging. The AT Probe supports source-level (symbolic) debugging for the standard assembler and for high-level languages such as C, Pascal, and FORTRAN. Real-time trace lets you capture and store program execution to create a rolling window of the last 2048 memory cycles. Also, you can set breakpoints on reading or writing memory, on doing I/O, at instruction execution, or upon interrupts.

The AT Probe's performance and timing-analysis software lets you create a histogram to display where the program spends its time. You can profile execution of individual procedures and display a procedure-duration measurement or do program event-count analysis and display an event-count measurement.

The AT Probe lists for $2495. Contact Atron, 20665 Fourth St., Saratoga, CA 95070, (408) 741-5900.
Inquiry 624.

TanPak Expansion Board

The TanPak multifunction board is specifically designed to fit the Tandy 1000's 11-inch expansion slots. It contains DMA circuitry, a serial port, and a clock, as well as software to support its features.

The TanPak comes in 128K-, 256K-, and 512K-byte versions. You can also get 256K-byte upgrade kits for those versions with less than 512K bytes of memory.

The 128K-byte TanPak board costs $399. Contact Hard Drive Specialist, 16208 Hickory Knoll, Houston, TX 77059, (800) 231-6671; in Texas, (713) 480-6000.
Inquiry 625.

Apple IIe Multifunction Card

Street Electronics says it has combined the most common Apple IIe interfacing needs on its BusinessCard. It includes two serial interfaces, a clock/calendar with battery backup, and built-in high-resolution graphics and text-screen printing capabilities using pull-down menus.

By adding three buffer chips, you can give the BusinessCard a 16K- or 64K-byte print buffer. The 64K-byte version allows storage of up to 20 pages of text.

The BusinessCard has more than 60 commands for printing graphics and text. Graphics printing commands include windowing, zoom, rotate, and inverse. Among available text-formatting

(continued)

ADD-INS

features are setting margins, line and page length, page titles, and page numbers.

The BusinessCard is also available in a version for parallel printers. It sells for less than $200. Contact Street Electronics Corp., 1140 Mark Ave., Carpinteria, CA 93013, (805) 684-4593.
Inquiry 626.

Quadsprint

Quadram's Quadsprint board, which comes with a plug-in cable that connects to the 8088 socket on the IBM PC's system board, doubles the PC's processing speed.

Quadsprint has a 10-MHz 8086 microprocessor with 4K bytes of high-speed cache memory. Its installation does not affect existing system memory.

Retail price for Quadsprint is $645. Contact Quadram Corp., 4355 International Blvd., Norcross, GA 30093, (404) 923-6666.
Inquiry 627.

Intel IBM PC Memory Products

Intel's add-in boards let you expand IBM PC, XT, and AT system memory up to 8 megabytes. Software support for Above Board/PC and Above Board/AT includes Lotus's Symphony and 1-2-3 and Ashton-Tate's Framework. Four Above Board/PCs, each with a maximum of 2 megabytes, expand IBM PC and PC XT system memory up to 8 megabytes. Two Above Board/ATs, each with a maximum of 4 megabytes using piggyback memory, expand PC AT system memory up to 8 megabytes.

An operating system driver, Above Board's Expanded Memory Manager supervises the expanded memory and supports multiple applications. You can mix memory types on one board to accommodate memory requirements.

The Above Board products include RAM-disk and print-buffer capabilities. They offer menu-driven installation, memory diagnostics, and fault isolation.

Intel is selling Above Board products in conjunction with its 8087/80287 Math Coprocessors. Above Board/PC retails for $395 with 64K bytes and $595 with 256K bytes of memory. Above Board/AT is $595 with 128K bytes and $995 with 512K bytes. Above Board/AT with piggyback memory costs $295 with 128K bytes and $795 with 512K bytes. Contact Intel Corp., 5200 Northeast Elam Young Parkway, Mail Stop TOC-03, Hillsboro, OR 97124-6497, (503) 629-7354.
Inquiry 628.

MacMegabytes and RAMDISC

Beck-Tech's MacMegabytes memory-expansion board lets you have more than a megabyte of internal memory in your 128K- or 512K-byte Macintosh.

With the MacMegabytes hardware, Beck-Tech provides the RAMDISC software package, which includes slide-show utilities and access to an electronic disk for faster program and data access.

MacMegabytes conversions are priced at $849 for your 128K-byte Macintosh and $549 for a 512K-byte machine. You can purchase MacMegabytes as a kit for $699 if you have a 128K-byte Mac and $399 if you have 512K bytes. The RAMDISC software alone is $39.95. Contact Beck-Tech Co., 41 Tunnel Rd., Berkeley, CA 94705, (415) 548-4054.
Inquiry 629.

PERIPHERALS

Programmable Backup Subsystems

Sysgen's Smart Image and Smart QIC-File tape-backup systems can be programmed to automatically back up your hard-disk drive or selected files at predetermined times. You program these drives using a menu-driven utility program that lets you preselect the files to be backed up. Files specified may include subdirectories or only those files that have changed since the last backup. Files may be backed up twice daily.

Your computer will beep if in use when a backup is scheduled. Then you can either approve the action or put the backup on hold until you exit to the operating system. Utility programs verify that the proper files have been backed up. The same file can be stored in different tape sets, and data can be restored to different hard disks than were originally backed up.

The cassette-based Smart Image subsystem is $995. The Smart QIC-File, which uses the QIC-format cartridge, costs $1395 (internal) and $1495 (external). Contact Sysgen Inc., 47853 Warm Springs Blvd., Fremont, CA 94539, (415) 490-6770.
Inquiry 630.

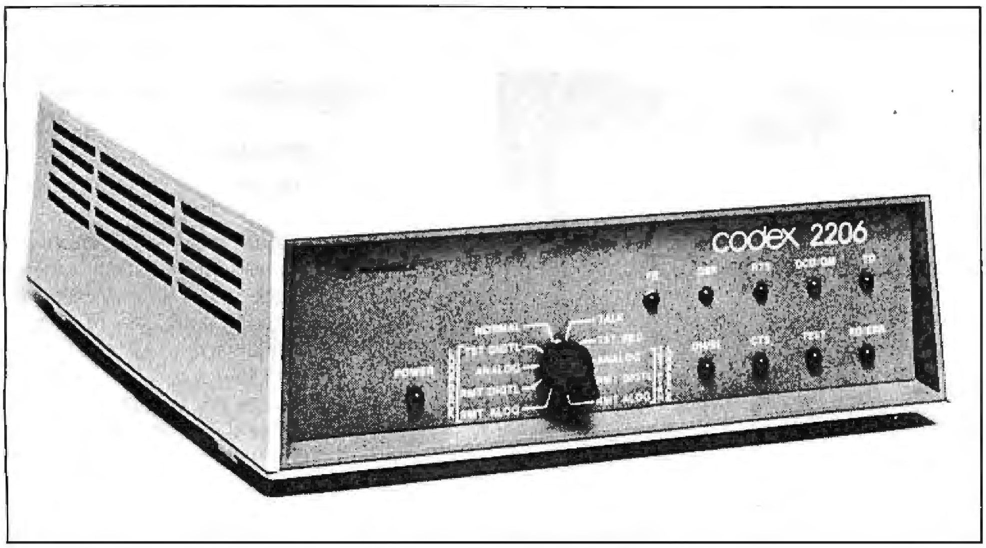
Memory-Card System

Dataser-Station encodes and reads pocket-size storage cards that are less sensitive to harsh environments than floppy disks. The station is compatible with any microprocessor that has a standard RS-232C interface.

The Datalok Memory Cards are configured in either 2K by 8 bits or 8K by 8 bits. The cards are hermetically sealed to exclude hydrocarbon solvents, dust, smoke, and chemical vapors. Electromagnetic field and electrostatic discharge do not affect the cards.

The Dataser-Station is $599.75. The 2K- by 8-bit card costs $85.95, while the 8K- by 8-bit card costs $226.80. The interface module lists for $376.25. Dataser-Station is manufactured by BI ELEC SA of Switzerland; information is available from the U.S. representative, Survivors Ltd., 4654 20th St. N, Arlington, VA 22207, (703) 528-1498.
Inquiry 631.

PERIPHERALS



The Codex 2206 modem transmits data at 4800, 7200, or 9600 bps.

9600-bps Modem

The Codex 2206 modem can transmit data at 9600 bps over dial or leased lines or at optional rates of 7200 or 4800 bps. It can operate in either two-wire half-duplex or four-wire full-duplex modes.

This microprocessor-based device uses a double-sided band, eight-phase, quadrature amplitude modulation (QAM) scheme. The QAM scheme's 1200-Hz digital adaptive equalizer with multiple settings improves output.

Currently available, the 2206 modem lists for $1995. Contact Codex Corp., 20 Cabot Blvd., Mansfield, MA 02048, (617) 364-2000.
Inquiry **632.**

Digital Copiers for IBM PCs

Two digital photocopiers from LaserFAX scan photographs, artwork, and text and digitize the captured image for use on an IBM PC XT, PC AT, or PC-compatible. The stored images can then be manipulated using graphics-editing software that is supplied with the copiers.

Scanning 200 lines per inch, the SpectraSCAN 200 copies 8½- by 14-inch color pages, while the DS-200 digitizes black-and-white images. Peripheral equipment ranging from dot-matrix to laser devices can print the digitized images.

The scanners are software-driven; you control operations through icon screens pulled down by a mouse. This screen looks like a standard photocopier control panel.

The machines contain vacant IBM slots for future applications. Current optional cards include the LaserFAXimile card for communications with facsimile machines and the TEXreader for direct scan-to-processing text reading.

The SpectraSCAN 200 costs $3995, and the DS-200 scanner lists for $2995. The LaserFAXimile card is $995, while the TEXreader costs $1200. Contact LaserFAX Inc., 2000 Palm St. S, Naples, FL 33962, (813) 775-2737.
Inquiry **633.**

Hard-Disk/Tape-Backup Subsystem

The PC Megastore 227 by Ampex Corporation gives you 20 megabytes of hard-disk storage and 25 megabytes of tape backup. This subsystem can be used with the IBM PC, XT, and compatibles and with the Apple II and IIe. Cards for the Macintosh, TRS-80, S-100 bus systems, and other systems will soon be available.

The tape backup has its own 64K-byte buffered memory, is directly addressable, and can function as the primary storage unit.

The PC Megastore 227 costs $3400; an adapter card is priced at $175. Available separately, 10- and 20-megabyte hard disks cost $1995 and $2395, respectively, and a 25-megabyte tape backup lists for $1995. Contact Ampex Corp., 10435 North Tantau Ave., Cupertino, CA 95014, (800) 421-6863; in California, (213) 640-0150.
Inquiry **634.**

19-inch Color Graphics Terminal

Amtron's CD1920 color monitor offers 150-MHz bandwidth, automatic vertical synchronization up to 180 MHz, and 0.31-mm dot pitch resolution resulting in a 1280- by 1024-pixel display. The terminal is said to work well with Artist and BMW graphics engines, but it must be adjusted to interface with the various boards' timing signals. The 19-inch screen is nested in a chassis of dimensions common for a 15-inch monitor. The terminal weighs 47 pounds.

The price for a single CD1920 ranges from $3800 to $4100, depending on options and on the host graphics system.

Contact Amtron Corp., 2260 De La Cruz Blvd., Santa Clara, CA 95050, (408) 748-8500.
Inquiry **635.**

Portable Disk Drive for Tandy Model 100

The Chipmunk portable disk drive allows Tandy Model 100 and 200 owners to store data on 3½-inch disks. Weighing in at 3½ pounds, the Chipmunk emulates the 100's "main menu" concept and appears

(continued)

PERIPHERALS

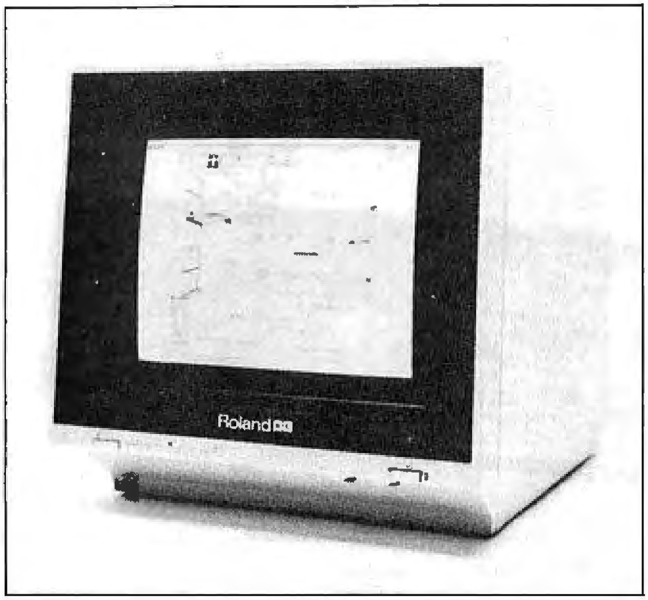
to the user as an extension of the computer's memory. The disk drive fits into the computer's 40-pin main bus and is controlled by CDOS—the Chipmunk Disk Operating System, which requires 5K bytes of the 100's RAM.

The drive lists for $599 and comes bundled with a telecommunications program and five other business programs. Contact Holmes Engineering/PCSG, 11035 Harry Hines Blvd. #207, Dallas, TX 75229, (214) 351-0564.
Inquiry 636.

Dot Matrix for IBM

Fujitsu America's DotMax Model 241 is a 24-wire dot-matrix printer that's compatible with IBM computers. The Model 241 emulates an IBM graphics printer for word processing and graphics, yet it can accept commands for the Epson FX-80 printer.

This printer features bit-mapped graphics, block character sets, and two



The MB-142 TTL black-and-white monitor.

graphics modes: an 8-bit image mode with 200- by 160-dot-per-inch resolution and a 24-bit image mode with 360 by 180 dpi. The DotMax 241 includes downloadable character fonts, cutsheet feeder commands, and such print options as underline and boldface.

The $1995 printer reaches speeds of 80 cps (letter quality) and 240 cps (draft quality). Dual serial and parallel interfaces are standard. Contact Fujitsu America Inc., 3055 Orchard Dr., San Jose, CA 95134, (408) 946-8777.
Inquiry 637.

Black-on-White Monitor

The MB-142 TTL monitor displays characters black-on-white or vice versa on command. The 14-inch display screen provides 720- by 350-dot resolution and creates characters somewhat larger than standard display. Text and graphics can be displayed simultaneously. The format is 80 columns by 25 lines.

The monitor plugs directly into the monochrome board of IBM and IBM-compatible computers. Text boards, including Persyst, STB, Paradise, Hercules, and AST, can be used. The MB-142 has a 25-MHz bandwidth.

The MB-142 is priced at $375. Contact Roland DG Corp., 7200 Dominion Circle, Los Angeles, CA 90040, (213) 685-5141.
Inquiry 638.

SOFTWARE • IBM PC

Matrix Laboratory

An integrated analysis program that specializes in matrix computations, PC-MATLAB combines graphics and data-manipulation capabilities to turn an IBM PC into a scientific and engineering workstation. It's suitable for such applications as numeric analysis, matrix theory, statistics, control theory, signal processing, geophysics, and other disciplines that employ matrix computation and linear algebra as tools.

The program accepts commands in standard mathematical notation for matrix operations. Eigenvalues and eigenvectors, fast Fourier transforms, digital filtering, linear-equation solution, singular-value decomposition, and matrix inversion are among its analytical capabilities. Graphics commands include linear, semilog, polar, and three-dimensional mesh surface plots.

Written in C, this program runs under MS-DOS 2.0 and higher on the PC, XT, AT, and compatibles with 256K bytes of memory and an 8087 coprocessor; an IBM color/graphics board is necessary if you want to use the graphics capabilities. PC-MATLAB costs $695. Contact The MathWorks Inc., 124 Foxwood Rd., Portola Valley, CA 94025, (415) 851-7217.
Inquiry 639.

Electronic-Design Package

The CT2000 CAE Design System, a program for designers of integrated circuits and printed-circuit boards, reportedly provides the functionality of a CAE (computer-aided engineering) workstation. Case Technology says its package should not be confused with schematic-entry and electronic CAD programs; the system includes a version of the SCALD tools developed in a mainframe environment at Lawrence Livermore National Laboratories.

CT2000 incorporates a structured graphics editor for schematic entry and design capture, a SCALD hardware compiler, a netlist postprocessor, a hardcopy postprocessor, a cross-reference generator, a firmware compiler, and component libraries.

According to Case, you

SOFTWARE • IBM PC

can easily create a hierarchical design database with the graphics editor. As you manipulate your design, the system automatically keeps track of all changes and maintains the database describing the state of the electrical circuit. You can create a schematic using your own guidelines and then use that same diagram as input to advanced design-analysis programs, such as a timing verifier and a logic simulator (both of which the vendor sells for $3500 each).

CT2000 runs on an IBM PC, XT, and AT. It costs $5200. Contact Case Technology Inc., Suite 250, 633 Menlo Ave., Menlo Park, CA 94025, (415) 322-4057.
Inquiry **640.**

Analytical Chemistry Software

Sim-Soft and Lab-Stat from Scientific Computing are software packages for use in analytical chemistry labs. Both programs run on an IBM PC or PC XT with at least 128K bytes of RAM.

Sim-Soft provides database management for lab samples and handles data storage, maintenance of data files, and status reports of samples. The package costs $895. (The company said versions for Apple and Hewlett-Packard computers will be available this summer.)

Lab-Stat is a statistical-analysis program that calculates standard deviation, relative standard deviation, percent error, average percent recovery, correlation coefficient, mean variance, and standard error of mean. It can be used as a standalone program or as a module of Sim-Soft. Lab-Stat is priced at $215, but if you buy Sim-Soft by September 15, Lab-Stat comes for free.

For more information, contact Scientific Computing Inc., 249 Jericho Rd., Essex Junction, VT 05452, (802) 899-2147.
Inquiry **641.**

APL Without an 8087

Running APL on a PC normally requires an 8087 (or 80287) math coprocessor, but the 8087 Eliminator from Fort's Software lets you run IBM's APL without the coprocessor by emulating its functions.

Two versions are available. The standard Eliminator works with the PCjr, PC, and PC XT and costs $49. The 8087 Eliminator/AT supports the PC AT and costs $75. Both programs have a 30-day money-back guarantee and are not copy-protected. Minimum requirements are IBM APL version 1.0, PC-DOS 2.0 or higher, and 128K bytes of RAM (although the vendor recommends 192K for all configurations except a PC with PC-DOS 2.x).

For more information, contact Fort's Software, Inquiries, POB 396, Manhattan, KS 66502.
Inquiry **642.**

PC XT Serial Communications

ISAC (Integrated Serial Asynchronous Communications) is a multilayered communications system written specifically for the PC XT and compatibles. The two top layers provide the commonly used functions of terminal emulation. ISAC can operate in its own smart mode or, with an option, emulate a DEC VT-100. It maintains a 10-page memory buffer to record data from the external host. You can selectively display the full contents of the buffer or write portions of it to disk without disturbing the serial link. ISAC can insert variable-length intercharacter and interline time delays and wait for a prompt from the host before transmitting each line.

The lower layers form what the vendor calls the SPM (Serial Port Manager), an assembly-language program that becomes an extension of DOS when you load it into memory. SPM provides an RS-232C/CCITT-style link between the PC and the outside world that's capable of running at up to 9600 bps. It's interrupt-driven, automatically buffers all data, and operates on either IBM serial port.

ISAC is priced at $140; the VT-100 emulator costs an extra $30; BASIC, FORTRAN, C, and Pascal interfaces to ISAC cost $25 each. Contact Akron Software Research and Development, 53 Hillside Ave., Toronto, Ontario M8V 1S7, Canada, (416) 251-1866.
Inquiry **643.**

Bulletin-Board Program

A bulletin-board program from Micro-Systems Software supports electronic mail and program- or data-file exchanges on PCs and compatibles. BBS-PC provides 16 separate sections, or sub-boards, four file-transfer protocols, and a terminal-mode feature that supports a second modem, COM port, and phone line to let you answer one modem and dial out on another.

BBS-PC, which can handle 1200 or 2400 bps, supports MODEM, XMODEM, MODEM7, and other protocols of the MODEM family, plus standard ASCII line- or block-transmission modes. A system can be partitioned into four sections: default drive or directory, with the system program, its master data file, and a user-log data file; message base; member files; and upload/download.

Other features include true message formatting, permanent user records, private messages, chat mode, and automatic reclamation of space when messages are deleted. The sysop has complete control over all sections and can implement 256 security levels.

BBS-PC runs on the PC, XT, and PCjr with 256K bytes of memory. Suggested retail price is $249. The vendor also offers applications software, including a word processor ($79.95), a smart-terminal communications package ($79.95), and a full-screen editor ($199). Contact Micro-Systems Software Inc., 4301-18 Oak Circle, Boca Raton, FL 33431, (305) 391-5077.
Inquiry **644.**

Plotting with the IBM and HP's Plotters

A graphics package developed for the IBM PC and Hewlett-Packard's HP 7470A and HP 7475A plotters, GRA-FIT is intended

(continued)

SOFTWARE • IBM PC

primarily for engineers and scientists. The program gives you control over the graph layout: pen selection, axis dimensions and labeling, titles, etc.

GRA-FIT is driven from a sequential command file that you create using EDLIN or another text editor. You can plot multiple curves on one graph and multiple graphs on one sheet of paper in horizontal or vertical format.

The package offers several methods for plotting. Data points can be plotted, points can be connected with straight lines or joined with a cubic spline, and data can be smoothed with piecewise polynomials prior to plotting. You can combine any number of these interpolation techniques on one graph or on one set of data.

GRA-FIT costs $95, is not copy-protected, and requires at least 128K bytes of memory, one disk drive, MS-DOS 1.1 or later, and an HP plotter. Contact Jayar Systems, POB 2885, Station A, Sudbury, Ontario P3A 5J3, Canada.
Inquiry 645.

Images and Text Over Ordinary Phone Lines

You can capture images with a video camera and transmit them to a remote IBM PC over ordinary telephone lines with PhotoMail, an icon-driven communications kit from Chorus Data Systems. Still-frame pictures of people, diagrams, and text can be sent at a resolution of up to 640 by 400 in 16 colors or levels of gray. Once an image is transmitted, you can save it on a disk or print it.

In addition to video images, the system can handle IBM 320 by 200 four-color graphic displays and screen displays generated by some applications programs. The communications icon supports the Hayes Smartmodem and compatibles as well as some 2400-bps units. Besides PC-to-PC communication with pictures, PhotoMail can format images to be used with electronic-mail services.

The complete PhotoMail kit is priced at $2495, which gets you a video digitizer, graphics display card, mouse, and software; the software by itself costs $795. PhotoMail runs on the PC, XT, AT, and compatibles. Contact Chorus Data Systems, 6 Continental Blvd., POB 370, Merrimack, NH 03054, (603) 424-2900.
Inquiry 646.

Speak Your Commands

With Pronounce, you can give instructions to your computer and enter data by speaking into a microphone. This speech-input system accepts vocabulary files of 128 words or short phrases. Each word or phrase can be associated with up to 255 keystrokes, thus letting you form a macro to fit your needs or standardize nonrelated programs under natural voice control.

When you say "memorize," Pronounce starts remembering the keystrokes you type. You then give these keystrokes a natural-language name and store them. Speaking the name into the microphone invokes them. At any time you can exit your application program, enter Pronounce, and add, modify, or retrain vocabulary words.

Pronounce costs $895 and consists of a circuit card, microphone, manual, and software. You'll need a PC, XT, AT, or true compatible with at least 256K bytes of memory. The vendor claims it works with most PC-DOS or MS-DOS applications. Contact MicroPhonics Technology Corp., Suite B, 234 Southwest 43rd St., Renton, WA 98057, (206) 251-9009.
Inquiry 647.

Package for Turbo Pascal Programmers

TurboPower Software has released a set of nine utilities for Turbo Pascal programmers. The package is designed to provide utilities usually found in a mainframe environment.

TurboPower Utilities includes a structure analyzer, execution timer, execution profiler, prettyprinter, command repeater, pattern replacer, difference finder, file finder, and directory. When practical, the utilities use MS-DOS path names and standard I/O facilities, the company said.

The package supports Turbo Pascal 2.0 and 3.0 and runs on the PC, XT, AT, and compatibles. An executable version that includes a manual costs $55; with full source code and a detailed programmer's manual, the price is $95. Contact TurboPower Software, Suite 196, 478 West Hamilton Ave., Campbell, CA 95008, (408) 378-3672.
Inquiry 648.

MIDI Sequencer/Editor

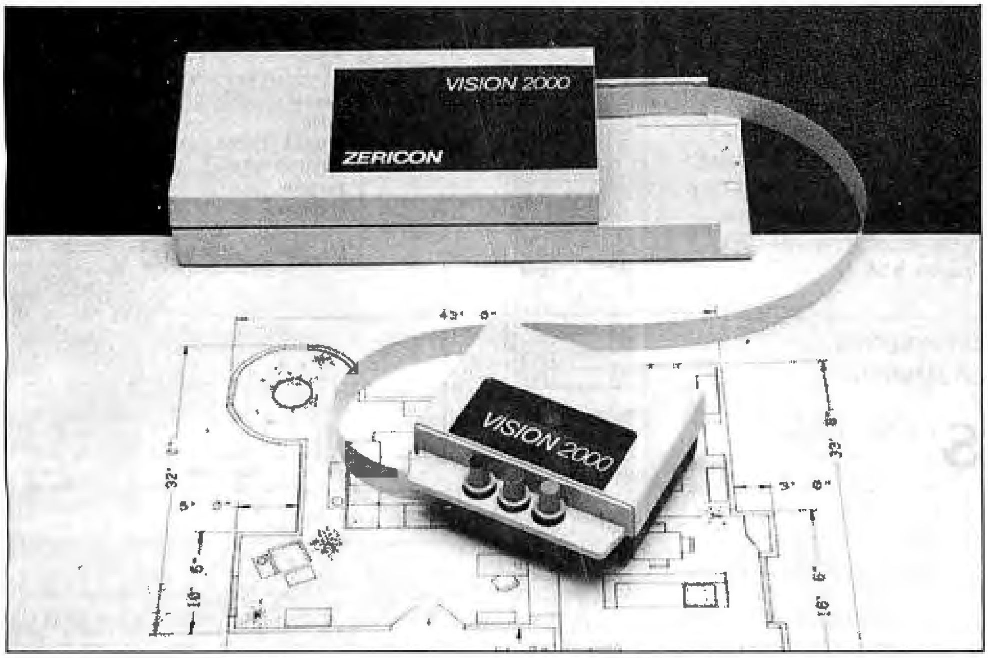
Octave Plateau's Sequencer Plus is designed to turn a PC into a 64-track MIDI recording and editing facility. The software records the control information from MIDI instruments (notes on and off, keystrike velocities, pitch bends, etc.) and stores them in memory. You can then use your PC to edit them and play them back through the instruments.

Among the program's features are full editing of all tracks (including independent per-track control of the MIDI channel); capacity to add to, copy, delete, and name individual tracks; automatic record of each track's bar length; full visual editing of all notes; recording and manipulation of MIDI program changes, both within a music track or as a separate control track; and playback quantizing that ranges from quarter notes down to 64th-note triplets.

You can control the time signature of each track, from $\frac{1}{2}$ to $\frac{32}{16}$, and mix time signatures within a track (or create polyrhythms between tracks). You can set the playback tempo from 16 to 255 beats per minute. With a 256K-byte system, you can store approximately 12,000 notes; a 640K-byte system can handle up to 60,000 notes. The program has 10 memory buffers.

Hardware requirements include a PC or compatible, Roland Corporation's MPU-401 MIDI processing unit and interface cables, and MIDI-equipped instruments. Sequencer Plus retails for $495. Contact Octave Plateau, 51 Main St., Yonkers, NY 10701, (914) 964-0225.
Inquiry 649.

SOFTWARE • APPLE



Zericon's two-dimensional drafting system, Vision 2000, *works with* Apple *and* IBM *computers.*

FORTH for the Macintosh

MasterForth 1.0, an implementation of FORTH for Apple's Macintosh, provides a 68000 macroassembler and supports the mouse, finder, menus, and graphics toolbox. With relocatable utilities and transient definitions, you can run substantial software packages even on a 128K Mac, the vendor said. The string package and resident debugger are regular features.

MasterForth 1.0 matches the FORTH-83 standard as described in *Mastering FORTH* by Anita Anderson and Martin Tracy (Bowie, MD: Brady Communications Co., 1984), a copy of which is included with the software.

MasterForth 1.0 is also available for the Apple II series, the IBM PC, the Commodore 64, and CP/M machines. You can write software on one system and run it on all the others.

The price of MasterForth 1.0 is $125. Optional extensions are available. Contact MicroMotion, 12077 Wilshire Blvd. #506, Los Angeles, CA 90025, (213) 821-4340.
Inquiry **650.**

Spectrum Analyzer

Zentech Systems' Data Analyzer is a hardware/software combination that converts your Macintosh into a spectrum analyzer. This package comprises a waveform digitizer that plugs into the Mac's modem port and control and analysis software.

Waveforms are displayed on the screen and can be manipulated, stored on disk, and subsequently transformed for analysis. Software control panels contain text, push buttons, and sliders to display and configure the parameters of the digitizer and to make such adjustments to the size, scaling, and viewing area of waveform windows. Waveforms can be transformed through functions such as FFT, IFFT, and convolution.

Suggested retail price of the Data Analyzer is $1499. Contact Zentech Systems Corp., 2226 West 12th Ave., Vancouver, British Columbia V6K 2N5, Canada, (604) 736-9764.
Inquiry **651.**

Tool for Drawing Circuit Boards

McCad is a package for drawing circuit boards on a Macintosh with either a mouse or a graphics tablet. The system supports six layers and comes with utility functions. You can design printed-circuit boards up to 30 by 30 inches.

The program outputs each layer individually in addition to a composite check-print. For output, you can use an Apple Imagewriter, Apple Laser Printer, or an ink plotter.

McCad runs on a Mac or Lisa. It costs $395. Contact VAMP Inc., POB 411, Los Angeles, CA 90028, (213) 466-5533.
Inquiry **652.**

CAD Drafting Package

A two-dimensional drafting system for Apple and IBM computers, Vision 2000 consists of a graphics touch-tablet and CAD software with automatic dimensioning capabilities for $495. An optional robotic pen plotter, which works with paper sizes up to 24 by 36 inches, is an additional $395.

Vision 2000 can be used to produce just about any kind of drawing, the vendor said, such as architectural, mechanical, and technical. Other applications include electrical schematics, circuit-board layouts, flowcharts, and interior designs.

With the tablet, you select screen commands and position the drawing cursor. You can create graphics to 14 decimal places of accuracy

(continued)

SOFTWARE • APPLE

on the PC and 6 decimal places on the Apple II. Commands are menu-selectable and a pop-up keypad handles numeric input.

Among its other features are multiple metric and English database units in fractions or decimals, 256 registered overlays, floating-point database structure, and relative and local coordinate systems. The system incorporates a device-independent software module that supports most popular pen plotters and graphics-input devices. Contact Zericon, Suite 416, 655 John Muir Dr., San Francisco, CA 94132, (415) 585-9329.
Inquiry 653.

Electrical Engineering with Mac

MacEngineer—Electric Engineering for the Macintosh contains formulas for the most frequently used calculations in such areas as lighting, motors, transformers, and direct current. You select a formula in one of these categories, enter the variables, and the software calculates and displays the result. Using the Mac's graphics capabilities, the program also prepares *x,y* and line graphs.

Formulas for lighting include room ratio, ceiling cavity ratio, and number of lamps needed. Some of the motor formulas are motor horsepower, full-load torque, and energy required for inertia. Among the formulas for transformers are number of turns/secondary winder, rated primary current, and secondary winding current. Direct-current formulas cover condensor capacitance and condensor requirements.

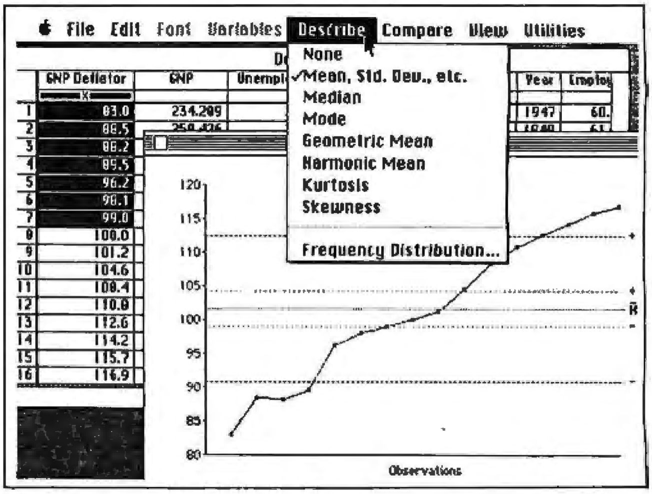
The price is $99.95. For more information, contact Superex Business Software, 151 Ludlow St., Yonkers, NY 10705, (800) 862-8800; in New York, (914) 964-5200.
Inquiry 654.

Interactive Statistics

StatView is a technical utility designed for data analysis. While keeping data on the screen, the package lets you use the Macintosh mouse to select data for analysis and choose the type of analysis from a pull-down menu. Results appear in another window, which changes as modifications are made to the data. In a window next to the data screen you can have tables, charts, scattergrams, or other graphic representations.

The types of evaluation possible with StatView include descriptive statistics, comparative statistics, and nonparametric tests. The program's descriptive capability encompasses harmonic and geometric mean, standard deviation and error, variance, median, and frequency distribution. All calculations are done with 80-bit precision using IEEE floating-point mathematics.

StatView is for use on all



A screen dump of Brainpower's StatView.

Macs and the 1-megabyte Lisa equipped with MacWorks. Suggested retail price is $199.95. Contact Brainpower Inc., 24009 Ventura Blvd., Calabasas, CA 91302, (818) 884-6911.
Inquiry 655.

Electronic Music Applications

Computers and Music has released several products for making music with Apples and synthesizers.

The Analyzer/Interpolator is a software/hardware system for the IIe that can digitally record a sound, analyze its harmonic content, plot the sound's amplitude envelope, and show the sampled sound-wave cycles on the screen. In addition, it lets you create a wave from a sampled sound that's compatible with systems from Syntauri, Passport Designs, and Mountain Music. It costs $100 and requires the Decillionix DX-1 Apple sampling board.

The MIDI Librarian software offloads either individual presets or banks of presets from the synthesizer into computer memory. You can then name, save, and retransmit the presets to the synthesizer. Also, you can reassign individual sounds from one bank to another. The MIDI Librarian is also available for the IBM PC. Both versions are $49.95. It supports the Yamaha DX-7, Roland Juno 106, Oberheim OB-8, and Casio CZ 101 and 1000.

The Apple IIe MIDI Development System contains one MIDI board (compatible with Passport, Yamaha, and Korg) and documented source code for sending and receiving MIDI bytes. Appropriate addresses are indicated, and a short program that displays MIDI bytes from any device that sends MIDI data is included. Board and software cost $125; software alone is $25.

For more information, contact Computers and Music, 1989 Junipero Serra Blvd., Daly City, CA 94014, (415) 994-2909.
Inquiry 656.

SOFTWARE • OTHER COMPUTERS

Window Controller for TRS

The PRO-NTO window-controller and applications-manager package runs on the TRS-80 Models 4/4P, II/12/16, or the Lobo MAX-80.

PRO-NTO's Window function supports four nested overlay windows that can be used directly from BASIC, C, FORTRAN, Pascal, and other languages by simple file I/O statements. Window sizes range from 1 by 1 to an 80 by 24 format screen. Other functions are character PEEK/POKE, cursor positioning, image transfer, and import/export between windows.

The application manager includes address mailing label and rotating index file, appointment scheduler, calculator, card filer and notepad, telephone list, and auto-dialer.

PRO-NTO lists for $49.95. Contact MISOSYS Inc., POB 239, Sterling, VA 22170, (703) 450-4181.
Inquiry 657.

Local-Area Network for Tandy Computers

ViaNet software and ARCnet hardware link Tandy computers running MS-DOS into a local-area network (LAN). ViaNet is an off-the-shelf LAN software system with a distributed architecture and thus does not require a dedicated file server.

Each computer on the network receives a board but also must have 128K bytes of its RAM dedicated to the network. Transparent to the user, ViaNet is logically structured and possesses a set of 11 simple commands.

The hardware/software package for each computer costs $499.95. Contact Tandy Corp./Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-2728.
Inquiry 658.

Modula-2 Language for Z80 CP/M

Hochstrasser Computing's Modula-2 System for Z80 CP/M-based computers consists of a compiler, a linker, utility programs, and a library of utility modules. The resulting Z80 code, which can be embedded in ROM, is said to be fast, small, and reentrant. Chaining and shared data between several programs are supported.

The entire system costs approximately $150, which covers any royalty fees for programs developed by using this system. Contact Hochstrasser Computing AG, Leonhardshalde 21, CH-8001 Zürich, Switzerland; tel: 01/47 55 48.
Inquiry 659.

Expert System and C Compiler

XPER and Super C systems from Abacus Software are said to offer advanced programming capabilities for the Commodore 64 and 128 computers.

XPER is an expert system that lets you build databases according to your own decision framework. Later, the system guides you through a series of searching techniques.

The Super C Language Compiler is a development system that supports the Kernighan & Ritchie C-language standard. The editor handles source-code files up to 41K bytes in length. The compiler produces 6510 machine code.

XPER costs $80, while the Super C compiler lists for $60. Contact Abacus Software Inc., POB 7211, Grand Rapids, MI 49510, (616) 241-5510.
Inquiry 660.

Pocket References for UNIX and C

Four versions of the *UNIX Command Summary* booklet are available from Specialized Systems Consultants: the 32-page System III booklet, the 48-page BSD version, the 48-page System V reference, and the 32-page XENIX edition.

Other resources include the *VI Reference*, a comprehensive guide to Berkeley's visual editor on an 8-sided card; a 16-page *C Library Reference* that includes all library functions; a *C Reference Card* for programmers without access to library functions; and the *Fortran 77 Reference* on a 10-sided card.

Prices range from $2.50 for individual cards to $4 for the booklets in 100-piece quantities. Contact Specialized Systems Consultants, POB 7, Northgate Station, Seattle, WA 98125, (206) 367-8649.
Inquiry 661.

LISP on UNIX

UniLISP is fully compatible with Common LISP and is suitable for developing expert systems. Its kernel requires 32K bytes of memory on most UNIX machines, so you can use it for building interpretive filters, knowledge networks, and natural-language front ends.

UniLISP offers a segmented object list called OBLIST and optional math, statistical, and graphic add-on object lists for expert-system development. It also features standard UNIX I/O support, support for UNIX operating systems calls, physical memory access, and such editing features as vi. UniLISP has arithmetic primitives, the ability to link and unlink files or pipes, and concurrent communications.

UniLISP runs on the DEC Pro 300 series and IBM PC AT machines. Ports to other computers are in the works. Pricing was not available at press time, but a company spokesperson estimated that the end-user price will be less than $1000 when UniLISP ships at the end of August. A demonstration disk is $30. Contact r/l group, 7623 Leviston St., El Cerrito, CA 94530, (415) 527-1438.
Inquiry 662.

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, POB 372, Hancock, NH 03449.

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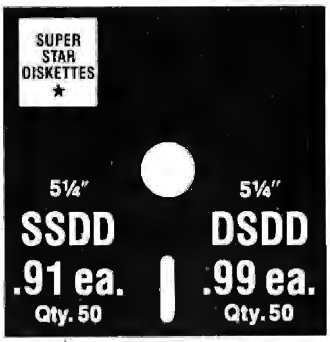

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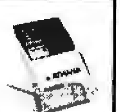

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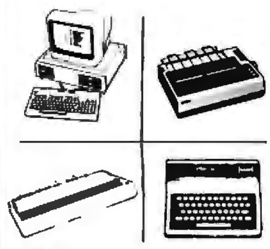

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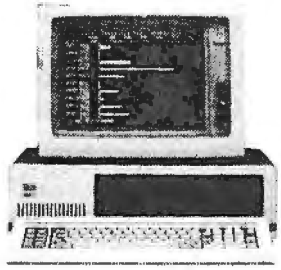

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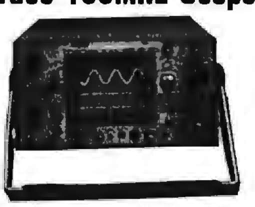

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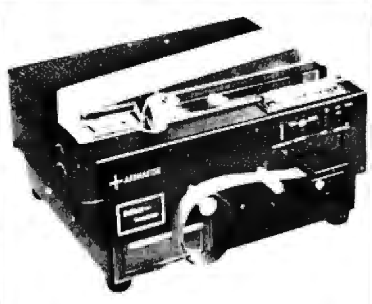

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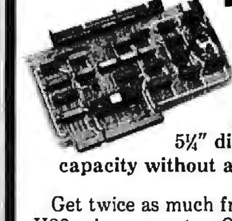

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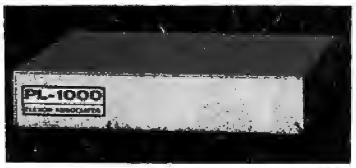

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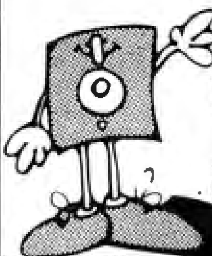

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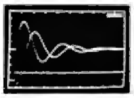

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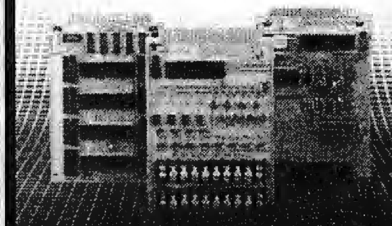

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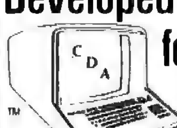

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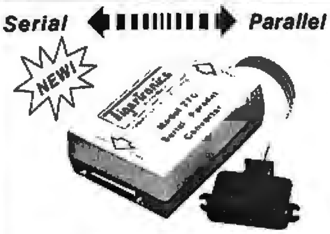

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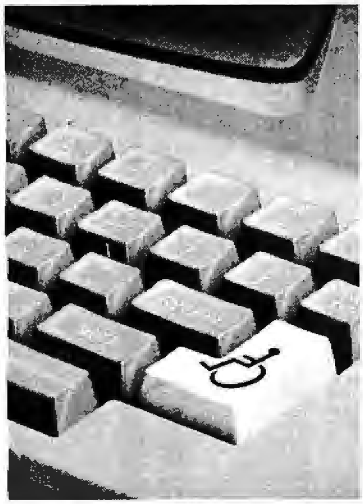

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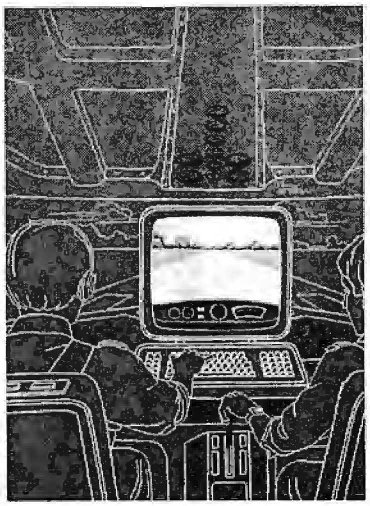

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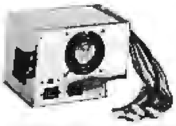

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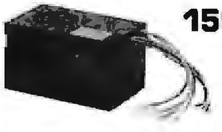

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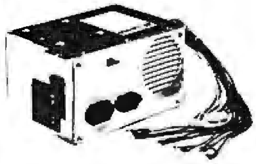

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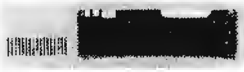

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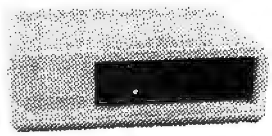

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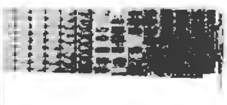

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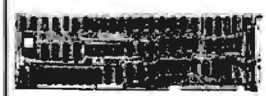

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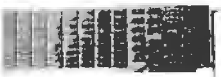

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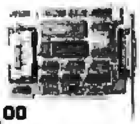

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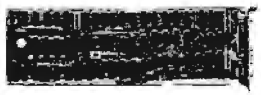

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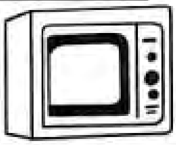

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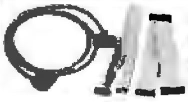

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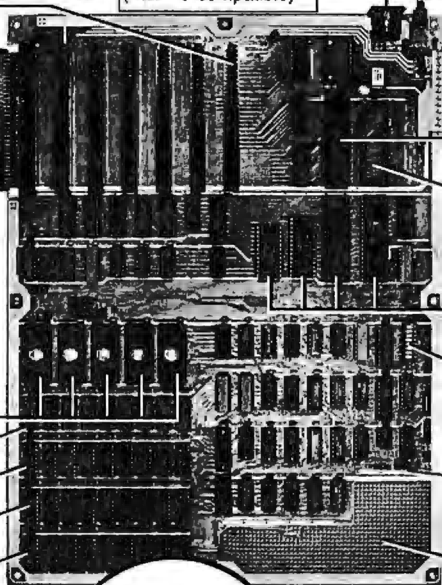

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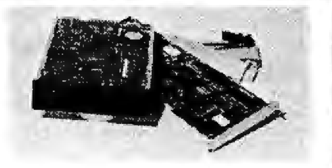

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At This Price, Supply Is Limited.
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PC UPGRADE SPECIAL
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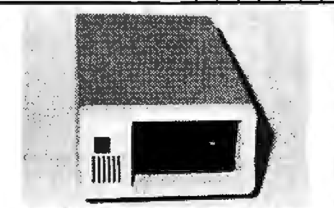

5 Mb EXTERNAL
Sharp IBM Look-a-like w/controller for IBM PC.
Sub-System Price: **$429.00**
Internal w/controller
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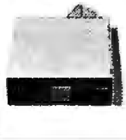
DELUXE JOYSTICK
$11.95

Compatible w/Atari 2600, 400, 800, VIC-20/64 and Apple. Requires optional cable adapter. Add **$1.50**

APPLE DISK DRIVE
$115.00



High quality ½ high drive for Apple II, II+, IIe or IIc. Apple IIc requires optional cable adapter. Add **$10.00**

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IBM PC, XT, AT (Several Configurations Available)............$Call
IBM PC with 10 Mb Hard Disk, 256K, 360K Disk Drive.......2169
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All AST Boards come with 1 year warranty
SixPakPlus w/64K Upgradeable to 384K, Now includes a FREE! copy of Borland's SIDEKICK (copiable) S, P, C 245
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I/O Plus II with Serial and Clock Calendar (parallel, game or second serial port optional) 127
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Advantage w/128K (Up to 3Mb) S, P, for AT........................399
Advantage w/3Mb 1675
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AST-5251-12 519
AST-3780 579
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All Intel Boards come with 5 year warranty. Intel Boards are compatible with Lotus/Symphony Bank switching Std.
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Graphics Card with Parallel port...305
Color Card with Parallel port..164

EPSON

ACP has the best prices on the new Epson Plus series with the NLQ option. All Epson printers have graphics capability. We stock the RX-100, FX-80+, FX-100+, JX-80 Color, LQ-1500, Spectrum LX-80 (Includes NLQ option) ....$Call
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Quadchrome II 14" Hi-Res Color Monitor...............................445

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HX-12E 690x240 Color Monitor..539
HX-12 690x240 Color Monitor..449
SR-12 720x480 Color Monitor..619
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TAXAN

Taxan 440 Ultra Hi-Res 720x400 (req. Bob Board) 579
Special Offer Taxan 440 plus Bob Board 995
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Taxan 415 (640x260 Acorn lable but a steal while supply lasts!) This monitor was sold for 699. Req cable to IBM ($18).....299

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Shugart SA450 DS/DD..79
Shugart SA350 3½"...250
IBM PC Compatible ½ High or Full SS/DD Drive....................49

	Qty 1	Qty 2-5
Teac 55B IBM PC type DS/DD (48tpi)	95	92
Tandon TM-100-2 Std. Hight IBM Style DS/DD	99	97

FLOPPY DISK DRIVES - Cont.

Shugart SA455 IBM Style DS/DD	99	97
Shugart 801R 8" SS/DD Supply Limited	249	239
Shugart 851R 8" DS/DD Supply Limited	449	435
Tandon TM-848-1E 8" SS/DD Thinline	269	259
Tandon TM-848-2E 8" DS/DD Thinline	369	349

Call us for your volume disk drive requirements. We are direct importers on several name brands.

ACP maintains full testing and alignment capability. If you are having problems with your drives, give us a call.

APPLE FLOPPY COMPATIBLE DRIVES

Apple II, II+, IIe Compatible Drive (½ Hight only) $115
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HARD DISK DRIVES

Shugart SA604 5Mb Seagate ST506 Compatible......................99
Shugart SA712 10Mb ½ Ht. Low Power. (Supply Limited) ...249
Miniscribe 3012 10Mb ½ Hight...275
CMI Call for 10, 22, 33Mb Drives ....$Call
Seagate ST212 10Mb 299
Quantum 42Mb 1375
Winchester Controller Same hard disk controller as used by IBM. Please specify your drive and we will supply with proper firmware. Firmware currently in stock for over 25 different drives. Comes with 1 year warranty 195

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5Mb Internal w/controller. (for PC req. added power............299
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TAPE CARTRIDGE BACK-UP

Excell 4500 PC Internal with 45Mb. This is the top selling tape back-up for the PC. It uses the Wangtek Tape Cartridge with controller. We are always back-ordered on this popular product 999
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Excell 4500 XT 1099

IBM PC HARDWARE KEY VALUES

ACP Multifunction 384K w/0K plus all the same function and features as the SixPakPlus 160
ACP Color Card139
ACP Monocard 139
ACP Floppy Card..99
PC Style Chassis (IBM Style chassis).......................................99
PC 130 Watt Power Supply (Drops right in)..........................119
IBM Style Monitor (Green w/TTL input) priced right............119
IBM PC 256K RAM Card w/64K ......69.95   w/256K 99.95

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Grappler+ (Most popular Printer Interface at new price).......88
Buffered Grappler from Orange Micro...................................165
Serial Grappler (Works great w/Immagewriter) 119
ACP 16K Buffered Serial Card 95
ACP 80 Column Card (Super in Apple II, II+) 69
Kennsinton System Saver (Preferred Apple Cooler)...............69
ACP System Cooling Fan (Similar to sys saver)......................30
Apple IIe Keyboard (Replacement keyboard for IIe) 30
Apple II/IIe Power Supply (Compatible to Apple) 60
Apple II, II+, IIe Disk Controller (Compatible).......................40
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ECHO II Speech Synthesizer (Best for II, II+, IIe) 99
Titan Ramcard 199
Titan Accelerator Card..299
ACP Extended 80 Column w/64K (for Apple IIe)...................99

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We stock a complete line of Apple and IBM Software titles all at discount prices. Call our sales desk for the current low price for your software needs.
Flashcalc (Super spreadsheet formerly Visicalc APII) 79
Wordstar (for IBM)...229
Supercalc I (Closeout on original IBM version) 20

Advanced Computer

California Digital

17700 Figueroa Street • Carson, California 90248

F10 DAISY WHEEL PRINTER

$499

LETTER QUALITY

The TEC F-10 Daisy Wheel printer is the perfect answer to a reasonablly priced 40 character word processing printer. While this printer is " extremely" similar to C.Itoh's F-10/40 Starwriter printer. Legal counsel for the C.Itoh Company have advised us that we should refrain from referring to the TEC printer as a Starwriter.

This 40 character per second printer auto installs with Wordstar and Perfect Writer. Features extensive built-in word processing functions that allow easy adaptability and reduced software complexity. Industry standard Centronics interface provides instant compatibility with all computers equiped with a parallel printer port. The TEC F-10 accepts paper up to 15 inches in width.

These printers were originally priced to sell at over $1400. Through a special arrangment California Digital has purchase these units from a major computer manufacturer and is offering these printers at a fraction of their original cost.

Options available include tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

10 MEGABYTE WINCHESTER SPECIAL

California Digital has recently purchased several thousand 10 Megabyte Winchester disk drives. The manufacturer has asked us not to advertise their name. Please telephone for details

$319

$119

Your Choice

TEAC 55B 55F 48TPI·96TPI

	One	Two	Ten
Five Inch Double Sided Drives			
TEAC FD55B half height	119	115	109
TEAC FD55F 96 TPI, half ht.	119	115	109
CONTROL DATA 9409 PC	169	159	155
SHUGART SA455 Half Height	119	115	109
SHUGART SA465 ½ Ht. 96TPI	119	115	109
TANDON 100-2 full height	149	145	139
TANDON 101-4 96TPI full ht.	299	289	279
MITSUBISHI 4851 halfheight	139	135	129
MITSUBISHI 4853 96/TPI½ Ht.	155	149	139
MITSUBISHI 4854 8" elec.	295	285	275
QUME 142 half height	219	205	199
Eight Inch Single Sided Drives			
SHUGART 801R			
SIEMENS FDD 100-8	119	115	109
TANDON 848E-1 Half Height	369	359	349
Eight Inch Double Sided Drives			
SHUGART SA851R	495	485	475
QUME 842 "QUME TRACK 8"	319	319	313
TANDON 848E-2 Half Height	459	447	435
REMEX RFD-4000	219	219	209
MITSUBISHI M2896-63 ½ Ht.	459	449	409

MEMORY

4164 DYNAMIC MEMORY 150ns

$1.35

Quantity 100

DYNAMIC MEMORY

		1-31	32 +	100 +
4164150ns. 64K 128 refresh	ICM-4164150	2.29	1.99	1.35
41256150ns.256K	ICM-41256150	8.95	8.50	7.25
4116 150ns.16K	ICM-4116150	1.75	1.65	1.45
4116 200ns.16K	ICM-4116200	1.75	1.65	1.45
4128 for IBM/AT	ICM-4128150	8.95	8.75	8.35
DP8409dynamiccontroller	ICT-8409	39.00	35.00	29.00
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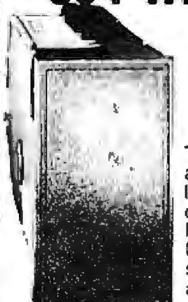
21L02 200ns. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02 450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns. 2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	3.95	3.85	3.70
6116 P3150ns. 2K x 8	ICM-6116150	4.55	4.35	4.15
EPROMS				
2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.50	4.25	3.97
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
2764 350ns. 8K x 8	ICE-2764	5.95	5.75	6.25
27128 350ns. 16K x 8	ICE-27128	7.95	7.35	6.95

Shugart

604 WINCHESTER

$99



These 6.7 Megabyte drives are new units recently released by the Shugart division of Xerox. The Shugart 604 is fully 506 industry compatible. Each drive is tested before shipment and is supplied with a 90 day warranty. SHU-604

Five Inch Winchester Hard Disk Drives

FUJITSU M2235AS	27 Meg.	899	859
RODIME RO-208	53 Meg.	1589	1493
MAXTOR XT10140	140 Meg.	3895	3785
SHUGART 712	13 Meg. ½ Ht	495	465
SHUGART 604	6.7 Meg.	99	89
TANDON 502	10 Meg.	419	395
TANDON 503	19 Meg.	695	675
SEAGATE 225	25 Meg.	695	625

VISA

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. • COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.

master charge

California Digital

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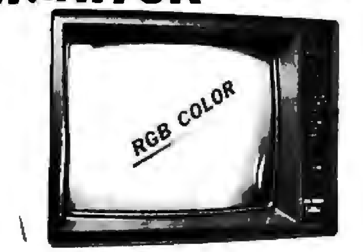
NEC RGB COLOR MONITOR $259



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.
These monitors are currently being used in applications far more critical than microcomputers.
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 prime "new" RGB monitors at a fraction of their original cost. Sanyo compatible NEC-1401/S; IBM/P/C Computer compatible NEC-1401/PC

MONITORS

BMC 12A green phosphor 15 MHz composit video	BMC-12A	78.95
BMC 12" high resolution, 20MHz	BMC-12EN	119.00
Amdek 300G 12" green phosphor	AMK-300G	128 95
Amdek 300A 12" amber phos., hi-resolution	AMK-300A	138 95
Amdek 310A designed for IBM/PC, amber	AMK-310A	158.95
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	89.95
Zenith ZVM 123 green phosphor 12" 40/80 column switch	ZTH-Z123	89 95
NEC JB1201 green phosphor 18 MHz. composit video.	NEC-JB1201	159.00
NEC JB1260 commercial grade composit	NEC-JB1260	119.00
Conrac 9" open frame requires horz sync & 12v. supply.	CON-BW9	59.00

COLOR

NEC JC1401D Medium/High 13" RGB	NEC-1401/X	259.00
BMC AU9191U Color composit video with sound	BMC-9191	238 95
BMC 9191M RGB designed for use with the IBM computer.	BMC-9191M	379.00
NEC JC1203DM, RGB color monitor	NEC-1203	699.00
NEC JC1215 color composit.	NEC-JC1215	339 00
Zenith ZVM135 RGB & composite suitable for IBM PC	ZTH-Z135	475 00
Amdek Color I, 13" composit video	AMK-100	299 00
Amdek Color II+, 13" RGB hi-resolution	AMK-200	419.95
Amdek Color III+, 13" RGB, medium resolution	AMK-300	359.95
Princeton HX-12 RGB IBM/PC compatible	PRN-HX12	478.95

PRINTERS

MATRIX PRINTERS

Star Gemini-10X 120 char/sec	STR-G10X	249.00
Star Gemini-15X. 100 char./sec. 15" paper.	STR-G15X	365.00
Star Gemini Delta 10, 160 Char/sec	STR-D10	359.00
Toshiba P1351, 192 char/sec letter quality	TOS-1351	1495.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	299 00
Okidata 92A parallel interface, 160 char/sec	OKI-92A	379.00
Okidata 83A & parallel 15" paper	OKI-83A	549.00
Okidata 84A & parallel 15" paper	OKI-84A	92900
Epson LX-80 10" 120 Char/sec	EPS-LX80	239.00
Epson FX80FT, 10" 160 char./sec with graphtrax	EPS-FX80	399.00
Epson FX100FT 15" 160 char./sec with graphtrax	EPS-FX100	599.00
Epson LQ1500, 15" corespondence quality	EPS-LQ1500	1079.00
Epson JX80 Color printer	EPS-JX80	579 00
Prowriter 8510 parallel 9½" paper	PRO-8510P	329.00
Prowriter II, parallel 15" paper, graphics	PRO-2P	599.00
Dataproducts B-600-3, band printer 600 LPM	DPS-B600	6985 00
Printronix P300 high speed printer 300 lines per minute.	PTX-P300	3995 00
Printronix P600 ultra high speed 600 lines per minute	PTX-P600	5795.00

WORD PROCESSING PRINTERS

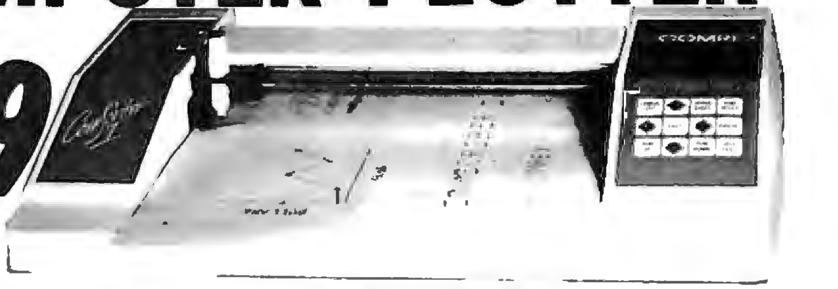
Starwriter F10 parallel, 40char/sec.	PRO-F10P	499 00
NEC8810 55 char/second, serial interface	NEC-8810	1659 00
NEC8830 55char/sec, par'l interface	NEC-8830	1659 00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599.00
NEC2050 designed for IBM/PC 20 char/sec. par'l.	NEC-2050	689.00
Silver Reed EXP500. 14 char/sec par'l interface	SRD-EXP500	319 00
Silver Reed EXP550 17 Char/sec par'l interface	SRD-EXP550	42900
Diablo 630 40 char/sec serial	DBL-630	1569 00
Diablo 620, proportional spacing, horz.& vert tab. 20 cps	OBL-620	76900
Juki 6100, 18 char./sec	JUK-6100	39900
Juki 6300, 40 char./sec	JUK-6300	699 00
Comrex CR2, 5k buffer, proportional spacing, par'l.	CRX-CR2P	395.00

TERMINALS

Freedom 100, split screen, detatchable keyboard	LIB-F100	495 00
Qume 102 green phosphor terminal	QUM-102	539.00
Ampex Dialogue 125 green screen,	APX-D125G	675 00
Ampex Dialouge 175 amber screen, two page, func. keys	APX-D175A	719.00
Wyse 50, 14" green phosphor	WYS-50	595.00
Wyse 300, Eight color display, split screen	WYS-300	1159.00
Zenith 29 terminal, VT52 compatible detatchable keyboard.	ZTH-Z29	76500
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo925, detatchable keyboard, 22 function keys	TVI-925	759 00
Televideo 950, graphic char., split screen, 22 func	TVI-950	950.00
Televideo970, 14" green, 132 column, European	TVI-970	1095.00

COMPUTER PLOTTER

$219



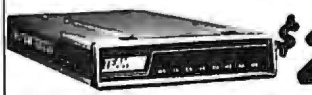
The Comrex Comscriber I is the ideal solution to make short work of translating financial and numeric data into a graphic presentation.
Many ready to run programs such as Lotus 1-2-3, Visi-on and Apple business graphics already support this plotter.
The Comscriber I features programmable paper sizes up to 8½ by 120 inches, 6 inch per second plot speed and 0.004" step size.
Easy to implement Centronics interface allows the Comscriber I immediate use with the printer port of most personal computers.
The Comscriber I is manufactured for Comrex by the Enter Computer Corporation. The plotter is marketed by Heath Kit and also sold under Enters own "Sweet P" Label. This is your opportunity to purchase a graphic plotter which was originally priced at $795 for only $219.
Also available is a support package which includes demonstration software, interface cable, amulticolor pen assortment and a variety of paper and transparency material.

MODEMS

$519

2400 BAUD

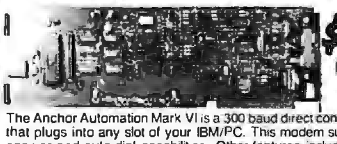
An exciting new modem from the telecommunication experts at Fujitsu. Reliable 2400 BPS communication over public phone lines. Automatically selects 2400 or 1200 baud depending incoming terminal speed. Integral speaker allows monitoring call progress. Will work in full and half duplex as well as simplex modes, both Synchronous and Asynchronous communication protocols are available. Switch selectable test modes available for digital loopback, analog loopback, as well as remote loopback. Four microprocessor design assures reliable operation over noisy phone lines at both 1200 and 2400 baud. Switch selectable Bell 212A or CCITT V.22 compatible. Sleep mode can be enabled through the use of the DTR line.



$229

The Team 212A offers all the features of the Hayes Smart Modem 1200 for a fraction of the price. Now is your opportunity to purchase a 1200 baud modem at the price of a 300 baud modem.
California Digital is so confident of your complete satisfaction that we will allow the return the Team 212A and apply the full credit towards the purchase of any other modem.

ANCHOR AUTOMATION



$69

The Anchor Automation Mark VI is a 300 baud direct connect modem that plugs into any slot of your IBM/PC. This modem supports auto answer and auto dial capabilities. Other features include telephone number storage, send / receive text files, single key-stroke dialing along with many other functions provided on disk. The Mark VI was originally priced at over $300.

Fujitsu 2400/1200 buad auto everything	FUJ-1935D	519.00
Team 1200 Hayes Compatible	TEM-SM1200	229.00
CTS 212AH 1200 baud, auto dial	CTS-212AH	299.00
Terminal software for CTS 212AH	CTS-212SFT	35.00
Prometheus 1200 super features	PRM-P1200	319.00
Prometheus 1200B internal PC	PRM-P1200B	279 00
Signalman Mark 12, 1200baud. Hayescompatible	SGL-MK12	239.00
Signalman Mark VI, 300 baud internal PC	SGL-MK6	69 00
Signalman Mark 1, direct connect with terminal cable	SGL-MK1	75.00
Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	429 00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	399 00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279 00
Hayes Chronograph, time & date	HYS-CHR232	199 00
Penril300/1200 industrial quality	PEN-12AD	495.00
Universal Data 103LP, line power, answer & originate	UDS-103LP	169 00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219 00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00

TELETYPE

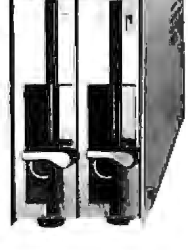
MODEL 40

$239

The Teletype Model 40 CRT terminal is continuous heavy duty communication equipment that have recently come off lease from a Cado Computer customer. It is seldom that California Digital becomes involved in the marketing of USED products but we felt that this peripheral represented such an exceptional value that we had to offer this equipment to our customers
Our engineering staff has fully tested every Model 40 terminal before Shipment.

DUAL TEAC SUBSYSTEM

$289



The dual Teac subsystem features your choice of two FD55B (48 tpi) or two FD55F (96tpi) 5¼" double sided disk drives. Also supplied within the subsystem is 50 watt power supply and a four foot shielded signal cable.

Return of a Smash Hit Sellout

DRAGON

$99

Compatible with most Radio Shack Color Computer software. The world famous Dragon computer is now available in the United States. Manufactured by the Tano Corp. under license of the British Broadcasting Company. The Dragon comes complete with 64K Byte of memory, serial modem port along with a Centronics printer interface. This unique microcomputer features Motorola's advanced 6809E microprocessor and comes standard with Microsoft Color Basic, data base manager, and a complete word processing package. The computer outputs color composite video along with R.F. video that allows the unit to be used in conjunction with any color television. This is the Ideal low cost computer to be used with any dial up information system such as the Source. Western Union's EasyLink or any other time share service.

TOLL FREE ORDER LINE
(800) 421-5041

TECHNICAL & CALIFORNIA
(213) 217-0500

Mouse by MOUSE SYSTEMS

	LIST	JADE
PC MOUSE with Pop-ups	$195	$139.95
PC MOUSE with Paint	$220	$159.95
FIELD MOUSE (male or female)	$175	$129.95
PC PAINT Software	$99	$69.95
MOUSE WINDOW Software	$150	$109.95
POP-UP MENU Software	$50	$39.95

64K RAM Upgrade Kits for Your IBM PC $17.95

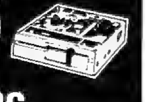
High speed RAM upgrade kit with FREE! parity (error detection) and one year warranty. We ship thousands of these kits to satisfied customers every week.

	LIST	JADE
128K RAM Chip Kit for AT	$359	$129.95
256K RAM Chip Kit	$495	$78.95

QUADRAM for IBM PC

	LIST	JADE
Quadboard *No RAM*	$269	$234.95
Quadboard 64K	$395	$275.95
Quadboard 128K	$495	$319.95
Quadboard 256K	$595	$399.95
Quadboard 384K	$795	$469.95
Quadlink	$680	$349.95

TEAC 55B 360K $99.95 Disk Drive for IBM PC



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TANDON 100-2	$299	$119.95
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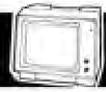

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Amdek 300A	$199	$149.95
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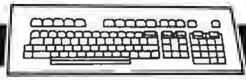
Taxan 210 RGB/Composite	$349	$289.95
Taxan TV Tuner for RGB Monitor	$99	$89.95

KEYTRONICS



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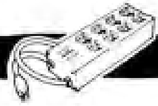
5150 Improved IBM Keyboard	$209	$159.95
5151 Deluxe IBM Keyboard	$299	$199.95

High Speed 8087 APU

LIST PRICE $293 .... SALE PRICE $119.95

ISO-BAR



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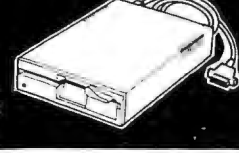

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- 4.77 or 7 MHz Clock
- 8 Expansion Slots
- Deluxe Keyboard
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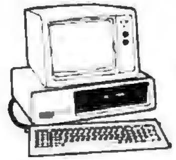

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- 63 Watt Power Supply
- 4.77 MHz Clock
- 5 Expansion Slots
- IBM Keyboard
- 90 Day Warranty

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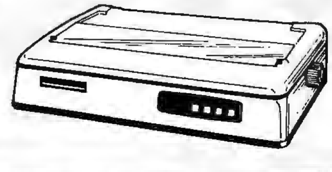

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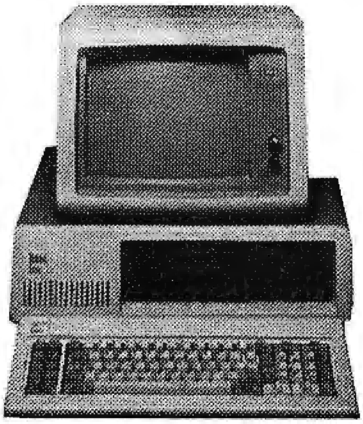

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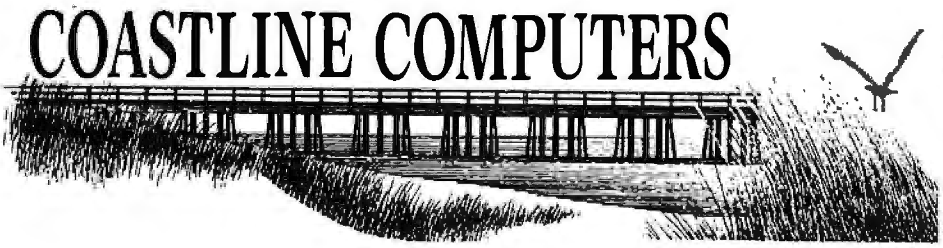

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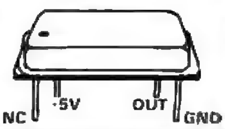

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74LS08	.28	74LS195	.69
74LS09	.29	74LS196	.79
74LS10	.25	74LS197	.79
74LS11	.35	74LS221	.89
74LS12	.35	74LS240	.95
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74LS14	.59	74LS242	.99
74LS15	.35	74LS243	.99
74LS20	.25	74LS244	1.29
74LS21	.29	74LS245	1.49
74LS22	.25	74LS247	.75
74LS26	.29	74LS248	.99
74LS27	.29	74LS249	.99
74LS28	.35	74LS251	.59
74LS30	.25	74LS253	.59
74LS32	.29	74LS257	.59
74LS33	.55	74LS258	.59
74LS37	.35	74LS259	2.75
74LS38	.35	74LS260	.59
74LS40	.25	74LS261	2.25
74LS42	.49	74LS266	.55
74LS47	.75	74LS273	1.49
74LS48	.75	74LS275	3.35
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74LS51	.25	74LS280	1.98
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74LS55	.29	74LS290	.89
74LS63	1.25	74LS293	.89
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7416	.25	74109	.45	74191	1.15
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7421	.35	74116	1.55	74194	.85
7422	.35	74120	1.20	74195	.85
7423	.29	74121	.29	74196	.79
7425	.29	74122	.45	74197	.75
7426	.29	74123	.49	74198	1.35
7427	.29	74125	.45	74199	1.35
7428	.45	74126	.45	74221	1.35
7430	.19	74128	.55	74246	1.35
7432	.29	74132	.45	74247	1.25
7433	.45	74136	.50	74248	1.85
7437	.29	74141	.65	74249	1.95
7438	.29	74142	2.95	74251	.75
7439	.79	74143	4.95	74259	2.25
7440	.19	74144	2.95	74265	1.35
7442	.49	74145	.60	74273	1.95
7443	.65	74147	1.75	74276	1.25
7444	.69	74148	1.20	74278	3.11
7445	.69	74150	1.35	74279	.75
7446	.69	74151	.55	74283	2.00
7447	.69	74152	.65	74284	3.75
7448	.69	74153	.55	74285	3.75
7450	.19	74154	1.25	74290	.95
7451	.23	74155	.75	74293	.75
7453	.23	74156	.65	74298	.85
7454	.23	74157	.55	74351	2.25
7460	.23	74159	1.65	74365	.65
7470	.35	74160	.85	74366	.65
7472	.29	74161	.69	74367	.65
7473	.34	74162	.85	74368	.65
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4023	.29	74C02	.35
4024	.65	74C04	.35
4025	.29	74C08	.35
4026	1.65	74C10	.35
4027	.45	74C14	.59
4028	.69	74C20	.35
4029	.79	74C30	.35
4030	.39	74C32	.39
4034	1.95	74C42	1.29
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4048	.69	74C90	1.19
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4050	.35	74C95	.99
4051	.79	74C150	5.75
4052	1.99	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4077	.59	74C192	1.49
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4081	.29	74C195	1.39
4082	.29	74C200	5.75
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4086	.95	74C244	2.25
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14409	12.95	74C903	.85
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74HC154	2.49	74HC4040	1.39
74HC157	.89	74HC4049	.89
74HC161	1.15	74HC4050	.89
74HC164	1.25	74HC4060	1.29
74HC166	2.95	74HC4511	2.39
74HC174	.99	74HC4538	2.29

74HCT00

74HCT: Direct, drop-in replacements for LSTTL and can be intermixed with 74LS in the same circuit.

74HCT00	.69	74HCT175	1.09
74HCT02	.69	74HCT193	1.39
74HCT04	.69	74HCT194	1.19
74HCT08	.69	74HCT195	1.29
74HCT10	.69	74HCT238	1.49
74HCT11	.69	74HCT240	2.19
74HCT14	.89	74HCT241	2.19
74HCT20	.69	74HCT242	2.19
74HCT27	.69	74HCT243	2.19
74HCT30	.69	74HCT244	2.19
74HCT32	.79	74HCT245	2.19
74HCT51	.69	74HCT251	1.09
74HCT74	.85	74HCT257	.99
74HCT75	.95	74HCT259	1.59
74HCT85	1.49	74HCT273	2.09
74HCT86	.79	74HCT299	5.25
74HCT93	1.29	74HCT367	1.09
74HCT125	1.29	74HCT373	2.49
74HCT132	1.29	74HCT374	2.49
74HCT138	1.15	74HCT393	1.59
74HCT139	1.15	74HCT4017	2.19
74HCT151	1.05	74HCT4020	1.59
74HCT153	1.05	74HCT4024	1.79
74HCT154	2.99	74HCT4040	1.59
74HCT157	.99	74HCT4049	.99
74HCT161	1.29	74HCT4050	.99
74HCT164	1.39	74HCT4060	1.49
74HCT166	3.05	74HCT4511	2.69
74HCT174	1.09	74HCT4538	2.59

SPECTRONICS CORPORATION

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW Cm²)	
PE-14		9	8,000	$83.00
PE-14T	x	9	8,000	$119.00
PE-24T	x	12	9,600	$175.00
PL-265T	x	30	9,600	$255.00
PR-125T	x	25	17,000	$349.00
PR-320T	x	42	17,000	$595.00

VOLTAGE REGULATORS

TO-220 CASE PACKAGE

7805T	.75	7905T	.85
7808T	.75	7908T	.85
7812T	.75	7912T	.85
7815T	.75	7915T	.85
7824T	.75	7924T	.85

TO-3 CASE PACKAGE

7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49

TO-92 CASE PACKAGE

78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79

OTHER VOLTAGE REGS

78M05C	5volt	½amp	TO-220	.35
LM323K	5volt	3amp	TO-3	4.95
LM338K	Adj.	5amp	TO-3	3.95
78H05K	5volt	5amp	TO-3	9.95
78H12K	12volt	5amp	TO-3	9.95
78P05K	5volt	10amp	TO-3	14.95
UA78S40	FAIRCHILD		DIP	1.95

LINEAR

LM301	.34	NE570	3.95
LM301H	.79	NE571	2.95
LM307	.45	NE590	2.50
LM308	.69	NE592	.98
LM308H	1.15	LM709	.59
LM309H	1.95	LM710	.75
LM309K	1.25	LM711	.79
LM310	1.75	LM723	.49
LM311	.64	LM723H	.55
LM311H	.89	LM733	.98
LM312H	1.75	LM741	.35
LM317K	3.95	LM741N-14	.35
LM317T	1.19	LM741H	.40
LM318	1.49	LM747	.69
LM318H	1.59	LM748	.59
LM319H	1.90	LM1014	1.19
LM319	1.25	LM1303	1.95
LM320	see7900	LM1310	1.49
LM322	1.65	MC1330	1.69
LM323K	4.95	MC1349	1.89
LM324	.59	MC1350	1.19
LM329	.65	MC1358	1.69
LM331	3.95	MC1372	6.95
LM334	1.19	LM1414	1.59
LM335	1.40	LM1458	.59
LM336	1.75	LM1488	.69
LM337T	1.95	LM1489	.69
LM337K	3.95	LM1496	.85
LM338K	3.95	LM1558H	3.10
LM339	.99	LM1800	2.37
LM340	see7800	LM1812	8.25
LM348	.99	LM1830	3.50
LM350K	4.95	LM1871	5.49
LM350T	4.60	LM1872	5.49
LM358	.69	LM1877	3.52
LM359	1.79	LM1889	1.95
LM376	3.75	LM1896	1.75
LM377	1.95	ULN2003	1.29
LM378	2.50	XR2206	3.75
LM379	4.50	LM2877	2.05
LM380	.89	LM2878	2.25
LM380N-8	1.10	LM2900	.85
LM381	1.60	LM2901	1.00
LM382	1.60	MPQ2907	1.95
LM383	1.95	LM2917	2.95
LM384	1.95	MC3487	2.95
LM386	.89	LM3900	.59
LM387	1.40	LM3905	1.25
LM389	1.35	LM3909	.98
LM390	1.95	LM3911	2.25
LM392	.69	LM3914	3.95
LM393	1.29	LM3915	3.95
LM394H	4.60	LM3916	3.95
LM399H	5.00	MC4024	3.95
NE531	2.95	MC4044	4.50
NE555	.34	RC4136	1.25
NE556	.65	RC4151	3.95
NE558	1.50	LM4250	1.75
NE564	2.95	LM4500	3.25
LM565	.99	RC4558	.69
LM566	1.49	LM13600	1.49
LM567	.89	LM13700	1.45

H=TO-5 CAN, K=TO-3, T=TO-220

RCA

CA3023	2.75	CA3083	1.55
CA3039	1.29	CA3086	.80
CA3046	1.25	CA3089	2.99
CA3059	2.90	CA3096	3.49
CA3060	2.90	CA3130	1.30
CA3065	1.75	CA3140	1.15
CA3080	1.10	CA3146	1.85
CA3081	1.65	CA3160	1.19
CA3082	1.65	CA3183	.99

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75108	1.49	75453	.39
75110	1.95	75454	.39
75150	1.95	75477	1.29
75154	1.95	75491	.79
75160	4.95	75492	.79
75188	1.25	75493	.89
75189	1.25	75494	.89

BI FET

TL066	.99	LF347	2.19
TL071	.79	LF351	.60
TL072	1.19	LF353	1.00
TL074	2.19	LF355	1.10
TL081	.79	LF356	1.10
TL082	1.19	LF357	1.40
TL083	1.19	LF411	1.29
TL084	2.19	LF412	1.99

TRANSISTORS

2N918	.50	2N3772	1.85
MPS918	.25	2N3903	.25
2N2102	.75	2N3904	.10
2N2218	.50	2N3906	.10
2N2218A	.50	2N4122	.25
2N2219	.50	2N4123	.25
2N2219A	.50	2N4249	.25
2N2222	.25	2N4304	.75
PN2222	.10	2N4401	.25
MPS2369	.25	2N4402	.25
2N2484	.25	2N4403	.25
2N2905	.50	2N4857	1.00
2N2907	.25	PN4916	.25
PN2907	.13	2N5086	.25
2N3055	.79	PN5129	.25
3055T	.69	PN5139	.25
2N3393	.30	2N5209	.25
2N3414	.25	2N6028	.35
2N3563	.40	2N6043	1.75
2N3565	.40	2N6045	1.75
PN3565	.25	MPS-A05	.25
MPS3638	.25	MPS-A06	.25
MPS3640	.25	MPS-A13	.40
PN3643	.25	MPS-A55	.25
PN3644	.25	MPU-131	.99
MPS3704	.15	TIP29	.65
MPS3706	.15	TIP31	.75
		TIP32	.79

IC SOCKETS

	1-99	100
8 PIN ST	.13	.11
14 PIN ST	.15	.12
16 PIN ST	.17	.13
18 PIN ST	.20	.18
20 PIN ST	.29	.27
22 PIN ST	.30	.27
24 PIN ST	.30	.27
28 PIN ST	.40	.32
40 PIN ST	.49	.39
64 PIN ST	4.25	CALL

ST=SOLDERTAIL

8 PIN WW	.59	.49
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80

WW=WIREWRAP

INTERFACE

8T26	1.59
8T28	1.98
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

DATA ACQ

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0816	14.95
ADC0817	9.95
ADC0831	8.95
DAC0800	4.49
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1021	7.95
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

EXAR

XR2206	3.75
XR2207	3.75
XR2208	3.75
XR2211	5.25
XR2240	3.25

9000

9304	.95
9316	1.00
9328	1.49
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
9637	2.95
96S02	1.95

SOUND CHIPS

76477	3.95
76488	5.95
76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
MC3340	1.49
SP1000	39.00

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL 113	1.75

Dear Sirs:

I just purchased the RP-525 Auto-Eprom Programmer for the Apple IIe. I want to thank you for a well-made and useful product. The instruction is easy to read and understand as is the operation of the programmer. Again, thank you for a fine product.

—Paul K. Pagel

VISA MasterCard

DB25S RS232 FEMALE SOLDER CUP 2.25 DB25P RS232 MALE SOLDER CUP 1.90

BARGAIN HUNTERS CORNER

DYNAMIC RAMS

4164 200ns $.99 ea.

100 PIECE MINIMUM

41256 150ns $5.50 ea.

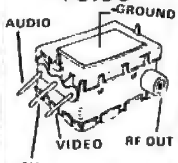
SPECIALS END 7/31/85

RF MODULATOR (ASTEC UM1082)

QUANTITIES LIMITED

- PRESET TO CHANNEL 3
- USE TO BUILD TV-COMPUTER INTERFACE
- 5 VOLT OPERATION

$6.95



EMI FILTER

- MAJOR MANUFACTURER
- LOW COST
- FITS LC-HP BELOW

$4.95

LINE CORDS

LC-2	2 CONDUCTOR	6 ft	.39
LC-3	3 CONDUCTOR	6 ft	.99
LC-HP	3 CONDUCTOR WITH STANDARD FEMALE SOCKET	6 ft	1.49
LC-CIR	CIGARETTE LIGHTER PLUG WITH 6 FOOT CORD		2.95

MUFFIN FANS

4.68" SQUARE	14.95
3" SQUARE	14.95

CAPACITORS

TANTALUM

1.0µ	15V	.40	.47µ	35V	.50
6.8	15V	.70	1.0	35V	.45
10	15V	.80	2.2	35V	.65
22	15V	1.35	4.7	35V	.85
.22	35V	.40	10	35V	1.00

DISC

10p	50V	.05	560	50V	.05
22	50V	.05	680	50V	.05
25	50V	.05	820	50V	.05
27	50V	.05	.001µ	50V	.05
33	50V	.05	.0015	50V	.05
47	50V	.05	.0022	50V	.06
56	50V	.05	.005	50V	.06
68	50V	.05	.01	50V	.07
82	50V	.05	.02	50V	.07
100	50V	.05	.05	50V	.07
220	50V	.05	.1	12V	.10

MONOLITHIC

.01µ	50V	.14	.1µ	50V	.18
.047µ	50V	.15	.47µ	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µ	25V	.14	1µ	50V	.14
2.2	35V	.15	4.7	16V	.14
4.7	50V	.15	10	16V	.14
10	50V	.15	10	50V	.16
47	35V	.18	22	16V	.14
100	16V	.18	47	50V	.20
220	35V	.20	100	15V	.20
470	25V	.30	100	35V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			2200	16V	.70
			6000	16V	.85

COMPUTER GRADE

44,000µ 30V 3.95

RESISTORS

1/4 WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG OHM

50 PIECES SAME VALUE	.025
100 PIECES SAME VALUE	.02
1000 PIECES SAME VALUE	.015

BYPASS CAPS

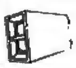
.01 µ DISC	100 $6.00
.01 µ MONOLITHIC	100 $12.00
.1 µ DISC	100 $8.00
.1 µ MONOLITHIC	100 $15.00

HARD TO FIND "SNAPABLE" HEADERS

Can easily be snapped apart to make any size header, all with .1" centers

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE	1.49
2x40	STRAIGHT LEAD	2.49
2x40	RIGHT ANGLE	2.99

SHORTING BLOCKS



SPACED AT .1" CENTERS
IDEAL FOR DISK DRIVES
OR ANY .1" HEADER

5/1.00

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95
10 POSITION	1.29

EDGECARD CONNECTORS

S-100 ST	S-100	3.95
S-100 WW	S-100	4.95
72 PIN ST		6.95
72 PIN WW		7.95
62 PIN ST	IBM PC	4.95
50 PIN ST	APPLE	4.95
44 PIN ST		2.95
44 PIN WW		4.95

36 PIN CENTRONICS

IDCEN36	RIBBON CABLE MALE	8.95
IDCEN36 F	RIBBON CABLE FEMALE	8.95
CEN36	SOLDER CUP MALE	7.95

DIODES

1N751	5.1 VOLT ZENER	.25
1N759	12.0 VOLT ZENER	.25
1N4148	(1N914)SWITCHING	25 1.00
1N4001	50PIV 1A	12 1.00
1N4004	400PIV RECTIFIER	10 1.00
1N5402	200PIV 3A	.25
KBP02	200PIV 1.5A BRIDGE	.45
KBP04	400PIV 1.5A BRIDGE	.55
MDA801	50PIV 12A BRIDGE	1.39
MDA980-1	50PIV 12A BRIDGE	1.95
MDA980-2	100PIV 12A BRIDGE	2.25
VM48	DIP-BRIDGE	.35

LED DISPLAYS

HP5082-7760	CC	.43"	1.29
MAN-72	CA	.3"	.99
MAN-74	CC	.3"	.99
FND-357(359)	CC	.375"	1.25
FND-500(503)	CC	.5"	1.49
FND-507(510)	CA	.5"	1.49
TIL-311 4x7 HEX W LOGIC		.270"	9.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.99	.99	.99	1.69	1.89	1.89	1.99	2.49	2.99
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	---	.95	.95	---	---	---	1.75	---	2.95

FOR ORDERING INSTRUCTIONS SEE IDC CONNECTORS BELOW

HEAT SINKS

TO-220	SCREW ON	.35
TO-220	CLIP ON	.35
TO-3	SCREW ON	.95
TO-220	INSULATOR	10 1.00
TO-3	INSULATOR	10 1.00

SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
BCD OUT	10 POSITION 6 PIN DIP	1.95

DIFFUSED LEDS

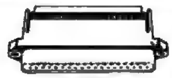
		1-99	100-up
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.18	.15
JUMBO YELLOW	T1¾	.18	.15
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09
MINI GREEN	T1	.18	.15
MINI YELLOW	T1	.18	.15
RECT RED	2x5mm	.25	.22
RECT GREEN	2x5mm	.30	.27
RECT YELLOW	2x5mm	.30	.27

D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	25	37	50
SOLDER CUP	MALE	DBxxP	1.19	1.59	1.90	2.85	4.25
	FEMALE	DBxxS	1.50	1.85	2.25	3.90	5.25
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.65	2.20	3.00	4.83	---
	FEMALE	DBxxSR	2.18	3.03	3.00	6.19	---
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	2.95	3.90	4.75	6.95	---
	FEMALE	IDBxxS	3.25	4.29	5.25	7.95	---
HOODS	BLACK	HOOD-B	---	---	.99	---	---
	GREY	HOODxx	.89	.99	.99	1.09	1.19

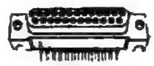
MOUNTING HARDWARE-$1.00

FOR ORDERING INSTRUCTIONS SEE IDC CONNECTORS BELOW



IDB37S

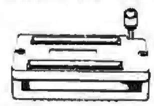
DB37S



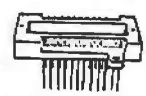
DB25SR

TEXTOOL ZERO INSERTION FORCE SOCKETS AND RECEPTACLES

SCREWDRIVER CLAMP
ECONO ZIF



LEVER CLAMP
ZIF SOCKET



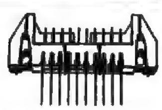
WW RECEPTACLES
ZIF RECEPTACLE

TYPE	CONTACTS 14	16	24	28	40
ECONO ZIF	---	4.95	6.75	7.75	9.95
ZIF SOCKET	4.95	4.95	5.95	6.95	9.95
ZIF RECEPTACLE	8.25	8.75	9.75	10.50	12.75

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

ORDERING INSTUCTIONS. INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 10 PIN RIGHT ANGLE HOLDER STYLE WOULD BE IDH10SR



IDH20W

IDE50

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	18	1.60	.83	7.30
16	.28	2.50	1.00	8.80
20	36	3.20	1.25	11.00
25	45	4.00	1.32	11.60
26	46	4.10	1.32	11.60
34	61	5.40	1.65	14.50
40	72	6.40	1.92	16.80
50	89	7.50	2.50	22.00

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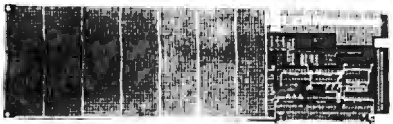
IBM PC PROTOTYPE CARD WITH DECODING LAYOUT $29.95

WIRE WRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD-PLATED EDGE-CARD FINGERS



IBM PR2

IBM

BOTH CARDS HAVE SILK SCREENED LEGENDS AND INCLUDES MOUNTING BRACKET

IBM-PR1	WITH +5V AND GROUND PLANE	$27.95
IBM-PR2	AS ABOVE WITH DECODING LAYOUT	$29.95

S-100

P100-1	BARE - NO FOIL PADS	$15.15
P100-2	HORIZONTAL BUS	$21.80
P100-3	VERTICAL BUS	$21.80
P100-4	SINGLE FOIL PADS PER HOLE	$22.75

APPLE

P500-1	BARE - NO FOIL PADS	$15.15
P500-3	HORIZONTAL BUS	$22.75
P500-4	SINGLE FOIL PADS PER HOLE	$21.80
7060-45	FOR APPLE IIe AUX SLOT	$30.00

GENERAL PURPOSE

22/44 PIN EDGE-CARD (.156" SPACING)

P441-1	BARE - NO FOIL PADS 4.5" x 6.0"	$9.45
P441-3	VERTICAL BUS 4.5" x 6.0"	$13.95
P441-4	SINGLE FOIL PADS 4.5" x 6.0"	$14.20
P442-1	BARE - NO FOIL PADS 4.5" x 9.0"	$10.40
P442-3	VERTICAL BUS 4.5" x 9.0"	$14.20
P442-4	SINGLE FOIL PADS 4.5" x 9.0"	$13.50

36/72 PIN EDGE-CARD (.1" SPACING)

P721-1	BARE - NO FOIL PADS 4.5" x 6.0"	$9.45
P721-3	VERTICAL BUS 4.5" x 6.0"	$13.25
P721-4	SINGLE FOIL PADS 4.5" x 6.0"	$14.20
P722-1	BARE - NO FOIL PADS 4.5" x 9.0"	$10.40
P722-3	VERTICAL BUS 4.5" x 9.0"	$14.20
P722-4	SINGLE FOIL PADS 4.5" x 9.0"	$15.15

BARE GLASS BOARDS

NO EDGE-CARD FINGERS OR FOIL

P25x45	2.5" x 4.5"	$2.40
P45x65	4.5" x 6.5"	$4.70
P45x85	4.5" x 8.5"	$6.20
P45x170	4.5" x 17.0"	$11.35
P85x170	8.5" x 17.0"	$18.95

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IBM	$45.00
APPLE	$45.00
MULTIBUS	$86.00

DISK DRIVES

TANDON

TM 100-1 5¼" (FOR IBM) SS DD	$119.95
TM 100-2 5¼" (FOR IBM) DS DD	$99.95

MPI

MPI-B52 5¼" (FOR IBM) DS DD	$89.95

TEAC

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FD-55F ½ HEIGHT DS QUAD	$99.95

SHUGART

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SA 460 5¼" (80 TRACK) DS QUAD	$199.95

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FD100-8 BY SIEMENS, SHUGART 801 EQUIV SS DD	$129.00
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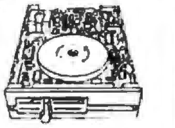
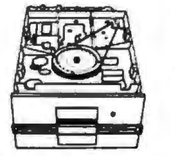
SUPPORT FOR QUAD DENSITY DRIVES FROM TALL TREE SYSTEMS



TEAC FD-55B



TANDON TM100-2

PLEASE INCLUDE SUFFICENT AMOUNT FOR SHIPPING ON ABOVE ITEMS

DISK DRIVE CABINETS

CABINET #1 $29.95
- Fits one full height 5¼" disk drive
- Color matches Apple

CABINET #2 $79.00
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- Please specify Grey or Tan

CABINET #3 $89.95
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- Complete with power supply, switch, line cord, fuse and standard power connectors

8" DISK DRIVE CABINETS ALSO AVAILABLE-PLEASE CALL

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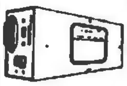
PS-IBM $99.95
- FOR IBM PC-XT COMPATIBLE
- 130 WATTS
- +5V @ 15A, +12V @ 4.2A -5V @ .5A, -12V @ .5A
- ONE YEAR WARRANTY



PS-A $49.95
- USE TO POWER APPLE TYPE SYSTEMS
- +5V @ 4A, +12V @ 2.5A -5V @ .5A, -12V @ .5A
- APPLE POWER CONNECTOR

PS-3 $39.95
- AS USED IN APPLE III
- +5V @ 4A, +12V @ 2.5A -5V @ .25A, -12V @ .30A,
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PS-ASTEC $19.95
- CAN POWER TWO 5¼" FDDS
- +5V @ 2.5A, +12V @ 2A -12V @ .1A
- -5V @ 5A IF +12V IS NOT USED
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- ONE PIECE METAL CONSTRUCTION
- EASILY EXTRACTS 8-24 PIN DEVICES
- LOW COST $2.19

EX-1

EX-2 IC EXTRACTION TOOL
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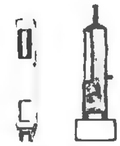
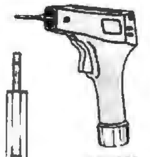
INS-1416	for 14-16 pin IC's	$5.15
MOS-1416	for 14-16 pin IC's	$10.92
MOS-2428	for 24-28 pin IC's	$10.92
MOS-40	for 40 pin IC's	$12.43

MOS series insertion tools have metal constuction and include grounding lug for CMOS applications.



INS-1416 INS-2428

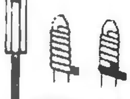
BW-630 WIRE WRAP GUN
- BATTERY POWERED-USES 2 NI-CAD C CELLS(NOT INCLUDED)
- POSITIVE INDEXING
- ANTI-OVERWRAP DEVICE $41.55



BW-630

WSU-30 WIRE WRAP TOOLS
- WRAPS, STRIPS, AND UNWRAPS
- WSU-30M WRAPS AN EXTRA TURN OF INSULATION

WSU-30 $8.84/WSU-30M $10.14

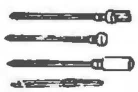


WSU-30 30M

WIRE WRAP TERMINALS

WWT-1	SLOTTED	25/$7.06
WWT-2	SINGLE SIDED	25/$4.25
WWT-3	IC SOCKET	25/$7.06
WWT-4	DOUBLE SIDED	25/2.80
INS-1	INSERTION TOOL	$3.64

WIRE DISPENSER
- WITH 50' ROLL OF WIRE
- BUILT IN PLUNGER CUTS WIRE
- BUILT IN STRIPPER STRIPES 1"
- REFILLABLE

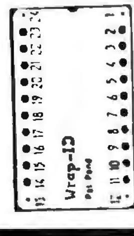


WD-30 $6.50 Specify Blue, white, Yellow or Red
WD-30TRI $9.50 With 50' of each: Red, Blue and White

SOCKET-WRAP I.D.™
- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON PLASTIC; SUCH AS IC #

PINS	PART#	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)



WIRE WRAP WIRE

PRECUT AND STRIPPED

Note: 1 inch of insulation is stripped on each end. A 3.5" wire has only 1.5" of insulation.

LENGTH (INCHES)	QUANTITY 100	500	1000
2.5	1.60	4.70	8.20
3	1.60	4.70	8.20
3.5	1.65	5.00	8.90
4	1.75	5.40	9.60
4.5	1.80	5.75	10.30
5	1.85	6.10	11.00
5.5	1.90	6.50	11.75
6	2.00	6.85	12.50
6.5	2.30	7.80	14.30
7	2.40	8.20	15.05
7.5	2.50	8.55	15.85
8	2.60	8.95	16.60
8.5	2.65	9.30	17.40
9	2.70	9.80	18.15
9.5	2.80	10.00	18.95
10	2.90	10.50	19.70

PRECUT ASSORTMENT IN ASSORTED COLORS $27.50

100ea: 5.5", 6", 6.5", 7"
250ea: 2.5", 4.5", 5"
500ea: .3", 3.5", 4"

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100 feet	$4.30	250 feet	$7.25
500 feet	$13.25	1000 feet	$21.95

Please specify color: Blue, Black, Yellow or Red

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12V AC	1 AMP	5.95
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9 VOLT	QTY. 1	$13.21

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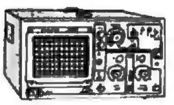
D CELLS	PKG. 1	$3.78 ea.
9 VOLT	PKG. 1	$7.57 ea.

20 MHz DUAL TRACE OSCILLOSCOPE



UNSURPASSED QUALITY AT AN UNBEATABLE PRICE

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$399.95 WITH PROBES

FULL ONE YEAR WARRANTY

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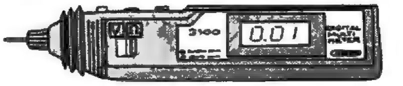

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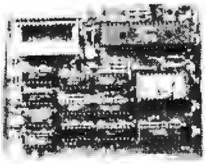
ONLY $49.95

TEAC-FD55B DS/DD ½ HT. FOR IBM PC $89.95 MPI-B52 DS/DD FULL HT. FOR IBM PC $89.95

EPROM PROGRAMMER
FOR APPLE COMPUTERS



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- EASY TO USE MENU-DRIVEN SOFTWARE INCLUDED
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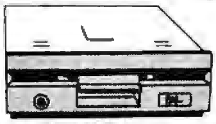
DISK DRIVES
FOR APPLE COMPUTERS



BAL-525 $119.95

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- 100% APPLE COMPATIBLE
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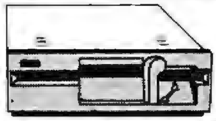

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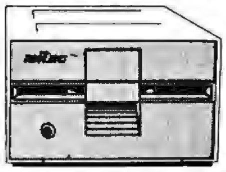
- TEAC MECHANISM- DIRECT DRIVE
- 100% APPLE COMPATIBLE
- FULL 1 YEAR WARRANTY



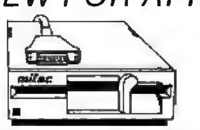
MITAC AD-1 $129.95

- FULL HT. SHUGART MECHANISM
- DIRECT REPLACEMENT FOR APPLE DISK II
- SIX MONTH WARRANTY

DISK DRIVE ACCESSORIES

DISK CONTROLLER CARD	$49.95
APPLE IIc ADAPTOR CABLE	$19.95

NEW FOR APPLE IIc



MITAC AD-3C $139.95

- 100% APPLE IIc COMPATIBLE, READY TO PLUG IN W/ SHIELDED CABLE & MOLDED 19 PIN CONNECTOR
- FAST, RELIABLE SLIMLINE DIRECT DRIVE
- SIX MONTH WARRANTY

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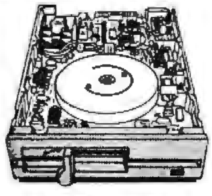
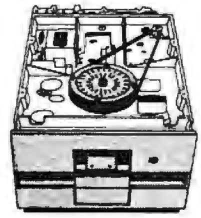


TEAC
FD55B
$89.95



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MPI
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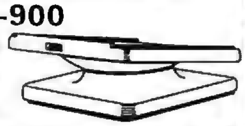

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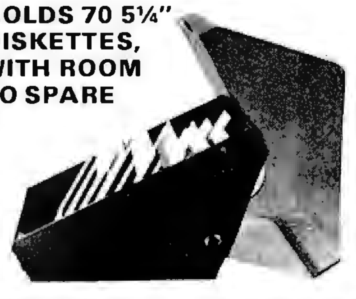
HOLDS 70 5¼" DISKETTES, WITH ROOM TO SPARE



NASHUA DISKETTES
5¼" SOFT SECTOR DS/DD WITH HUB RINGS

BULK PACKAGED IN FACTORY SEALED BAGS OF 50. INCLUDES DISKETTE SLEEVES AND WRITE PROTECT TABS. IDEAL FOR SCHOOLS, CLUBS, AND USERS GROUPS. THIS IS A SPECIAL PURCHASE, SO QUANTITIES ARE LIMITED. THERE IS A 5 YEAR WARRANTY.

$.89ea.	$.95ea.	$.99ea.
QTY 250	QTY 100	QTY 50

NASHUA DISKETTES WERE JUDGED TO HAVE THE HIGHEST POLISH AND RECORDED AMPLITUDE OF ANY DISKETTES TESTED. (SEE "COMPARING FLOPPY DISKS", BYTE 9/84)

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SS/DD	SOFT SECTOR	$29.95
SS/DD	10 SECTOR HARD	$29.95
DS/DD	SOFT SECTOR	$34.95

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130 WATT $99.95

XT COMPATIBLE

- +5V @ 15A, +12 @ 4.2A -5 @ .5A, -12 @ .5A
- UPGRADE YOUR PC, POWERS HARD DISK
- POWER CABLES FOR 4 FDDs
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- SWITCH ON SIDE (FITS IBM CASE)

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- FOR USE IN OTHER IBM TYPE MACHINES
- AVAILABLE IN 100W OR 130W VERSIONS
- 90 DAY WARRANTY

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WANTED: Nonprofit educational organization seeks tax-deductible donation of IBM System/34 and peripherals. John B. Ellison, International Correspondence Institute, c/o Division of Foreign Missions, 1445 Boonville Ave., Springfield, MO 65802.

WANTED: Nonprofit organization serving southeastern Kentucky area seeks tax-deductible donation of IBM computers, hardware, and public-domain software for youth rehabilitation program. Kentucky Youth, c/o Bob Rains, 520 Beach St., POB 173, Benham, KY 40807.

WANTED: Eastside Mental Health (a nonprofit organization) seeks tax-deductible donation of IBM PC or Macintosh, peripherals, printer, monitor, terminals, public-domain software, etc., for applied research with the chronically disturbed. Will pay shipping. Debbie Bertram, Eastside Mental Health, 1605 116th Ave. NE, Bellevue, WA 98004, (206) 455-4357.

NEEDED: Nonprofit Costa Rican educational foundation seeks donation of disk-based microcomputers (Heath H-89 or similar) to teach programming to poor students. Will pay shipping. FILEC, POB 2911, San Jose 1000, Costa Rica.

WANTED: Nonprofit environmental education center seeks tax-deductible donation of a computer (preferably IBM-compatible) and printer for use with school groups and in our office. Montclair State College, New Jersey School of Conservation, RD #2, Box 272, Branchville, NJ 07826, (201) 948-4646.

WANTED: Information on operating microcomputer equipment in the marine environment. Can a computer survive fog, dampness, humidity, and salt air if kept dry and at a moderate temperature? Alan Born, POB 272, Tiburon, CA 94920, (415) 924-6352.

WANTED: Nonprofit community organization needs tax-deductible donation of computers, printers, terminals, and public-domain software to assist in ADM and training. R. Hankins, PCT Inc., 160 Milagra Dr., Pacifica, CA 94044, (415) 355-8000.

WANTED: Tax-deductible donation of peripherals, printers, monitors, disk drives, memory expansion, etc., for the TRS-80 Model I. Certified receipts furnished: will pay reasonable shipping. Pirchei Agudath Israel of Kew Gardens Hills, 144-19 70th Rd., Flushing, NY 11367.

WANTED: Christian academy seeks tax-deductible donations of Apple IIe computers with minimum 64K, disk drives, 80-column card, and monitor for high school math and science classes. Cheswick Christian Academy, 1407 Pittsburgh St., Cheswick, PA 15024, (412) 274-4846.

WANTED: Nonprofit organization seeks tax-deductible donation of IBM PC, 256K to 512K RAM, two 360K disk drives or 5- or 10-megabyte hard-disk drive, and monochrome monitor for running high school track meets. Massachusetts State Track Coaches Association, c/o Edmund N. Delgado, 28 Warbler Lane, West Yarmouth, MA 02673, (617) 394-7571.

WANTED: Information and equipment for an old Ohio Scientific Challenger 1P 8K microcomputer used in school. We need manuals, ideas for use, and public-domain software. Jeffrey Branzburg, Castle Hill JHS, 1560 Purdy St., Bronx, NY 10462.

WANTED: Casio PB-700 user in Australia wishes to correspond with users in America or anywhere about starting a users group. Terry Gill, 35A Kent St., Regents Park, New South Wales 2143, Australia.

NEEDED: My Access-Actrix monitor is missing dots. Need schematic or other service assistance. L. Rogers, 313 South Ravinia, Dallas, TX 75211, (214) 339-7007.

NEEDED: Manuals, schematics, etc., for Seattle Computer Products 8086 CPU and CPU Support Board (SCP-200 and SCP-300). Also information on 8087 accessory board. Willing to pay. Stephen Hathaway, 86 Parsons St., Northampton, MA 01060, (413) 586-4341, evenings.

NEEDED: User-written scientific applications software in Applesoft and Apple Pascal. Statistics, plotting, data logging, modeling, etc. Peter Petokas, POB 16, Little York, NY 13087.

FOR SALE: Davong 5-megabyte hard disk with controller for IBM PC: $325. Colby PC-1 portable with power supply, amber monochrome display, and keyboard; install your own PC board, drives, and display adapter to create portable machine; brand new: $650. Buyer pays shipping and COD charges. Tom Guyton, 12 Harned Ct., Odessa, TX 79762.

FOR SALE: Microvox text-to-speech voice synthesizer expertly assembled from Micromint kit; will connect to any computer with RS-232C (with RTS input) or Centronics-compatible parallel I/O: $200. Includes Realistic Wedge speaker. Hans Raillard, 6400 Lone Pine Rd., Sebastopol, CA 95472.

FOR SALE: Various S-100 components and disk drives including CPU boards, memory boards, floppy-disk controllers, and Tandon 848-1 disk drives. Richard Whiteman, 635 Holman Ave., Athens, GA 30606, (404) 546-8814.

FOR SALE: TI 99/4A peripheral-expansion system, disk-controller card, disk drive, memory-expansion card (32K RAM): $400. All items are new. Dave Watters, 3901 Torrington Ave., Parma, OH 44134, (216) 845-9669.

FOR SALE: Atari 850 interface, Bit 3 80-column card, and more: $300. Sonam Gyato, (201) 868-9695.

WANTED: TI 99/4As, KIM-1s, Altair 8800/A/Bs, and similar machines for community project. Nothing elaborate or expensive. Also need *The First Book of KIM* and *Machine Language Programming for the 8008*. Dr. I. R. Johnston, Edon Institute, POB 2258, Saginaw, MI 48605.

TRADE: Physics student with TI 99/4A computer seeks working or nonworking stand-alone disk drive and compatible dot-matrix printer with interface in exchange for public-domain BASIC/Extended software. Will pay postage. Dennis Hothem, 1218 10th Ave., Belle Fourche, SD 57717, (605) 892-3752.

FOR SALE: Viewmax-80 for Apple II, new. Best offer. John Chen, Rt. 8, Box 483, Caldwell, ID 83605.

FOR SALE: BYTE, November 1977 through May 1980: $2 per issue. Digital Group 4-port parallel I/O board: $20. Digital Group dress cabinet for 9-inch monitor: $10. Digital Group keyboard: $60. Buyer pays shipping. Harold Frye, 1551 5th Ave. SW, Rochester, MN 55902, (507) 289-0247.

FOR SALE: Tecmar 1st Mate for IBM PC XT or compatible, 64K, clock/calendar, serial port, parallel port. Brand new, $275. N. D. Diamantides, 2517 14th St., Cuyahoga Falls, OH 44223.

WANTED: Public-domain or non-copyrighted CBIOS to interface CP/M 2.2 to a North Star single-density micro-disk system running on a SOL terminal computer. Most interested in the source code for the deblocking and disk-access routines. David J. Mankoff, 3 Skyvue Ct., South Setauket, NY 11720, (516) 736-3631.

FOR SALE: "Tubeless Terminal" Synertek KT3-3/40 with 24 by 40 display, RS-232C–compatible output, and optional Micro-Verter MVX-500 that transmits UHF signal on UHF 14-17. Best offer. Al Safer, 77 LaBelle Circle, Chicopee, MA 01020.

FOR SALE: HP 86A with 512K, HP 82913A monitor, two HP 9130A 5¼-inch drives, HP 82905 printer. Also, HP 9816S with 768K, HP 9121D dual 3½-inch drives, large keyboard, HP 82905B printer, and more. Make offer. John Blair, POB 164, Swan Lake, MT 59911, (406) 886-2370.

WANTED: If you own an Atari or Apple computer and want to join the National Software Consortium, contact National Software Consortium, c/o S. Mikutel, 95-18 Ashbourn Dr., Burke, VA 22015.

UNCLASSIFIED ADS MUST *be noncommercial, from readers who have computer equipment to buy, sell, or trade on a onetime basis. All requests for donated computer equipment must be from nonprofit organizations. Programs to be exchanged must be written by the individual or be in the public domain. Ads must be typed double-spaced, contain* 50 *words or less, and include full name and address. This is a free service; ads are printed as space permits.* BYTE *reserves the right to reject any unclassified ad that does not meet these criteria. When you submit your ad* (BYTE, *Unclassified Ads,* POB 372, *Hancock,* NH 03449), *allow at least four months for it to appear.*

WANTED: Correspondence about Japanese computing scene. Keiko Orata, Nishi-tsutsuji 1-24-1, Chofu City, Tokyo 182, Japan, 0424-85-0860.

FOR SALE: DECwriter IV (LA34), lightweight desktop terminal, 1 year old, original carton with documentation, extra ribbons, 45 cps, 7 by 9 dot matrix, variable pitch, plain paper or preprinted forms, RS-232C interface, used less than 20 hours: $895 or best offer. Mike Kwiatkowski, 136 Lyndale Ave., Baltimore, MD 21236, (301) 665-6261.

WANTED: New or used tractor feed for a Brother HR-1 printer. J. Fears, 665 Sapphire Lane, Stevensville, MT 59870.

FOR SALE: Sanyo 1000 8-inch disk-controller board, cable, and card guide. Data General "Dasher" print head, new. Motors for same. John Johnson, 707 Edge Hill Rd., New Bern, NC 28560, (919) 638-6976.

FOR SALE: BYTE, 1979 (volume 4) to present. $2 per copy. David Moore, 2031 Maine, Quincy, IL 62301, (217) 228-1792, evenings.

FOR SALE: BYTE, October 1975, March 1976, July 1976 through December 1984 (except August 1980). *Kilobaud*, January 1977 through March 1978; *Creative Computing*, March/April 1975 through September/October 1978; *Interface Age*, July 1976 through May 1978. Other publications available. Make offer. Steve Baylus, 12212 Old Creedmoor Rd., Raleigh, NC 27612, (919) 781-0605 or 848-3018.

FOR SALE: Two Tektronix 4054 graphics computers with 19-inch screens and ¼-inch tape drives: $3000 each or best offer. Tektronix 4631 hard-copy unit: $700. Tim Zeisloft, 2161 Shattuck Ave. #210, Berkeley, CA 94704, (415) 849-0629.

FOR SALE: GIMIX #39 mainframe, two 8-inch floppy drives, one 5-inch floppy, 5-megabyte hard disk, 340K static RAM, intelligent I/O processor, other I/O boards, Privac hi-res graphics, Meta-Labs Z80 CP/M board, Windrush PROM burner, Z19 terminal 9511, and more. Asking $7500. Will sell separately. Dick Bartholomew, 4849 Bethlehem Pike, Telfor, PA 18969, (215) 257-3992.

FOR SALE: Two TeleVideo 925 terminals: $500 each. Two S-100 systems with Advanced Digital Super Six SBC (6-MHz Z80, 128K RAM, 4K ROM), dual 8-inch Mitsubishi DS/DD floppy drives, Integrand 7 slot, wood-grain cabinet, all manuals: $1750 each. Phil Erwin Jr., 2101A Mona Ct., Lexington, KY 40503, (606) 299-4096.

FOR SALE: 8K RAM for Radio Shack PC-2 or the Sharp PC-1500 pocket computer. Asking $50. Also, seek 16K RAM with battery backup for same machines. Interested in starting a users group for pocket computers. Robert Lerner, 23 Mayer Dr., Suffern, NY 10901.

FOR SALE: BYTE, number 1 through September 1980; all in excellent condition (missing numbers 6 and 8, 1977; numbers 4 and 5, 1978; and number 7, 1980): $300. Negotiable. Jack Molinelli, 499 Harding Rd., Fair Haven, NJ 07701, (201) 842-7036.

FOR SALE OR TRADE: Heathkit H-14 printer with many features: $300. Donald Mayes, Apt. #3, 8515 Greenwood Ave., Takoma Park, MD 20912, (301) 589-4190 or (202) 282-0585.

FOR SALE: Mindset computer with expansion unit purchased new September 1984. Includes parallel card, mouse, Quadchrome HX-12 color monitor. All original manuals. Will guarantee operation. $2750 or best offer. S. Adams, (212) 675-6707.

WANTED: Anyone wanting to sell a Sinclair ZX80 or ZX81 in working condition. I'm interested in parallel processing for music applications. Chris Schaefer, 2140 Harvard St., Palo Alto, CA 94306.

FOR SALE: TI 99/4A with original packing. Good condition. Seller will pay postage. $110. Mike Busing, 1129 Harter Blvd., Anderson, IN 46011, (317) 642-9063.

FOR SALE: Heath H-89 computer, 64K, three disk drives, three SIO ports, CDR DD controller, Cleveland Codonics graphics board, and more. $1800 for the works. Tom Dorsett, East 2726 Golden Rd., Spokane, WA 99208, (509) 466-0585.

FOR SALE: TRS-80 Model 12, Daisy Wheel Printer II, excellent condition; asking $4000. Charles Denison, 14 Landover Dr., Coatesville, PA 19320, (215) 384-1869, after 6 p.m.

B·O·M·B

BYTE's Ongoing Monitor Box

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July BOMB *Results*

HOME RUN WON

The first in the series from Ciarcia's Circuit Cellar on how to "Build the Home Run Control System" placed first in April. It introduced a project for energy management, convenience, and security for the home or factory. Jerry Pournelle's "Over the Moat" captured second place. His battles with the flu, construction, and computer-type issues continue in the saga of Computing at Chaos Manor. And whether it's new or not, "What's Not" did win third. In fourth, and the winner of the $100 prize, is John K. Stevens's theme article on a model of circuitry entitled "Reverse Engineering the Brain." And in fifth place is "The Quest to Understand Thinking." Roger Schank and Larry Hunter will half the $50 bonus. Congratulations to all.

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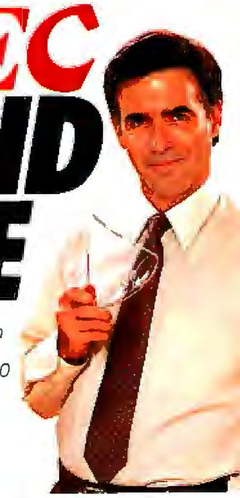

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