BYTE

THE SMALL SYSTEMS JOURNAL®

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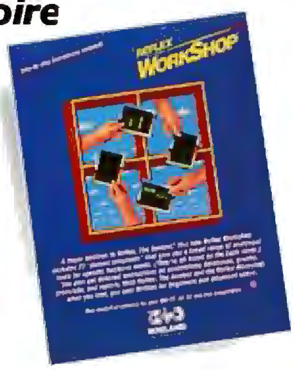

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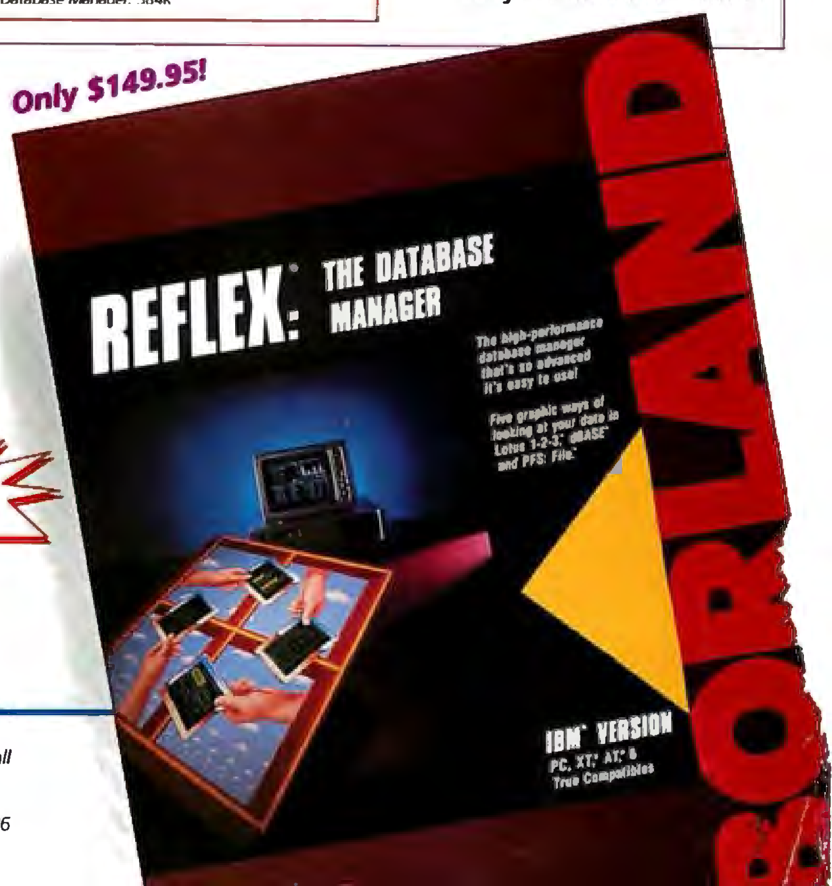

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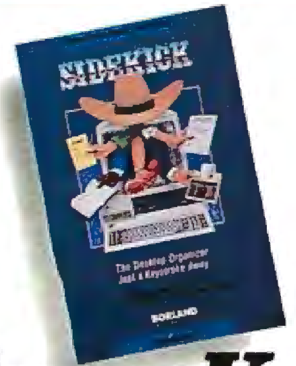

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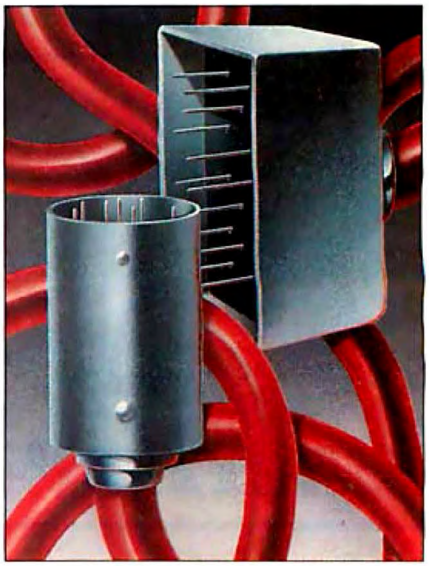

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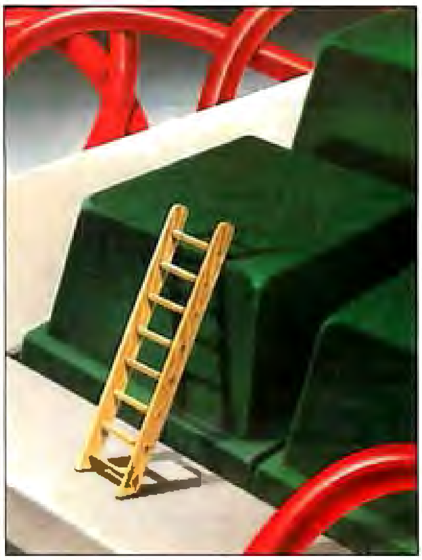

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EDITORIAL

The Hidden Peril of Electronic Publishing

Although BYTE appreciates and uses the possibilities of electronic publishing as much as anyone, we also see danger lurking. Editors, journalists, and thoughtful publishers have labored through the centuries to establish basic editorial principles that are taken for granted by most print publications. Editors select and write articles to meet the interests and needs of their readers. There can be no sale of editorial coverage, nor guarantee of editorial coverage in exchange for advertisements. Print publications that violate these rules deceive readers and are held in contempt by writers, editors, and readers who recognize what is going on.

Many databases operate under different and often undeclared rules. Companies routinely pay "listing fees" to have notices appear in databases. For example, companies pay a fee to have an item appear in a real estate listing. This kind of listings service can serve both buyer and seller well as long as everyone understands two things. First, items appear in the database if—and only if—a payment is made; and second, the operator of the listings service may or may not—only up-front disclosure lets you know—check or screen the accuracy of the information submitted to the database. If users of the database fully understand that, for example, buyers pay $100 to have an item appear in the database and that the database service does no checking on the accuracy of the information or screening of its appropriateness, then everyone knows the rules and no one is deceived or misled. Unfortunately, many databases fail to disclose any of this information to users.

Another danger can occur if database rules—or the lack of them—are applied to publications. Suppose, for example, that a computer magazine started charging companies for coverage in the magazine. If a company refused to pay, its products would not be mentioned. The greater the payment, the greater the coverage. Magazine readers would assume that items had been selected based on the editorial space available and the editors' judgment of which items would most interest their readers. The publication would become nothing more than a cheerleader for its advertisers and would lose its value to readers. To the extent that readers still bought and relied on the magazine as a buying guide, they would be victims of a deception.

Why raise these questions here? Because recent discussions of a proposed business venture with executives—we won't name the company—who have backgrounds in database operations made it clear that the threat to the integrity of publishing is real. "You should charge people to have items appear in your new product section," one executive said. Another suggested that we could attract advertisers to an issue by guaranteeing coverage of all the advertisers in that issue.

Respectable publishers rejected such tactics many years ago. Publishing executives who considered such tactics now would never be foolish enough to discuss them openly. But these executives with database backgrounds lacked all sensitivity to these issues. They saw the role of the publication as being simply to deliver information for companies that pay fees. There was no understanding that the publication has obligations to its readers.

To guard against the threatening degradation of publishing standards, users of databases and readers of magazines must demand to know the criteria for inclusion of material in a publication or a database. Does a vendor have to buy an ad, pay a fee, or offer some other consideration? Are those who refuse to pay excluded? Is a database comprehensive, covering every vendor, or only every vendor who pays? If the publication or database is comprehensive, do vendors who buy ads or pay other fees get preferred coverage or other special treatment?

BYTE pledges to disclose fully the conditions for inclusion of material in our electronic and print products: In all our current products, on-line and in print, editors decide all questions of coverage based solely on our understanding of the interests of our readers and subject to limitations of editorial space available. We may not always make the right choices in our coverage, but you know our standards.

—Phil Lemmons
Editor in Chief

BIX Happenings in February

We are planning a number of special BIX conference events for February, with topics in software, hardware, and communications highlighted.

Two events are planned in the area of data storage for small systems. The first will look at the new generation of very-high-capacity storage devices for personal computers. Magnetic hard disks with capacities of 200-plus megabytes will be the focus of this event. The second will be a discussion of the advances in recording medium and head positioning technology that are making high-capacity hard disks and very-high-density floppy disks feasible for small systems.

One of the areas of computer communications that has begun to receive a great amount of attention in recent years is microcomputer-to-mainframe links. A special conference is planned to look at the technical issues involved in terminal emulation (beyond VT52), the communications links involved, and microcomputer LAN-to-mainframe gateways.

While most programmers have adopted new languages, thousands of lines of scientific and engineering code are still being written in FORTRAN. A BIX conference will look at the current state of this venerable language and its role in "hard sciences" computing.

Contained within the new tax laws are sections with major implications for consultants, independent engineers, and freelance programmers. A special conference looking at these sections and how professionals can minimize the negative impact of the new rules will be continuing throughout this month.

Among the other conference events the BIX staff is planning are specials covering progress in the field of artificial intelligence and an examination of the current status of the U.S. space program.

BIX also provides public domain software, technical documents, and program listings from BYTE articles for downloading from the listings section.

For information on specific starting dates of these and other special conferences and conference events, join the system.news conference on BIX.

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

Organic Computing: Practical Biochip-based Systems Expected in Five Years

Primitive hybrid computers made from silicon and biochips are under development, and practical systems should be available within the next five years, according to speakers at the BioTech conference in San Francisco. The first prototype hybrids will use analog and digital logic to differentiate colors and feed that information into a computing device so that the system actually simulates the human eye.

At the heart of such a system, according to Richard Taylor, manager of Arthur D. Little's Applied Biotechnology Laboratory (Boston), are light-activated molecules that control the electron flow through the silicon chip. "The integration between the silicon and the organic biochips has already taken place," Taylor explained, "and the best features of the silicon and organic materials are being utilized." Taylor went on to say that the necessary biological molecules have been identified and have been put on silicon using methodologies such as molecular lithography and special thin-film technology for laying down reproducible protein patterns. Asked by Microbytes Daily which companies are developing silicon/biochip computers, Taylor wouldn't specify, stating that the information is proprietary and that a race is on between manufacturers to get the first practical system to the marketplace.

Among the basic biochip devices that have been developed are amplification and threshold switches, molecular diodes that use electron-transporting dyes, photomolecular memory arrays, and biomolecular interlocked electrode circuits. Once these devices get beyond the prototype stage, practical applications will include memory-intensive systems such as 3-D graphics displays, image processing and storage, robotics, and AI.

PC AT in Court: Micro Helps Produce Instant Transcripts

A Phoenix federal court is using an IBM PC AT to break a long-standing bottleneck in court procedure—the time it takes to get transcripts. Judge Roger G. Strand's courtroom now uses the computer to aid the court reporter in producing transcripts of proceedings. The computer can also be tied to Mead Data Central's LEXIS database of legal decisions so lawyers can do legal research from their desks.

The computer is hooked to a modified stenographic machine operated by a court reporter. The machine's output is normally a long tape with words represented by syllable marks. The tapes are unreadable by nonstenographers and must be transcribed with a typewriter or word processor. It can take days or weeks to produce a trial transcript, and such transcripts are vital for appeals and other proceedings.

In Strand's courtroom, the PC AT translates the transcript as it is created. The text is displayed on screens on the judge's bench and on the attorneys' tables as fast as it is typed in. This lets attorneys rephrase questions and review testimony without having to ask the reporter to read back the transcript.

"Primarily what it does is increase the speed and accuracy in a number of ways without increasing cost," Strand said. He added that the system could theoretically cut the time it takes to hear an appeal from weeks to hours. "Literally, a proceeding that took place on a Monday morning could be in the 9th Circuit [Court of Appeals; the court that hears appeals from Arizona] by 11 o'clock the same morning to be reviewed that day."

The system was developed by Xcribe Corp. (Torrey Pines, CA) and was provided to the court free by Xcribe and Mead Data Central for the test. It was installed by the National Shorthand Reporters Association.

NANOBYTES

John Sculley, Apple Computer's chief executive, forecasts trouble for cloners of IBM PCs. During his talk at the **Technologic Partners'** forum on the 1987 outlook for personal computing, Sculley said, "There will be some protected mode in IBM's future," referring to a move by IBM to a less-open architecture for its microcomputers. "The companies that are trying to be like IBM will have to be 100 percent compatible. A lot of compatibles companies will be squeezed out," Sculley claimed. . . . Speaking at the same forum, **Ed Esber,** Ashton-Tate's chairman, talked about Big Blue too. "IBM is going proprietary, first in silicon, then in communications, then in graphics. There's a big question about the operating system." Esber said, "There will be two standards in personal computing, or perhaps three. The IBM standard, the Macintosh standard, and perhaps the Microsoft standard if IBM goes proprietary.". . . Several sources at the conference claimed that the protected-mode DOS in the works at **Microsoft** for the 80286 processor is currently huge, with estimates ranging from 562K bytes to 1 megabyte. But another source disagreed, saying that versions distributed so far have included large amounts of debugging code and have performed well nonetheless. According to this source, the OS is totally new. . . . Another forum speaker, **Clyde V. Prestowitz,** a fellow of the Woodrow Wilson Center for Scholars and former counselor on Japan affairs to the U.S. Secretary of Commerce, said Japanese companies are rolling in cash and will try to buy U.S. firms that have strong distribution channels in this country. "Takeovers will solve the distribution problem in the U.S. for the Japanese," Prestowitz

continued

predicted. . . . **Quickview Systems** (Los Altos, CA) has upgraded its Zoomracks file manager for the Atari ST so that it can work as a picture database. Zoomracks II can link files from DEGAS, a color paint program, with Zoomracks data. Expect an IBM PC version of Zoomracks this year, Quickview said. . . . Another company has decided to go with DDL, the document description language from **Imagen Corp.** (Santa Clara, CA). Imagen says Ventura Publisher, designed by **Ventura Software** and distributed by **Xerox**, will be available with a DDL driver in the first quarter of next year. **Hewlett-Packard** and **Cordata** have also adopted DDL. . . . The newly formed **National Association of Desktop Publishers** (Boston) offers a bimonthly journal, buyer's guide, and discount admission to trade shows. Annual membership is $75, according to spokesperson Michael Mahoney, who said the group's purpose is to provide "a central source for solid information on desktop publishing.". . . **Signetics** (Sunnyvale, CA) claims its CRT display controller chip set, the Bit-Mapped Alphanumeric Processor, supports bit-mapped multiple fonts at the highest text-insertion rate of any similar device. One chip controls access to display memory, another manages windows—as many as eight—in hardware. Samples are expected in the second quarter. . . . Not everyone in **New Hampshire** is a lumberjack or an editor at a computer magazine. Last year, the state led the nation in most electronics workers per 1000 people. According to the **American Electronics Association**, 40 of every 1000 Granite State citizens were employed by the electronics industry. Neighbor Massachusetts was second (37 per 1000), and neighbor Vermont tied with California for third (23 per 1000).

Optical Disk System Uses Erasable Metal Alloys for Storage Media

An experimental read/write optical disk storage system under development at Hitachi's Thin-Film Research Center in Japan uses a thin-film, shape-memory metal alloy as the basis of the storage media. As with most optical disks, lasers are used to write information to the storage media, resulting in microscopic surface deformation on the disk. However, researchers have discovered that the shape-memory metal returns to its original shape when a higher-intensity laser beam passes over written-to areas. When the metal returns to its original shape, the data is, in effect, erased.

Hitachi America officials would not comment on the research project. But engineers familiar with both laser and shape-metal technology indicated that the success of such a project is feasible because of advances in vapor coating techniques for shape-memory metal alloys and the availability of small but powerful high-resolution lasers. Vapor coating enables engineers to deposit very thin layers of metal alloy onto substrate material in contrast to the more conventional method of rolling metal onto a base material.

After being formed into a particular shape, shape-memory metals are able to return to their original form when heated above a certain temperature. The force generated by the isotropic shift of the atoms is so great that a square inch of alloy can move a 50,000-pound object. Memory metal alloys commonly consist of nickel-titanium or copper-zinc-aluminum.

Scientists Try Using AI to Make Money

Scientists at the Oak Ridge National Laboratory in Tennessee are exploring the use of artificial intelligence techniques to help in the production of U.S. currency. One application is in the formulation of inks, where an expert system has been used in a somewhat limited sense to help in the mixing of ink components.

A more important goal is to develop a machine-vision system for inspecting printed notes. The current process is very labor-intensive, with each note requiring about 2 seconds to be examined by a trained worker.

Developing a system to detect flaws in printed matter as complex as a currency note is a formidable task. According to Carroll Johnson, a research scientist at Oak Ridge, the problem is compounded by the fact that machines might recognize flaws differently than humans do. For example, a human might immediately spot a flaw in George Washington's nose but miss a flaw in one of the many scrolls on a one-dollar note. A computer, however, might do the opposite.

The Oak Ridge group is surveying human inspectors to determine what mistakes they would most likely catch, the goal being to develop a model of human perception. Later, a machine-vision system will be tailored to emulate that model. The Oak Ridge group hopes to have a working currency-inspection system ready for the Bureau of Engraving by 1990. A similar system might also be used in the production of postage stamps.

Phoneme-based Speech System Recognizes Thousands of Words

Speech Systems (Tarzana, CA) has developed a speech-recognition device, called the Phonetic Engine, that differs from other similar systems in that it is based on phonemes—basic units of sound that are to spoken words what alphabetic characters are to written words—rather than on words or phrases. Current word-based systems are usually limited to 64 words, although one word-based system, from Kurzweil, can recognize 1000 words.

The Phonetic Engine, however, reportedly recognizes 40 phonemes that can be combined into more than 20,000 words. In addition, these words can be spoken in a natural way, without the speaker having to pause between each word.

The Phonetic Engine turns speech sounds into phonetic codes that are transmitted through an RS-232C line to a host computer. In the computer, a program called the Phonetic Decoder then changes the codes into text according to a dictionary of phonetic codes and a set of predefined syntax

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* Resistance: 2k ohms — 2M ohms, 4 ranges
* DC current: 2mA — 2A, 4 ranges
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* Input impedance: 10M ohm
* 130 x 75 x 28mm, weighs 195 grams

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structures. The company calls its system Empirical Artificial Intelligence. The system creates a speech-discrimination model based on a series of interconnected expert systems.

Although the system has some speaker-independent capabilities, it works best after it has been trained to recognize a particular user's speech; the user reads to the machine a sample of "phoneme-rich" sentences, which takes approximately 20 minutes. In a demonstration, a company representative read a preselected paragraph of text. The system took about two minutes to decode approximately one minute of speech.

The Phonetic Engine consists of two printed circuit boards housed in a small box that is connected to a host computer with a serial cable. Voice is input to the Engine through a telephone-style handset.

The Phonetic Decoder software is written in C and currently runs on a Sun desktop computer. The Phonetic Engine comes in two configurations. A development system, called the DS100, is available immediately for $52,000; the PE200, an end-user system, should be available next spring for $5000. The company wants to install the Engine on two IBM PC expansion boards and port the Decoder software to the PC as well.

At Supercomputer Center, Mac-to-Cray Connection Aids Researchers; Prodigy Boosts Macintosh

The San Diego Supercomputer Center (SDSC) is testing a micro-to-mainframe link that involves a Cray supercomputer and "supercharged" Apple Macintosh workstations. More than one thousand researchers around the country currently tie into the center's Cray X-MP/48 to solve extraordinarily complex problems, such as designing the hypersonic jet that might someday zip from New York City to Tokyo in less than three hours.

SDSC is experimenting with two Macintosh-based Prodigy 4 systems from Levco (San Diego, CA) and plans to buy more. The $7000 Prodigy 4 has a 16-MHz 68020, 68881 numeric coprocessor, 4 megabytes of RAM, and an SCSI interface. Curt Johnson, Levco's president, claimed that programs on the Mac Plus run 4 to 10 times faster with the Prodigy 4 installed, while programs optimized for the 68881 (using Apple-standard floating-point SANE routines) can run as much as 100 times faster.

One of the primary functions of SDSC's Cray is to generate graphics from engineering and scientific data. "The Macintosh would be ideal for viewing and accessing that graphic data," said Serge Polevitzky, manager of peripheral systems at SDSC, "but it's limited by its 8-MHz 68000 CPU to a 320K-bytes-per-second data-transfer rate," compared to 10 megabits per second available from VAX computers via Ethernet.

"The idea behind using the Prodigy is that it gives us an idea of what the next generation of Macintosh will be like so we can plan for it," Polevitzky told Microbytes Daily.

SDSC researchers are already using 83 Macintosh Plus computers as "user-friendly shells" to the Cray and VAXes, Polevitzky said. He foresees the Cray generating animated sequences of 30 frames per second that can then be interactively edited at one of the Levco stations or on a future Mac. "Right now, the Cray could crank all night on a given set of graphics output and upload to the Mac" and play back the different screens one at a time to provide a sense of motion, Polevitzky explained. "But you couldn't move the mouse and get a different view to see, for example, different parts of molecules moved around or rotated." Polevitzky said he hopes to have a shared editor that can run on both the Cray and the Mac to speed effective data transfer up to ten times by communicating only changes to the image. This would enable researchers to manipulate a model of a molecule and play "what if" games with an equation in a window.

"We see the Prodigy 4 as a window to the future," Polevitzky said. "We want to 'Crayize' researchers and computer scientists and get them thinking big. It's essential if the U.S. is going to maintain its lead in science."

Doctors Using Prolog Program to Diagnose Heart Attacks

Researchers at the Medical College of Ohio (Toledo, OH) are developing an expert system written in Borland International's Turbo Prolog to help emergency room doctors determine if patients have indeed suffered heart attacks. The expert program, part of a system called Expert Scene Segmentation, evaluates data collected by ultrasound scanners.

To determine if an attack has occurred, image data of the patient's heart is gathered using a Hewlett-Packard ultrasound scanner. That data is then sent to a computer that uses morphology algorithms (written in C) for analysis. This analysis defines the location of the heart's wall based on its "shape" in the image and defines a series of "edge" points that may or may not represent the wall. Due to the nature of ultrasonic imaging, some points may not actually represent the heart wall.

The data is then sent to an IBM PC AT running a 500-line 47-clause Turbo Prolog program that evaluates each edge point and decides if everything about the point agrees with the program's knowledge of both ultrasound and heart-wall geometry.

The program then selects 360 points that define the heart wall and discards those that do not. An output image, which consists of those points that have been retained, is generated and sent to a computer that analyzes motion and plots how each segment of the wall moves throughout the cardiac cycle. It then compares the resultant motion to known motion patterns, using pattern-recognition techniques, and produces a report the doctor uses to evaluate the functional state of the heart.

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Able, Not Willing

I have read with interest Paul Walton's article "The State of Soviet Microelectronics" (November 1986 BYTE). I feel entitled to a few comments, as I am personally experienced in this subject.

I am a political refugee from communist Poland, a naturalized U.S. citizen, an electronics engineer, and a manufacturer/exporter of computerized medical equipment to over 50 countries, including the U.S.S.R. Additionally, to my credits I have recently added 16 months' experience dealing with the U.S. Export Administration's variety of agencies, including the famous "Exodus," the U.S. Customs' high-tech counterespionage arm.

I am also under criminal investigation by the Federal Grand Jury for shipping to the Soviet Union for medical exhibition a Rat Respiration Monitor, which uses as a controller a Taiwanese IBM PC clone, (no hard disk, no color, 128K bytes of memory). Apparently the feds object to the shipping of a PC without an export license.

While I wholeheartedly agree that the technology to manufacture computers should be restricted, paranoia about export licenses for every PC is not justified. In every issue of Polish Warsaw Daily are multiple classified ads selling IBM PC/XT/ATs with a variety of peripherals. IBM maintains its offices in every communist country and is quoting and selling all models of the PC/XT/AT with short delivery times plus about 100 development programs, assemblers, compilers, etc. Companies from Taiwan and Hong Kong are offering to Soviet Bloc customers everything that is available in the U.S., with no restrictions, at prices even lower than those in the U.S. Our Western allies take convenient and lenient interpretation of COCOM (NATO Coordinating Committee) agreements and pay only formal attention to the export controls on any kind of personal computer made either in the U.S. or locally (i.e., in Italy by Olivetti or in Sweden by Ericsson, not to mention Japan).

Bulgarians, staunch Soviet allies, are assembling IBM PC XT clones with high-resolution monitor, hard disk, etc., from Taiwanese, Soviet, and Japanese components and are ready to sell them to anybody in the East or West. In fact, to prove my point and to defend myself from absurd U.S. Customs' accusations of being a "Soviet high-tech spy," I have imported one. It runs all IBM PC software as well or better than the original IBM PC XT.

The Department of Commerce has since purchased this Bulgarian "marvel" from me. In the meantime, American exporters are waiting three to six months for export licenses for products that are available at a moment's notice to Soviets from other countries. The only limitation for Soviets in obtaining a sufficient number of PCs is not the U.S. export controls, but the Soviets' lack of hard currency and ideological restraints. They are hesitant to allow PCs to fall into the hands of millions of Soviet citizens.

In fact, as Mr. Walton briefly alluded, current export controls may be very beneficial to the Soviet Union in the long run. Soviets will start to rely more on their own research and development rather than copying Western products. It is obvious to anyone who has anything to do with new products development that the best defense in competition is to keep our own research and development efforts high and our economy vital and uncomplicated. No company or country can prosper for long by picking someone else's brains.

If we will apply cumbersome licensing bureaucracy to every IBM PC clone sent, not only to the Soviet Union, but to Taiwan or South Korea, as current export regulations require, then we will slow down our own economy to the point where it will be similar to that of the Soviet Union. The Soviets will win the technological competition without moving any faster. They will also live in a country with civil liberties similar to American ones where anyone can be labeled (by the federal Exodus agents) a spy, threatened with 5 or 10 years in prison, have his property confiscated at whim, etc. This scenario is not a dreadful nightmare of the American future, it has already happened to me here in the United States.

Ironically, Pentagon hard-liners on computer exports have full support of their counterparts in the Soviet Bloc. Here is a translation of a recent statement made by Polish General Wojtasik, head of the department of propaganda and public relations of the communist Polish Peoples' Army:

"The tendency in the mass proliferation of (micro) computers is creating a variety of ideological endangerments (to the communistic system)."

"...Some programmers, under the inspiration of Western centers of ideological subversion are creating programs that help to form (in Polish people) anti-communistic political consciousness."

General Wojtasik is apparently not fully aware that he has full support in another (similar) professional organization on the other side of the Iron Curtain, located in Washington, D.C. Apparently, great minds always think alike.

Anyone who would like to know more about my experience with the Exodus superscope may call or write. Please be aware that my phone may be tapped and my mail may be monitored.

Jan Czekajewski
Columbus Instruments
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I have no quarrel with Paul Walton's facts, but I am startled by a matter of interpretation. My perception of the Soviets is based, not on direct experience, but on contact with the expatriate community while I studied the Russian language.

Mr. Walton seems to take the use of personal computers as an indicator of the level of microelectronic technology. I submit that these may be linked in our economic system, but not in the Soviets'. They seek to gain the most effective workstations possible for their loyal workers doing authorized work, while absolutely preventing the personal use of computers.

At present, those Soviet citizens who wish to circulate information not approved by the government (which controls all the printing presses) must type individual

continued

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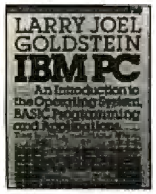

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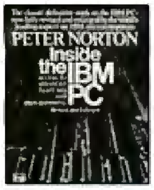

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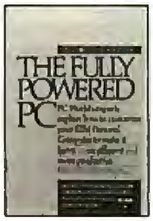

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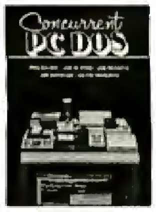

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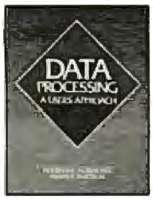

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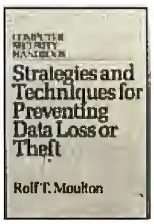

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copies one at a time. This is called *samizdat* (self-publishing). Access to photocopier machines is rigidly controlled. Computers that don't generate Cyrillic characters and word processors that run in English are additional assurance that if someone did get access to a computer, it wouldn't be much good for printing or duplicating information for use by the general population.

I can imagine very few things more destructive of government control of information flow than having a million stations equivalent to our Commodore 64, randomly distributed to private citizens, with perhaps a thousand in activist hands. Even a lowly Commodore 1541 disk drive can duplicate a 160-kilocharacter disk in four or five minutes. The liberating effect of not having to individually enter every character every time information is to be shared should dramatically increase the flow of information.

Information distributed in our society is mainly on paper rather than magnetic media for reasons of cost-effectiveness: The message gets to more people per dollar. The bottleneck of *samizdat* is not money, but time. If the computers were available at any cost, it would be more effective to invest the hours now being spent in repetitive typing into earning cash to get a computer, no matter how *long it* took.

If I were circulating information the government didn't like in the Soviet Bloc, I would have little interest in a modem—too easily monitored. But there is a brisk underground trade in audio cassettes of Western music. Can you imagine the headaches (literal and figurative) for security agents if text files were transported by overwriting binary onto one channel in the middle of a stereo cassette of heavy metal music? One would hope it would be less risky to carry such a cassette than a disk, let alone a compromising manuscript.

At any rate, I wouldn't take the Soviets' retarded state of personal computing as an indicator of their capability in any field they want to develop.

Harry R. Meyer
San Diego, CA

Good Enough for Me

I was interested in your preview of the Apple IIGS (October 1986); not necessarily the machine itself, but in your incidental comments.

The fact that Apple has chosen a "conventional" design for its GS says more about the state of the marketplace than about the state of Apple's technology. Is the machine "weighted down" by its "venerable and outdated" architecture? Really?

continued

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And the LDP-2000's access speed is really impressive: under 1.5 seconds from frame 1 to frame 54,000.

Of course, the LDP-2000 is an integral part of the Sony View System, the only totally integrated intelligent video system.

But if all you need now is a videodisc player, remember Sony's is the only one that won't box you in.

For more information or to arrange a demonstration, write to: Sony Information Center, Dept. A, P.O. Box 6185, Union, N.J. 07083.

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It appears to me that the problems in the microcomputer industry have more to do with the attitude that change is essential than with any other cause. This especially applies to the "home" side of the industry, where consumers must spend their own hard-earned money.

Most magazines, your own included, tend to criticize a manufacturer for not installing the latest, up-to-the-second chunk of hard stuff inside its GFRgLBx micro (love all those consonants!). Most manufacturers are more than happy to provide ever-new incompatible GFRgLBxes in the hope that hardware-hungry consumers will replace last month's $5000 item with this month's $6000 item, while having to "upgrade" with new versions of software they already have! But who has the dough for this kind of game?

In that kind of market, software cannot keep up. And *software* is what computers are really all about. That is, what they do must be more important than what they are.

Do you care, for instance, how your vacuum cleaner works, or just that it does its job? And would you buy a new vacuum cleaner solely because it has a new alloy in its motor, even if your current one is still working properly? And would you buy a vacuum cleaner that can also strip the old varnish from hardwood floors if your plywood floors are covered with carpet? Similarly, what user really cares that his microprocessor only has a 16-bit-wide data bus and the current latest is 73?

Hey, don't get me wrong; I like computers for what they are. I get a big thrill if I can make my disk drives read a chunk of data a quarter of a second faster. (Jeez, now I've got the time I need to conquer Europe!) I would love to be able to insert a whole meg of RAM into my computers, even though I could never use it all (if I could do it for free). But in the end, I have to *use* my "obsolete" machines, and since they do their jobs satisfactorily, I don't intend to buy more plastic.

Getting back to Apples: The attempt to make the new machine compatible with earlier IIs shows that the company is sensitive to the needs of the user, as opposed to the desires of the "buff." If I were looking for my first computer, I would want to know that it could run readily available, tested software. Furthermore, if I did not intend to become a computer hobbyist, I wouldn't care how it accomplished what it did.

You say that the GS will "ironically" suffer from the traditional lack of software upon its introduction. At least the consumer will be able to tap the vast market of existing Apple II software while waiting for the fancy new stuff and still be able to look forward to making the new features sing when machine-specific software finally arrives. That's a lot more than can be said for recent releases from other companies.

On the other hand, I agree that the II would suffice for most home and school users at a lower cost, and for that reason it will likely continue to be a mainstay. This doesn't show any weakness on Apple's part, but rather the strength of its original design and its adequacy for the majority of users at whom it is aimed. If Apple were to reduce its II prices further, it could knock a lot of the newer, "unobsolete," and flashier machines out of the water. Bundle it with software, a color monitor and disk drive, charge a reasonable price, then watch.

To sum up, I have this ugly feeling that the industry is headed for a bad fall if it expects the consumer will forever be compelled to spend salaries or profits on so-called high-technology upgrades or expensive, overengineered first machines. The companies that last will (like Apple and IBM) continue to provide machines that are reliable and offer a large and varied software base. Some decline is to be expected anyway, since computers don't wear out like cars and the market is only so big.

Please be aware that I am not an apologist for Apple; they can look after themselves. I don't even own any Apple products. (I'm an Acorn user and edit an Acorn newsletter.) What I am is a computer user who wonders what all the yelling about technology is accomplishing. I use my camera to photograph, my car to drive, and my computers to compute. What else really matters?

John Lasruk
Toronto, Ontario, Canada

More on Pan-Reif

In connection with the Pan-Reif iterative method of matrix inversion treated in your "number crunching" issue (April 1986), an important variant due to Alan Mackay of the University of London (*Practical Computing*, September 1981) might interest the analysts among your readers.

To possess a conventional "inverse," a matrix must be square; but Mackay proposes an $m \times n$ "generalized inverse" $B(m,n)$ of the $n \times m$ rectangular matrix $A(n,m)$, defined by an iteration $B_k \rightarrow B$, $k = 1,2,\ldots$ If I denotes the unit matrix, the iteration is either

$$B_{k+1}(m,n) = B_k(m,n) \times [2 \times I(n,n) - A(n,m) \times B_k(m,n)]$$

or

$$B_{k+1}(m,n) = [2 \times I(m,m) - B_k(m,n) \times A(n,m)] \times B_k(m,n),$$

continued

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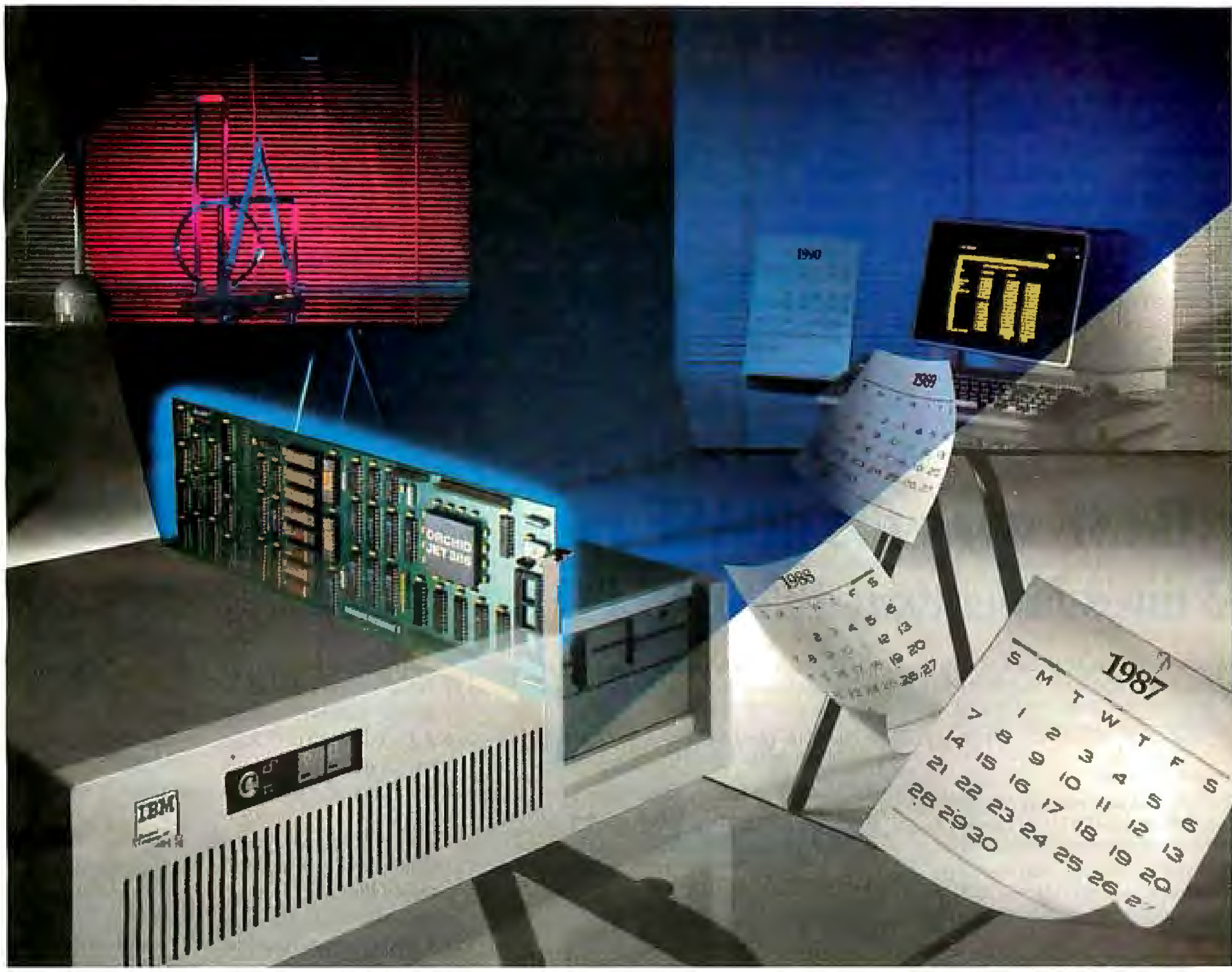

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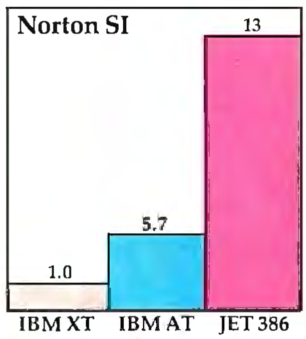

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the first (right inverse) being computationally more efficient for the case $m>n$ and the second (left inverse) for $n>m$. Iteration may be halted when the trace (sum of diagonal elements) of the product matrix $A \times B_k$ or $B_k \times A$ in the square bracket ceases to increase. For an initial value, Mackay uses $B(m,n) = k \times A(m,n)$, where $1/k$ is the sum of absolute values of all entries of the product matrix of $A(n,m)$ and its transpose $A(m,n)$.

Though slower than Pan-Reif, the Mackay iteration possesses even more remarkable stability properties, inasmuch as it converges regardless of whether the system of linear equations to which it corresponds is over- or underdetermined, and it shows excellent tolerance for redundancy of those equations, singularity of A, etc. If n represents the number of equations, input data, or linear constraints and m represents the number of unknowns or adjustable constants, either of the above iterations generally converges to a "best approximate" inverse matrix, whether $n>m$, $n = m$, or $n<m$. These properties make it of interest for small as well as large matrix inversions. (Pan-Reif iterations are of practical interest only for large matrices.) In the overdetermined case ($n>m$), the approximation is best in the least-squares sense; so, least-squares fitting is accomplished automatically. In the $n<m$ case, even more remarkably, the process assigns best-available values to all unknowns, furnishing a full solution set of m smallest (otherwise nonunique) numbers consistent with the (inadequate) input data. The importance of such a capacity for stable control (e.g., of robots operating in uncertain, off-design, or data-impoverished environments) is apparent. Mackay's generalized inversion concept should prove to be of broader interest in mathematics.

Thomas E. Phipps Jr.
Urbana, IL

Teachers'BBS

I am a teacher who, over the past two years, has gotten into using computers; not because I wanted to but because I needed computers in order to do my work as an educational program evaluator. In doing this, one of the areas that I have been interested in is telecommunications. Thus, I have spent a lot of time on local and sometimes far-remote bulletin board systems and I have found out that most of these systems carry the same kinds of programs and educational administration and evaluation.

Since it is evident that there are no bulletin-board systems for educators to exchange ideas on issues, nor to exchange applications which they have developed for program evaluation and administration, nor to learn about others' "impressions" on instructional software, I am setting one up for this purpose.

I would appreciate it if you would inform your readers about this service. I would also appreciate any comments or ideas you or they may have on making this BBS useful to educators. If anyone has any questions or would like to discuss this further, please leave me a message on the BBS at (616) 754-3077.

Marianne C. McFall
Greenville, MI

The Cowboy Did It

I have just read the Mathematical Recreations article entitled "Paradoxes of Probability" by Robert T. Kurosaka (November 1986). I draw your attention to the last part of the article, "Poker Challenge."

Mr. Kurosaka must be fairly young; I would guess under 30. Were he older, he might remember a TV show popular in the late 1950s called "Maverick," in which this hustle was illustrated.

Bart Maverick was a member of the jury

continued

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Inquiry 14

in a typical "western" murder trial. Maverick and all the jurors save one had all agreed to acquit. Maverick bet the remaining juror that he (Maverick) could make five "pat" hands out of the first 25 cards dealt from a deck. If successful, the odd man would change his vote to acquittal; if unsuccessful, Maverick would change his vote to guilty.

As Kurosaka indicates, Maverick won and that ended the story. When asked how often that could be done, Maverick said it worked almost every time. He called it "Maverick Solitaire."

While I was in the Navy in the mid-sixties, I won a lot of money and drinks with this same hustle. I can't remember the last time I was unsuccessful.

Scott Wagner
Park Ridge, IL

Anybody Here Seen Loglan?

This is a call to whomever may know the whereabouts of any current research or activity in Loglan.

Loglan is an artificial *human* language developed by James Cooke Brown. It has grammar that is based on the laws of formal logic and a vocabulary derived algorithmically from the corresponding words in the eight largest natural languages. The rules of spelling and pronunciation are designed so that any given string of spoken Loglan syllables can be parsed into words in only one way; this makes the language uniquely suited for machine transcription. The overall goal was to design a language with minimum ambiguity that could still express the full range of human thought.

It strikes me that with the proper software, current personal computers could serve as Loglan tutors; besides its potential as an international auxiliary tongue, Loglan could become the lingua franca of intelligent machines. It might also serve as an intermediate stage in machine translation between the eight natural languages.

James Cooke Brown hoped to test certain theories of linguistic philosopher Benjamin Lee Whorf. If people could become fluent enough in Loglan to think in it, the clarity and efficiency of their thinking should improve. I have not heard whether this level was reached; the most recent material I have found is from 1975. Loglan research was always a shoestring affair, largely financed by Brown himself. If the language could be made available to computer hobbyists, much more might be done.

If anyone knows the current status and whereabouts of Loglan research, please write to me:

John Hodges
P.O. Box 912
Blacksburg, VA 24060

FIXES

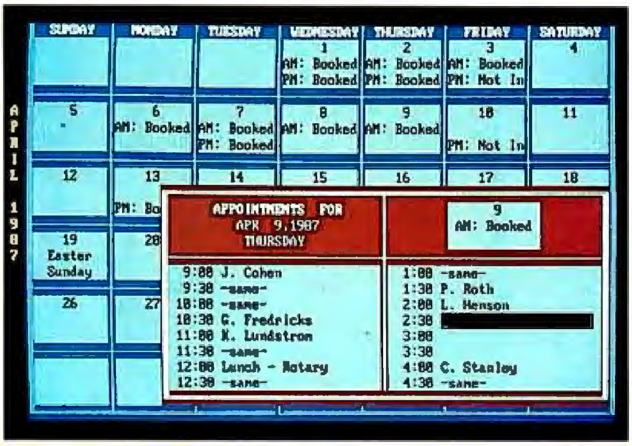
Protected-Mode Program

Ross Nelson's "A Protected-Mode Program for the PC AT" (BYTE's *Inside the IBM PCs*, Fall 1986) included some MASM source code. When the code was written, only version 2.0 was available. Now, a number of people have the latest version (4.0) and the code will not assemble properly. The solution is to remove the statement INCLUDE protect.inc and change the line .286C to .286P. Thanks to BIXer "scoles" for pointing this out.

Version of Turbo Pascal

Douglas F. Yriart, in his article "Using DOS Functions from Turbo Pascal" (December 1986), states on page 105 that the program DirectoryDemo compiles correctly with version 2 and 3 of Turbo Pascal. After further testing, we have found that it compiles correctly only with version 3. ■

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



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

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

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

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

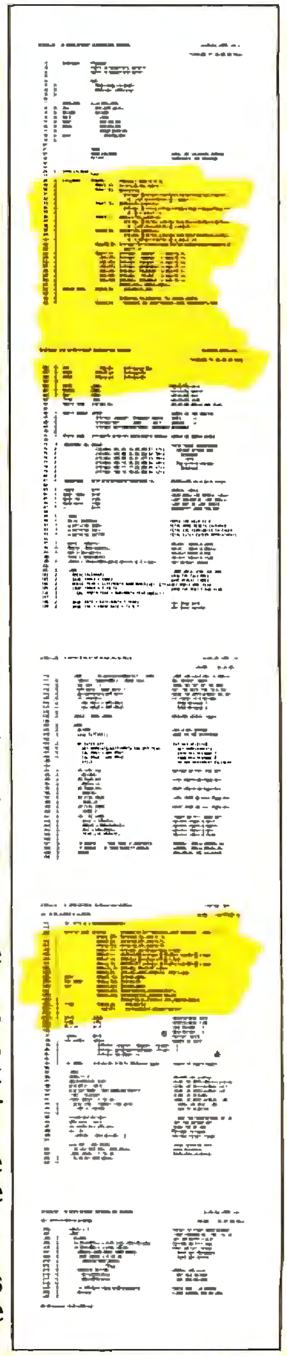
CLARION knows that a PC monitor is refreshed from memory, so it treats a screen layout like a group of variables. Just move data to a screen variable, and it shows up on the monitor.

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

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

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

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



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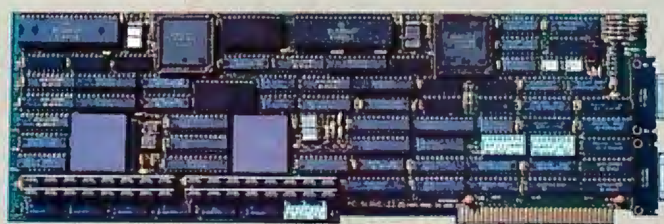

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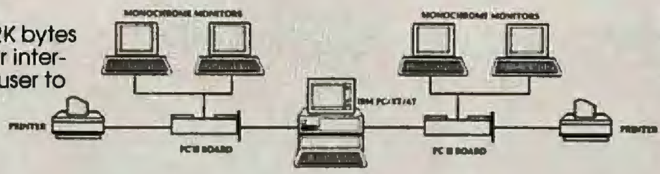

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Text and Graphics on the Apple IIGS

GraphicWriter is a word processor that enables you to mix graphics and text on the same page. Left, right, center, full justification, and multiple line spacing are all standard. Basic fonts and styles are also included, and a paint palette gives you a choice of 48 colors in which to print. Along the bottom of the screen are object-oriented graphic tools that you can incorporate into your documents. The program also has a feature called Canvas Mode, which lets you draw freehand and also import graphics from other programs.

GraphicWriter is compatible with Imagewriter II and LaserWriter printers. The program costs $149.95. Contact DataPak Software Inc., 14011 Ventura Blvd., Suite 507, Sherman Oaks, CA 91423, (818) 905-6419.
Inquiry **550.**

Epson's Equity III+ has an 80286 that can run at three speeds.

New Equity Adds Slots, Speed

Epson America's newest addition to its Equity line, the Equity III+, is compatible with the IBM PC AT and has an 80286 processor that can run at three different clock speeds: 6, 8, and 10 MHz (all with one wait state). The clock speed is selectable from a front panel switch. The III+ has nine full-size expansion slots, seven of which are compatible with the PC AT's 16-bit bus. System architecture supports real address and protected virtual address modes.

A unique feature of the system is that the standard memory and ROM BIOS chips are on a removable board. Also, you can remove the motherboard itself by sliding it out through the front of the machine.

The Equity III+ comes with a 1.2-megabyte floppy disk drive, 640K bytes of memory (expandable to 15.5 megabytes), 64K bytes of ROM (selectable EPROM pairs; expandable to 128K bytes), MS-DOS 3.2, and GW-BASIC for $2695. An enhanced version, which features a 40-megabyte hard disk, costs $3895.

Among the available extras are a color graphics adapter, multimode graphics adapter, EGA-type board, and color and monochrome monitors.

For more information, contact Epson America, 2780 Lomita Blvd., Torrance, CA 90505, (213) 539-9140.
Inquiry **551.**

Data Logger for Industry and Science

Designed primarily for industry and laboratory applications, Loggernaut is a hardware/software combo for the IBM PC that provides data logging, trend recording, alarm monitoring, and data collecting capabilities. Cyborg says Loggernaut, with 14-bit A/D resolution, 500-volt isolation, and the ability to connect directly to sensor inputs, is well suited to batch and process monitoring, quality testing, and on/off machine control. It is also designed for situations where data from instruments and sensors is collected and analyzed during various lengths of time.

Hardware consists of an interface card that plugs into a slot in the PC's backplane and an outboard sensor I/O board; the I/O board has 16 channels for analog input, 8 channels for digital input, and 8 for digital output. You can link as many as four of these boards on a single interface card for 64 analog input channels, 32 for digital input, and 32 for digital output. The on-board digital input channels can be used to monitor switches, relays, and triggers. The digital outputs are designed to be controlled by alarm conditions set on the analog input signals.

The menu-driven software lets you define scans of up to 64 analog input signals as well as digital input and output. Scans can occur at intervals you define or can be event-driven. Data can be logged to disk automatically. Each channel is converted to engineering units. The software continues to scan and log data even while you edit signals, calculate, and handle setup routines. When an alarm condition arises, Loggernaut can change scanning conditions, switch a process on or off, print data, change the display, or log data to disk. The software also lets you display as many as 16 channels simultaneously in strip charts or bar graphs.

The basic Loggernaut system described here costs $2950. For more information, contact Cyborg Corp., 55 Chapel St., Newton, MA 02158, (617) 964-9020.
Inquiry **552.**

Integrated Business Program for the Macintosh

Monogram Software has announced Business Sense, a $595 integrated business program for the Macintosh and Macintosh Plus. The program includes general ledger, accounts payable, and accounts receivable modules. The modules work together, so that when you enter information into the accounts receivable or payable modules, the general ledger is automatically updated. An

continued

audit trail is created in the update process.

You can use the program in a multi- or single-user environment. File locking capabilities ensure data integrity in a multiuser system. Business Sense requires a minimum of 512K RAM and an Imagewriter for printing reports.

For more information, contact Monogram Software Inc., 8295 South La Cienega Blvd., Inglewood, CA 90301, (213) 215-0355.

Inquiry **553.**

Epoch is a program for future astrodynamicists.

Dynaperspective lets you model solids in 3-D.

Three That Teach

Children between the ages of 5 and 8 can learn the concepts of addition and subtraction with the series of graphic routines offered in 1st Math, a $39.95 program from Stone and Associates. Equations, Construction, and the Freight Depot Game are the routines included.

Designed to run on the IBM PC and compatibles, the program requires 128K RAM, MS-DOS or PC-DOS 1.1 or higher, and a color graphics card. For more information, contact Stone & Associates, 7910 Ivanhoe Ave., Suite 319, La Jolla, CA 92037, (619) 459-9173.

Inquiry **554.**

Epoch is an elementary orbital mechanics package intended for current and future astrodynamicists from high school age and up.

The program was designed at Virginia Polytechnic Institute by an aerospace engineering graduate student. The primary goal was to offer access to space mechanics problems from within the microcomputer environment. The result is a program that can be used in the classroom, as a pocket research guide for calculations at the college level, and as a first-guess generator for industrial applications that use mainframes.

Epoch is made up of 10 modules that you can access from the main menu. To run the program you must have an IBM PC XT or compatible with MS-DOS or PC-DOS 2.1 or higher, an EGA or CGA, and a color or monochrome monitor.
or monochrome monitor.

The program costs $49.95. For more information, contact Epoch International, P.O. Box 670, Blacksburg, VA 24060, (703) 961-3535.

Inquiry **555.**

Botanical Gardens has a seed room where students choose seeds; a library where they can read about the plants; two greenhouse gardens where the seeds will grow; and graph rooms where students will record the environmental variables of light, soil, heat, and water. The program, geared toward students in grades 6 through 12, teaches how to collect experimental data and calculate averages. Students also learn to interpret data from graphs and gain insight into the advantages of systematic problem solving through control of variables.

The program sells for $59 and runs on Apple IIs with 64K RAM. For more information, contact Sunburst Communications Inc., 39 Washington Ave., Pleasantville, NY 10570, (800) 431-1934; in New York, (800) 221-5912.

Inquiry **556.**

Solid-Surface Modeling in Three Dimensions

Dynaperspective is a three-dimensional solid-modeling graphics program that combines line, shape, form, color, and shade to create renderings in two- and three-dimensional formats. It is based on solid-surface modeling using hidden-surface functions rather than wireframe modeling. You can view the renderings you create from any perspective within seconds, according to Dynaware. You can also present renderings with full surface color and light-source shading.

The main menu features draw, attribute, select, edit, grid, region, and screen selections. Extra is another selection that includes resident screen options such as calculator, ink control, and viewing parameters.

Other features include a library of frequently used symbols, walkpath capabilities for slide-show presentations, and pull-down menus with user-friendly icons.

Dynaperspective costs $1850 and runs on IBM PCs, ATs, XTs, and compatibles with 640K RAM, a graphics card, and a monitor. For more information, contact Dynaware Division, Sun Grade Inc., 1309 114th SE, Bellefield Bldg., Suite 316, Bellevue, WA 98004, (206) 451-0200.

Inquiry **557.**

Coprocessor Board Has Four 5-MIPS NEC Chips

Data Flow Imaging's peripheral processor board for the IBM PC contains four 5-MIPS NEC μPD7281 data-flow, or token-passing, processors that work in parallel with the PC's CPU. Suggested applications for the DF-1 include array processing, circuit simulation, digital signal processing,

continued

image processing and compression, data encryption, and graphics manipulation. The company claims that any algorithm that performs repetitive processing on big streams of data should run well on this board.

Besides its pipelined architecture, the chip has a 17- by 17-bit hardware multiplier; because of its inherent parallelism, Data Flow says, the processor is well suited to matrix multiplications. The DF-1 also has 128K bytes of local image memory and an NEC µPD9305 memory access and bus-interface chip.

The board supports DMA data transport between the PC's memory and the DF-1's image memory. It can be set up to use interrupt-driven communications with the CPU of the PC. For $995, the DF-1 package comes with a manual, demo software, sample code, a menu-driven monitor program, and C interface software. Or you can buy the board without the NEC chips for $695.

Contact Data Flow Imaging Inc., P.O. Box 116, Westwood, NJ 07675, (201) 666-7970.
Inquiry **558.**

Video Digitizer for the Apple IIGS

AST Research has developed a video digitizer for the Apple IIGS. The AST-VisionPlus is a single board that plugs into the IIGS and lets you send video images (color or black-and-white) into your computer from any NTSC device such as a video camera or a VCR. You can then display a live image or store the image and work with it later. With appropriate software—such as AST's companion program, VisionEffects—you can manipulate digitized images by painting in colors, changing gray-scale levels, zooming in and out, altering aspect ratios, and using a "pencil" tool.

Because pictures are stored in standard IIGS format, you can enhance and alter them using graphics and paint programs that work with that machine. Output can be sent to an Imagewriter; when the necessary drivers are ready, output can be sent to a LaserWriter, a spokesperson said.

Image generated on an Apple IIGS using AST-VisionPlus.

AST-VisionPlus has black-and-white resolution of 320 by 200 and 640 by 200 pixels; color resolution is 320 by 200. It can display 16 colors at the same time and has a memory buffer of 128K bytes.

The board comes with AST-VisionEffects software and sells for $295. Contact AST Research Inc., Apple Products Division, 2121 Alton Ave., Irvine, CA 92714-4992, (714) 553-0340.
Inquiry **559.**

Publishing Systems Mix Micro, Laser Printer, Scanner

Canon has packaged an IBM PC AT-type microcomputer, a laser printer, and an image scanner as its Desktop Publishing System. The 8-MHz computer comes with a 20-megabyte hard disk, 640K RAM, 1 megabyte of EMS memory, and a printer controller. The Canon Laser Beam printer comes with a high-speed video interface. And the IX-12 image scanner has a resolution of 300 dots per inch. A color graphics monitor is also part of the configuration.

The system uses editing/page-makeup software developed by Beyond Words (Fairfax, CA). The software lets you create layouts with multiple columns, horizontal rows, and headers and footers. You can also switch layout and composition style of a whole document automatically or selectively. The word processor features search/replace, copy, and undo commands and supports keyboard macros. All text editing and manipulating is done on the composed page in WYSIWYG format.

A windows feature lets you see two views of the same material; you can transfer text between windows. The program offers nine levels of zooming; complete editing capability is available at each level. You can choose and use typefaces from ITC, Compugraphic, and Bitstream.

The Canon Desktop Publishing System costs around $10,000 (that's as definite as Canon would be at press time). Contact Canon U.S.A. Inc., One Canon Plaza, Lake Success, NY 11042-9979, (516) 488-6700.
Inquiry **560.**

Cordata has also put together a desktop publishing system. Intellipress consists of Aldus Corporation's PageMaker page composition software (running under Microsoft Windows), a PC A' mpatible computer, a laser printer, a 15-inch display monitor, and a mouse. A digital scanner is sold as an option.

The 80286-based computer features 640K bytes of RAM, a 1.2-megabyte floppy disk, and a 30-megabyte hard disk. The laser printer outputs eight pages per minute at 300 dots per inch. It has 1.25 megabytes of RAM. The WYSIWYG black-on-white monitor has a resolution of 1280 by 800 lines. The optional Cordata scanner offers resolution of 300 by 300 dots per inch, 16 shades of gray, and a scan rate of five pages per minute.

The Intellipress system sells for $11,995. The scanner costs $1495. For more information, contact Cordata, 275 East Hillcrest Dr., Thousand Oaks, CA 91360, (805) 495-5800.
Inquiry **561.**

In-Circuit Emulator for Intel's 80386

New Micro's in-circuit emulator for Intel's 80386 is a self-contained unit that runs with IBM PCs, XTs, ATs, or compatibles or with a MicroVAX using VMS or Ultrix. The MICE-32/80386 implements architecture that features 32-bit-wide registers and a 104-bit-wide trace buffer.

Other features include 256K bytes of software-mappable memory, a conditional trace buffer (allowing you to

continued

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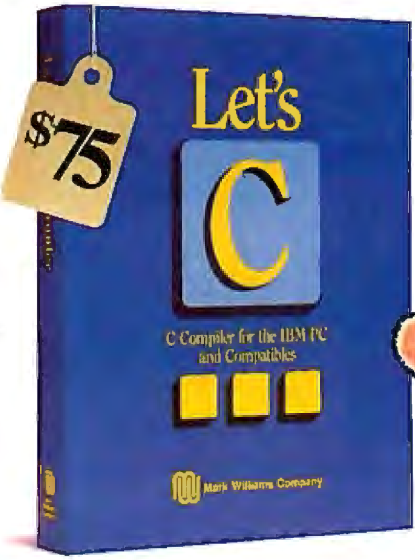

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specify only those machine cycles to be stored in the trace buffer), a 2048- by 104-bit trace buffer, with room enough for eight external hardware signals, real-time emulation at up to 16 MHz, and six breakpoints. The device also has two serial interfaces, or one serial and one parallel interface.

The emulator supports real and protected addressing modes; pipeline and non-pipeline address modes; multiprocessor synchronization; dynamic bus sizing, bus breakpoints, execution breakpoints, and external trigger breakpoints; and, according to New Micro, all stepping modes, including cycle and instruction stepping. The 386 emulator costs $14,000.

To go along with its emulator, the company sells a language-oriented symbolic debugger that supports windowing, user-created macros, and waveform analysis. It also supports all Intel 8/16 OMF files. Features include an arithmetic and logical expression evaluator for use with macros, auto-execution, and provisions for user-defined softkeys. MSD-3 works with any host running DOS, VMS, MicroVMS, Ultrix, or UNIX. The PC software sells for $840; a version for a MicroVAX is $1650.

Contact New Micro Inc., 16901 South Western Ave., Gardena, CA 90247, (213) 538-5369.
Inquiry **562.**

Add a Fax

Used with Microtek's image scanners (MS-300A or MSF-300), Microtek's MFAX card turns an IBM PC into an intelligent facsimile system. Compatible with CCITT Group 3 fax units, MFAX can transmit and receive documents to and from other fax devices at 9600 bps. The scanners can process text, line art, or photos for transmitting through MFAX to other fax machines. Or ASCII documents generated by the host and stored on the screen can be sent using the card.

The bundled software allows for storage of as many as 9999 phone numbers, which can be dialed automatically or manually. You can use delayed transmission for sending multipage documents to several locations. Other features include polling; recording times, dates, and number or pages; and support for a speaker phone.

The MFAX card costs $995. Contact Microtek Lab Inc., 16901 South Western Ave., Gardena, CA 90247, (800) 654-4160; in California, (213) 321-2121.
Inquiry **563.**

Meanwhile, Electronic Information Technology has revamped its facsimile interface board, pc-FAX, to include PC-to-PC communications software that lets you poll and receive most disk files, including executable programs, source code, command files, ASCII and fax files, and scanned images. It also handles CCITT Group 3 transmissions between fax machines and microcomputers.

The card slips inside an IBM PC and hooks up to a standard phone line. It can then serve as a 9600-bps modem. In addition to a device controller and modem, pc-FAX comes with menu-driven software that provides image handling, text-image merging, ASCII-to-fax conversion, and all CCITT functions.

The package retails for $1095. A program that lets the fax machine double as an optical scanner retails for $495. Contact Electronic Information Technology Inc., 373 Route 46 W, Fairfield, NJ 07006, (201) 227-1447.
Inquiry **564.**

9-pound MS-DOS Machine with Supertwisted Screen


Datavue's Spark comes with a supertwisted birefringent screen.

Datavue's 9-pound MS-DOS machine, the Spark, runs an 80C88 at 4.77 or 9.54 MHz and comes with one 3½-inch 720K-byte floppy disk drive, 384K bytes of DRAM, and a blue-on-gray supertwisted crystal birefringent screen. The Spark has external RGB, composite, serial, and parallel ports. You can add another 3½-inch disk drive, an internal 300/1200-bps modem with two RJ-11 jacks, an electroluminescent backlit screen, and a board holding 256K bytes of memory.

The screen displays 80 characters by 25 lines and has bit-mapped graphics capability. At medium resolution, it displays 320 by 200 pixels; at high resolution, 640 by 200. The portable is equipped with an AC power adapter and will run for eight hours on rechargeable nicad batteries.

The Spark is manufactured in Japan using surface-mount technology, a spokesperson said. The basic model sells for $995. A second 3½-inch disk drive costs "under $200"; an internal modem, "less than $300"; and a 256K-byte memory board, "less than $100."

For more information, contact Datavue Corp., One Meca Way, Norcross, GA 30093-2919, (404) 564-5555.
Inquiry **565.**

Silk

Daybreak Technologies has announced Silk, a $149 spreadsheet for the IBM PC. According to Daybreak, Silk offers continual help, English-language formulas, and recording of keystrokes. The program also lets you create allocation and time-series models, and a validation command lets you create a menu of data-entry choices and acceptable data characteristics. Also included is a circular reference trace feature that pinpoints causes of circular references and a goal-seeking command that replaces complex "what if" commands.

The spreadsheet has 265 columns by 2048 rows (or 524,288 cells). To run the program you need at least 512K RAM and a monochrome or color monitor. The program supports the 8087 and 80287 coprocessors and the EGA and Hercules card. For more information, contact Daybreak Technologies Inc., 2271 205th St., Suite 103, Torrance, CA 90501, (213) 212-3030.
Inquiry **566.**

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*as reported in Micro Cornucopia, August-September 1985. Turbo Pascal is a registered trademark of Borland International.

AT-compatible Tandon Targa

Tandon designed several custom chips and put them on a six-layer VLSI system board for the heart of its PC AT-compatible Targa. That same board accommodates both serial and parallel interfaces, so you don't need to buy an accessory card. A binary video card supports monochrome and color graphics monitors.

The Targa's design is compact. Set up horizontally, the main box takes up a space 12.6 inches wide and 15.7 inches deep; standing vertically, the footprint is 6.3 inches wide and 15.7 inches deep.

A 30-megabyte 3½-inch Winchester disk drive comes with the Targa, which also has a 1.2-megabyte floppy disk drive. The main board can support 1 megabyte of RAM without using any expansion slots; five full slots are available in the main unit. For software, the Targa comes with MS-DOS 3.2 and GW-BASIC.

The machine's 80286 can run at either 6 or 8 MHz.

The Targa costs "under $3000." For more information, contact Tandon Corp., 20320 Prairie St., Chatsworth, CA 91311, (818) 993-6644.
Inquiry **567.**

Tandon's Targa is a compact AT-compatible.

386-based PC, Two Diskless Workstations from Multitech

Multitech has brought out an 80386-based microcomputer that it claims can run AT applications as much as three times faster than IBM's machine and can operate under MS-DOS, UNIX, or XENIX. The basic Multitech 1100 comes with 1 megabyte of RAM on the main board, a 1.2-megabyte floppy disk drive, a 40-megabyte hard disk drive, a floppy/hard disk controller board, a battery-backed clock/calendar, two serial ports, a parallel port, and a keyboard. There's room for five half-height 5¼-inch storage devices and a socket for an 80287 math chip.

Of the eight expansion slots, two can handle XT-type boards and three are for AT-compatible boards. Of the three 32-bit slots, one is a dedicated 32-bit memory bus and two accept AT boards.

The basic Multitech 1100 costs $3995. With an 80-megabyte disk, the 1100 costs $5995; with a 130-megabyte disk, $6495. A color graphics board sells for $379; a color display for $599.

Multitech's two new diskless workstations, the LAN 900 and the LAN 500, are compatible with IBM's PC AT and regular PC, respectively. The LAN 900 has an 80286-based CPU, 640K RAM expandable to 1 megabyte on the motherboard, a video controller, a floppy drive controller, two serial ports, and room for a 5¼-inch half-height storage unit. With an ARCNet LAN card, it sells for $1499; without the ARCNet card, it's $1299.

The 8088-based LAN 500 comes with 512K RAM expandable to 640K and can take two 5¼-inch half-height floppy drives. Like the LAN 900, it also has a monochrome graphics adapter, a high-resolution display, and a parallel port. With the ARCNet card, it costs $1059; without, $759.

Contact Multitech Electronics Inc., 1012 Stewart Dr., Sunnyvale, CA 94086, (408) 773-8400.
Inquiry **568.**

Single-Board 80188-based Computer

The Micro-Link STD-206 is a general-purpose STD-bus computer based on the 16-bit 80188 central processor. The company says that even though the card uses the 80188's 8-MHz clock, it's still fully compatible with the 4-MHz STD-Z80 bus; accesses to the bus are synchronized to the slower speed. The card accesses its on-board RAM without wait states; the lowest 64K can be accessed by an external DMA controller (a disk controller card, for example). The board also provides dual DMA channels, three counter/timers, two serial ports, an 8-bit parallel port with DMA, and a multisource interrupt controller. It supports Z80 vectored interrupts and the Z80 return-from-interrupt op codes. The 80188 interrupt controller can provide vectors and prioritization for all or some of the on- and off-board interrupts.

Besides 256K bytes of parity-protected DRAM, on-board features include two 28-pin JEDEC sockets for EPROM or static RAM and an SBX connector to permit piggybacking standard I/O boards.

The STD-206 costs $475; quantities of more than 100 are discounted 20 percent. The board comes with a two-year warranty. For more information, contact Micro-Link Corp., 14602 North U.S. Highway 31, Carmel, IN 46032, (800) 428-6155; in Indiana, (317) 846-1721.
Inquiry **569.**

Multiuser 32-bitter Designed for OEMs

Future International says its 80386-based XA-600 can operate in multiuser, multitasking environments or as a single-user 16-MHz system running PC AT programs. The XA-600 can address as much as 16 megabytes of RAM and can switch from MS-DOS to UNIX. It comes with 4 megabytes of RAM (expandable to 16) on the system board. Storage options include 1.2-megabyte floppy drives; 40-, 60-, 80-, and 130-megabyte hard disks; and tape backup. Monitor options are 12-inch monochrome, 15-inch black-and-white, and 14-inch color.

The XA-600 is sold in two styles: a low-profile four-slot, four-drive desktop version or an eight-slot, six-drive tower version. Both allow memory expansion with daughterboards. For more information, contact Future International Inc., 5820 Stoneridge Mall Rd., Suite 100, Pleasanton, CA 94566, (415) 847-2064.
Inquiry **570.**

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PERIPHERALS

Laser Printer with Malleable Fonts

Kyocera Unison's F-2010 Compact Laser Printer comes with 36 resident fonts that you can manipulate to design others; 1.5 megabytes of RAM; a pair of 250-sheet paper trays; a collator; and serial and parallel ports. It can print 850 characters per second and 10 pages per minute at 300 dots per inch and can handle legal-size pages and envelopes. The F-2010 can emulate the Diablo 630, Qume Sprint II, NEC Spinwriter, IBM Graphics Printer, and Hewlett-Packard LaserJet Plus.

Prescribe, Kyocera's programming language, increases the printer's font capabilities and supports some graphics: boxes, circles, pie charts, arcs, shading, and bar codes.

The F-2010 warms up in less than 30 seconds, the company says. It sells for $5295. Contact Kyocera Unison Inc., 3165 Adeline St., P.O. Box 3056, Berkeley, CA 94703, (415) 848-6680.
Inquiry **571.**

Removable Cartridge Drive for Macintosh

The Totem line of storage devices for the Macintosh uses 5¼-inch removable cartridges, each holding 20 megabytes, and implements Bernoulli technology. Each cartridge, the vendor points out, is about the size of a slice of bread and hence can be transported or stored easily. The Totem system is transparent to the Macintosh.

Three models of the Totem are available: model 1020R, with a single 20-megabyte cartridge, costs $1495; model 1220R, with two 20-megabyte cartridges, costs $2295; and model 1220C, which combines a 20-megabyte removable cartridge and a 20-megabyte fixed disk, costs $2295. Contact Bering Industries, 250 Technology Circle, Scotts Valley, CA 95066, (408) 438-8779.
Inquiry **572.**

Kyocera's F-2010 comes with fonts you can manipulate.

Amiga 20-meg Drive, SCSI Controller Card

C Ltd. has introduced a 20-megabyte hard disk drive and an SCSI/hard drive controller card for Commodore Amiga users. The controller card hooks to the Amiga expansion port and conforms to the Amiga AutoConfig protocol for fixed memory devices, C Ltd. says. The controller will support as many as seven SCSI devices, including CD-ROM drives. The half-height drive is less than 3 inches tall and less than 6 inches wide.

You can buy the hard drive by itself for $799.95, the SCSI controller card for $299.95, or both for $999.95. For more information, contact C Ltd., 723 East Skinner, Wichita, KS 67211, (316) 267-6321.
Inquiry **573.**

Amiga Side Line

Side Effects has developed a series of products for Commodore's Amiga: an expansion box, a memory board, and a hard disk drive.

Side Arm, a six-slot expansion cage, meets all the specs to be considered a Zorro box, the company says. It has space for two half-height drives and can power two external floppy disk drives. Side Arm has its own power supply and can handle up to 8 megabytes of RAM. It costs $949.

Side Store, a memory board with RAM disk, is available with 1 or 2 megabytes of no-wait-state RAM. The RAM disk survives warm resets and reboots, Side Effects says. With 1 megabyte, the board costs $649; with 2 megabytes, $799.

Side Track, a hard disk drive, holds 20 megabytes and uses direct memory access. Data is double-buffered. The drive costs $799; just the controller, $449.

For more information, contact Side Effects Inc., 6513 Johnsdale Rd., Raleigh, NC 27615, (919) 876-1434.
Inquiry **574.**

Big Monitor Lets You See What You'll Get

The LM-300 monitor from Princeton Graphic Systems has a 15-inch portrait-mounted screen that can display a full page of graphics and text, in WYSIWYG format, without scrolling. Pixel resolution is 1200 by 1664. Video bandwidth is 160 MHz. Scan rate is 74.63 kHz. The monitor emulates a resolution of 300 dots per inch (1:1 aspect ratio), making it compatible with many laser printers.

Other features include 42,000-character display and support for four shades of gray. The monitor is attached to a tilt-and-swivel stand. It comes with a 9-pin shielded cable that connects directly to IBM PCs and most compatibles. Suggested retail price is $750.

Contact Princeton Graphic Systems, 601 Ewing St., Bldg. A, Princeton, NJ 08540, (609) 683-1660.
Inquiry **575.**

Dot-Matrix Printer with Snap-in Color

You can switch Seikosha's MP-1300 dot-matrix printer from standard black output to color by snapping in a cartridge containing a seven-color ribbon and ribbon cassette spacer. With the cartridge installed, the MP-1300 can print in black, green, orange, yellow, purple, blue, and red. With software commands, you can specify the color of each dot.

Compatible with IBM graphic and Epson standards (including color software for the Epson JX-80), the MP-1300 prints at 300 characters per second in near-letter-quality mode and 60 cps in letter-quality mode. The machine offers 185 software-generated character sets and eight international fonts. Character sets can be downloaded into the 10K-byte buffer. Attributes include double strike, italic cursive, superscript and subscript, and proportional spacing.

The MP-1300 has a suggested list price of $699. The color kit costs $155. Contact Seikosha Company Ltd., 10080 North Wolfe Rd., Suite SW3/249, Cupertino, CA 95014, (408) 446-5820.
Inquiry **576.**

continued


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ADD-INS

Text-to-Speech Converter

Accent is a board for the IBM PC series and compatibles that converts ASCII text into speech. It works in one of two modes: speaking the words of the text in ordinary fashion or spelling out every character, including punctuation. With software commands, you can change its speech parameters, including voice characteristics. Accent's software device driver lets you control it with any high-level language.

The board has an 800-byte wraparound text buffer. Accent can be connected to a 4- or 8-ohm speaker. An RS-232C serial port is provided for interfacing with the PC, a terminal, or a printer. You can select either the PC or the serial port as the host. Text and software commands go from the host to Accent's on-board processor.

In addition to the text-to-speech synthesizer board, you get software (device driver, demo program, and utilities) and a manual for $495. For more information, contact Aicom Corp., P.O. Box 710310, San Jose, CA 95171-0310, (408) 238-0485.
Inquiry **577.**

One Board Lets You Put Two in Compaq Portable

A Houston company has designed a card it says will let you fit two short cards in one long slot of a Compaq Portable. Radix Associates says most IBM PC-compatible short cards can fit in one of the two slots on its Bus Expander Card; one slot measures 4⅞ inches, the other 6⅛ inches. (The user will have to make special accommodations for cabling, Radix says.) After connecting the short cards on the longer card, you can fit it into the Compaq; slot 4 is best, Radix says.

Because of the difference in chassis sizes, the Expander Card will fit in a Compaq Portable but not in an IBM PC, Radix warns. The card sells for $79.95. Contact Radix Associates, 2314 Cheshire Lane, Houston, TX 77018, (713) 683-9076.
Inquiry **578.**

Graphics Controller

CADcard is an 80186-equipped 10-MHz graphics controller for the IBM PC line and compatibles. It emulates IBM's PGC and CGA, has 512K bytes of display memory, 380K bytes of user memory, and 132K bytes of on-board graphics firmware. Options include firmware development tools, software development tools, a GKS subroutine library, and a graphics accelerator that speeds drawing from 2500 to 15,000 vectors per second.

CADCard costs $1750.

Intelligent Graphics also puts together a CADcard graphics workstation based on an 80286 computer with 640K bytes of memory, an AT-compatible BIOS, and the graphics controller. The system also has a 20-megabyte hard disk, a 1.2-megabyte floppy drive, a color monitor, two serial ports, and a parallel port. MS-DOS 3.1, CADcard diagnostics, and a demo package are also standard. The workstation costs $7500.

For more information, contact Intelligent Graphics Corp., 4800 Great America Parkway, Santa Clara, CA 95050, (408) 986-8373.
Inquiry **579.**

VMEbus Disk Controller

Motorola has introduced an intelligent VMEbus-compatible controller board that can handle two 5¼-inch Winchester disks and as many as four 5¼-inch floppy disks. The Model MVME321 board incorporates a 10-MHz MC68010 processor. Motorola says on-board control is handled by a multitasking executive kernel that supports concurrent operations.

The board is capable of 32-bit DMA transfers at 8 megabytes per second over the VMEbus, the company says. It supports 24- or 32-bit DMA addressing.

Driver software for VERSAdos and System V/68 (Motorola's UNIX System V derivative) comes with the disk controller. "Scatter/gather" algorithms are implemented in the UNIX driver software and in the on-board firmware. Motorola says this technique relieves the host of having to buffer disk I/O data in a virtual paged environment.

The MVME321 costs $2295. Contact the Microcomputer Division Marketing Dept., Motorola, P.O. Box 20912, Phoenix, AZ 85036, (602) 438-3501.
Inquiry **580.**

Video Overlay

U.S. Video's Overlay! 400 lets you combine images from any NTSC-compatible source, such as a video camera or VCR, with text and graphics generated by an IBM PC and save the resulting images on a video recorder. You can also use it to build computer windows containing video images. The card overlays in opaque or transparent mode.

Overlay! 400 works with PCs, XTs, ATs, and compatibles and most CGA and EGA cards. Scan rate is 15.75 kHz. I/O is switch-selectable. The card is not dependent on a particular operating system. It retails for $1200. For more information, contact U.S. Video, 900 Winderley Place, Maitland Center, Suite 140, Maitland, FL 32751, (305) 875-0800.
Inquiry **581.**

Accelerator, EGA Combo for PCs, XTs

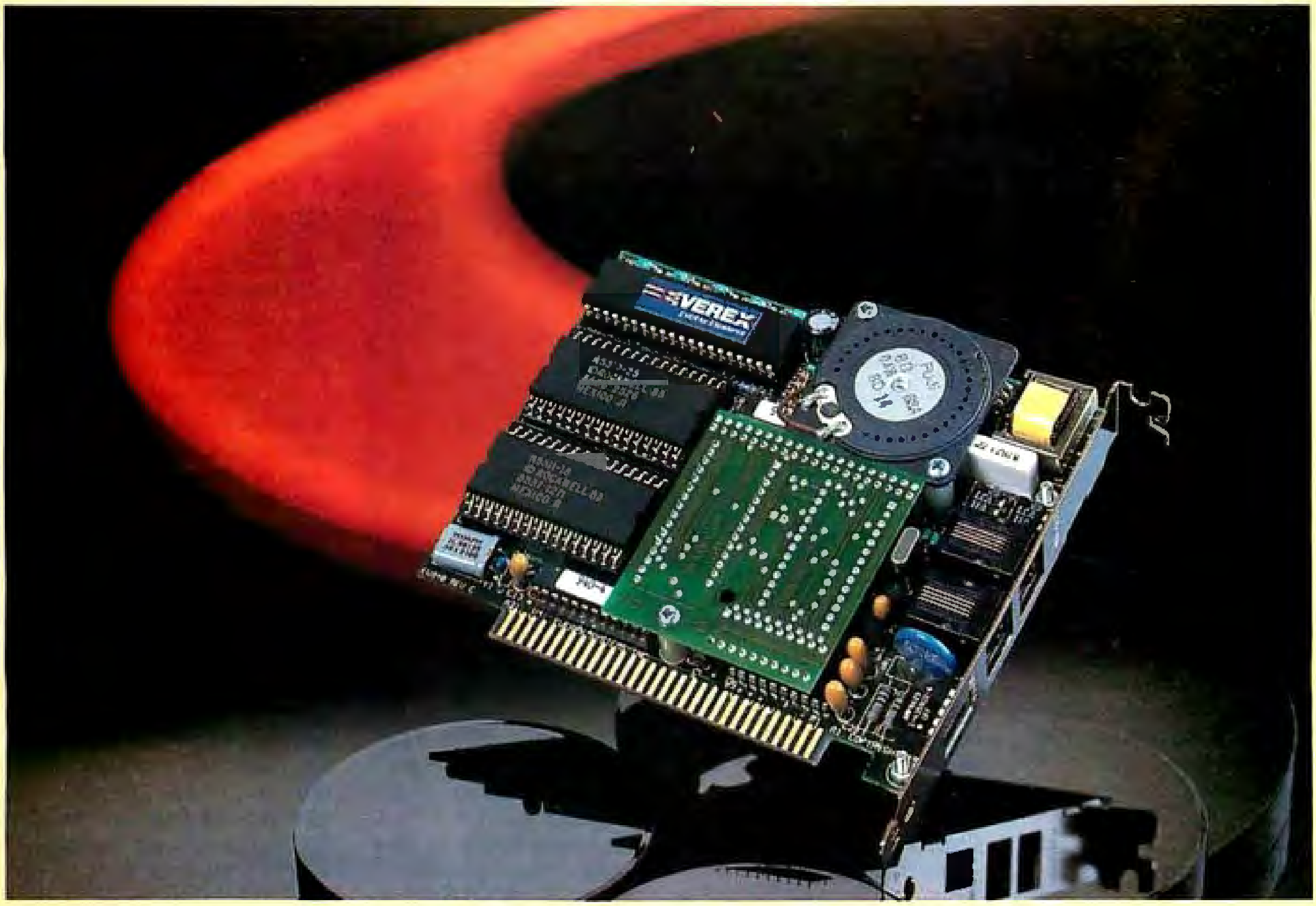
Mitsubishi says its AT/EGA Card speeds up processing on IBM PCs, XTs, and compatibles with its 8-MHz 80286 by as much as four times. The card runs PC-DOS or MS-DOS 3.1 and runs "most" PC and XT programs and "99 percent" of AT-compatible software. It performs disk caching and print buffering using the host's 8088 and uses RAM-based BIOS to execute one-wait-state, word-wide fetches. Onboard, there are 640K bytes of RAM, which is expandable to 12.6 megabytes using a piggyback socket, and 128K bytes for soft BIOS.

The EGA side of the card has 256K bytes of video RAM. The EGA BIOS runs out of 16-bit-access RAM. The card supports monitors compatible with IBM's Monochrome Display, Color Display, and Enhanced Color Display.

The card's other features include a socket for an 80287 numeric coprocessor, an AT-compatible serial port and keyboard controller, serial-port emulation of the host hardware, 16K-byte bootstrap ROM with debugger, and an on-board switching that allows the card to appear in 16 unique I/O port ranges. A 35-foot cable can hook up to a workstation; with a long-distance driver, you can run cable as far as 535 feet.

The AT/EGA card costs $1300. Contact Mitsubishi International Corp., Embarcadero Corporate Center, 2483 East Bayshore Rd., Suite 210, Palo Alto, CA 94303, (415) 494-1545.
Inquiry **582.**

continued



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Inquiry 91 for End-Users. Inquiry 92 for DEALERS ONLY.

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Intelligent Backup Manages Hard Disk Data

Manage your hard disk with Intelligent Backup. Some of the program's features include prompting, multiple device support, a DOS-command interface, and a full screen editor. You can set many of the program's features to perform automatically. The program also has a feature called Intelligent Backup, which means that only files that have been altered are backed up.

Intelligent Backup sells for $149.95 and is not copy-protected. For more information, contact Vamco, 10310 Markinson Rd., Dallas, TX 75238, (214) 343-5708.
Inquiry **583.**

Vamco's Intelligent Backup manages data on hard disks.

Multitasking in C

Cytek has added three programs to its Multi-C multitasking library for C programmers.

Multi-Comm ($149) is a communications library that supports interrupt-driven data transfers, multiple device types in asynchronous or synchronous mode, and background communications by Multi-C tasks.

Multi-Windows ($295) offers you the ability to create overlapping, pop-up windows.

Multi-Forms ($149) works with Multi-Windows to produce data entry and display screens.

For more information, contact Cytek Inc., 805 Turnpike St., Unit 202, North Andover, MA 01845, (617) 687-8086.
Inquiry **584.**

Turbo Pascal Numerical Methods Toolbox

Borland has announced the Turbo Pascal Numerical Methods Toolbox for its Turbo Pascal language development system. The toolbox is made up of 10 modules that enable you to find solutions to equations, interpolations, calculus with numerical derivatives and integrals, matrix operations, eigenvalues, differential equations, least-squares approximations, and Fourier transforms.

You can modify each of the modules and incorporate them into your own programs. The source code is provided.

The toolbox runs on IBM PCs, XTs, and ATs, with or without an 8087 or 80287 math coprocessor. The graphics module requires that you have a graphics monitor and the Turbo Pascal Graphix Toolbox. The Numerical Methods Toolbox sells for $99.95 and is not copy-protected.

For more information, contact Borland International, 4585 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-8400.
Inquiry **585.**

Tools for Creating Expert Systems

IntelligenceWare has announced Experteach-II, a collection of expert system tutorials, case studies, on-line and interactive teaching programs, tools with source code, sample expert systems, and artificial intelligence languages. Also included are six rule-based expert system shells implemented in LISP, Prolog, and Pascal.

Experteach-II runs on IBM PCs and compatibles with 256K RAM and MS-DOS or PC-DOS 2.0 or higher. The program sells for $475. For more information, contact IntelligenceWare Inc., 9800 South Sepulveda Blvd., Suite 730, Los Angeles, CA 90045, (213) 417-8896.
Inquiry **586.**

Stay-Res Puts Your BASIC Programs in Memory

MicroHelp has announced Stay-Res, a $95 BASIC programmer's package that makes compiled BASIC programs memory-resident. Stay-Res saves the current screen when the program is popped up, and when the program is popped down, the screen is automatically restored.

The program is not copy-protected. It requires an IBM PC, XT, AT, or compatible, MS-DOS 2.0, and a BASIC compiler. Programs compiled with QuickBASIC 2.0 require DOS 3.0 or higher.

For more information, contact MicroHelp Inc., 2220 Carlyle Dr., Marietta, GA 30062, (800) 922-3383; in Georgia; (404) 973-9272.
Inquiry **587.**

A Compiler for the Amiga

Absoft has announced a FORTRAN/020 compiler for Amigas using MC68020/MC68881 upgrades. The compiler comes with a source-level symbolic debugger, generates position-independent reentrant code, and supports Amiga's ROM routines and VAX and FORTRAN 8X extensions. Also featured is a linker, library manager, IEEE single- and double-precision floating-point software, virtual array support, overlay support, dynamic linking at run time, and a C interface.

The program is not copy-protected. Absoft also reports that there is no limitation on code or data size. The compiler sells for $495. For more information, contact Absoft Corp., 4268 North Woodward, Royal Oak, MI 48072, (313) 549-7111.
Inquiry **588.**

C Compiler for 80386 Applications

Intel has introduced a C language compiler and utilities package for IBM PC ATs and compatibles running MS-DOS or PC-DOS 3.0 or higher. The programs were designed for the development of 80386 application software. The C 386 Compiler and RLL 386 Relocation, Linkage, and Library Tools package can be used on IBM PC ATs alone or linked with other PCs or VAX and MicroVAX computers over the Intel Open-NET network.

The C 386 Compiler is $900, and the RLL 386 Relocation, Linkage, and Library Tools package is $600. For more information, contact Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051, (503) 681-2279.
Inquiry **589.**

continued

Is this the best monitor for desktop publishing?

You can make book on it.

Sometimes, you can't tell a book by its cover. And that's particularly true of the new 1280 graphics subsystem by Amdek. It's designed specifically for the high resolution demands of desktop publishing and CAD applications. But it's still completely compatible with all standard IBM PC software.

Amdek's 1280 consists of a high-contrast, non-glare 15″ white phosphor monitor and a bit-mapped graphics board. The extra-large CRT can display up to 160 characters per line by 50 lines of text (vs. 80 x 25 for IBM).

Incredibly high resolution, 1280 (H) x 800 (V), plus the use of a 16 x 32 dot character (vs. 8 x 8 IBM standard), result in text and graphics that are remarkably sharp and easy to read. So, creating high quality flyers, reports, newsletters, bulletins or whatever else you want to "publish" at your desk is as simple as ABC.

The Amdek 1280 is also supported by one of the most popular IBM PC desktop publishing software packages, Clickart by T/Maker. Compatibility with AutoCAD and CADvance gives you full CAD potential. Convenience features include front-mounted operator controls for power, brightness and contrast; and a tilt-swivel base which allows you to select the most comfortable viewing angle.

So, stop the presses—Amdek has done it again! Because everything that's fit to print looks better on an Amdek 1280.

AMDEK

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Inquiry 15

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

Two- and Three-Dimensional Design with VersaCAD Designer

VersaCAD Designer offers two-dimensional drafting and three-dimensional modeling capabilities, materials reports, and CAD communications in a $2995 package. Its three-dimensional modeling capabilities include color shading, automatic extrusion, various display modes, and programmability. Other features include built-in primitives, and you can also customize your own.

The program's customization ability lets you make your own menus, record and play back design operations through macros, define the screen colors, and program expert systems operations through the built-in CAD Programming Language.

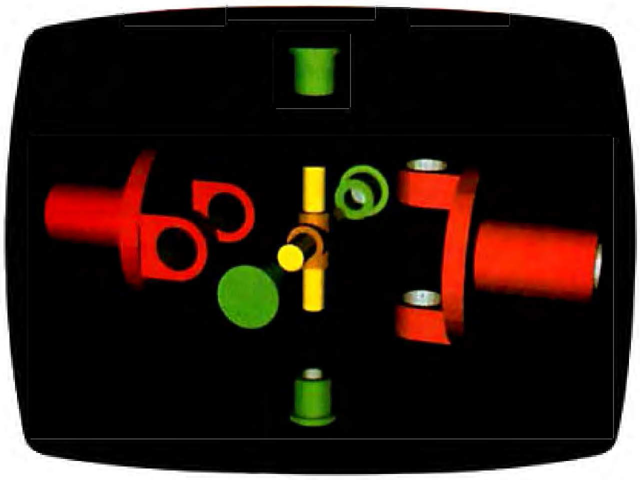
From the main menus, you can move your design back and forth between two- and three-dimensional models, and you can bring two-dimensional objects into the three-dimensional database for automatic extrusion, circular sweeps, or editing.

You can display your model in orthographic, wireframe, isometric, or perspective views with hidden-line removal. The program generates planes using polygons with the number of sides you designate.

VersaCAD Designer features two-way communication links to other software and telephone support.

The program runs on IBM PC XTs and ATs with 640K bytes of RAM. A digitizer or mouse are recommended as input devices.

For more information, contact T&W Systems Inc., 7372 Prince Dr., Suite 106, Huntington Beach, CA 92647, (714) 847-9960.
Inquiry **590.**



VersaCAD Designer offers 2-D and 3-D capabilities.

Digital Oscilloscope and Spectrum Analyzer

PCGen is a transfer function analyzer that integrates the functions of a digital oscilloscope and a spectrum analyzer. The program enables you to acquire real-time data in the form of analog voltages, display the time histories of the sampled data on the screen (like an oscilloscope), and perform Fourier analysis on the data. According to Hansen Instruments, manufacturer of PCGen, no programming is required, and all functions are controlled by the function keys and menu.

Time domain functions enable you to acquire and display one or two channels at a time. You can also select the sample frequency, sensitivity, record length, and triggering. You can store time data on disk or on a time data plot, which also displays voltage and time at current position.

Frequency domain functions include computation and display of frequency spectra for either channel, both at the same time or individually.

The functions of PCGen are selectable by the 10 function keys. Through the master menu, you can select operating parameters, and setups are stored and retrieved from the setup file. You exit the program by pressing a single key.

PCGen requires an IBM PC, XT, AT, or compatible with a math coprocessor chip, a graphics board, a monitor compatible with your graphics board, and a data-acquisition board. Your system must also have 384K RAM, one floppy or hard disk drive, and MS-DOS or PC-DOS 2.0 or higher.

The software sells for $250. For more information, contact Hansen Instruments, 577 Gerard Ct., Pleasanton, CA 94566, (415) 846-7925.
Inquiry **591.**

Analyze Stress and Vibration with Finite Elements

MacNeal-Schwendler has announced MSC/pal, a static and dynamic finite-element analysis program for stress and vibration analysis. Versions are available for the 512K-byte Macintosh ($995) and 1-megabyte systems ($1495). The 512K version can analyze models with a maximum node point limit of 300, and the larger version can analyze up to 500 node points. The program is copy-protected.

You can use MSC/pal in the design and analysis of mechanical systems, stress analysis of mechanical components, servomechanism vibration analysis, stress analysis of pressure vessels, vibration analysis of printed circuit boards, and automotive and aerospace structural strength analysis.

Graphic capabilities include three-dimensional wireframe plotting, scaling, and rotating, deformed/undeformed overlays, element and node point numbering, and *x,y* plotting for element stress scanning and dynamic response.

For more information, contact MacNeal-Schwendler Corp., 815 Colorado Blvd., Los Angeles, CA 90041, (213) 258-9111.
Inquiry **592.**

Image Processing

DT/Image-Pro from Data Translation is image processing software that runs on the IBM PC AT. The program lets you perform real-time image processing and graphics functions with the click of a mouse. Built into the program is a graphics package called HALOVision. It enables you to add labels, grids, ellipses, and lines to images, and you can paint over or cut and paste portions of the images.

The program's main menu offers image analysis, image measurement, a graphics editor, and submenus that feature acquisition, processing, and display functions.

To run DT/Image-Pro you need an IBM PC AT with 512K bytes of RAM and MS-DOS or PC-DOS 3.0 or higher, a Data Translation frame grabber, and an input device such as a mouse.

DT/Image-Pro sells for $1495. For more information, contact Data Translation Inc., 100 Locke Dr., Marlboro, MA 01752, (617) 481-3700.
Inquiry **593.**

ANNOUNCING DAC-EASY BASE

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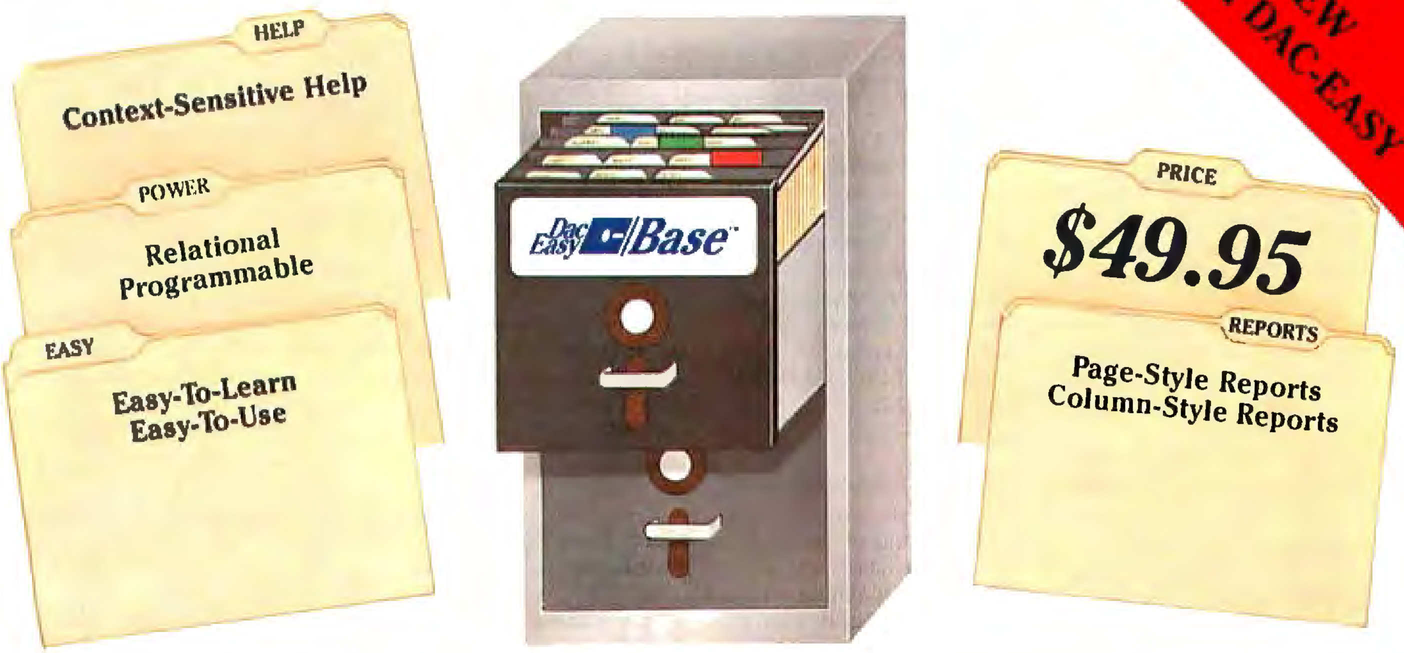

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FLEXIBLE MENU SYSTEM

Dac-Easy Base is actually two systems in one. If you are a novice you will appreciate the special Beginner Menu which contains the most commonly used features for creating, editing, and printing files. The more experienced database user will find the Advanced Menu allows instant access to each and every one of the powerful routines. In both menus, you are only a keystroke away from the context-sensitive help screens. The help screens in Dac-Easy Base are so complete you may never have to consult the accompanying 200 page manual.

EASY FILE AND REPORT CREATION

Design professional-looking data input screens without leaving the menu structure. There is no need for complex programming. Once created, the edit screen allows you to input and edit your information in a matter of minutes. Also attach special notes to any of your records with the built-in MemoWriter. The MemoWriter is the perfect way to attach specific information to a single record. Custom reports are easy to create without using the available programming language. Column or page-style reports can be created quickly, and viewed on your computer screen or printed to paper. As with all reports generated by Dac-Easy Base, you can select which records will be included in your report and how they will be sorted. Special headings and subtotals can be added to give you the exact information you need.

GREAT FOR ADVANCED USERS

Yes, Dac-Easy Base is easy to use, and it is also very powerful. An unlimited number of records with up to 60 fields per record, ability to access up to three files at a time, date arithmetic capability, formula fields for calculations within files, dynamic abbreviations, and keyboard macros are just a few

II files and can run DBASE II programs.

30 DAY MONEY BACK GUARANTEE

Dac offers a 30 day unconditional guarantee on all products bought directly from Dac Software (less shipping charges). There is a $10.00 restocking fee if the disk envelope is opened.

Minimum Hardware Requirements:
IBM or other compatibles, 256K memory, MS-DOS or PC-DOS 2.0 or later, two DSDD drives, color or monochrome monitor.

Inquiry 76

GREAT FOR THE HOME

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SOFTWARE • BUSINESS AND OTHER

Creating Graphics with Hoops

Hoops, a graphics software program made up of a library of three-dimensional routines, has a hierarchical segment structure. The routines control geometric modeling, viewing, rendering, and user interaction. The program also contains an interactive graphics debugger. It features hidden-line removal, hidden-surface removal, and shaded image-rendering capabilities. You can transform, highlight, rotate, and scale complex objects, as well.

The routines are written in C and are callable from any C or FORTRAN application. The program is built around a device-independent interface, so an application developed on one device can be run on another without modification. Hoops runs under UNIX, VMS, and DOS operating systems. The cost of the microcomputer version of the program is $875; licenses for additional machines cost $250.

For more information, contact Flying Moose Systems and Graphics Co. Ltd., The Clinton House, Ithaca, NY 14850, (607) 273-3690.
Inquiry **594.**

Tax Reform Act Accounted for in Software

The Tax Mini-Miser is available in a Tax Reform Edition for IBM PCs ($195) and Apple IIs ($119).

You can calculate the potential tax savings of deferring income or taking a capital gain this year instead of next, and you can create and review up to six tax strategies and project them on the screen at the same time. According to Sunrise, the manufacturer, the program calculates a typical three-year projection in 5 to 15 seconds.

Tax Mini-Miser works with Lotus 1-2-3; however, 1-2-3 is not required to run the program.

A California version that computes Federal and California state taxes simultaneously is also available. The IBM PC version costs $295; the Apple version, $149.

For more information, contact Sunrise Software Inc., 240 Twin Dolphin Dr., Suite E, Redwood City, CA 94065, (415) 595-5255.
Inquiry **595.**

EZTax-Plan is a tax planning and projection program that runs on the IBM PC and Macintosh with a Lotus 1-2-3, Multiplan, or Excel spreadsheet. It takes the changes in the capital-gain rate into account, along with the exemption, interest deduction, and passive loss phaseout. You can analyze and compare tax strategies for each year and print out reports and summaries.

The Personal Planning Edition is $95, and the Business/Corporate Planning edition is $295.

For more information, contact EZWare Corp., 29 Bala Ave., Bala Cynwyd, PA 19004, (800) 543-1040; in Pennsylvania, (215) 667-4064.
Inquiry **596.**

Taxworks is a tax-return preparation program that automatically stores data you enter and lets you experiment with various tax strategies. It runs on IBM PCs and CP/M computers. A Federal version designed for tax professionals prepares 18 Federal forms and schedules; it sells for $500. Smaller versions, which contain fewer schedules, are priced from $75 to $175. And a California program, which transfers applicable data from the Federal to the California schedules, costs an additional $100.

For more information, contact Hollingsworth Business Services, 881 Alma Real Dr., Suite T-2, Pacific Palisades, CA 90272, (213) 459-2746.
Inquiry **597.**

Keep Your Home Finances on Balance

On Balance is a home finance program with screens that work and look like a checkbook register. You can enter up to 800 financial transactions and set up 175 accounts, defining them as assets, liabilities, income, or expenses. You can also flag any tax-related expenses to simplify recall at tax time.

On Balance runs on the Apple IIe and IIc with a minimum of 128K RAM. The program sells for $99.95.

For more information, contact Broderbund Software Inc., 17 Paul Dr., San Rafael, CA 94903-2101, (415) 479-1700.
Inquiry **598.**

Business Modeling

Business Strategist is a $249.95 business training application that lets you simulate a company's operation. Competitors and case histories for the computer, oil and gas, brewing, automotive, and pharmaceutical industries are provided.

Simulation models within the program include economic information on real-world situations, consumers, investors, and expert analysts. During the simulation you must make business decisions on pricing, financing, advertising, and labor costs, and help is available to you at each stage.

The program runs on IBM PCs, XTs, ATs, and compatibles with at least 384K RAM and MS-DOS or PC-DOS 2.0 or higher. For more information, contact Reality Technologies, 3624 Market St., Philadelphia, PA 19104, (800) 346-2024.
Inquiry **599.**

Personal Portfolio Manager

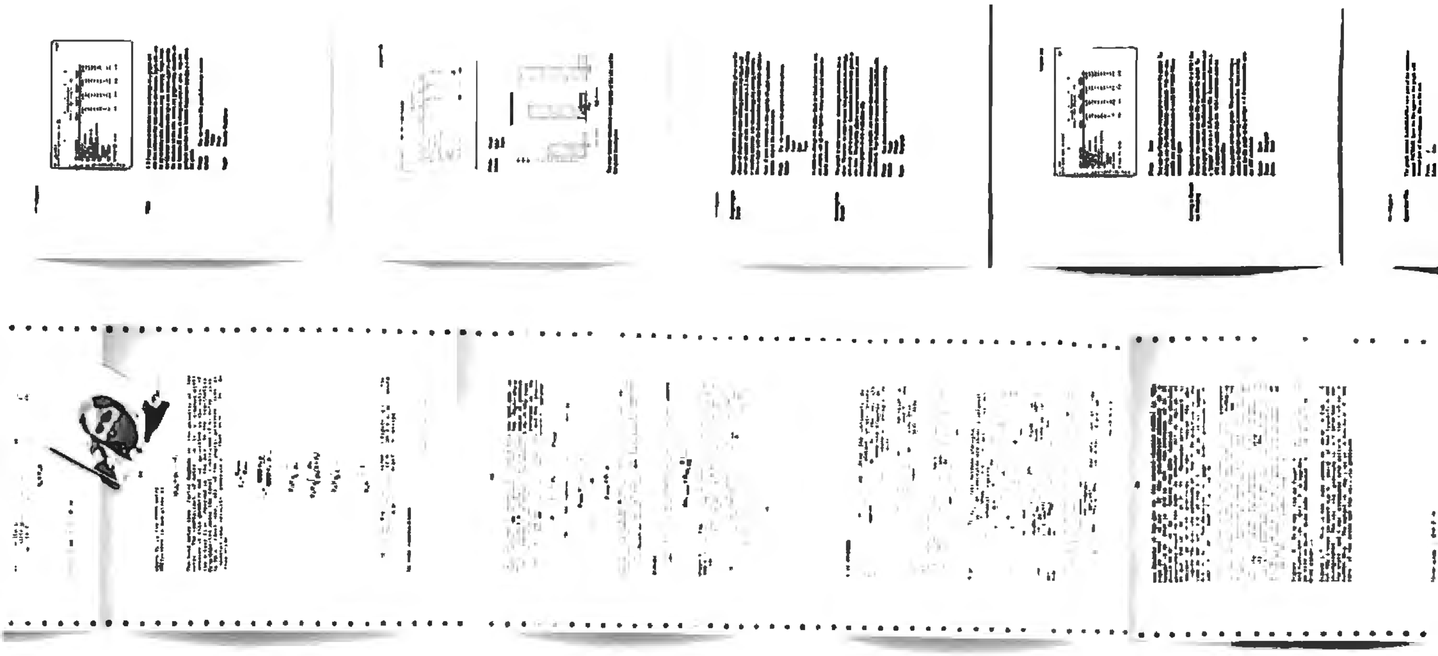
This management and analysis software lets you generate reports, including Schedule B and D Federal income tax liabilities. You can keep a year-to-date transaction file, analyze different trading strategies, and flag securities that have met your buy and sell objectives. According to Abacus, the program enables you to manage as many portfolios as your computer's memory permits.

The program features the capability to update quotes automatically through the Dow Jones News/Retrieval or Warner Computer systems.

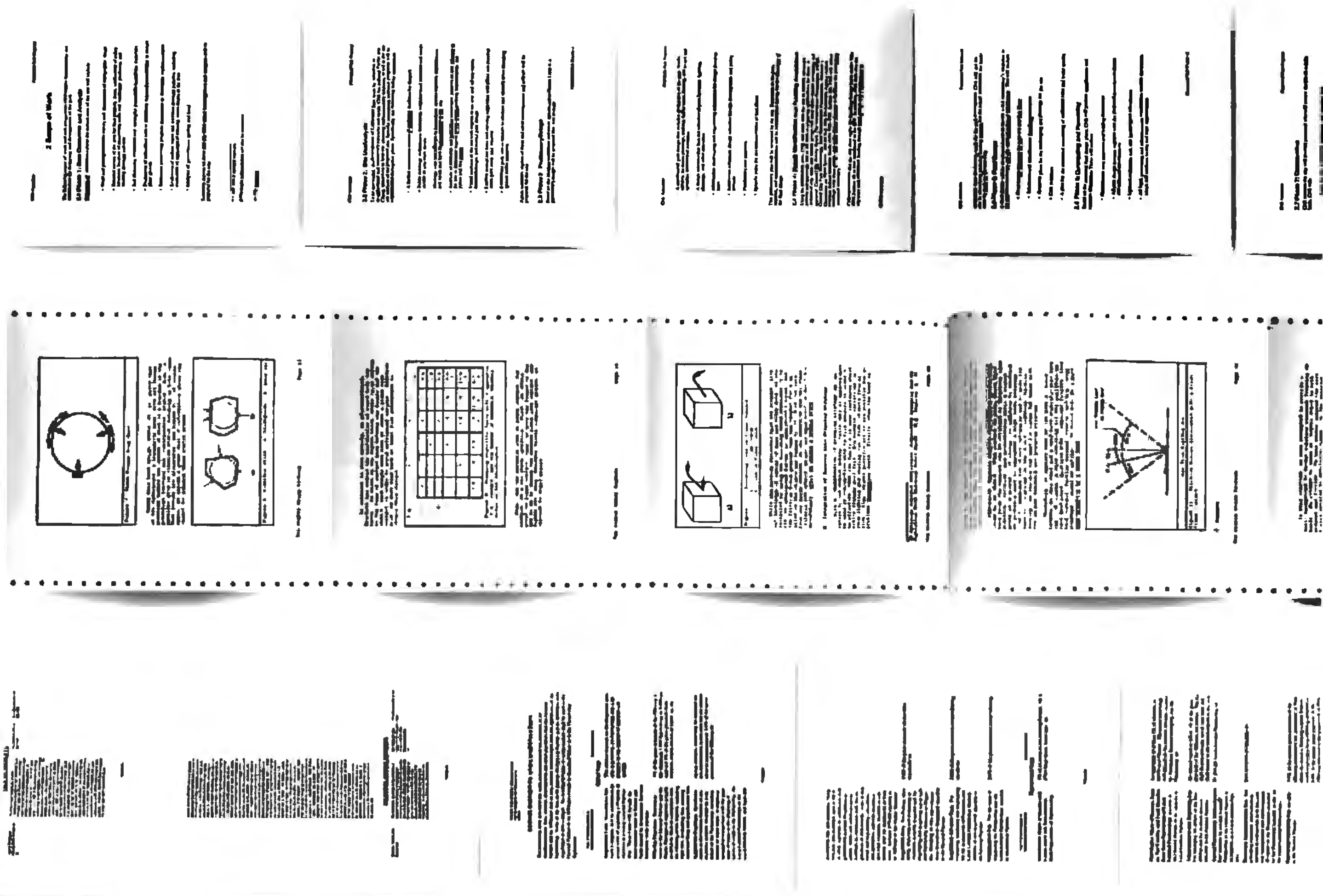
PPM runs on IBM PCs, XTs, ATs, and compatibles with 256K bytes of RAM, MS-DOS or PC-DOS 2.1 or higher, and a Hayes-compatible modem to access the on-line services. The program sells for $79.95.

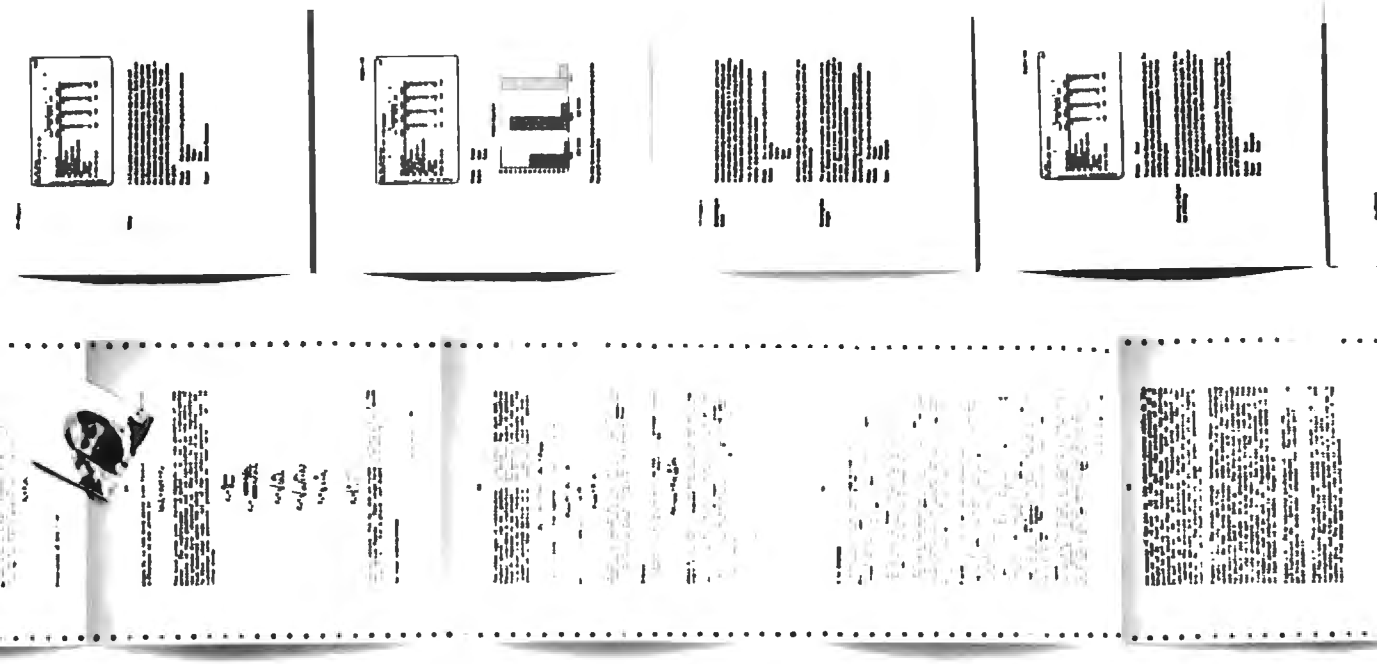
For more information, contact Abacus Software, 2201 Kalamazoo SE, P.O. Box 7211, Grand Rapids, MI 49510, (616) 241-5510.
Inquiry **600.**

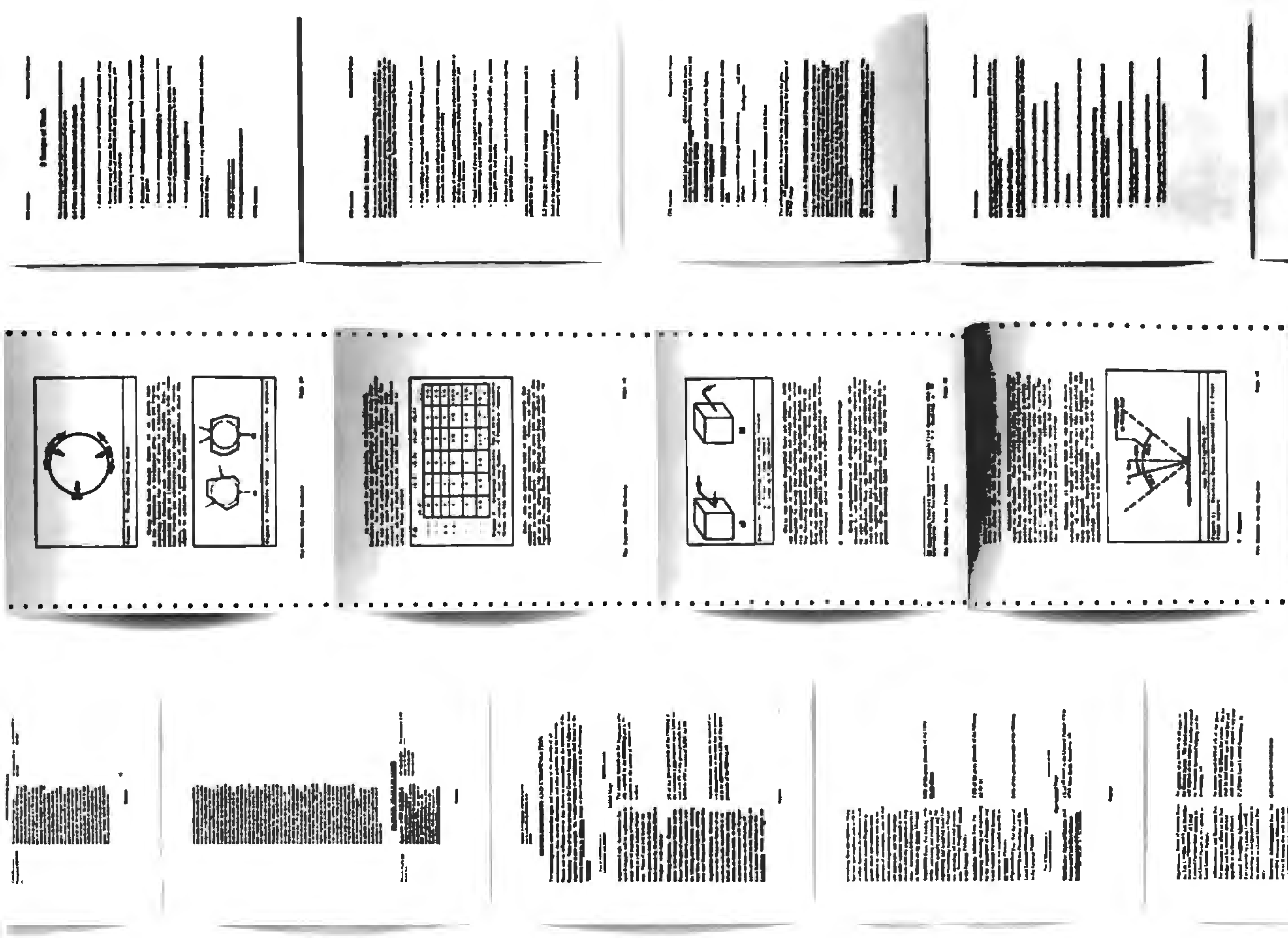
WHERE DO NEW PRODUCT ITEMS COME FROM?
The new products listed in this section of BYTE are chosen from the thousands of press releases, letters, and telephone calls we receive each month from manufacturers, distributors, designers, and readers. The basic criteria for selection for publication are: (a) does a product match our readers' interests? and (b) is it new or is it simply a reintroduction of an old item? Because of the volume of submissions we must sort through every month, the items we publish are based on vendors' statements and are not individually verified. If you want your product to be considered for publication (at no charge), send full information about it, including its price and an address and telephone number where a reader can get further information, to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

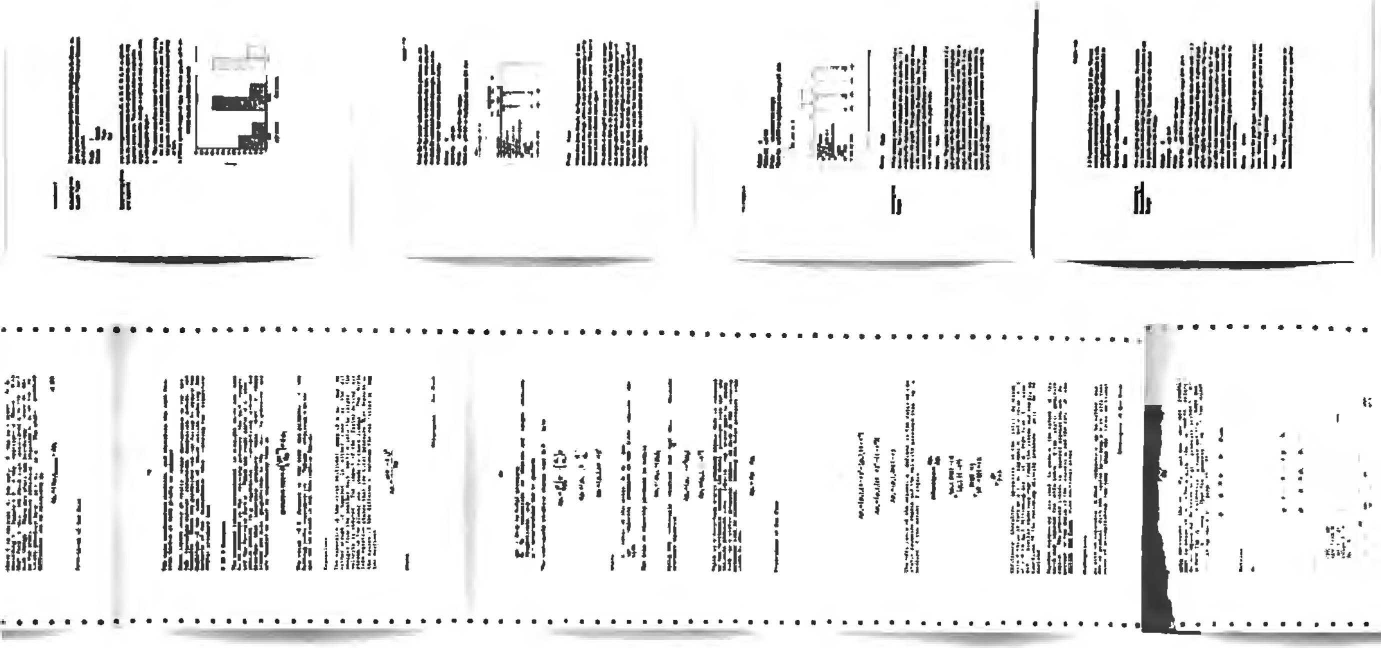


a very long, very complex,

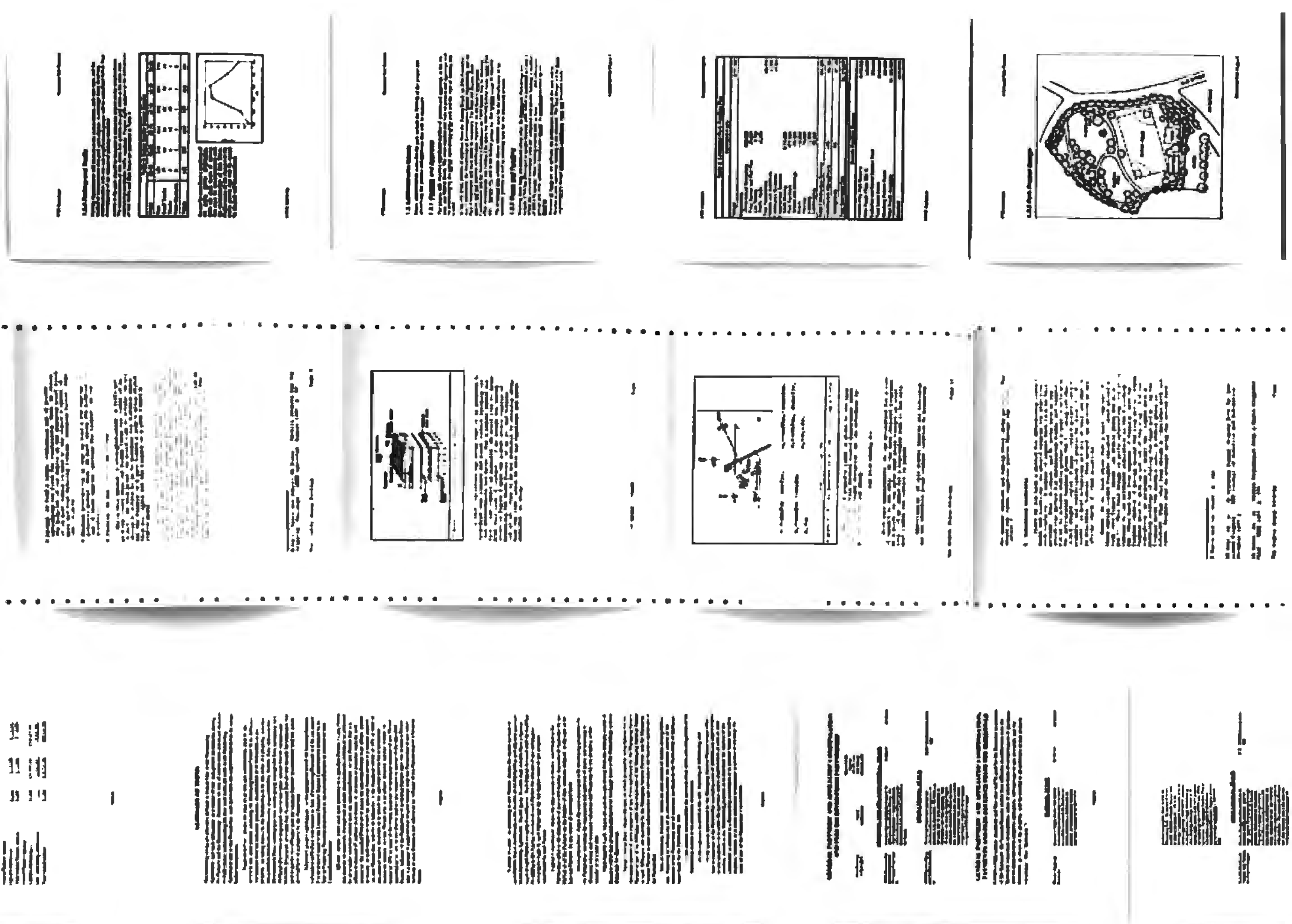


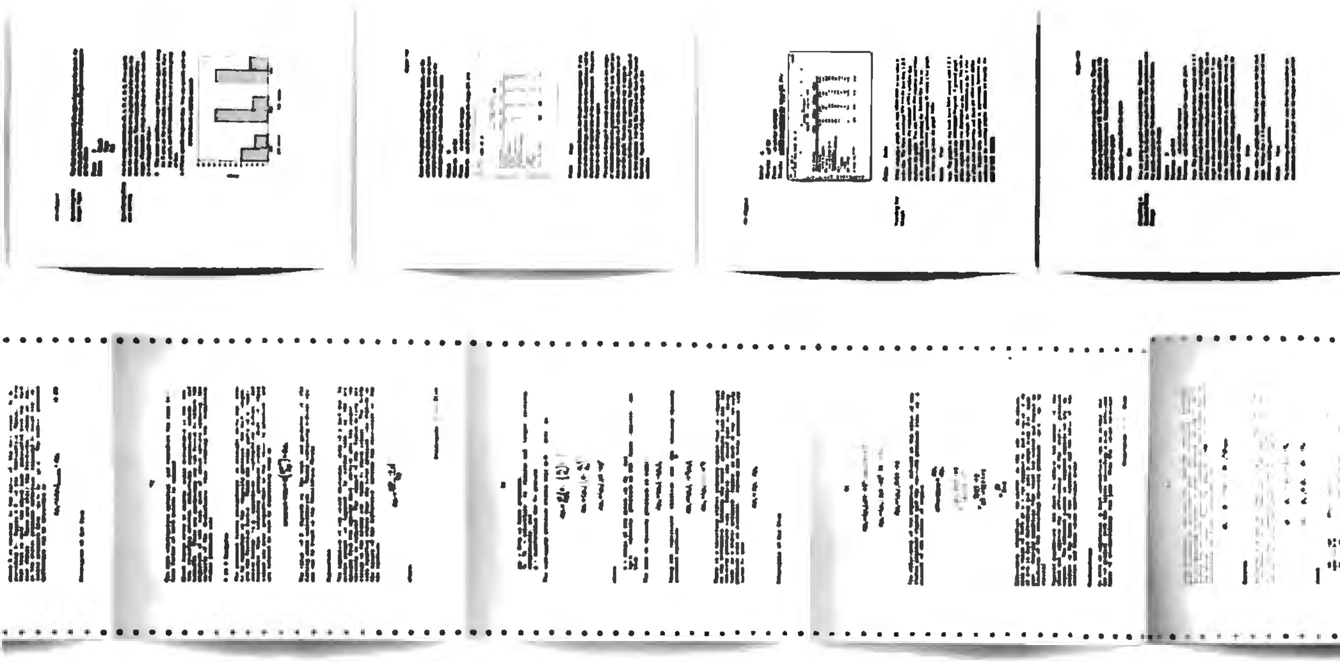




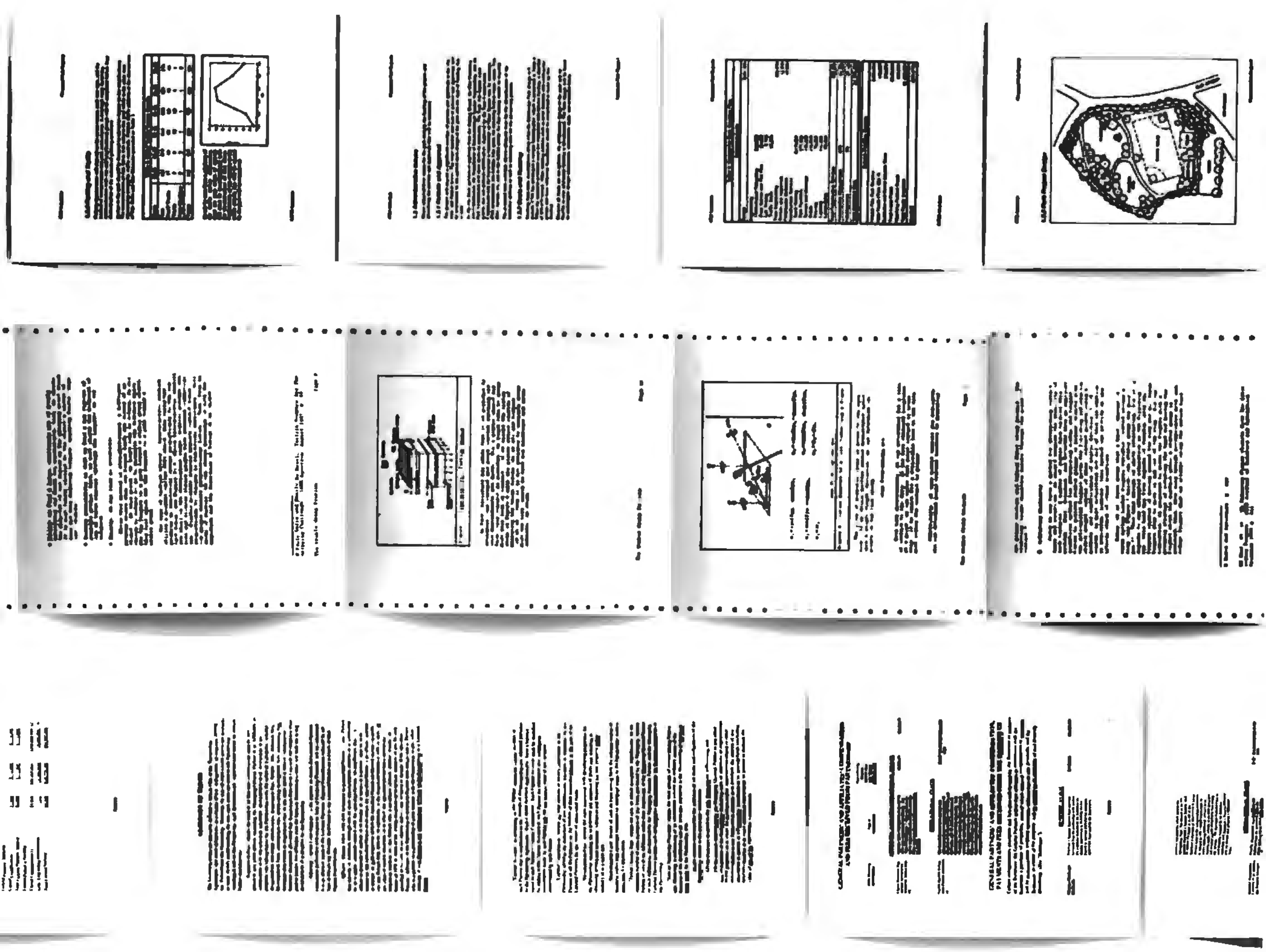


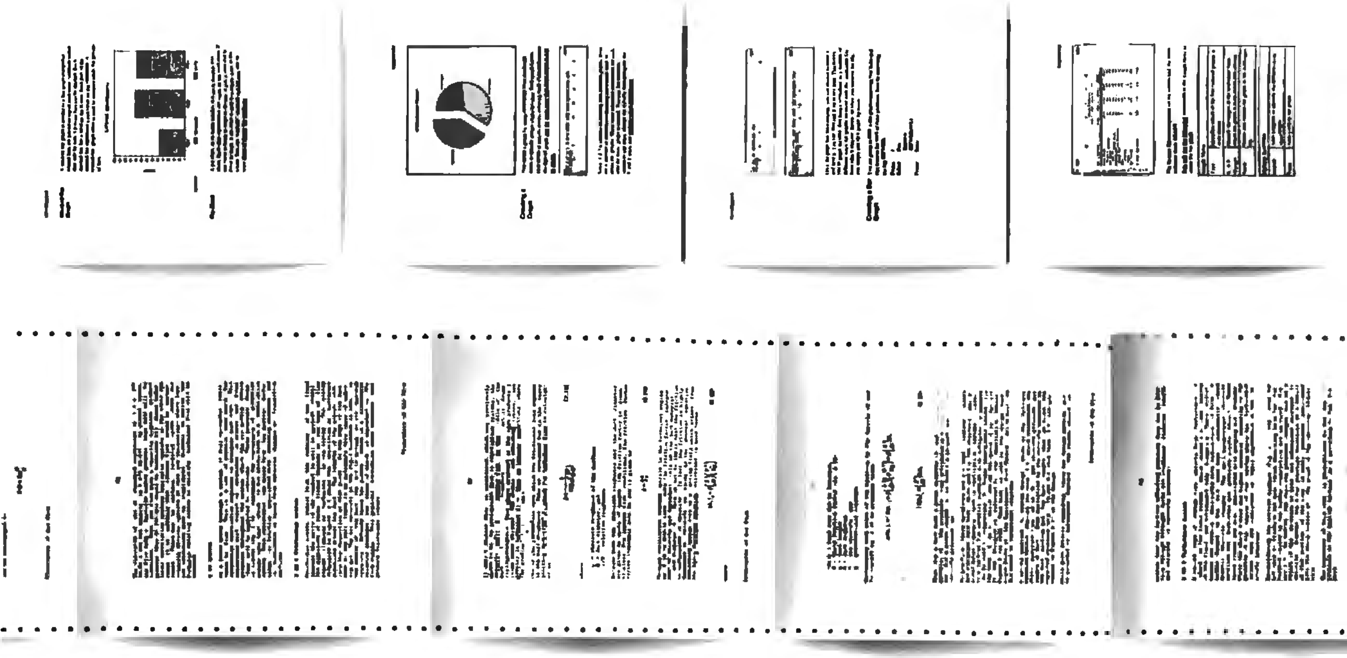
this time you have to do



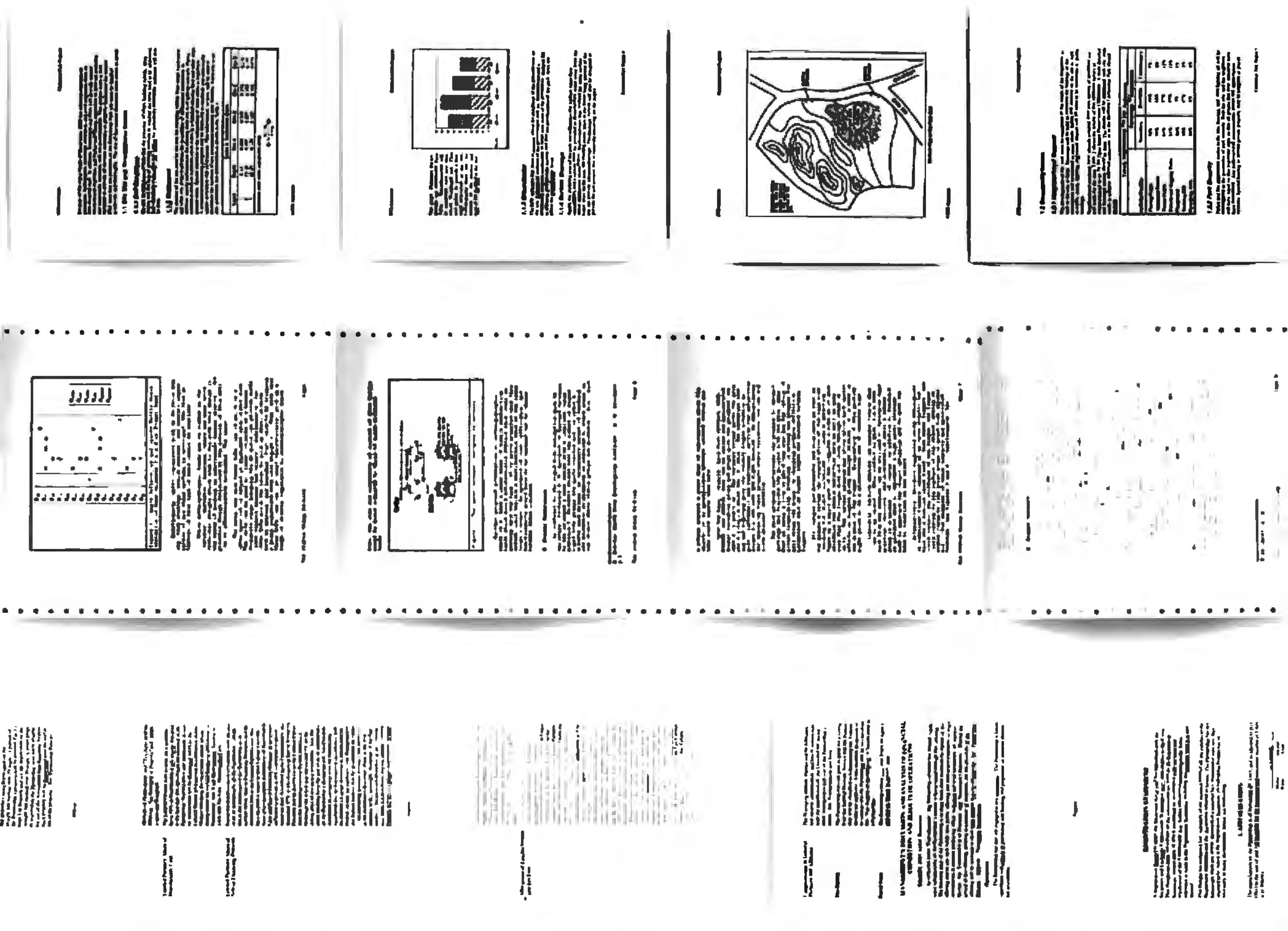


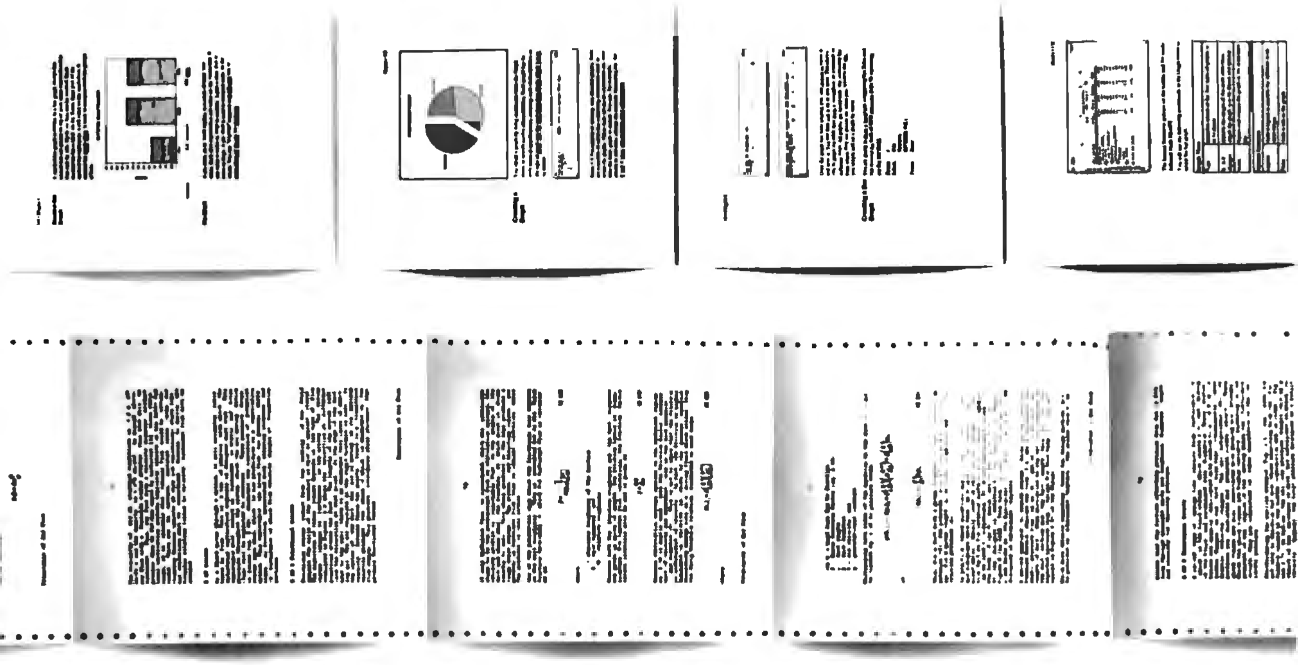
Let's say you have to do



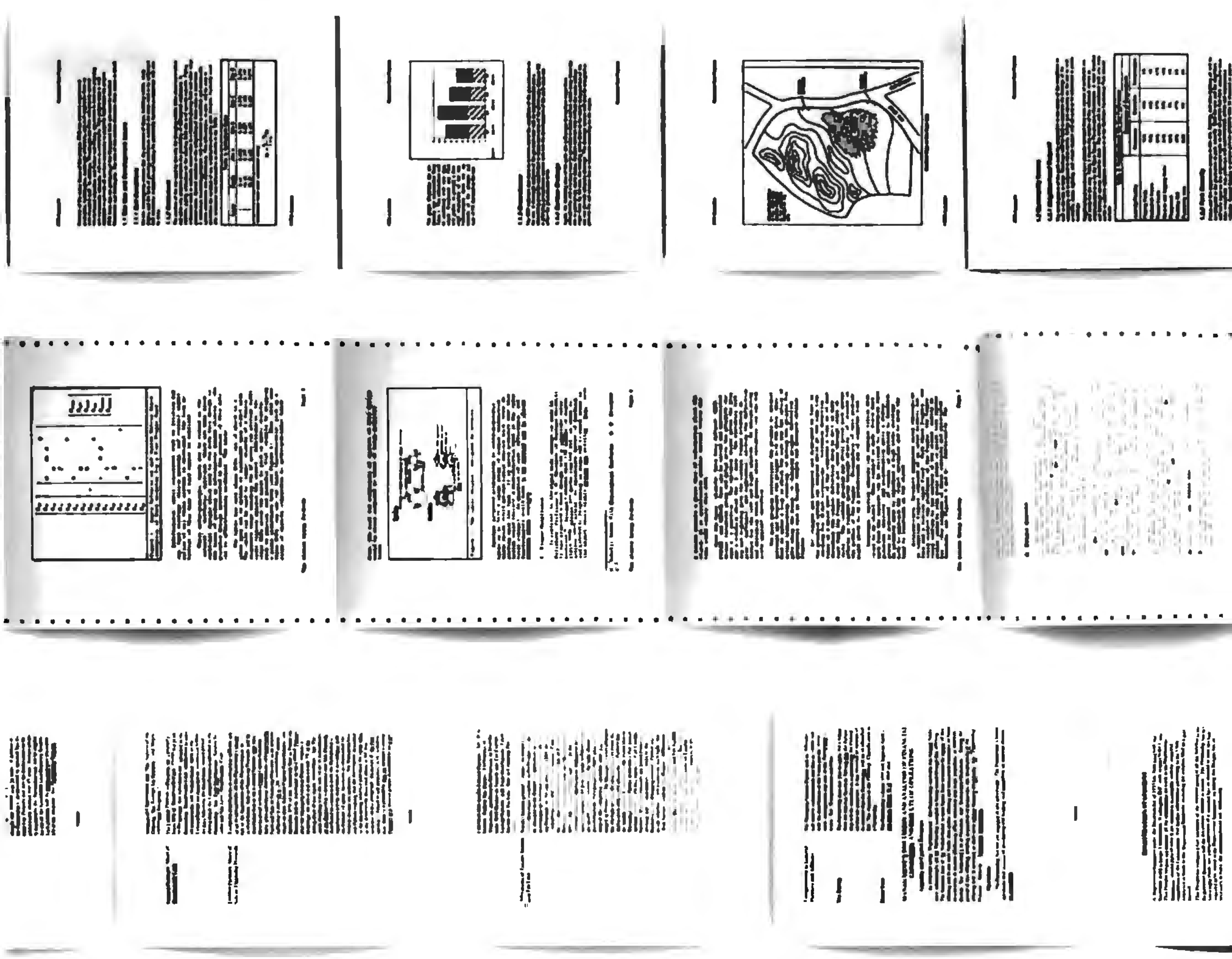


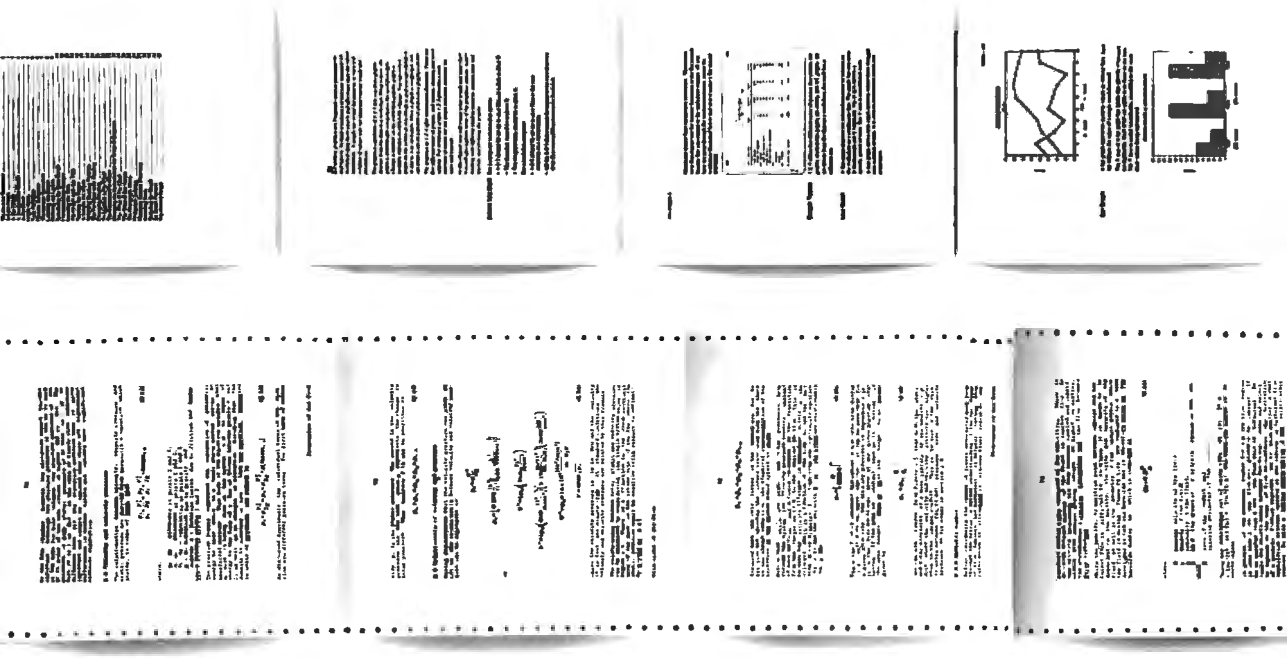
enough of a challenge,



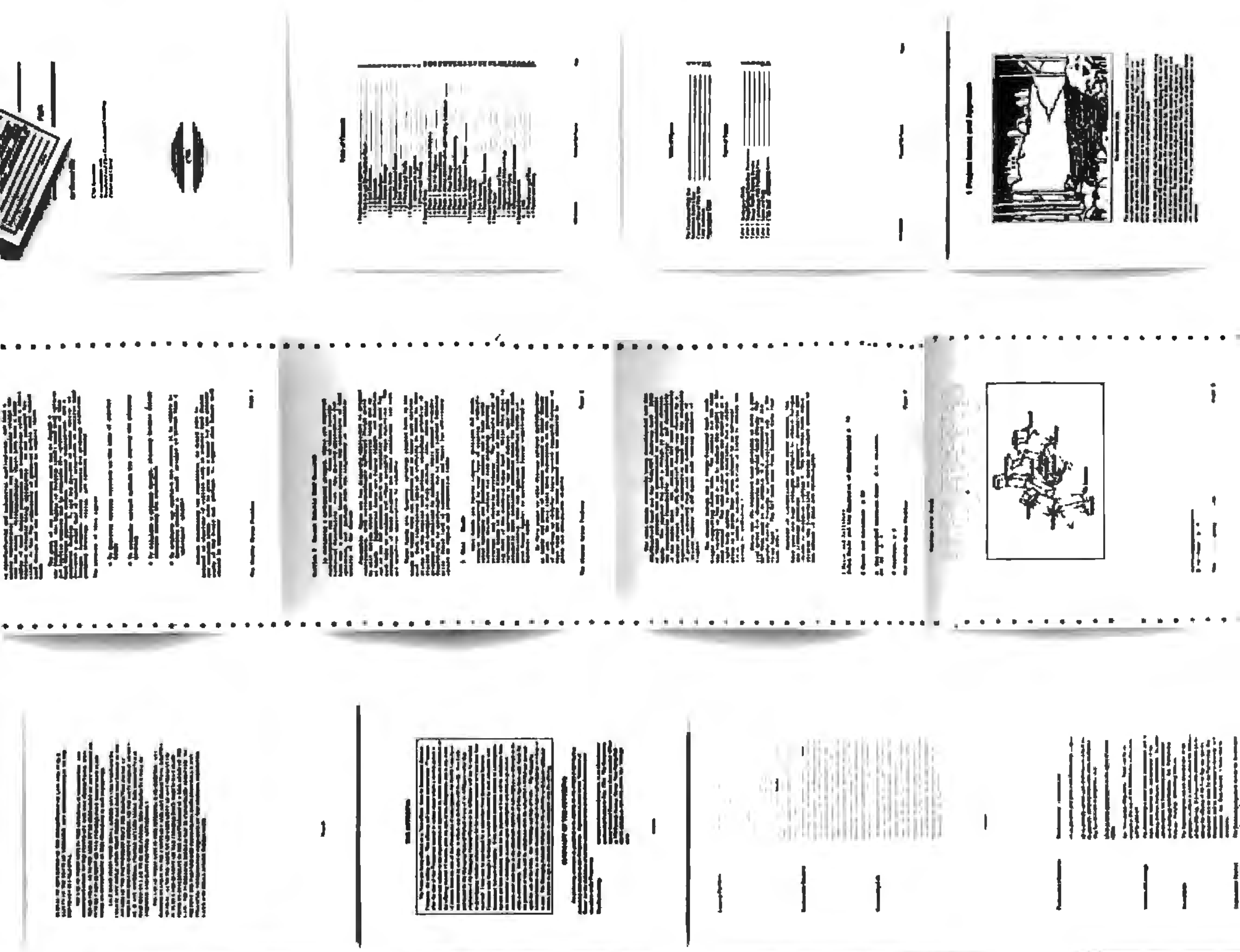


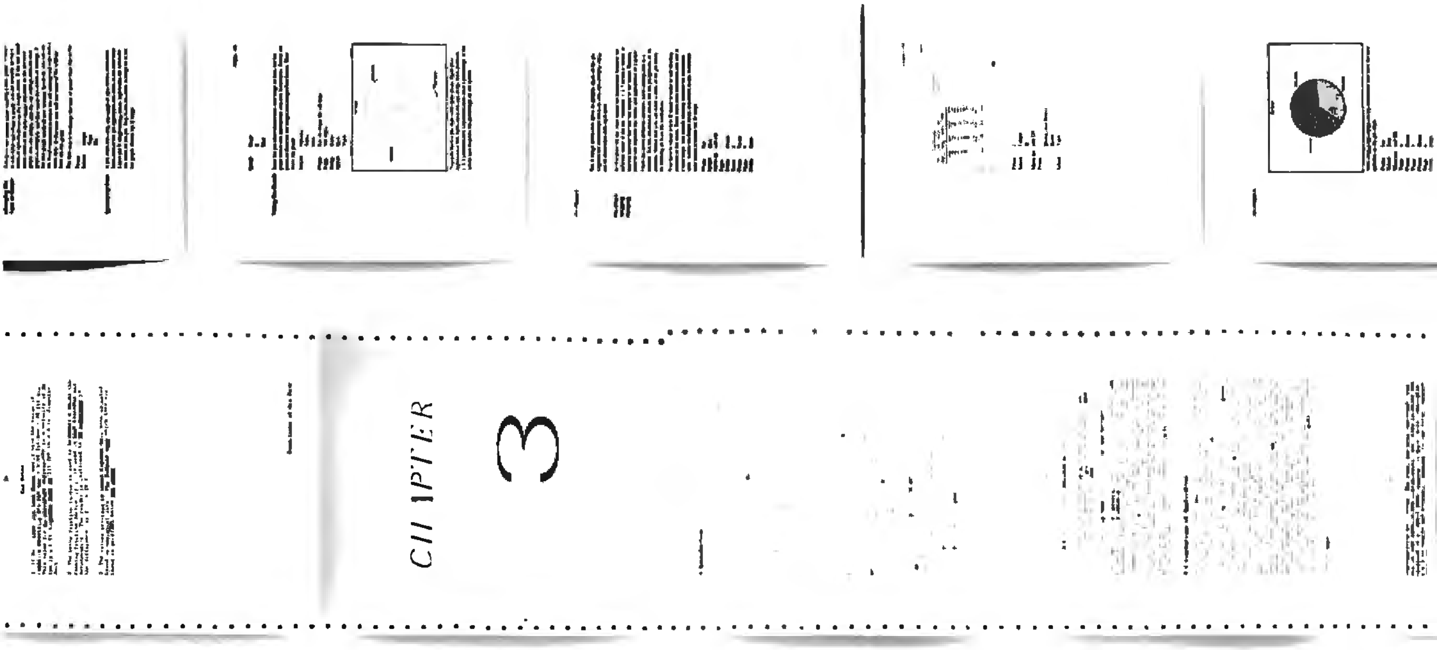
But wait, it's even worse,



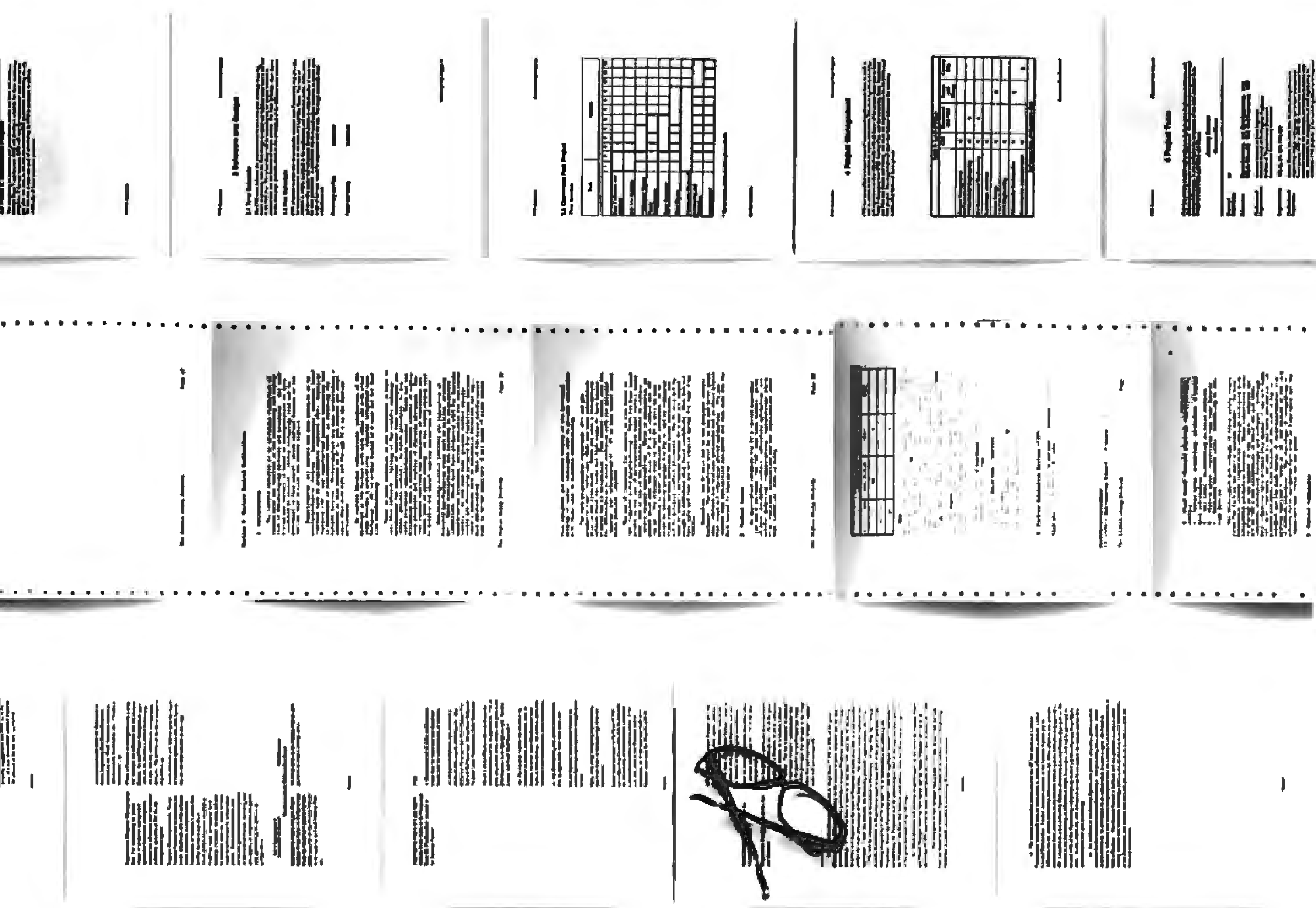


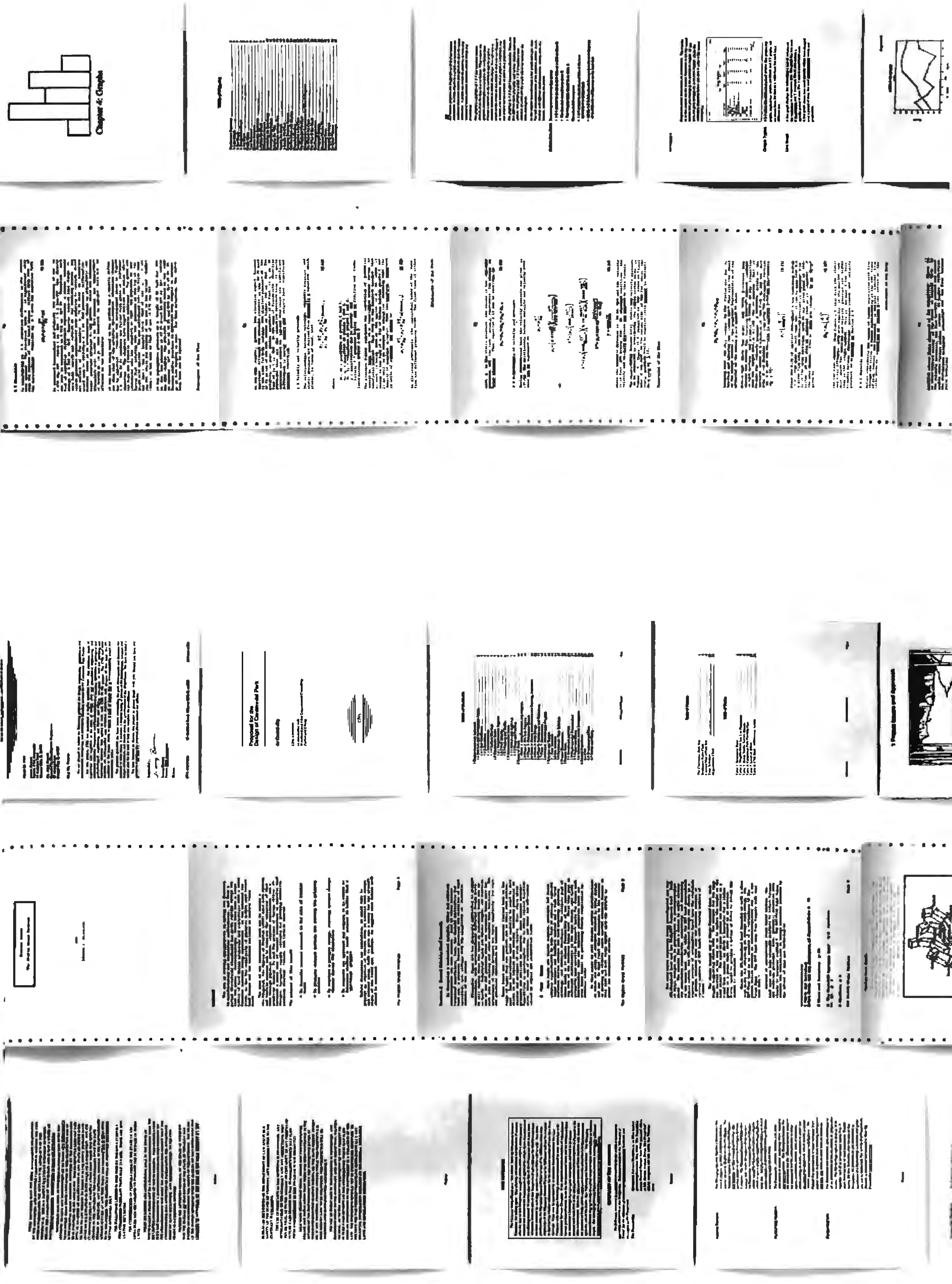
And, as if that was not

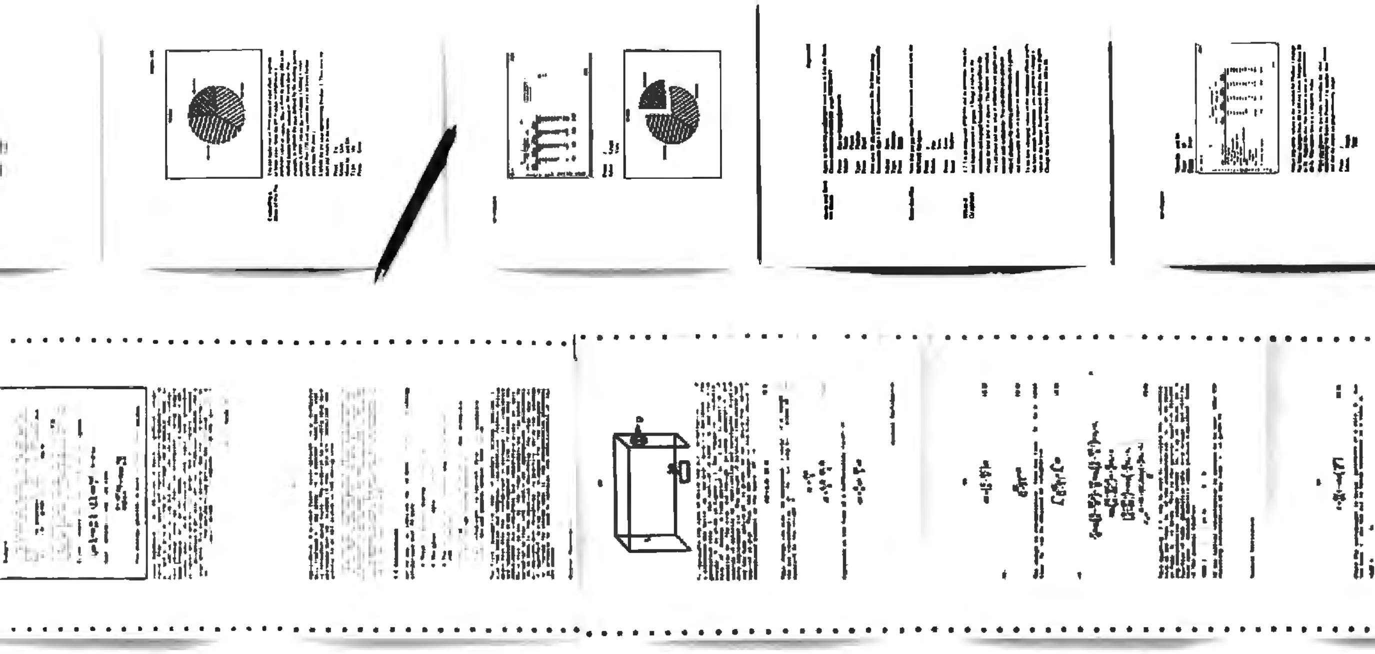




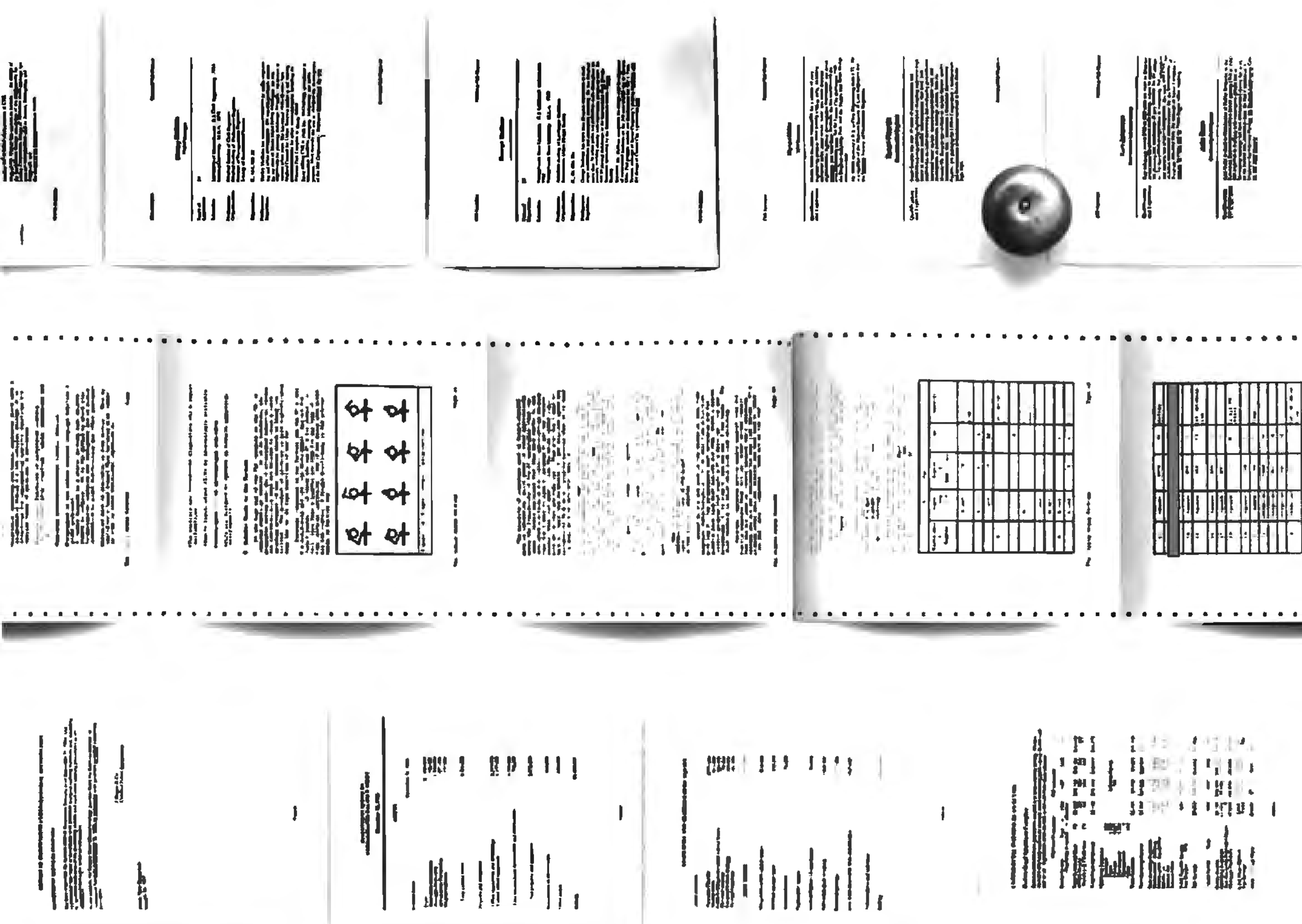
very technical document,



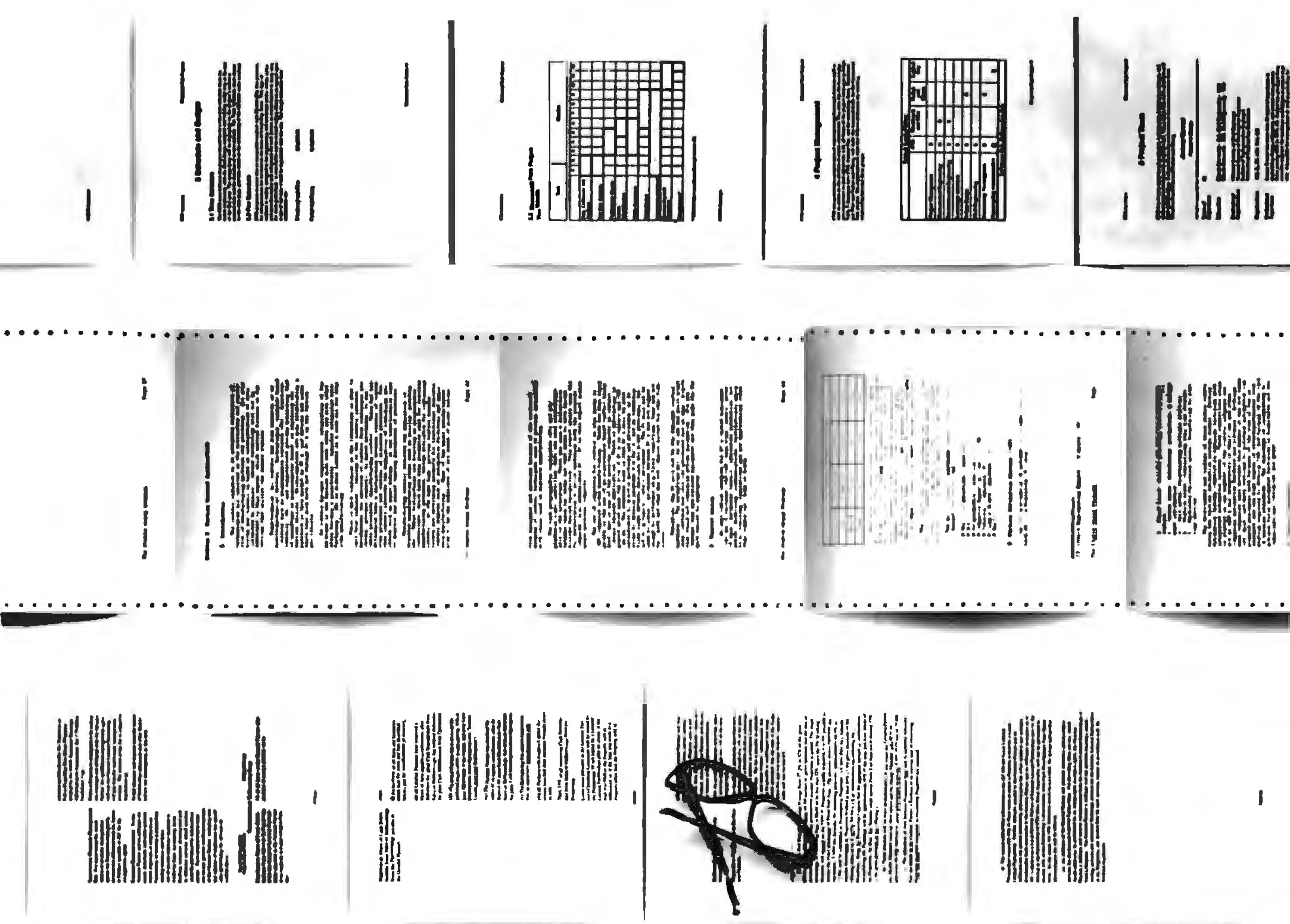

Chapter 4: Graphs
Proposal for the Design of Centennial Park

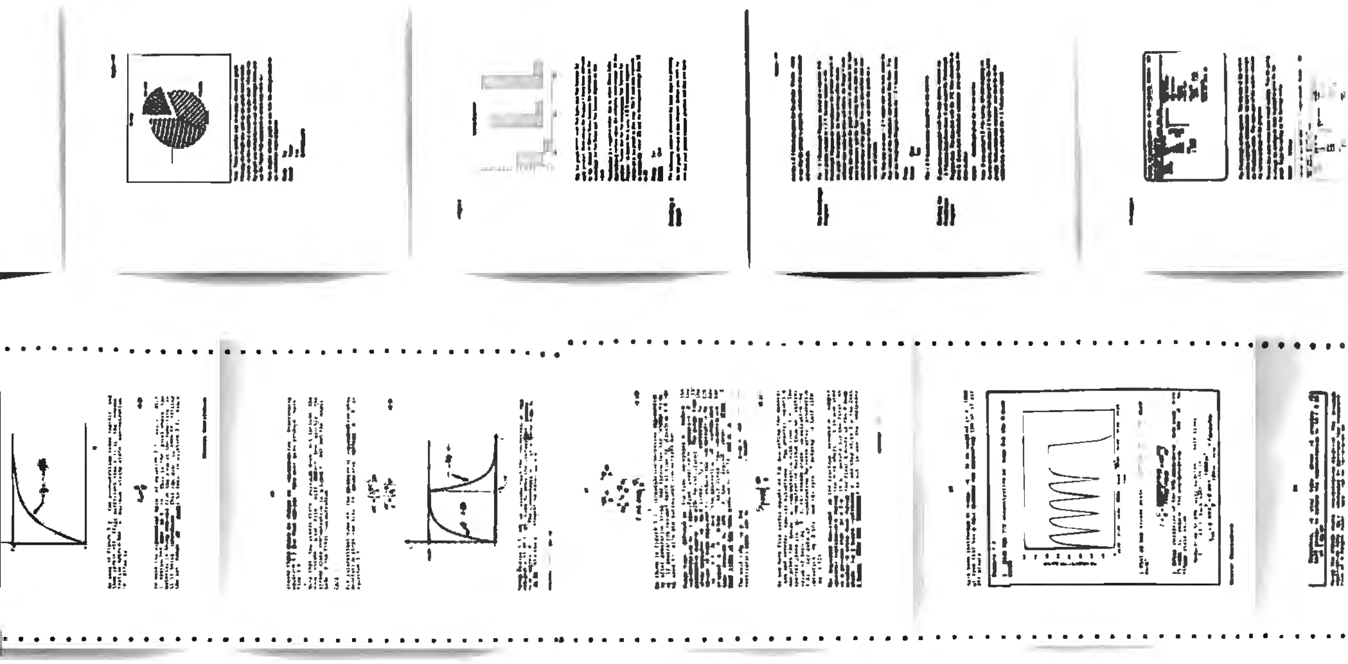


a structured document,

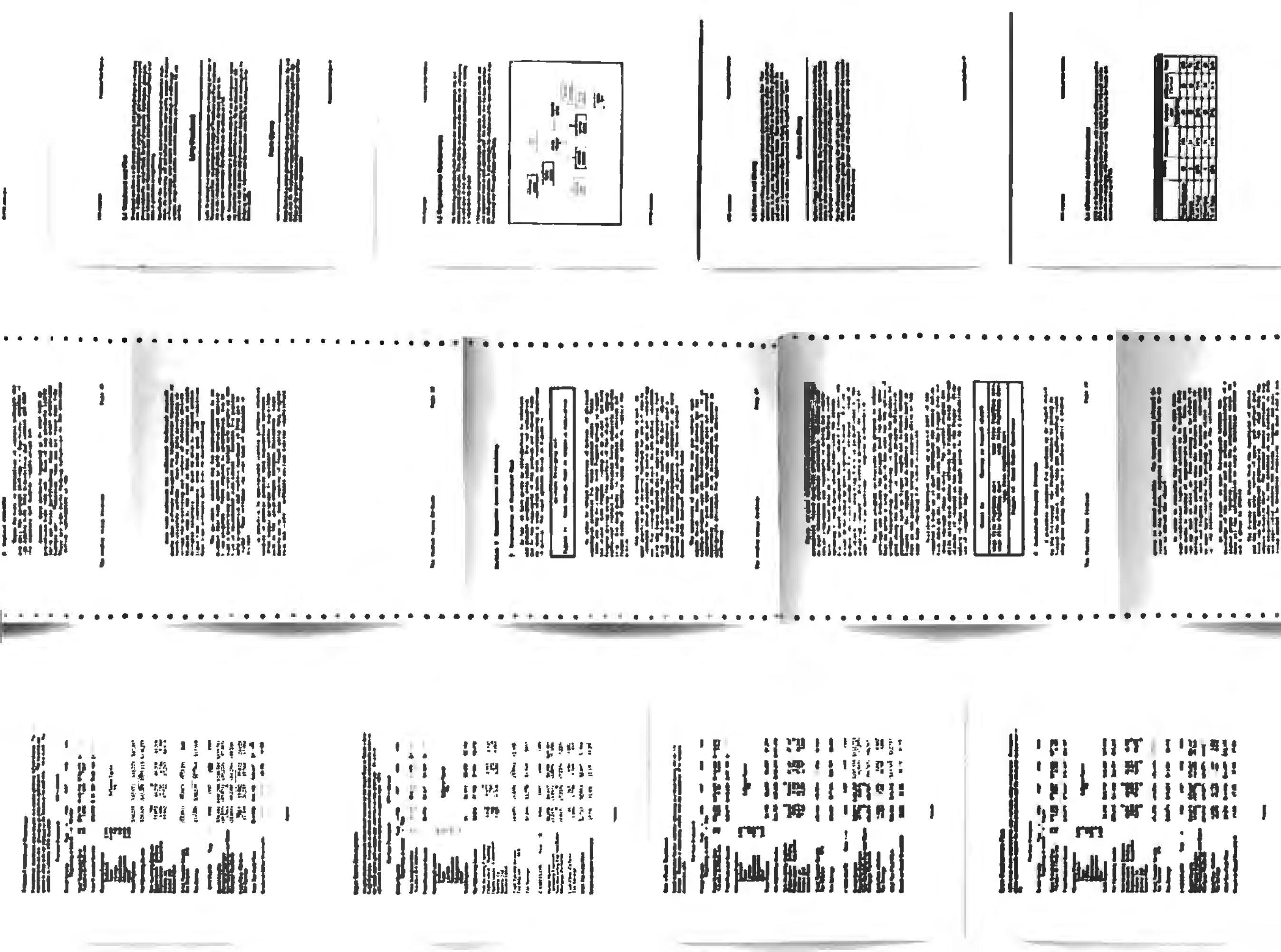


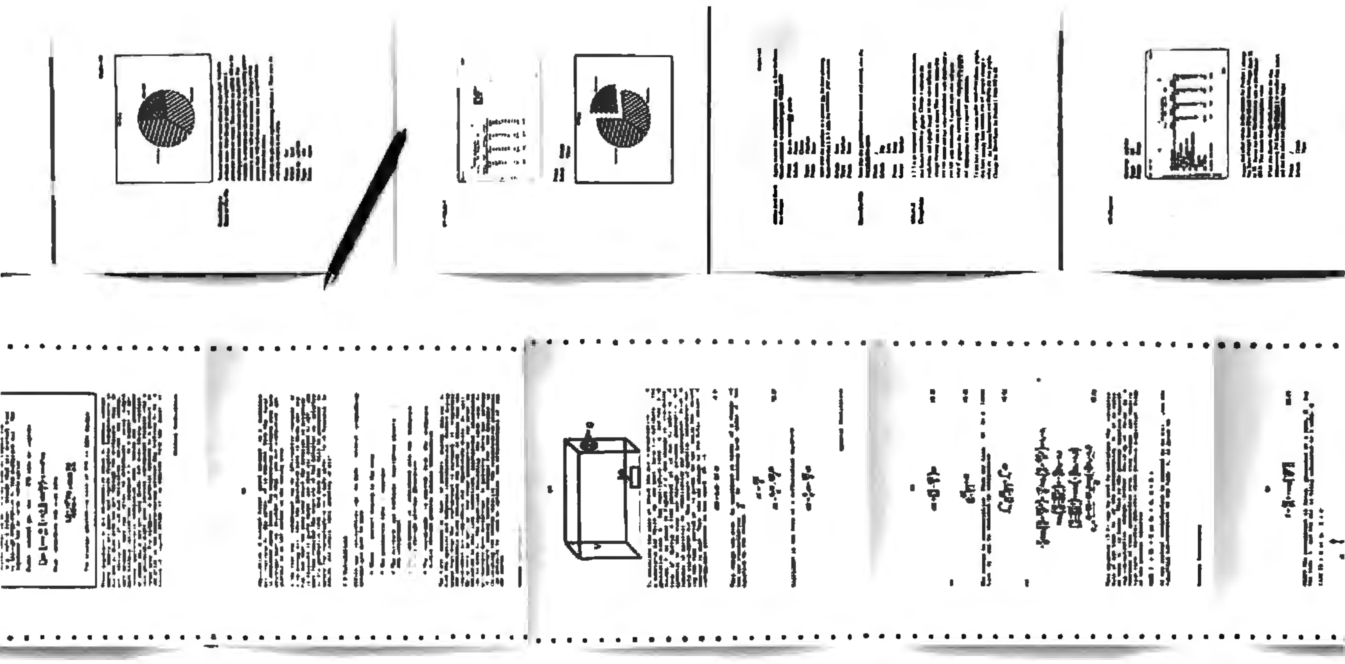
designed to write like this?



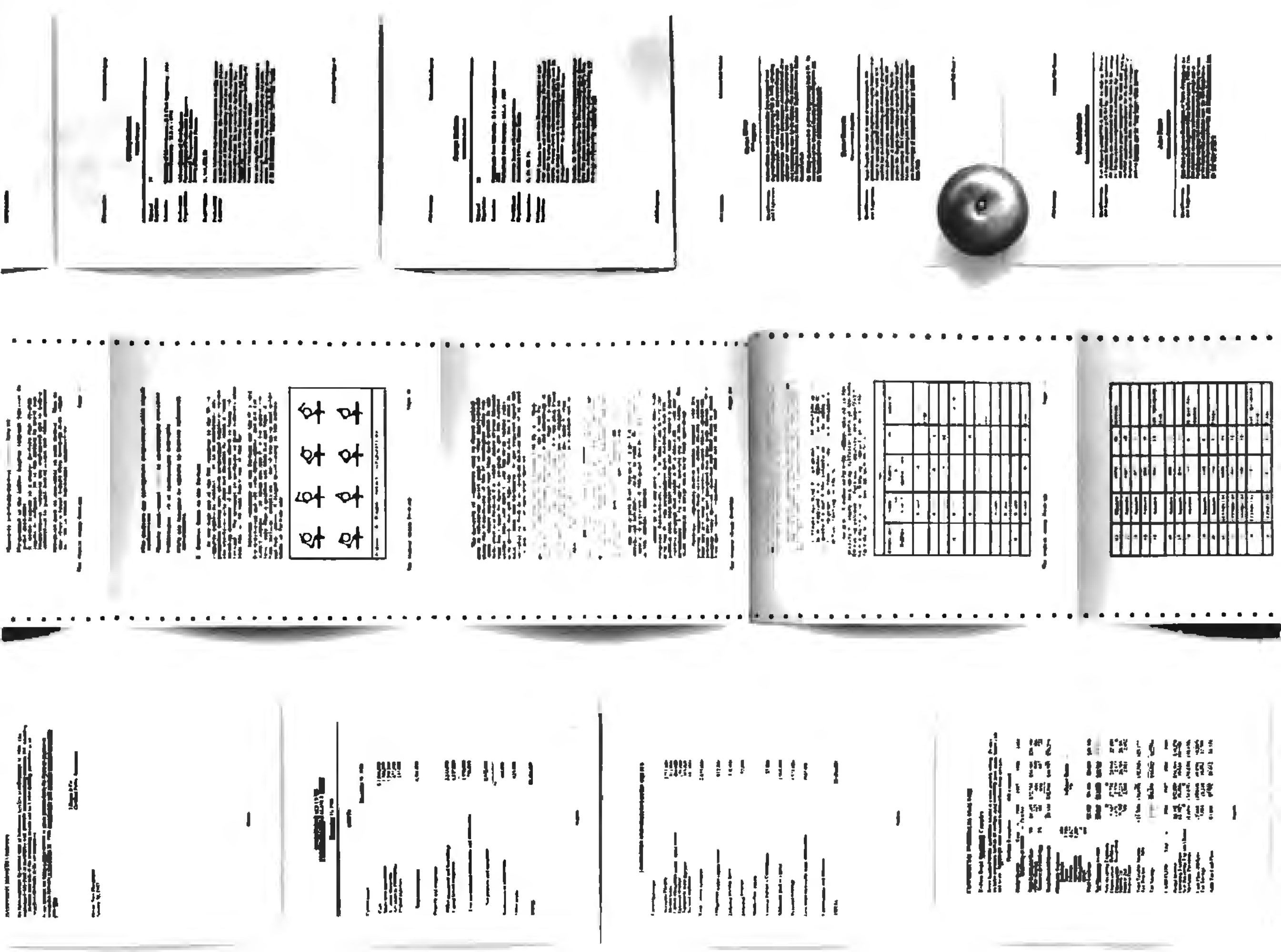


with plenty of revisions.





in a short amount of time.



May we suggest Manuscript.

Yes, Lotus Manuscript™ is a very different kind of word processor. Because when you're processing long, technical documents such as proposals, specifications and reports, you have very different kinds of needs.

Needs like mixing text and graphics on the same page. Or, creating complex equations. Or, working with columns and tables. Or, making wholesale revisions.

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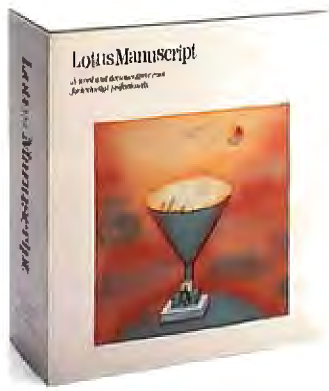
Another feature designed specifically for the writer of technical documents is Manuscript's integrated Outliner. When you collapse the document you're able to navigate the outline much easier than wading through the entire piece. You can move a page, or even an entire chapter with just a few keystrokes.



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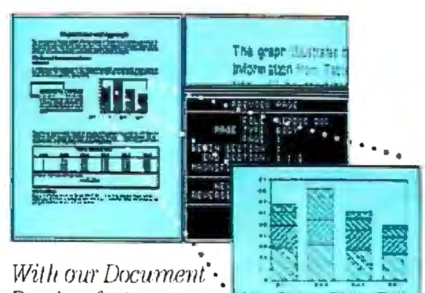
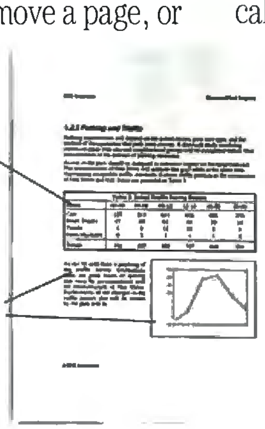


With our Document Preview feature you can see how any page will look before it's printed. Zoom capability lets you take a closer look at graphics and equations.



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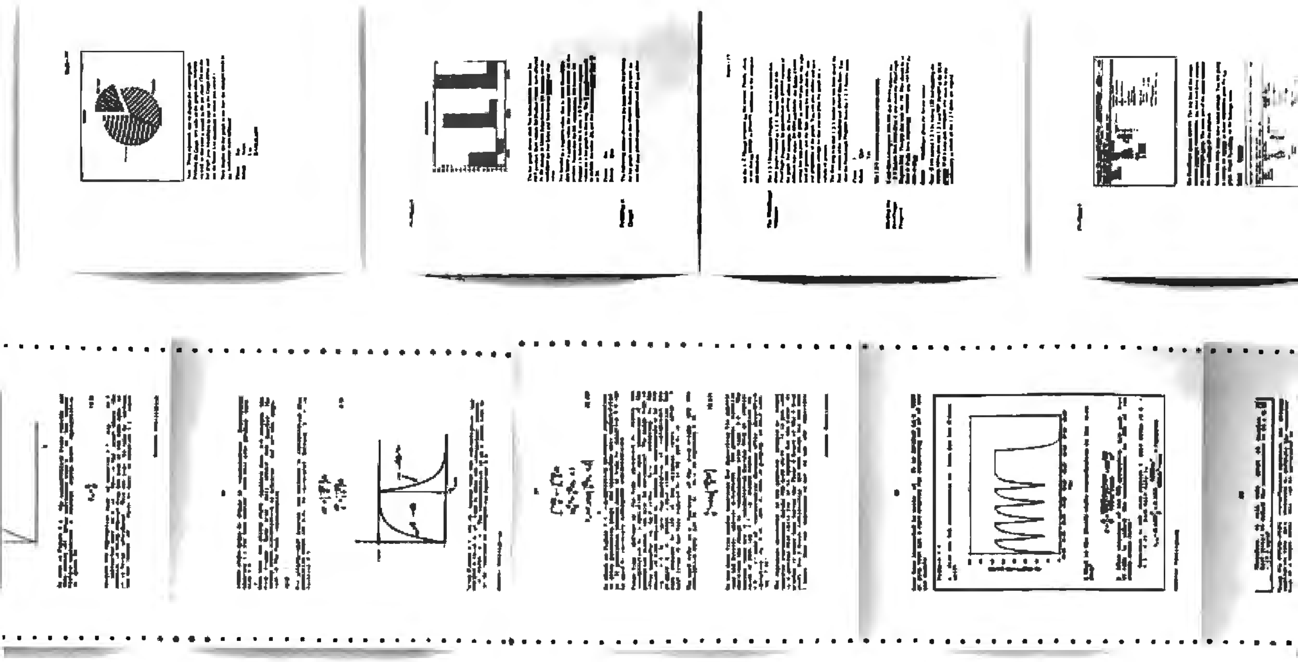
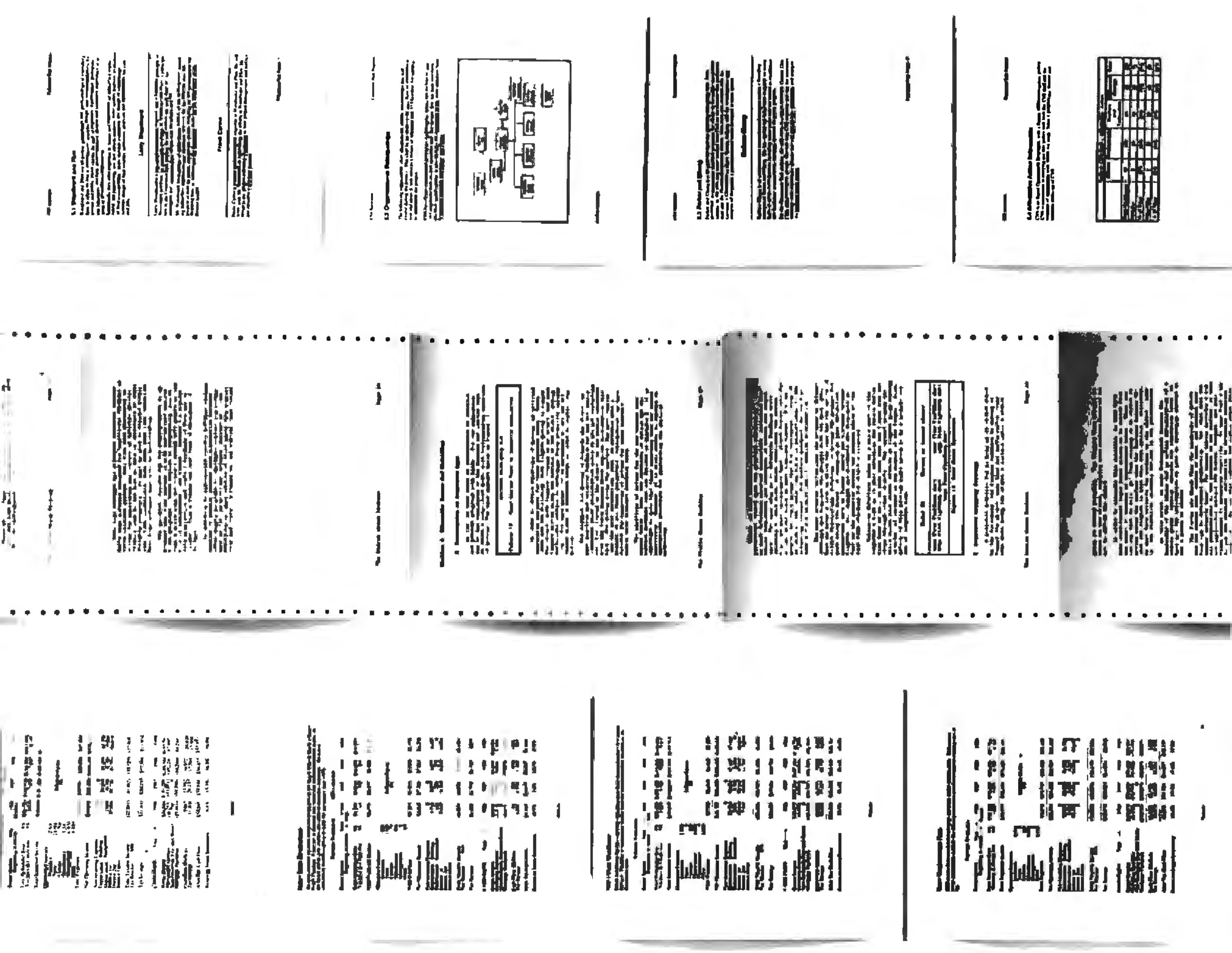


mixing text and graphics.



EVENTS AND CLUBS

February 1987

EVENTS

1987 Computer Graphic Invitational Computer Conference, San Jose, CA, and North Dallas, TX. Invitational Computer Conference, 3151 Airway Ave. #C-2, Costa Mesa, CA 92626, (714) 957-0171. *February*

Third International Conference on Data Engineering, Los Angeles, CA. Computer Science Department, Marguerite Jacks Hall, Stanford University, Stanford, CA 94305, (415) 723-0685. *February 3–5*

Sixteenth Annual Computers in Education Conference: Macro Vision—A Broader View of Technology, Portland, OR. Bob Hamel, Multnomah ESD, 220 Southeast 102nd, Portland, OR 97216, or call Tony Vaught, (503) 657-5154. *February 5–7*

Sixth Annual Computers in Education Conference, Manchester, NH. Carol Anne Eldridge, New Hampshire Association for Computer Education Statewide, 741 Chestnut St., Manchester, NH 03104, or call Michael Goldsmith, (603) 225-0815. *February 9*

Communication Networks '87, Washington, DC. CW/Conference Management Group, P.O. Box 9171, 375 Cochituate Rd., Framingham, MA 01701-9171, (800) 225-4698; in Massachusetts, (617) 879-0700. *February 9–12*

1987 Systems Design & Integration Conference, Santa Clara, CA. Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965. *February 10–12*

Mansfield Mid-Winter Hamfest/Computer Show, Mansfield, OH. Dean Wrasse KB8MG, 1094 Beal Rd., Mansfield, OH 44905, (419) 589-2415. *February 15*

Electronic Imaging West, Anaheim, CA. MG Expositions Group, 1050 Commonwealth Ave., Boston, MA 02215, (800) 223-7126; in Massachusetts, (617) 232-5470. *February 16–19*

Artificial Intelligence: Technology, Industry, and Applications, Los Angeles, CA. UCLA Extension, P.O. Box 24901, Los Angeles, CA 90024, (213) 825-3344. *February 17–20*

Fifteenth Annual ACM Computer Science Conference and SIGCSE Symposium, St. Louis, MO. ACM, Conference Department, 11 West 42nd St., Third Floor, New York, NY 10036, (212) 869-7440. *February 17–20*

Which Computer? Show, Birmingham, Warwickshire, U.K. British Information Services, 845 Third Ave., New York, NY 10022, (212) 752-8400. *February 17–20*

Second Guelph Conference on Computer Conferencing and Electronic Messaging, Guelph, Ontario. Robert J. McQueen, Department of Communications Services, University of Guelph, Guelph, Ontario, Canada N1G 2W1. *February 18–19*

Fifth Annual Missouri Computer-Using Educators Conference, Columbia, MO. Michael C. Holden, 205 Hill Hall, University of Missouri, Columbia, MO 65211, (314) 882-7403. *February 20–21*

Microcomputers in Control Systems: Hardware, Software, and Interfacing, Washington, DC. Continuing Engineering Education, The George Washington University, Washington, DC 20052, (800) 424-9773; in Canada, (800) 535-4567; in DC, (202) 994-6106. *February 23–27*

Computer-Aided Software Engineering Symposium, Atlanta, GA. Digital Consulting Associates Inc., 6 Windsor St., Andover, MA 01810, (617) 470-3870. *February 24–26*

Ohio Department of Education and the Ohio Education Data Systems Association's Sixth Annual Computer Fair, Columbus, OH. Dan Henige, Penta Schools, 30095 Oregon Rd., Perrysburg, OH 43551, (419) 666-1120. *February 25–26*

COMMTEX '87, Atlanta, GA. International Communications Industries Association, 3150 Spring St., Fairfax, VA 22031-2399, (703) 273-7200. *February 26–28*

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

CLUBS

***Hands On!* newsletter,** Technical Education Research Centers, 1696 Massachusetts Ave., Cambridge, MA 02138.

Assembly on Computers in English, affiliate of the National Council of Teachers of English. Contact Lenora Cook, ACE, 12 Coral Tree Lane, Rolling Hills Estates, CA 90274, (213) 377-3701.

COMPress Quarterly, newsletter on educational software, COMPress, P.O. Box 102, Wentworth, NH 03282.

California Educational Computing Consortium Newsletter, Hal Roach, Mt. San Antonio College, 1100 North Grand Ave., Walnut, CA 91789.

Academically Speaking, educational computing newsletter from Scholastech, P.O. Box 1545, Cambridge, MA 02238.

T-BUG, Chicago-area Tandy Business Users Group, Ellen D. Weinstein, 1642 Coloma Place, Wheaton, IL 60187.

ComputAbility, catalog of special products for handicapped IBM users, ComputAbility Corp., 101 Route 46, Pine Brook, NJ 07058, (201) 882-0171.

SCPCUG, for IBM PC and compatible users, P.O. Box 0396, Titusville, FL 32780, Alan Tietjen, (305) 269-7815.

Cape PC Users Group, Gene Neill, 131 West Heather Rd., Wildwood Crest, NJ 08260.

Amiga Guru, newsletter of the Cleveland Area Amiga Users' Group (CA-AUG), 3715 Townley Rd., Shaker Heights, OH 44122, BBS: (216) 341-4452.

Tele/Tech, BBS for real estate professionals, (703) 560-8931, or call Robert D. Weaver at (703) 560-8981.

Sydney Kaypro Users Group (SKUG), Hans Schneider, 122 Murriverie Rd., North Bondi, New South Wales 2026, Australia.

PC Life, newsletter of the Long Island PC Users' Group, P.O. Box 280, Commack, NY 11725; South of the Bauder BBS: (516) 932-2860. ■

We're not too big

If you find portable computers that leave you hanging a little hard to take, meet MultiSpeed™ from NEC.

A breakthrough of truly small proportions.

Our Multi is a mini. Just a decimal point over 11 lbs. So you can really travel light. More important, you can travel bright.

You can do more with MultiSpeed. Because it has more power (640K) and more memory. And at 9.54 MHz it runs at twice the speed of the IBM Convertible.

Of course, you can expand our competitor's capabilities. But to do that you have to add "slices". And pay the prices of the slices. Which can run hundreds of dollars. For features that come standard on MultiSpeed.

And that's not the least of it. Because the slices make their portable more portly. Most are over two inches and weigh about a pound.

Then there's MultiSpeed's detachable screen. It has a remarkable twist: a Super Twist LCD. Compare our readability to theirs. There's no comparison. Besides a better view, you get a 15% bigger view. Best of all, there's nothing small-minded about MultiSpeed. It can do most anything your desktop

Feature	NEC MultiSpeed	IBM Convertible
Clock Speed	9.54/4.77 MHz	4.77 MHz
Standard Memory	640K bytes	256K bytes
Built-in Pop-up Firmware	Yes	No
Separate Numeric Keypad	Yes	No
Screen Type	S-Twist LCD	LCD
Keybd. Compat. IBM PC/XT	Yes	No*
Total Keys	85	78
Weight	11.2 lbs.	12.2lbs.

C&C Computers and Communications

*IBM Convertible is not compatible with IBM keyboard part No. 8529297.
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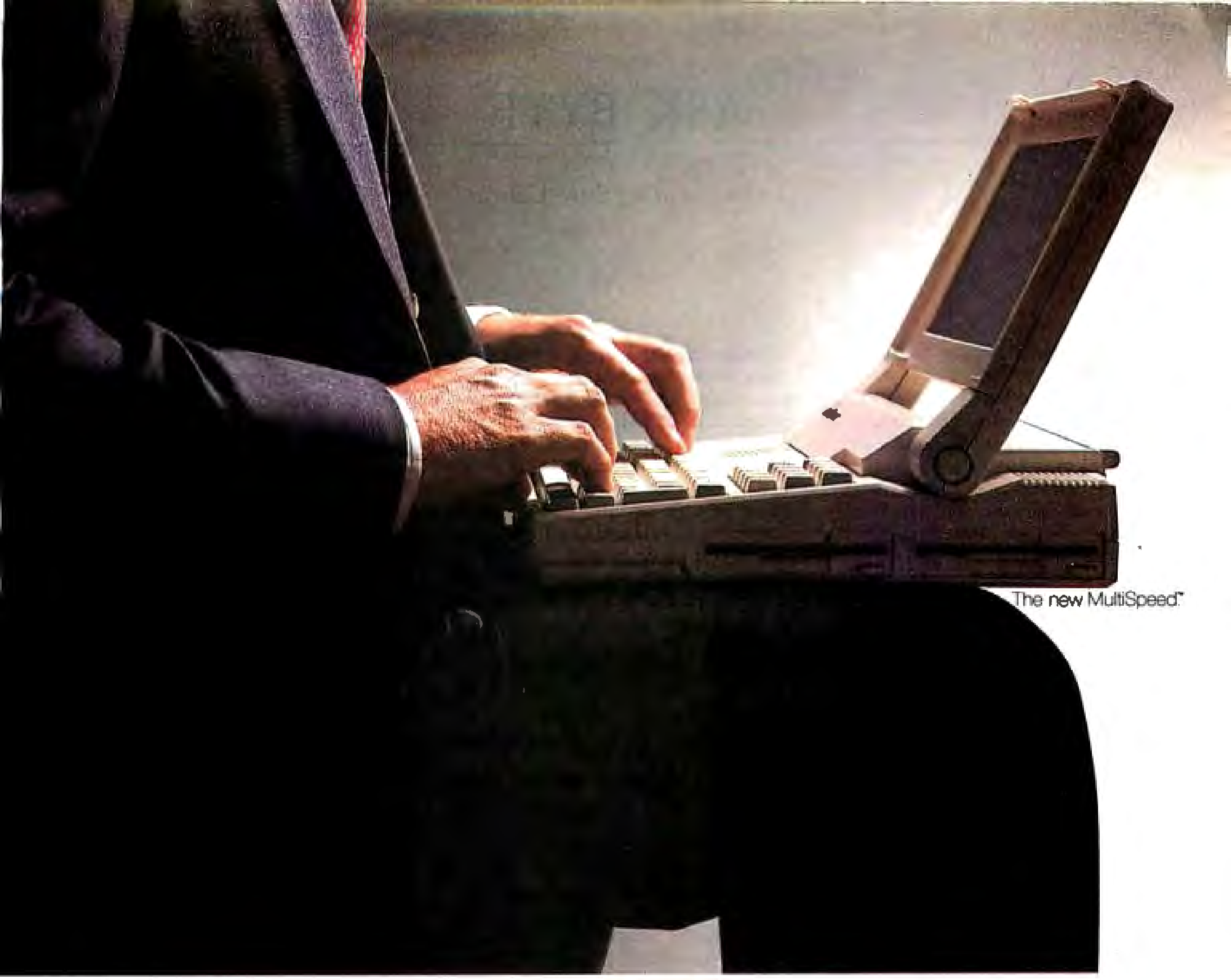

for your britches.

PC can. And, MultiSpeed is chock-full of savvy ideas.

Like a built-in full-function word processor with a spell checker of 20,000 words.

It has a personal filing system and outliner. Plus Telcom, a powerful telecommunications package.

MultiSpeed is compatible with the IBM PC and has an optional Hayes compatible modem.

What's more, it even does windows. It has a special multiple windowing feature built right in. Which works at the touch of a single "Pop Up" key. MultiSpeed has a separate numeric keypad and the same feel of the desktop keyboard you're used to.

And, when you discover everything it comes with, you'll be delighted at what it goes for.

So, why settle for the portable computer that's more brawny. When you can have the one that's more brainy. You'll find MultiSpeed at Bell Atlantic Business Center, Compumat, Compushop, Computerland, Connecting Point and Micro Age. For the dealer nearest you call 1-800-447-4700.

For technical information call 1-800-NEC-SOFT. Or write NEC Home Electronics, Computer Products Division, 1255 Michael Drive, Wood Dale, IL 60191-1094.

Take the Multi and run.
MultiSpeed™

NEC

ASK BYTE

Conducted by Steve Ciarcia

Talking to Your Printer

Dear Steve,

I have been working in Amiga BASIC and Amiga C. I own two printers: an Epson FX-185 and an Okidata Okimate 20. The problem is that I am unable to successfully send escape codes to either printer, although the software I use—including D-Paint, Notepad, and D-Print—all work fine with either printer.

I have written directly to Commodore for help. Commodore sent a reply that included a page from the *ROM Kernel Manual* with escape sequences but no programming examples. When I tried doing what the letter suggested, I had no success.

Thanks for any help you can give me.

Beverly Tranka
Gansevoort, NY

The Amiga "talks" to the printer using a piece of software called a device driver. The device driver handles, among other things, conversion of control code sequences between the Amiga and your printer. This conversion allows the Amiga to support many different printers.

The Amiga only understands its own set of printer control codes. For example, ESC [0 z *is used by the Amiga to set the line spacing on your printer. Your program should send this sequence to the printer, regardless of what brand or model of printer you have connected. When you send any characters to the printer, the device driver gets them before the printer. If you are sending a control sequence, the device driver will not send it to the printer. Instead, it will translate it into the proper codes for the printer that you have selected using the Preferences utility on the Workbench. If you have selected the Epson FX-80 printer, then the above control code will be translated to* ESC 0 *and sent to the printer. This will set the line spacing on the Epson to eight lines per inch.*

A complete listing of the Amiga control codes can be found in the Amiga ROM Kernel Manual, Volume I, *beginning on page 3-198.*—Steve

Desperately Seeking Printer

Dear Steve,

We have searched without success for a moderately priced, serial-interface, bottom-feed printer designed to efficiently handle one-across labels on tractor-feed paper stock 6½ inches wide. The labels must be produced on demand rather than in a batch mode and, as a result, two unused labels between every pair of useful labels are wasted when each set is advanced past the tractors for removal. These pressure-sensitive labels must be bottom-fed, as they tend to pull away from the backing paper and jam the printer if they have to roll around the platen. This eliminates printers with tractors preceding the platen. Standard printers require letter-width paper. Help!

David W. Jessup
Seattle, WA

There are two approaches you can take to solve your problem.

First, you could look into the Okidata line of printers (I believe you have a dealer in Seattle), specifically the ML92, which has bottom-feed capabilites and an adjustable top tractor. To use this—or any other parallel printer that meets your needs—you will have to use a printer buffer or printer adapter to convert your RS-232C serial data to parallel format.

Second, you might contact Centronics Data Computer Corp. (One Wall St., Hudson, NH 03051, (603) 883-0111, Ext. 4004) for information on their nearest representative. I know that they make several printers that would meet your needs, but they are a little harder to deal with as they service large- and medium-size systems. If my past experience is any guide, a serial printer with bottom-feed in the Centronics 700 series would be in the region of $600.
—Steve

Upgrading an IBM PC

Dear Steve,

I want to upgrade my IBM PC to an XT (or XT clone) as cheaply as possible so I can add a hard disk and some more cards. If I bought a new case, a bigger power supply, and an 8-slot clone motherboard, could I expect my original IBM ROM BIOS chips to work in the clone board and give me a true XT compatible?

Jack G. Aubert
Paris, France

If your need is primarily to add a hard disk, the cheapest way is to buy one of the aftermarket hard disk drive/controller sets available for around $400 from many sources advertised in BYTE and most other personal computer magazines. There are some combination hard and floppy drive controllers available that would enable you to add the hard drive without losing a slot. One company supplying these is Maynard Electronics, 430 East Semoran Blvd., Casselberry, FL 32707, (800) 821-8782 or (305) 331-6402.

If you really need to add slots, then a clone is probably your most economical route. These are not usually similar enough to the IBM that you can simply transfer all the PC chips to a blank clone board, although many of the PC chips could probably be used. Since populated boards are not very expensive, your best bet might be to save your current PC board intact as a spare or sell it along with the case. I know of no clone boards that will take the IBM ROM chips; they usually use EPROMS that are not pin-compatible with the IBM ROM chips.
—Steve

Transmitting Data over the Air

Dear Steve,

I would like to be able to transmit digital data over the airwaves. I would like to use a pulse-width modulated (PWM) scheme or some equivalent to transmit in full-duplex serial. I would also like to have a fairly powerful transmission in order to extend the range of the signal. Although this system will not be broadcasting out-

continued

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MICROSOFT LANGUAGES NEWSLETTER Vol. 2, No. 2

News about the Microsoft Language Family

The Evolution of Optimization Techniques Used in Microsoft® C.

One of the reasons the Microsoft C Compiler has been chosen by leading software developers is because of the optimization techniques used in the code generator of our production-quality compilers. Microsoft's advanced optimization capabilities mean that generated code is small and fast.

Local optimization was implemented in Microsoft C Version 3.0. Most MS-DOS®-based C compilers implement this technique, but good local code generation such as that in Microsoft C Version 3.0 uses *pattern matching* to select optimal sequences and *register targeting* to evaluate expressions in their target destinations. *Peephole analysis* is also used and includes such optimizations as *redundant load/store* analysis. This increases the efficiency of the resulting code by removing unnecessary or duplicate instructions. The compiler also optimizes branches by shortening or removing branches where it can.

Microsoft C Version 4.0 went one step further with block optimizations that used *common subexpression elimination.* This improved code optimization still further. The advantage is the time saved by avoiding recalculation of computations which are used repeatedly in the program.

For example:

```
a = b * (c/d); will evaluate to:
        tmp = (c/d);
        a = b * tmp;
e = f * (c/d); will evaluate to:
        e = f * tmp;
```

Note: depending on the context, tmp might be a register variable rather than a memory location.

The next progression for block optimizations is to do *loop optimizations* in our future production-quality compilers. If a calculation inside a loop does not depend on any calculations inside the loop, it can be moved outside the loop. This is called *invariant code motion.* A second loop optimization technique is called *induction variables.* This means that while in a loop, multiplies by the control variable can be turned into additions.

Examples of *induction variable* optimization:

```
1.  for (i = 0; i < 10; ++i)
        j+=i * 7;
    evaluates to:
    for (i = 0; i < 70; i+=7)
        j+=i;

2.  char a[10];
        for (i = 0; i < 10, i++)
            a[i] = 'c';
    evaluates to:
        memset (a, 'c', 10);
    ie: the following 8086 instruction would be generated:
        REP     STOSB
```

There is also *loop enregistering,* in which case calculations can be kept in a register for the whole loop. Loop optimization is implemented in the new 386 C Compiler in the XENIX® 386 Software Development Toolkit.

For more information on the products and features discussed in the Newsletter,
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Look for the Microsoft Languages Newsletter every month in this publication.

side of a building, I'm sure the FCC will want to limit the transmission strength. Unfortunately, I don't know how to accomplish all this. All the literature I have is in reference to modems using a transmission medium such as a wire.

Since the transmission will be over the air I assume that a great deal of noise will occur. To prevent this noise from overwhelming the data, I would like to add additional error-detection/correction bits to the transmitted signal. Ideally, I would like to be able to detect and correct up to 2-bit errors using a small number of ICs (I don't have a lot of board real estate available). Are you aware of any ICs that implement such algorithms?

Also, because I will be transmitting on the open airwaves and some data may be of a sensitive nature, I would like to guard against unauthorized interception. I would like to encode this data with a key encryption scheme where the key can be set by means of data lines to an IC. I know that the National Bureau of Standards has released a Data Encryption Standard, known as the DES; is this implemented in IC form?

One last question: I was under the impression that some minicomputers and mainframes automatically detect baud rates of terminals before the log-on sequence is fully established. Is this accomplished through hardware using an intelligent UART or USART, or does the terminal send some predefined ASCII sequence until the host machine guesses the correct baud rate and begins the session?

Thomas F. Geary III
Cohasset, MA

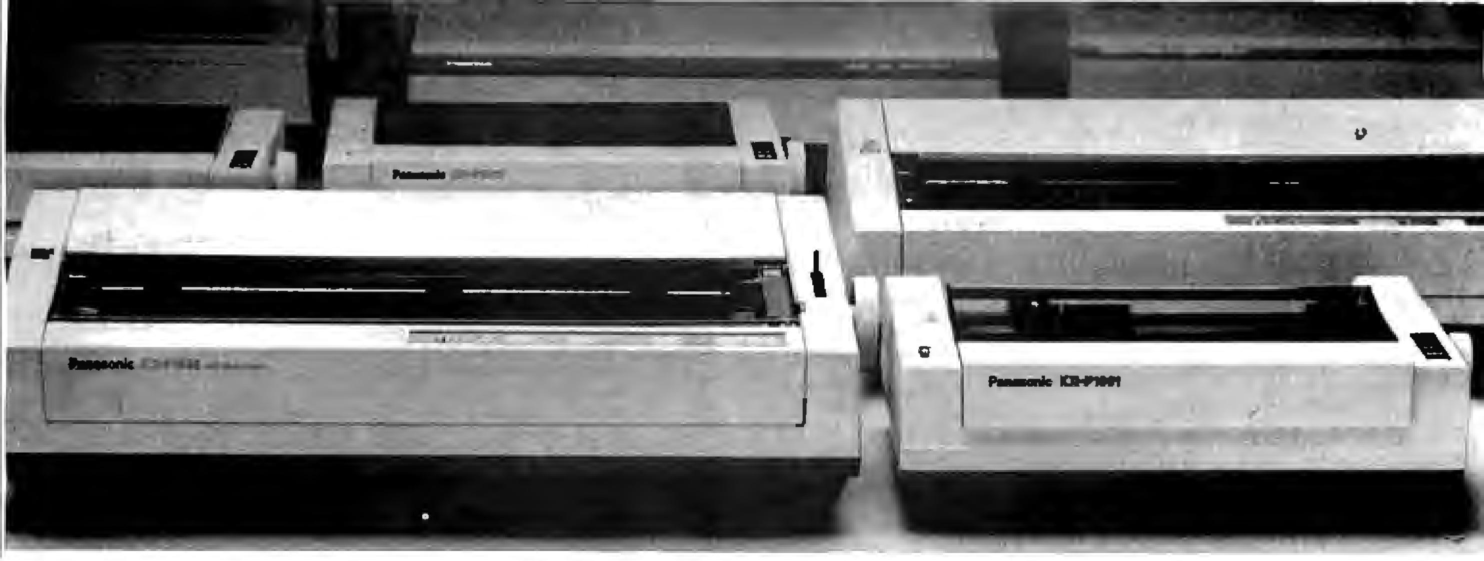
A common scheme to detect baud rate is to have the terminal send carriage returns, one at a time, to the computer. If you look at the bit pattern for a carriage return, you will see that there is a long "low" (or zero) time in the character. It is this first string of zeros that you can time in software to determine the baud rate. Of course, if the terminal doesn't send the right character, the software could end up with the wrong rate.

As far as sending digital information via radio frequencies, you are correct in stating that the FCC has imposed limits. In fact, you might want to get a copy of the Code of Federal Regulations, Title 47 (Telecommunications), Book 1, *as well as information on frequency allocations for various services. In other words, you can have an unlicensed device meeting certain criteria or you will need to have a licensed device (which requires more overhead for both you and the consumer). The rules cover low-power devices that might be of use to you. You can obtain copies of these rules from the Government Printing Office, 710 North Capitol St., Washington, DC 20402-9325.*

A handy source of circuits for designing transmitters and receivers is The Radio Amateur's Handbook *(Harper & Row, 1983).*

To answer your questions on error correction and using an encryption algorithm, two articles in the September 1986 BYTE present some practical solutions for you. The first is my article "Build a Hardware Data Encryptor," which presents a scheme that does not use block encoding/decoding. The second is a Programming Project, "Calculating CRCs by Bits and Bytes" by Greg Morse. Since you mention full-duplex transmission and a desire to keep things reasonably simple, your system could call for retransmission upon detecting a transmission error. Another reference is published by Control Data, "A Study of Methods of Error Detection During Transmission of Binary Information." The cost is $6 plus shipping. The address is CDC Literature Distribution

continued



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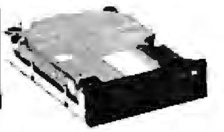

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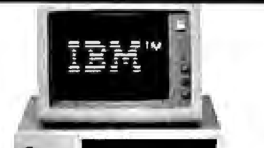

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Good luck on your project.—Steve

Game Port Thermometer

Dear Steve,

As a science teacher, I am attempting to show my students the methods by which microcomputers can be used to gather and process laboratory data. I have built some photosensors that interface with an Apple II through the game port and am using these for timing purposes. I would like to construct temperature probes that also interface through the game port, but I am unsure of how this can best be done. Can you offer any advice or assistance?

Danny Roberts
Fort McMurray, Alberta, Canada

The game port on the Apple II computer allows a user to connect both digital and analog devices. This connector has three 1-bit inputs, four 1-bit outputs, a data strobe, and four analog inputs.

The analog inputs, found on game I/O connector pins 6, 7, 10, and 11, can be hooked up using a variable resistor (typically in the range of 150,000 ohms) between the input pin and +5 volts. The variable resistance is used in a one-shot timer; as you vary the resistance, its frequency is changed, and an internal routine in the Apple converts this frequency to a value that an Applesoft program can read using the PDL() function.

An article in The Best of Micro Series, Volume 3 *(Micro Ink, 1980), entitled "A Digital Thermometer for the Apple II" by Carl J. Kershner describes a program to read the temperature from a thermistor and convert it to a digital display.*—Steve

Info on Lear Siegler

Dear Steve,

I was given a Lear Siegler ADM 3A terminal recently. Where can I get some technical information, such as a manual or schematics, for this device? Also, for computer systems that use battery backup for nonvolatile RAM, how does the circuitry make the switch from power supply current to battery current? You can't have both the battery and the power supply on-line during the switch, can you?

Jeffrey L. Thorssell
Towson, MD

For information on your Lear Siegler ADM 3A, check with Howard W. Sams Inc. through their toll-free number, (800) 428-7267. They publish many service bulletins and books for computer equipment.

In regard to your second question, you're correct in stating that the battery and power supply are not connected at the same time. The usual trick is to put a diode in series with the battery to block reverse current to the battery. Of course, a diode is a fast switch, so when the power goes away, the battery can take over. There are other, more esoteric designs that take the chip enable line into consideration as well.—Steve

Digitizing Feet

Dear Steve,

I need to be able to superimpose computer graphics and video from a camera in real time. My application is in the realm of biomechanics, where the computer graphics are real-time plots of the forces acting on a person's foot while walking (about 100 data points per second). The video would be a picture of the foot in motion.

Tecmar manufactures a graphics board for digitizing video images that has both RGB and composite outputs. Do you know of any company that makes a moderately priced mixer with synchronizing capabilities?

Dr. Nathan H. Cook
North Eastham, MA

The device you're looking for is a bit specialized, sliding out of the computer area and into the video domain. Tecmar does not make a mixer for their graphics board, and upgrading to a different board with mixer would likely cost more than the purchase of a high-end consumer or industrial video mixer.

Your best bet is to contact a local JVC or Sony Industrial Video dealer. Both companies manufacture full lines of video-mixing and special-effects devices that range from simple (in the $300 to $800 vicinity) to very sophisticated ($5000 or more). Your specific needs and desires will dictate the right model for you.

The method normally used with such mixers is to use one source as a reference for sync timing (in your case, this would be the graphics card) and lock the timing of the other sources to the reference by providing a "genlock" signal to them. The camera used must have the ability to use this signal. Fortunately, many industrial and home models have such provisions. If you're unsure, contact the dealer where you bought the camera.

The other possible method is to correct timing using a television "frame-store" device on each source, but I won't ruin your day by telling you the cost of that equipment.

If this is to be a short-term project, perhaps it would be easier and cheaper to contact a video production company or TV station in your area. If they have a mobile or portable mixer system, they

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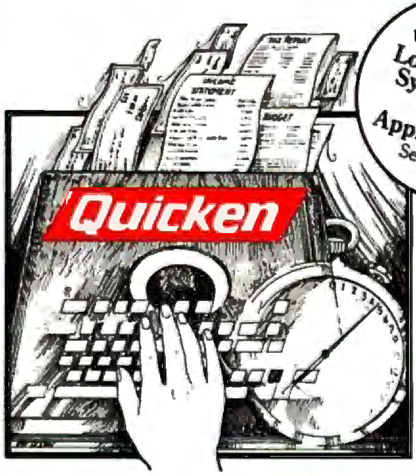

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Limits of C-64

Dear Steve,

I just bought a C programming package for my Commodore 64 and am very happy with it. It is a full Kernighan and Ritchie implementation and very easy to use. I have found only one problem with it: I have to wait for it to load the editor, save the source, load the compiler, compile from the disk, load the translator, save to disk, load and run the linker, load the optimizer (this is actually optional), and finally load the executable file. By this time, I usually discover that I have forgotten to include a function call, so I have to go back and repeat the entire process.

I can live with the 1541 disk drive's speed (or lack thereof) in most cases, but for software development using a compiled language, the 1541 is too slow. I am considering building a RAM disk, but I haven't found any schematics for one compatible with the C-64. Can you help?

David Godshall
Goshen, IN

Regrettably, you may be forced to live with things as they are. The C-64 is a very capable machine for what it was designed to do, but it presents major obstacles when you begin considering memory-expansion projects like a RAM disk.

The 6510 microprocessor contained in the C-64 is quite limited in register capabilities, and it is designed to address only 65,536 bytes, maximum. With these limitations taken into account, the only reasonable approach to designing a RAM disk would be to create a two-stage software addressing scheme and use bank switching to select the added memory. This would be a slow process, since the only access to the processor bus is through the expansion port; you would have to use software to select the bank, select the address, read or write the data, and manage time-sharing with the application. I'm sure you can see that there would be little benefit realized overall.—Steve

CIRCUIT CELLAR FEEDBACK

Power Interrupt Switch

Dear Steve,

After spending a tedious hour salvaging blitzed directory areas on two of my CP/M disks, it occurred to me that you may have already designed a computer power switch that would have prevented this sort of damage.

As a fellow country-dweller, your problems are probably not much different from mine. Two years ago, I built the power-line filter you described in the December 1983 Circuit Cellar. I am very grateful for the project; I've lost no hardware to power-line surges since. (The database program I use is reputedly sensitive to minor fluctuations, but the errors I used to have disappeared after I installed the filter.)

Of course, my power-line filter does not prevent disk overwrites if the power goes off and returns a second later. Such occurrences are frequent here. The fluorescent light in our kitchen (normally kept on) goes off when the power flickers and we have to restart it manually. Is it possible to use this principle for an interrupt switch in a computer's power supply so that the power stays off (or the computer turns itself off) when the main supply fails? If so, could you design a circuit simple enough for the average user to build (i.e., those of us familiar only with soldering-iron usage and not possessing any expensive calibration meters)?

Donald J. C. Phillipson
Carlsbad Springs, Ontario, Canada

continued

If it only took you a "tedious hour" to recover your disks, you must be living right. Congratulations!

Power supply design has taken a turn for the better in the last few years. IBM PCs, for example, have a signal (called "power good") coming from the supply that is active when the power supply voltages are within normal tolerances. When this signal is inactive (bad power) the 8088 is forced into a reset state so it can't do any harm. A power dropout does no harm until the power supply voltages fail, at which time the processor is reset. The power must remain off for at least 1 second to allow the "power good" to become active again, at which time the system performs a complete power-on reset. Short power dropouts require you to flip the power switch manually.

This signal ensures that low voltages don't cause too much damage; a fluctuation may cause you to lose all open files as if the power had gone out completely, but your system won't go crazy. Your CP/M system doesn't include such a signal. Adding it to your computer via some external device isn't too difficult, but there are some interesting trade-offs. If the device is too sensitive it will shut your system down, even for dropouts that ordinarily would not have caused any problems. If the device is not sensitive enough it won't solve anything. The load on your power supply determines how long the supply will continue delivering good power during a dropout, and this "survival window" will change if you add more cards or RAM.

Also, there's no good way to test the device once you've built it. You would need to remove the 120-V AC power for a specific number of cycles. This would require some fairly fancy test equipment. —Steve

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Tim Stryker
Galacticomm Inc.
Plantation, FL

Since many of my projects use the latest technology, they often serve as application examples for industrial users. I congratulate you on your product innovation and wish you luck.—Steve ■

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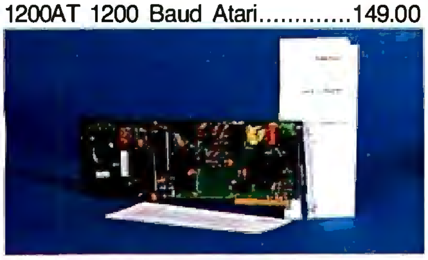

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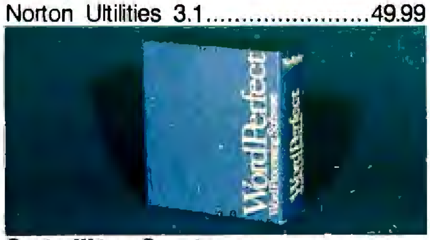

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IN SEARCH OF THE MOST AMAZING THING: CHILDREN, EDUCATION, AND COMPUTERS
Tom Snyder and Jane Palmer
Addison-Wesley
Reading, MA: 1986
ISBN 0-201-16437-X
154 pages, $10.95

A PRACTICAL GUIDE TO COMPUTER USES IN THE ENGLISH/ LANGUAGE ARTS CLASSROOM
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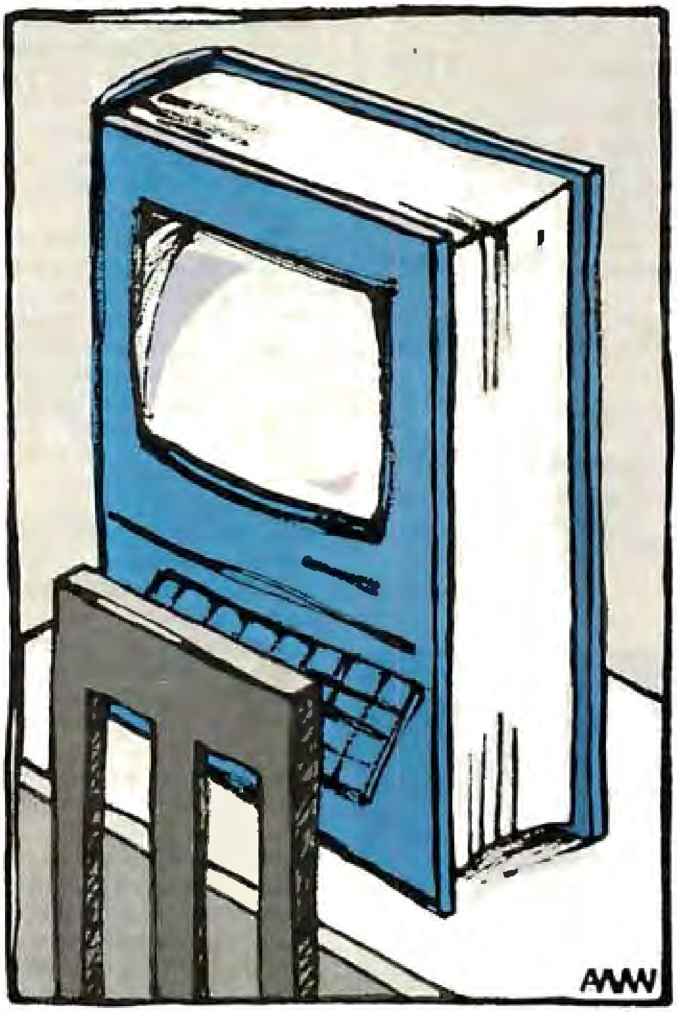

In Search of the Most Amazing Thing: Children, Education, and Computers
Reviewed by Karl S. Wittman

In 1983, Spinnaker Software (Cambridge, MA) published an educational program called In Search of the Most Amazing Thing. The game was a good computer simulation and made learning fun. Tom Snyder, who wrote the game, uses the same title for his new book. A former teacher and software publisher, Snyder teamed up with writer Jane Palmer to critique traditional concepts of educational computing. They build a strong case for developing games and simulations that help the teacher teach.

A Crisis in Education
Recently, intellectuals and politicians have criticized the nation's schools for our children's poor performance in the basic skills. This crisis in education, with its emphasis on measurable achievement and test score results, has produced a climate in which the new technology of computers has seemed to offer a magical way to improve student performance. In this context, the authors argue that the educational community has been uncritical in its acceptance of computers. Snyder and Palmer suggest that the schools have focused on the technology rather than on providing a quality education for our children, which should be their primary objective.

The book stands on the premise that neither educators nor people who work in the software and hardware industry know how to use the new technology to support education on the scale being demanded by the public. While Snyder and Palmer grant that some educational software is effective, they dismiss most educational programs as inadequate and lacking innovation. Yet educators and parents have an "excessively high opinion of the computer's educational potency," they claim.

The authors have no sympathy for those who mindlessly embrace computers as a panacea for the ills of education. Parents, they say, are often deluded into thinking that microcomputers in their child's classroom or bedroom will solve his or her learning deficiencies by making the child "computer literate." School boards, responding to the public pressure to have computers in their schools, have climbed on the same bandwagon.

The Computer As an Instructional Medium
A great debate continues between traditionalists who use the notion of programmed instruction, computer-assisted instruction (CAI), and those visionaries who seek to use the computer more progressively. This tug-of-war is a recurring theme in the book.

Although CAI has been used in schools for about 15 years, its widespread acceptance and the accelerated development of software keyed to the curriculum have been apparent only since the appearance of the microcomputer. While computing power outstripping what was possible 15 years ago is potentially available on every school desk, educational software has not made

continued

the transition nearly as well. (See "A Hard Look at Educational Software" by Adeline Naiman on page 193). CAI's two basic modes still exist: drill and practice, and the tutorial.

Drill-and-practice software assumes that the student understands the subject-matter principles and needs practice to convert this general understanding into mastery and application of the material. The tutorial mode uses the computer to deliver instruction and attempts to imitate the student-teacher relationship.

These CAI modes are easily understood by educators and parents because they closely parallel traditional teaching methods. But the authors doubt the validity of the CAI approach. Why continue to use dull, routine CAI programs, say Snyder and Palmer, when they merely represent a transfer of workbooks and texts to computer format? The computer is being wasted as an educational resource if it is used as a delivery system for teaching skills that could as easily be taught by conventional means.

The authors believe that software publishers have too great an influence on teaching because they tend to closely correlate their programs to existing curricula, rendering it fixed and difficult to change. School officials and teachers buy so-called wraparound software—programs that drill, test, and measure their charges to make sure they conform to the rigid parameters of the curriculum. Snyder and Palmer warn us not to institutionalize technology before the school system really knows how to teach and has found effective ways to use the computer.

The authors argue that the current crop of educational software is ineffective for most students because the technological algorithms that produce CAI are inherently linear processes. The step-by-step nature of programmed instruction, despite the most sophisticated branching and computer management of previously learned skills, cannot match a five-year-old's "creative insights and cognitive leaps." Significant learning is often intuitive, requiring interpretation, contextual references, and dialogue between teacher and learner. Simply put, CAI is not yet capable of artificial intelligence.

The Computer As Tool

Several researchers and writers, including Henry F. Olds Jr., senior editor of *Classroom Computer Learning* magazine, have classified the functional uses of computers in schools. *In Search of the Most Amazing Thing* borrows Olds's three-part taxonomy as a foundation for analyzing educational computing. The authors clearly give low marks to the first element in Olds's scheme, computer as an instructional medium. They find computer applications more interesting than CAI but argue, for example, that a word processor cannot improve writing skills or transform a bad essay into a good one. Rather, the book makes an interesting case for inventing new and more useful software applications for the teacher.

The Computer As Modeling Device

The authors believe that the best use of computers in education is to "create environments supportive of teaching." A good computer model helps a student learn by providing a forum for experimentation. Although adults can conceptualize the need to learn facts and processes for later application, children usually must wait a long time to appreciate their practical uses. Simulations provide a method that teachers can use to stimulate students' discovery of the application of abstract learning.

The Role of Interaction

Game playing has many virtues that the authors see as fundamental to effective learning, and it contains some basically different approaches to traditional teaching methods. Snyder and Palmer contend that educationally effective games and simulations are

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UNIX TOOLS FOR YOUR PC

based on the idea that children learn primarily through social interaction. That is, the game provides an environment in which youngsters, with a teacher's guidance, can act out situations, respond to the consequences of their actions, and compare and test out their new discoveries with others in the classroom.

Snyder uses his own programs as a basis for describing features that make this format desirable. Simulations succeed when they are integrated into other teaching methods and rely on things computers do best: manipulating large amounts of data and managing the many elements of a simulated setting.

If you enter a classroom where the children are successfully using a computer game, say Snyder and Palmer, you should have trouble finding the computer. Children are at the center of the action, combining conventional and computer resources under the guidance of a talented teacher. Directions for "play" don't specify information gathering and analysis, note taking, decision making, or teamwork. Yet these interactive skills are fostered because kids are compelled to develop them in order to achieve the game's objective.

Refocus Priorities

In Search of the Most Amazing Thing is an important book for parents, teachers, and policymakers to read. It reminds us that education must remain focused on the child and not on the technology. The authors draw extensively on critics of the computer revolution in schools, particularly on MIT computer scientist Joseph Weisenbaum. Like Weisenbaum, the authors are clearly frustrated with the direction schools and industry have taken. As a result, the book does not present a balanced view.

The authors are frequently at odds with the thinking of classroom teachers. Case in point: Although Snyder and Palmer disapprove of traditional CAI, according to the current Johns Hopkins University survey on the educational uses of computers (see "Using Computers for Instruction" by Henry Jay Becker on page 149), CAI still accounts for about half of all computer-related activity. The authors also generally neglect to mention CAI's positive aspects and application programs and the new innovative approaches, such as Voyage of the Mimi, a program that combines videotapes, computer programs, and print materials.

Despite the book's harsh criticism of the educational community, readers will be pleased that it places the teacher at the center of learning. Teachers, say Snyder and Palmer, need time to assimilate the technology, to "mess around" with the promise of the computer, and, we presume, to search for that most amazing thing: sound educational practices as the school's top priority.

A Practical Guide to Computer Uses in the English/ Language Arts Classroom

Reviewed by Karl S. Wittman

Children start their formal schooling with a remarkable ability to communicate using spoken language. But getting youngsters to put those thoughts down on paper—in logical order, using correct grammar and accurate spelling—is another matter entirely. Writing teachers are always searching for strategies that capitalize on the natural eagerness of children to create.

Can computers in the classroom help do the job? Many writing teachers have enthusiastically adopted word processors and desktop publishing to strengthen student interest in language. William Wresch explores these and other applications of educational and productivity software to improve writing skills.

Finding the Software

Wresch's book is built on the premise that while computers cannot teach writing, they can enhance a solid language arts cur-

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riculum taught by teachers willing to experiment. The author guides his readers through the large volume of published software by choosing a few programs that illustrate applications for each segment of the writing process: creating ideas, composing the text, and editing and revising the work.

Although he believes that much of today's educational software is inadequate, Wresch tries to help teachers in grades 4 through 12 squeeze the best out of what's available for microcomputers. This is a modest objective, but Wresch's slim book only partially succeeds.

Word Processing and Writing

Wresch provides some useful hints for using word processors. For example, he suggests that teachers focus on one type of revision at a time, such as content, transition, or sentence structure. To avoid discouraging beginners with complex word processing commands, he says, teachers should first introduce the essential text insertion, deletion, and printing functions. By starting students off with short writing assignments, Wresch believes teachers can build confidence in using the computer and software.

The book also describes a number of simple classroom activities that teachers can adapt to any available word processor. For example, a short essay is prepared without paragraphs. The text is distributed on disks to students who use a word processor to produce an indented version for critique. Another activity involves using the search-and-replace function to improve word use and build vocabulary. The teacher supplies a list of commonly overused words, and students locate those words in their own work and substitute better choices.

Prewriting

"Prewriting" exercises are used to help students discover ideas for their writing. Some programs mimic traditional methods by using a set of questions or brainstorming exercises to stimulate a youngster's thoughts. These idea processors can be particularly useful in helping younger students develop new writing topics, learn information organization and sequence, and explore their ideas from different perspectives.

One typical prewriting program uses outline and categorization routines to teach students to concentrate on grouping related subjects. Children learn how to bring ideas together to form a paragraph and how to create a series of connected paragraphs. Wresch wisely advises teachers to search for prewriting software capable of easily transferring its output to a word processor so that students can continue to work on their text without retyping.

Revising and Editing

Learning to write means learning to rewrite. Rewriting needs to be encouraged because students often see themselves as failures if their first draft is not perfect. Fortunately, with a word processor the drudgery of retyping no longer exists; youngsters with a neatly printed essay will be more willing to share their efforts with classmates. Wresch contends that the computer lowers the "cost of change" in time and effort, encouraging youngsters to rewrite more often.

Rewriting also means revising—for style, for tone, and to more clearly focus content to an audience. Wresch describes one group of programs that are able to disassemble a paragraph by placing each sentence on a new line. Seen by themselves, explains Wresch, sentence fragments can be more quickly identified, and sentences that are incoherent can be corrected.

The author describes a controversial group of programs called style analyzers. These packages identify such writing characteristics as sentence length, use of passive construction, readabili-

continued

ty level, and phrasing. Critics argue that computers are not able to evaluate factors that constitute a composition because analysis algorithms are based on comparing the student's work with only the style attributes of the few authors programmed into the software. Wresch conveys the limitations while suggesting the ways in which teachers might effectively use style analysis software with more advanced students. He cautions that children are ready to experiment with style analyzers only after they understand the concepts of audience, purpose, and organization and they have mastered writing mechanics.

The book also includes an informative section about using interactive story generators as a creative writing technique. These programs, modern versions of text adventure games, exploit the computer's ability to keep track of a story's complex twists and turns. Using this software, students learn concepts of plot, character development, interaction, and dialogue.

Conclusions

I have mixed feelings about this book. On one hand, Wresch offers many good insights and examples for writing teachers interested in just how the new computer technology can be effective for them. However, Wresch's guide suffers from the basic approach of compiling reviews for a limited number of software products. The educational computing market is rapidly expanding, and out-of-date software is quickly replaced with far superior products. Wresch considers a few classic programs but fails to describe many more recent additions offering better graphics and content.

The book's diminutive size limits the number of programs and the extent to which they can be examined. More frustrating, Wresch's book lacks the space to elaborate fully on many topics. Drill-and-practice software is the least effective application of the computer. Electronic workbooks are no better than their print counterparts to teach writing mechanics. Yet the book provides only the briefest of software evaluation checklists from the National Council of Teachers of English. I am sure that teachers, especially those new to educational computing, would appreciate a more extensive and critical analysis of how to go about evaluating software.

A Practical Guide to Computer Uses in the English/Language Arts Classroom has much to offer, and teachers who follow Wresch's suggestions likely will be motivated to search for additional resources. Unfortunately, the author provides no sources that will keep an interested teacher up to date on products, instructional computing methods, and hints from colleagues. I was disappointed, for example, that Wresch did not suggest his readers consult the magazine *The Computing Teacher* for its monthly column directed at language arts teachers.

Rather than devote a few pages to a superficial treatment of computer hardware, Wresch could have used the space to include sources of public domain software or an annotated list of support groups, such as Computer-Using Educators (CUE, 1776 Educational Park Dr., San Jose, CA 95133). I also expected Wresch to detail some of the more exciting developments, such as IBM's Writing to Read program and the use of bulletin board systems and on-line databases to motivate young writers.

Despite its shortcomings, this book will be a valuable addition to the library of many writing teachers. Wresch does a good job of describing the features of various types of writing software. His treatment of teaching methods and program reviews clearly illustrates how software tools can be applied to most categories of language arts instruction.

Dr. Karl S. Wittman writes on education and computers. He is an administrator with the New York State Education Department. He can be reached at 8 Reid Place, Delmar, NY 12054.

continued

BOOK REVIEWS

The Legal Guide to Developing, Protecting and Marketing Software

Reviewed by David A. Price

Numerous technological developments have presented difficult questions to our legal system, and the computer has been no exception. To avoid unwelcome surprises in the legal realm, managers who are involved with computer software will therefore need to broaden their knowledge to include not only technical expertise but also a smattering of legal expertise. In *The Legal Guide to Developing, Protecting and Marketing Software*, Thomas Smedinghoff, a computer law specialist, ably explains some difficult aspects of the field in layman's terms.

Smedinghoff devotes the first part of his book to the protection of property rights in software, including copyright, trade secret, and patent protection. The section on copyright explains how to obtain copyright protection and how to enforce a copyright if it has been infringed. Here, as elsewhere, the author offers some practical information that may be surprising. For example, the *(c)* symbol, used in many programs, is not an officially accepted substitute for the international copyright symbol ©. (For *domestic* protection in the U.S., though, the word "copyright" in the copyright notice is enough.) The section on copyright also provides useful guidance on whether to register a program with the Copyright Office and whether to register revised versions.

The second part of the book focuses on the employer-employee relationship in software development. It examines confidentiality agreements and noncompetition agreements. In an industry such as software development, where job-hopping is common, a conflict arises because employers want to keep confidential information away from rivals, while employees want to maintain the greatest number of employment possibilities. Smedinghoff explains that such agreements are generally enforceable but that employers are not permitted to use their bargaining position to extract an unreasonably restrictive agreement.

The third part of the book is devoted to the drafting and interpretation of contracts that govern software transactions. Although Smedinghoff covers the full range of software contracts, including sale, distributorship, and development contracts, the questions surrounding "shrink-wrap" licenses are especially interesting. These licenses are meant to disclaim all or most of the developer's liability for defects while also preventing the customer from disclosing the software to others. The licenses, which are usually quite unfavorable to the customer, purport to take effect without the customer's signature—breaking the cellophane shrink wrap on the package is supposedly enough. But is it really enough? As lawsuits filter through the courts, different states are likely to decide in different ways.

The book also discusses other aspects of software law: potential tort liability for a developer of defective software, tax treatment of software, and criminal acts involving software. Finally, numerous appendixes provide sample forms and agreements.

The Legal Guide to Developing, Protecting and Marketing Software is written for the layman. Yet Smedinghoff does not reach for oversimplified, pat answers. He notes carefully that the laws governing many of these issues are just beginning to develop or are in a state of flux. At the same time he is not so circumspect that he fails to guide the reader. Anyone involved in the software industry—particularly in a small enterprise that cannot afford to consult an attorney at every turn—would benefit from having a book like *The Legal Guide* on his or her bookshelf.

David A. Price (111 Ivy Dr., #11, Charlottesville, VA 22901) is a recent graduate of Harvard Law School and the author of several books on computer programming languages.

continued

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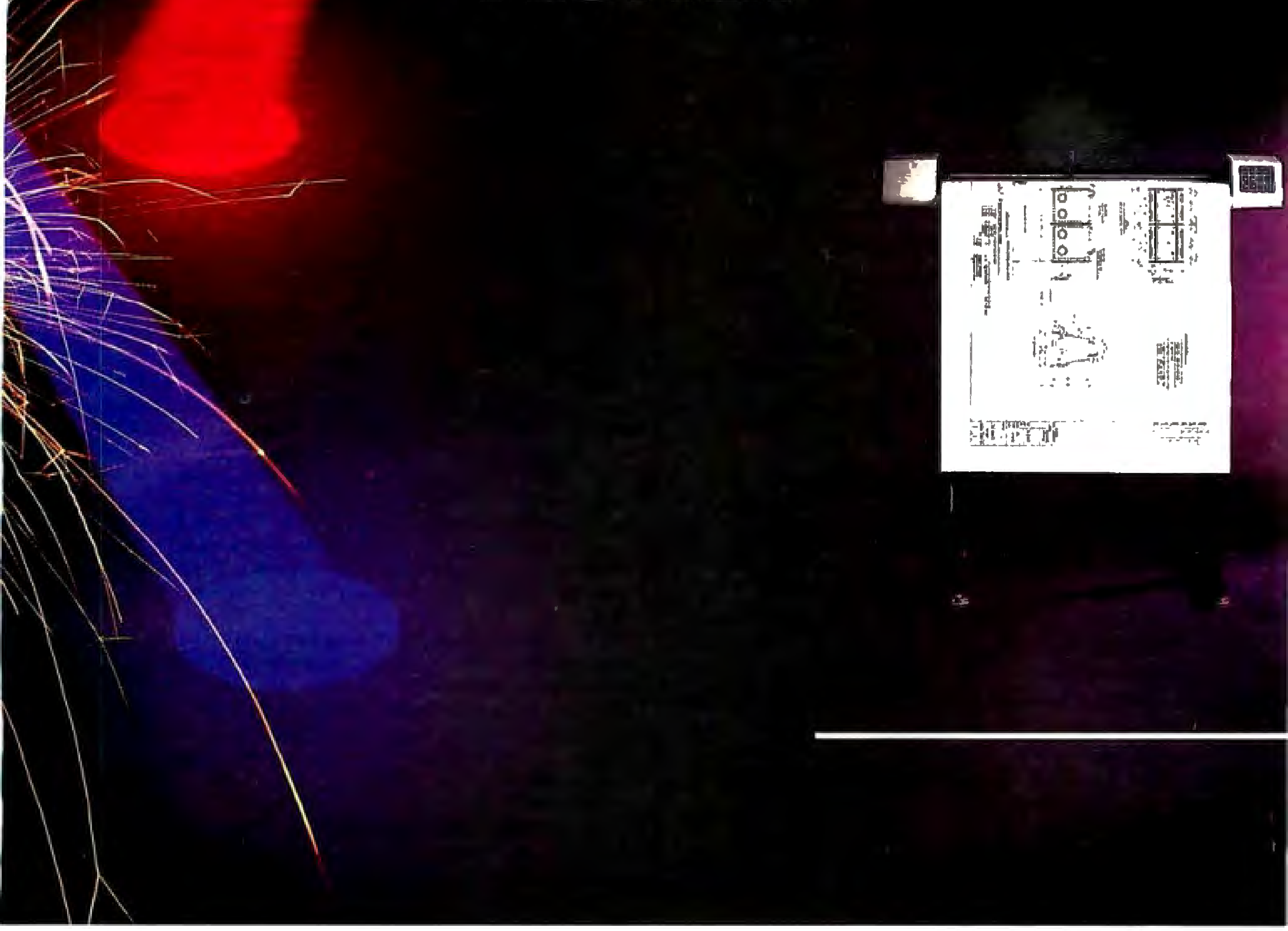

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Inquiry 115

An Introduction to Digital Image Processing
Reviewed by John V. Olson

As the author of this book states, digital image processing is a rapidly growing field. The advent of fast, image-oriented, small computers has contributed to this growth and to the demand for information on image processing. But *An Introduction to Digital Image Processing* by Wayne Niblack is not for the uninitiated. It is for the scientist, technician, student, or programmer who has a sound background in mathematics and statistics and who is interested in an overview of image processing. It is not a book for an amateur interested in producing images with a computer.

Once the reader is introduced to the fundamental topics in image processing in the opening chapters, the groundwork is laid for further coverage. The description of the picture content using image histograms is described beginning with the basic definition of a pixel and the numerical representation of brightness. There is a brief discussion of the perception of brightness and the current definitions used in color displays. Coverage of two-dimensional digital filters and filters based on digital Fourier transforms is followed by image processing through methods including segmenting the picture, geometric transformations, mapping and scaling, and the statistical classification of picture elements. One chapter is devoted to a very brief review of convolution and principal component analysis. A few software examples are given that cover histogram matching, window processing, and IHS-RGB color transformation. Niblack includes a bibliography of useful references at the end of the book. Each chapter contains several problems and questions at the end to give the reader some practice with the topics presented.

The author has made use of images from medicine, astronomy, and the LANDSAT satellite to illustrate the techniques he covers. While these would seem sufficient, the presentation is not balanced. Most of the images are drawn from the satellite data. More than 20 examples using satellite images are covered, while a single star cluster is analyzed three times and a single medical x-ray is analyzed twice. This is not a balanced view of the subject matter of image processing.

The publisher's presentation of images detracts from the story the author has to tell. The page size, 6 by 8 inches, forces the images to such a small size that detail is lost. The format of most of the images shows a "before" and "after" rendering side by side, and this confines the images to mere 2-inch squares. The text also suffers from inadequate typography, especially in the presentation of mathematics.

This is not a textbook. *An Introduction to Digital Image Processing* would be useful as a supplementary text in a course on image processing if the instructor or the principal text were to give complete developments of the mathematical techniques presented here. In this light, though, the problems at the end of each chapter seem inappropriate. There are too few of them to properly develop the student's understanding of the material presented, and they are almost incomprehensible given the preparation in the text. One could only hope to complete them with the assistance of an instructor or with other reference materials.

This book should be useful as a guide to the techniques of image processing for the experienced user. It covers a broad range of techniques and briefly discusses their utility. If it has a fault, it is brevity. I hope the author will expand the discussions and broaden the variety of examples in later editions. ■

Dr. John V. Olson is an associate professor of physics at the University of Alaska (Fairbanks, AK 99775).

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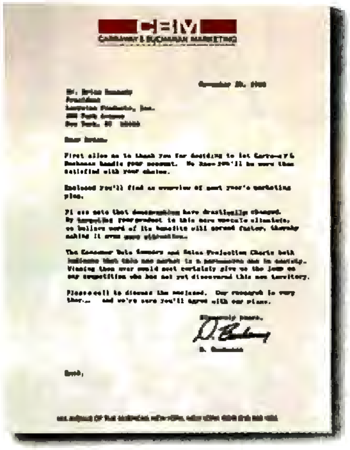

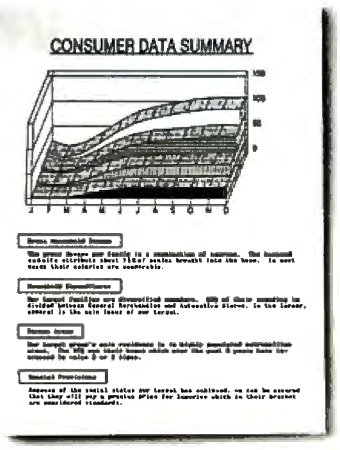

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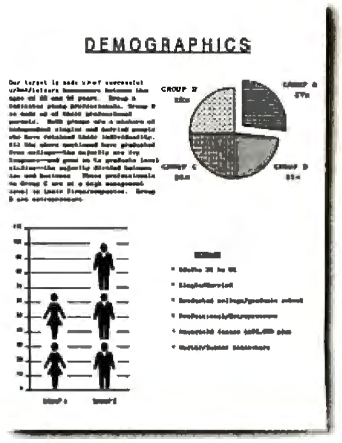

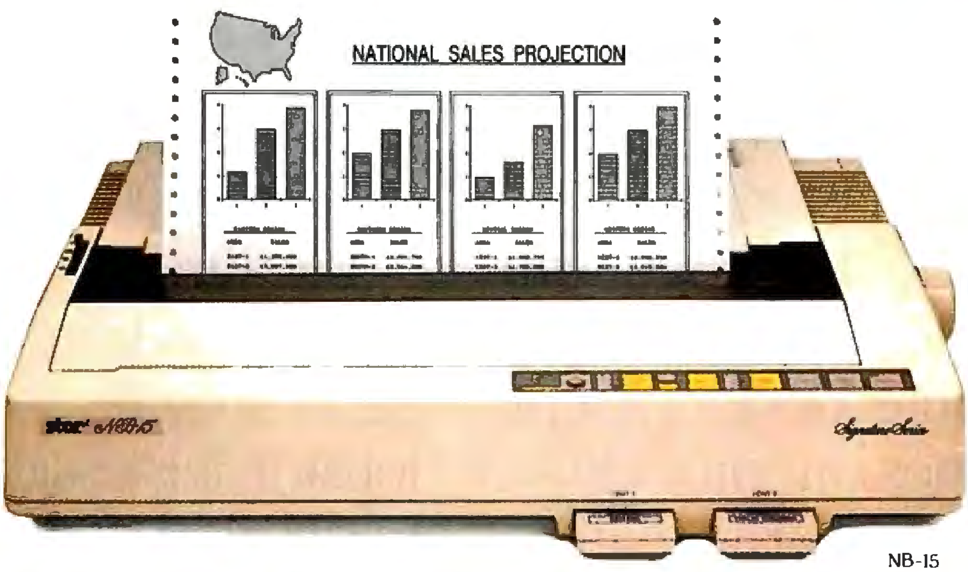

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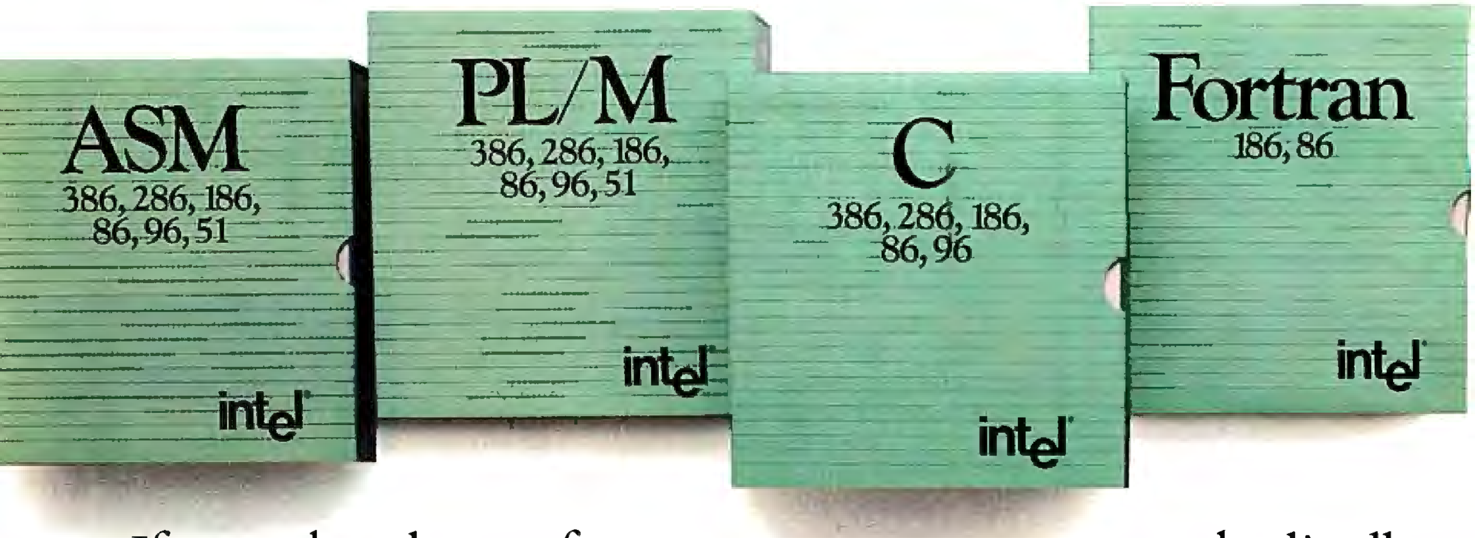

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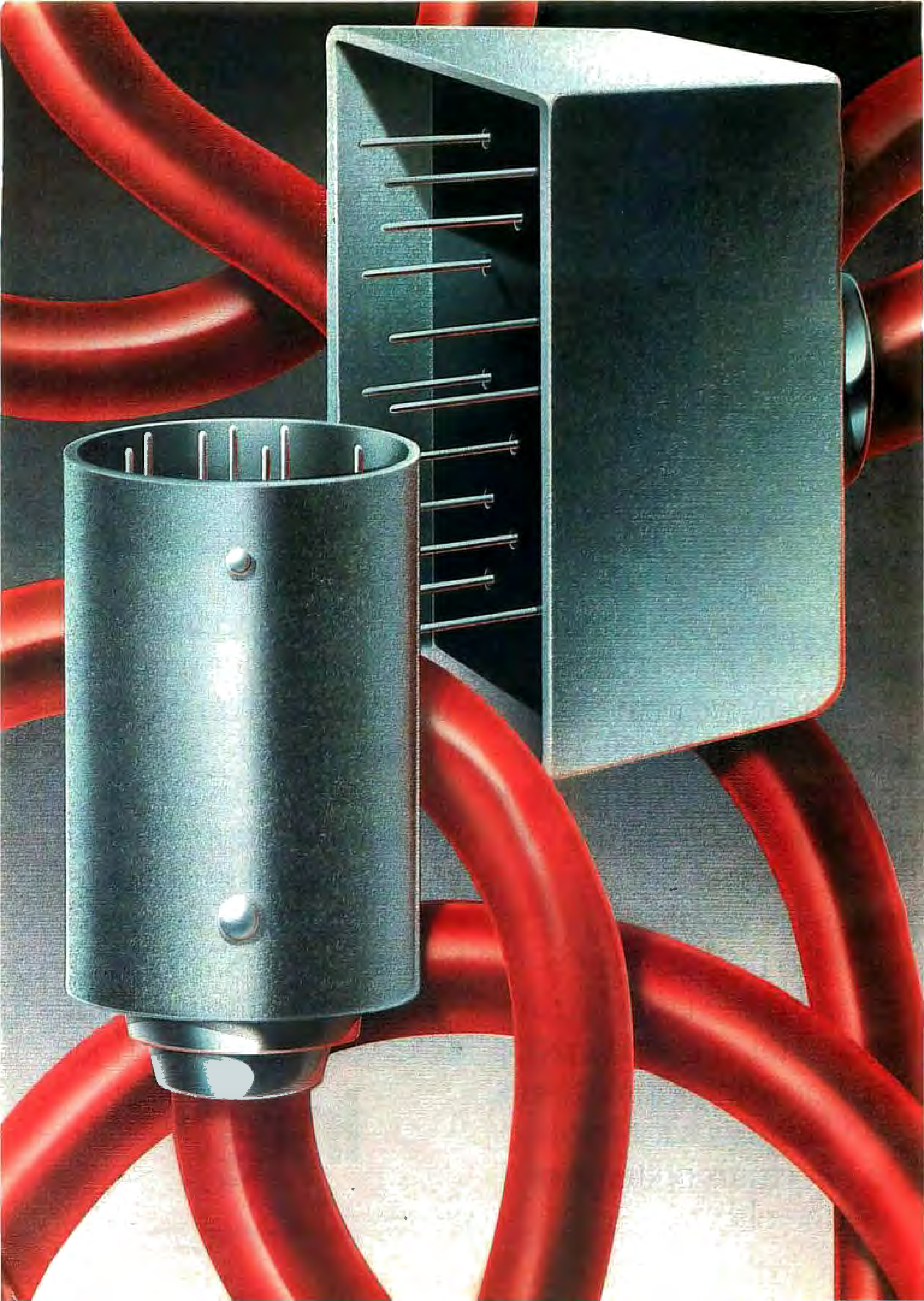


Features

THE PHRASE "WORKSTATION POWER" increasingly turns up in personal computer advertising these days, but just how exaggerated is the claim? BYTE technical editors George Stewart and Chuck Weston made a hands-on evaluation of three current workstations—the Apollo DS3000, the Sun-3/160, and the Xerox 6085—and they report their findings in this month's lead feature. What they found, in short, was a glimpse into the future of personal computers.

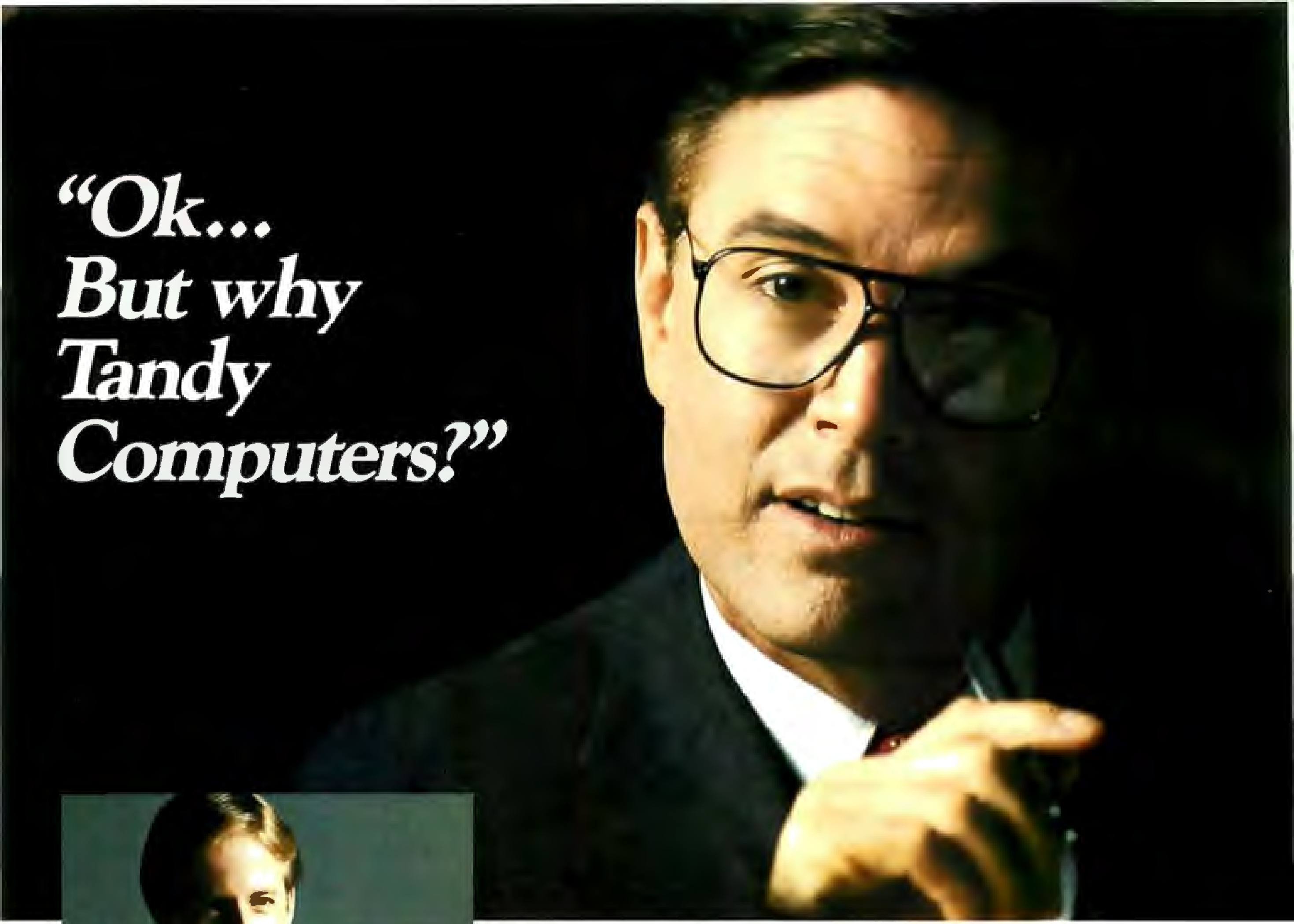
Steve Ciarcia returns to a topic he particularly enjoys: making life in his house easier and more comfortable. One of the problems of the many automatic features he has installed is that the only way to activate something is through the control system. A way to overcome this is a wireless remote-control device that communicates specific commands to a computerized control system. And that is precisely what we get this month in the IRCOMM, a custom hand-held infrared transmitter and receiver.

Functional programming may not be as practical as conventional languages, but according to Arch D. Robison it offers a new programming style with several important advantages. In this month's Programming Project, he introduces us to his own Illinois Functional Programming, a public domain language that runs under MS-DOS and UNIX.

If you've considered doubling your Amiga's RAM with the optional expansion cartridge, Richard F. Retter and Andrew N. Morelli Jr. can save you money. They explain how to build a 256K-byte expansion RAM and save yourself over a hundred dollars.

In a Programming Insight, Rene Stolk and George Ettershank offer an algorithm for "Calculating the Area of an Irregular Shape." They incorporate the algorithm into a program in BASIC, and the result is a versatile mathematical tool useful to any number of technical fields.

Our last feature, also a Programming Insight, is Robert J. Sciamanda's "Another Approach to Data Compression." Sciamanda has written a set of BASIC programs based on the Nyquist sampling theorem. This important software calculation tool helps you reduce a large quantity of data to a sample set and then reconstruct it later.



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Inquiry 241

Charles D. Weston and George A. Stewart

Workstations

A hands-on evaluation of three IBM PC–compatible models offers a tantalizing glimpse of where personal computers are going

Are the capabilities of workstations coming to personal computers? On the basis of hardware specifications, the answer is clearly yes. On the basis of a total system including hardware, software, and real-world applications, though, the answer is debatable. Nevertheless, the phrase "workstation power" is likely to turn up with increasing frequency in personal computer advertising.

In this article, we'll define the technological and practical issues by taking a firsthand look at three distinctive workstations: the Apollo Domain Series 3000, the Sun-3/160, and the Xerox 6085. All three systems share the ability to run MS-DOS applications in an IBM PC emulation mode—making it possible to state unequivocally that personal computer power *is* coming to workstations.

Definition of a Workstation

Briefly, a workstation must provide all the computing tools that technical professionals need in their daily work routines—including specialized applications like CAD and large-scale mathematical modeling, as well as general-purpose tools for programming, writing, and sharing information over a local or wide area network. A considerable amount of the computing power and storage capacity is usually located inside the workstation, differentiating it from a terminal connected to a mainframe.

Workstations must offer true multitasking so the user doesn't spend a significant amount of time waiting for the computer to finish one job. While a lengthy job is in process, the user expects to be able to jump into another task on the workstation without any noticeable degradation in the system's response time.

Demands on personal computers are generally not as intensive as those on workstations. A personal computer user relies on the machine for a few functions, such as word processing, accounting, programming, or spreadsheet modeling. Spooling and telecommunications often suffice for multitasking and networking.

In at least one area—ease of use—the demands on personal computers have been more rigorous than on workstations. Technical people have been willing to accept more intricate systems that presume a certain amount of programming expertise. Management and clerical workers, on the other hand, come to the personal computer expecting an appliance that is not much more difficult to master than other office equipment.

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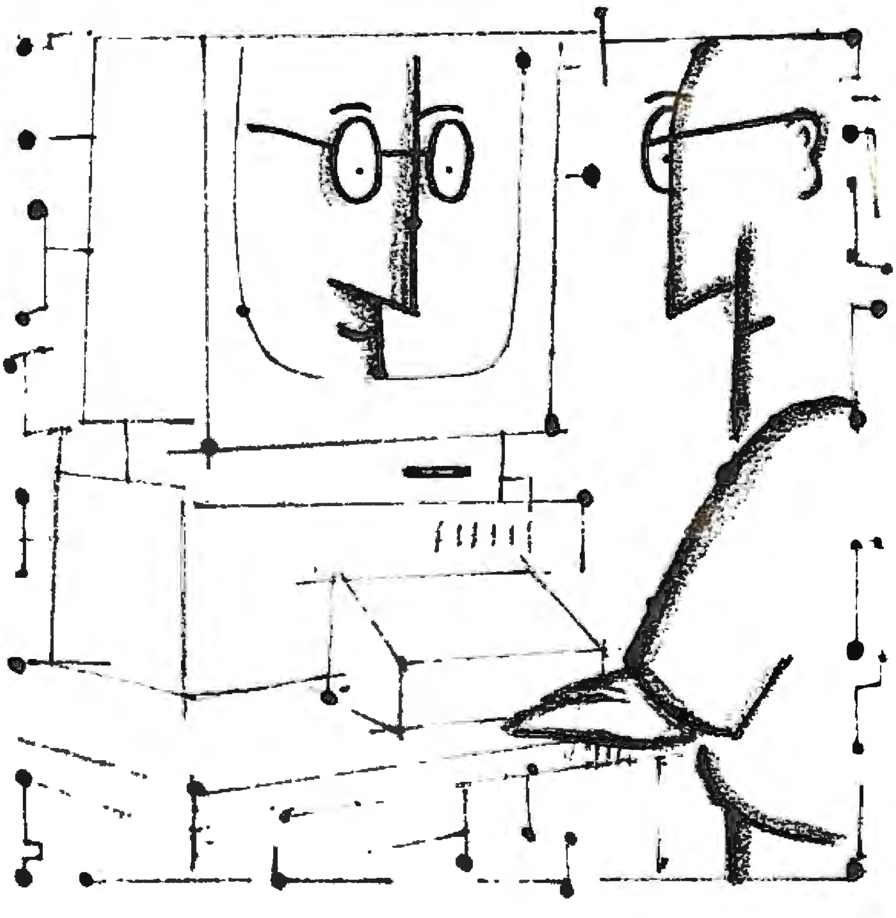

Charles D. Weston and George A. Stewart are BYTE technical editors. They can be reached at One Phoenix Mill Lane, Peterborough, NH 03458.

ILLUSTRATED BY MACIEK ALBRECHT

In a few areas, personal computer applications have outstripped the workstation's offerings. Electronic spreadsheeting is the best example. The widespread acceptance of MS-DOS programs like Lotus 1-2-3 has made its impression throughout the technical world, and now workstation manufacturers are offering personal computer emulation as a foot into the door of managers and other personal computer users and perhaps also to placate traditional workstation users who have eyed some IBM PC software with envy.

An additional use for PC emulation is as a means of sharing data between PCs and workstations, using the floppy disk as a transfer medium.

Computing Power

Regardless of the particular application of a workstation—engineering, publishing, or scientific analysis—certain hardware features are needed to provide suitable computing power.

The obvious place to start is with the CPU. A 32-bit address space and an execution speed of at least 1 million instructions per second are common requirements for workstations. Optional floating-point, array, and graphics processing hardware can further improve the performance.

The Apollo and Sun systems use Motorola 68020 microprocessors; the systems are rated at 1.3 MIPS and 2 MIPS, respectively. The Xerox 6085 uses a proprietary central processor called the Mesa, which is rated at 2 MIPS, according to Xerox engineers.

Tables 1 and 2 summarize the results of standard benchmarks we tried on the three systems.

The multitasking environment requires several megabytes of main memory and a virtual memory system based on disk storage and network resources. Hard disk storage capabilities range from 20 megabytes to more than 1 gigabyte.

At first glance, the performance of high-end personal computers and low-end workstations seems to overlap. But specifications of CPU clock rates, processor MIPS, and benchmark results like Dhrystones do not tell the true story. It is not until you encounter multitasking, multiprocess operating systems that the differences begin to show up. Optimization of the internal hardware architecture to overlap as many processes as possible cannot be appreciated outside of a multitasking, networking environment.

Workstation performance is optimized by careful balancing of CPU and operating system throughput. Systems in which every component is running at its maximum rate are not necessarily faster in a multitasking environment. Integrating the speeds and data-transfer rates of devices and processes results in a system with an overall higher throughput.

Graphics

Large, high-resolution, and extremely fast graphic displays are probably the most obvious characteristic of workstations. Speed in particular distinguishes them from personal computer capabilities. A typical demonstration of such graphics might be the rotation of a multicolored polyhedron in real time with accurate shadowing based on an imaginary fixed light source. This show might be taking place in one window while a high-speed data transfer proceeds in a second window and a text file scrolls across a third.

Displays are as large as 19 inches diagonally, allowing several large windows to be displayed at once. Two 8½- by 11-inch "pages" can be displayed side by side on such a screen.

A screen resolution of 1024 by 800 pixels is perhaps the lowest acceptable limit for workstations, while some go as high as 1280 by 1024. Color systems can display at least 256 distinct colors simultaneously from a palette of more than 4096—or even many more—shades. This degree of color subtlety is necessary for the delicate shading, coloration, and texturing seen in many workstation displays.

One measure of graphics speed is the rate of plotting 2-D vectors; speeds for workstations range from 5000 vectors per second in a basic system to 40,000 vectors per second when a graphics accelerator is used.

To provide a versatile platform on which to run a variety of commercial graphics packages, workstations usually offer implementations of one or more graphics standards such as the ANSI Computer Graphics Interface or the ANSI Graphical Kernel System. The standards are extensible and flexible enough so that different applications can run acceptably on systems of widely varying capabilities.

User Interface

Personal computer users who call themselves "power users" would probably enjoy the challenge of the typical workstation interface. The systems are extremely complex but, in turn, equally powerful. Some of the complexity derives from the UNIX command shell (included with most workstations) and some from the enhanced keyboards of most workstations.

One workstation feature that has already become common in personal computers is the mouse/window interface. Important distinctions between workstations and personal computers remain, however, in quality and functionality. For example, the optical mouse, which moves across a dotted surface, predominates in workstations, while personal computer offerings are usually mechanical devices subject to degradation from wear and desktop dirt. A more important distinction is the flexibility of the user interface on some workstations. You can accomplish most functions through keyboard commands *or* through mouse actions involving icons. The Macintosh, as the prime example of a mouse-based personal computer, tends to rely more on mouse operations at the desktop-environment level.

UNIX

The UNIX operating system is provided with most workstations. The operating system, most of which is written in C, was conceived of as an ideal environment for software development. It offers a powerful set of built-in tools for programming and file handling.

UNIX is particularly appropriate for use in workstations. The 32-bit microprocessors at the heart of today's workstations—particularly the Motorola 68000 family—have features that map well into UNIX. First, the microprocessors' large linear address space (32-bit addresses) makes it unnecessary to manage large sets of memory segment pointers to manipulate process images (UNIX constructs). Second, the dual operating states of these chips translate conveniently into the UNIX user and kernel modes.

Furthermore, the microprocessors' general-purpose registers can be loaded from main memory, manipulated, and stored back in memory, simplifying the changing of operating system states during UNIX context shifts. In addition, manipulating data in registers eliminates time-consuming memory cycles, thereby speeding up the UNIX context shift process.

Workstation microprocessors do not include memory management instructions, allowing great latitude in the operating system implementation. In such a hardware environment, a flexible, fairly portable system like UNIX is desirable.

Networking

An essential part of the workstation's role is communication and data sharing over a network—often on a high-volume basis that rarely comes up in a personal computer application. The concept of an engineering "work group," in which several individuals are working at once on different aspects of a large project, makes a high-performance network an essential characteristic of a useful workstation.

Workstations communicate in local area networks (Ethernet or proprietary systems) at speeds of up to 10 to 12 megabits per second. Compare this with the 230K-bits-per-second rate of the AppleTalk net-

continued

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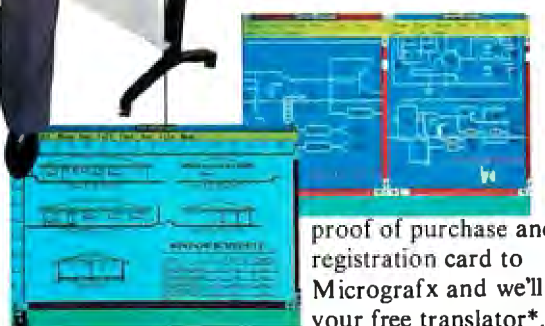

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work. The higher speeds make it practical to share memory resources through network traffic as part of the virtual memory scheme, giving workstations virtual memory spaces of 64 to 256 megabytes per process. Another application of networking is the ability to distribute processing to other systems on the network. A user can find idle systems on the network, log in remotely, and start jobs running.

The huge databases required for CAD and CAE graphic applications can exist only through this kind of virtually unlimited memory and processing power. PC networking, on the other hand, is usually limited to simple data transfers and, less frequently, to file sharing.

PC Emulation Method

All the workstations we looked at provide PC emulation through a combination of hardware and software. All include a circuit board with an 80186 or 80286 microprocessor, RAM, and a 360K-byte or 1.2-megabyte floppy disk drive. Beyond that, the method of emulation diverges.

The IBM keyboard, screen adapter, and I/O channels are emulated in software. The Apollo Domain Series 3000 provides the most thorough PC emulation, including an AT-compatible bus with seven 16-bit AT-compatible slots and one 8-bit XT-compatible slot. The systems emulate the IBM PC monochrome and Color Graphics Adapter display systems, and all except for the Xerox 6085 also emulate the Hercules Graphics Card.

At the software level, compatibility is quite good, allowing both well-behaved and non-well-behaved applications to run without problems. Software we ran successfully includes Microsoft's Multiplan and GW-BASIC and Xyquest's XyWrite.

Murphy's Law Revisited

The workstations we looked at range in price from around $10,000 for the Xerox workstation to $20,000 to $30,000 for the Apollo and Sun systems. (The systems we tested weren't comparable in every respect, so the price differential doesn't necessarily indicate which company has the most economical or expensive solution for a given application.)

Ironically, the elements of the system that are probably of most interest to PC users are the most expensive parts—high-resolution color displays, graphics processors, and high-capacity hard disk drives. The parts of the system that represent overkill for PC users—huge amounts of RAM and high-speed computing—are the very parts that are coming down in price. Perhaps it's yet another addition to Murphy's Law: If you don't need something, you can easily afford it; if you've got to have something, it's too expensive.

Apollo Domain Series 3000

Apollo Computer Inc.
330 Billerica Rd.
Chelmsford, MA 01824

The Domain Series 3000, described as a "desktop" workstation in contrast to some "deskside" workstations, features an IBM PC AT-compatible bus, complete with expansion slots. This low-end 1.2-MIPS workstation uses a triple-bus internal architecture and is based on a 12-MHz Motorola 68020 CPU and a 68881 math coprocessor. Peripherals include a 1.2-megabyte floppy disk drive, an 86-megabyte (unformatted) ESDI (enhanced small device interface) Winchester hard disk, 15-inch and 19-inch color and monochrome high-resolution displays, and Domain and Ethernet networking hardware and software.

Bus Architecture

The central processor, math coprocessor, and memory management unit all reside on the DS3000's 32-bit internal "virtual bus." The CPU generates 32 bits of virtual address and a 3-bit function code. The virtual bus "wraps" at 26 bits (bits 27 through 31 are ignored). Once on the bus, the virtual address is translated or passed through the MMU, transferred to the 68881 floating-point coprocessor, or transferred to the interrupt-vector generation circuit to generate interrupt-acknowledge cycles for the 68020 CPU.

The system's CPU control register and status register, central processor, demand-paged MMU, floating-point unit, direct memory access controllers, and page register all reside on a "private," or physical, internal bus. So do the interrupt controllers, serial I/O ports, system timer and calendar, network ID PROM and boot PROM, and main memory (up to 8 megabytes). This private bus supports 32-bit data (the CPU control, status, and page parity-error registers are only 16 bits wide) and 16-bit addresses. The DMA controllers and page register, interrupt controller, serial I/O ports, system timer and calendar, network ID PROM, and boot PROM are all 8-bit devices.

AT-compatible Bus

All peripheral controllers (disk, graphics, network) and IBM PC AT options slots reside on the AT-compatible bus. (The bus actually contains six AT-compatible slots and one XT-compatible slot.) The personal computer coprocessor (PCC) supports two address spaces, the Intel-defined 16-bit I/O address space (64K bytes) and a 1-megabyte memory-address space. To accommodate the 16-bit area within the DS3000's address space (64K bytes) and provide per-page access checking and protection for I/O devices on the AT bus, the DS3000 remaps all AT-compatible I/O addresses into its own address range. The operating system maps each 8-byte group of addresses to the first eight bytes of different but consecutive 1024-byte pages. The AT-compatible bus supports all compatible devices that use 20- or 24-bit physical addresses.

The discrete MMU (DMMU) is a compatible subset of the Motorola 68851 paged memory management unit. The 68020 CPU emits 32-bit virtual addresses, but the DMMU translates only 26 bits. In mapped or virtual mode, the DMMU performs address checking and translates

26-bit addresses into 24-bit physical addresses, so the CPU can use them to access physical memory or device registers. In unmapped mode the low-order 24 bits of the virtual address become the physical address. The DMA page register provides the address bits needed for the DMA controllers to access 24 bits of address space. The DMA controllers can transfer data to main memory or memory devices existing on the AT-compatible bus.

All Domain devices are mapped into an area composed of the upper 4 megabytes of the 64-megabyte virtual address space, called the "supervisor global" area, or "global B." In global B, commonly used pages can be shared by processes, eliminating per-process page replication.

AT-compatible Coprocessor

The Domain PCC is made up of an 8-MHz Intel 80286 CPU, an optional 80287 floating-point accelerator, and 1 megabyte of on-board main memory contained on an IBM PC AT bus-compatible board. Graphics capability includes emulation of the IBM monochrome monitor, the IBM CGA, and the Hercules Graphics Card. Applications running in the PCC window have access to the DS3000 1.2-megabyte floppy disk drive and can read IBM PC-formatted disks. All DS3000 resources, including file access, disk access, and network printers, are available to the PCC user from the PCC window.

Graphics Support

Graphics support includes 15-inch and 19-inch color and monochrome monitors. A dedicated 512K-byte image memory stores bit maps used by the four-plane color display controller. Each word in the image memory represents 16 horizontal pixels in one of the planes.

Although the color image memory contains 1024 by 1024 pixels, the display resolution is actually 1024 by 800 pixels. Image memory that is not used for the actual display is used to store fonts and other graphics elements needed by the display hardware. Similarly, the monochrome image memory (256K bytes) represents 2048 by 1024 pixels, but the screen displays only 1280 by 1024 pixels. The additional image memory is used for other graphics functions.

The DS3000's graphics resources include support for a number of popular graphics standards such as GKS (Graphical Kernel System); Apollo GSR (Graphics Service Routines), a set of graphics routines and support for their use; an emulator for the Tektronix 4014 graphics terminal; and GMR (Graphics Metafile

continued

Resources), a set of 2-D and 3-D routines and a graphics database.

Operating System

On the surface, the Domain/IX operating system looks like a twin port of both Berkeley 4.2 and AT&T System V UNIX operating systems. But it is actually an object-oriented operating system whose inner kernel is termed the *nucleus*. The nucleus acts as a higher-level manager whose tasks are page replacement, page fault control, and control of the bit-streams transferred between the lower-level processes. In this instance, the Berkeley 4.2 shell, the AT&T System V shell, Apollo's Aegis operating system, and applications such as language interpreters and the display manager are all treated as "objects" under control of the nucleus. Data can be transferred between the objects without the nucleus requiring any knowledge of data types.

Language System

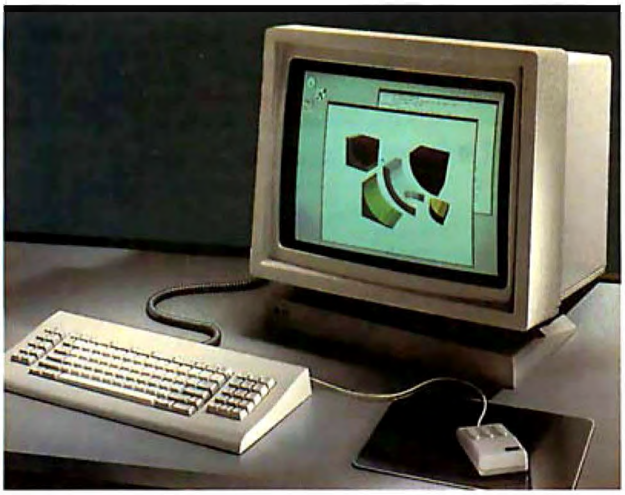
The Domain Language System includes FORTRAN 77, ISO Pascal, Domain/C, and Domain/LISP programming languages, plus miscellaneous utilities to aid programmers. The C and LISP compilers include significant extensions to take advantage of the Domain system.

Programmers can write different portions of large programs in any of these languages, suiting the language to the problem, and then combine them into a single application.

Other tools for programmers include the software engineering environment and a mail program for communications between users on the network.

The DS3000 looks like a programmer's dream in terms of computing power and programming convenience. It is not the system for a nontechnical person, however, and could not be used to its potential outside of a computing-intensive networked environment.

Sun-3/160



Sun Microsystems Inc.
2550 Garcia Ave.
Mountain View, CA 94043

Sun describes the 3/160 deskside workstation as an intermediate model on the company's price/performance scale. The company claims that performance for this machine is 2 MIPS. The Sun-3/160 uses a 16.67-MHz Motorola 68020 as its central processor and a 16.67-MHz 68881 as its math coprocessor.

This workstation is designed around the Motorola VMEbus architecture. It incorporates 16 slots for VMEbus-compatible boards in the triple-height, quad-depth Eurocard format. The hardware architecture of the 3/160 workstation incorporates two internal buses. A high-speed, synchronous 32-bit P2 bus handles access to the main memory and the optional floating-point accelerator when present. The 32-bit VMEbus handles all I/O operations.

The system can use up to 16 megabytes of main memory and 256 megabytes of virtual memory per process. Additional memory is available to the system in the form of a graphics buffer but is not addressed as main memory and is under control of the graphics processor.

The 3/160 that we used was equipped with 8 megabytes of RAM. The central processor, graphics processor, SunIPC processor, synchronous disk controller, and RAM occupied 8 of the 16 available slots.

The Sun-3/160 graphics processor and optional graphics buffer support 19-inch monochrome, gray-scale, and color monitors at a resolution of 1152 by 900 pixels. The graphics processor can display 256 colors simultaneously in any window from a palette of 16 million.

Disks

The 3/160 system incorporates a four-channel SCSI- and ESMD-compatible synchronous disk controller. Hard disks are available in sizes from 71 megabytes to 1.1 gigabytes. The average access time for the 280-megabyte ESMD disks is 20 milliseconds, and the data-transfer rate is 2.4 megabits per second. The 575-megabyte disk is even faster at 18-ms average access time. A deskside SunServer can accommodate four 280-megabyte or 575-megabyte hard disks. The system that BYTE benchmarked contained one 360K-byte and one 1.2-megabyte floppy disk drive, a 280-megabyte hard disk, and a 60-megabyte ¼-inch tape backup system.

Operating System

Sun workstations use SunOS, a version of UNIX. The operating system is based on Berkeley 4.2BSD with enhancements from 4.3BSD. It has been extended to add System V functionality into the kernel, libraries, and utilities.

Although most functions can be combined into a single operating system, some significant differences still exist between Berkeley 4.2 and System V. For those functions that can't be combined, the System V versions are supplied in separate directories or libraries. A program developed on a Sun workstation can be either Berkeley- or System V-compatible or can take advantage of the functionality of both operating system shells. This dual functionality allows programs developed on System V to be relatively easy to port over to a Sun workstation.

The SunOS supports NFS (Network File System) for remote execution, file locking, and transparent file sharing with other nodes on the network. (At this time, more than 50 manufacturers of workstations, including Apollo, support NFS.) The virtual memory concept is extended by the use of NFS to allow demand paging across the network. Individual processes can use up to 256 megabytes of virtual memory each.

Sun workstations support Ethernet software and hardware and a wide range of communications protocols, such as OSI, SNA 3270, BSC 3270, and BSC RJE, and wide-area network protocols including X.25 and other internetwork routers.

User Interface

Sun uses the window and mouse environment common to all workstations. The 3/160 workstation uses a three-button optical mouse. The leftmost mouse button selects icons, the middle button adjusts or modifies a selection, and the right button activates menus.

The Sun interface is distinctive in that you can pick up commands with the mouse and copy them into the command line. When you master this system, you can issue the often forbiddingly complex UNIX commands in rapid-fire succession with a minimum of typing.

Coprocessor Hardware

Sun refers to its AT-compatible coprocessor as the SunIPC, or Integrated Personal Computer for the Sun workstation. The IPC hardware consists of a 10-MHz Intel 80286 CPU, an 8-MHz Intel 80287 math coprocessor, a parallel port, 1 megabyte of 100-nanosecond, dual-ported local memory available to the IPC software, MS-DOS 3.1, and PC application software (640K bytes are available to run PC application software).

The IPC also provides two emulated serial ports operating at up to 2400 bits per second, one logical hard disk (dynamically sized), two emulated printer ports (LPT1 and LPT3), and emulation of the expanded memory specification defined by Lotus, Intel, and Microsoft. The emulated printer ports actually output to the serial ports on the workstation in which the SunIPC board is installed. Remember that in a networked system like the Sun-3/160, everything, including the SunIPC board, can be shared across the network.

The window in which SunIPC runs can be selected by the keyboard command pctool or by icon. A 3/160 workstation can support up to four IPC boards. Typing pctool at the native system (UNIX) command line gets you the first available board, or you can specify the ID of the board that you wish to use. You can access a remote SunIPC by typing the node name and board ID at the pctool window command line.

SunIPCs are available in single-user or multi-access configuration. The multi-access configuration can be local access or remote access and can be shared by unlimited users, but only one at a time. There are some limitations to this scheme.

continued

Data cannot be transferred between IPC windows because each IPC window stores files on its own logical disk. There is a way around the problem, however. You can transfer your IPC files to the network file server and have the network manager mount the Network File System that contains your files from the other IPC window. Both IPCs now share the file system.

IPC Peripherals

SunIPC peripherals include single- or dual-drive floppy disks (360K bytes and 1.2 megabytes), NFS, an emulation of Microsoft's parallel PC mouse, the hardware parallel port on the board itself, and any of three emulated graphics display adapters—IBM 80 by 25 monochrome, 720 by 348 CGA, and Hercules 720 by 348 monochrome.

The Sun keyboard emulates the IBM PC AT keyboard through the use of keyboard mapping. Sun supplies a chart with the SunIPC that shows the correlation between the native Sun keyboard and the IBM PC AT keyboard.

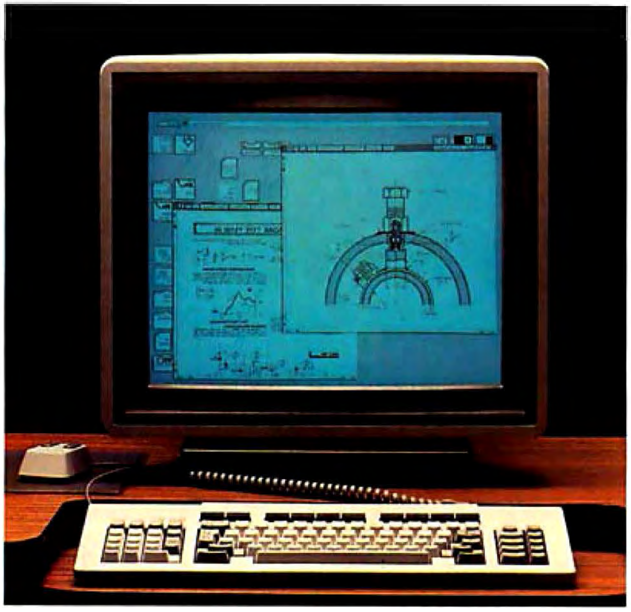
The SunIPC supports those IBM PC AT peripherals that can be connected to the parallel port on the IPC board itself, the emulated serial ports on the Sun workstation, and the logical devices LPT1, LPT2, and LPT3. SunIPC does not incorporate a hardware AT bus. Consequently, PC AT peripherals that communicate over the AT bus cannot be used with the IPC.

Sun workstations support three printers as logical devices LPT1, LPT2, and LPT3. LPT1 is the default printer for SunIPC. This printer can be a SunLaserWriter or another high-speed printer. You can send ASCII files to LPT1.

LPT2 refers to the parallel printer connected to the parallel port on the Sun workstation you are using. LPT3 is the default printer for the Sun workstation you are using. However, the default printer for LPT3 is a SunLaserWriter that automatically converts files in Epson format into PostScript format. This enables LPT3 to handle graphics as well as text. File conversion for LPT3 is transparent to the user.

Like the DS3000, the Sun system is an extremely powerful workstation for technical professionals, especially programmers. Languages available include C, FORTRAN 77, Pascal, and assembly. Sun has also taken the unusual and very helpful effort of rewriting the UNIX documentation almost from the ground up. Based on three of the overview manuals, we can say that Sun has done an excellent job of documentation, which makes its system quite a bit more attractive to users who don't have much experience with UNIX.

Xerox 6085



Xerox Corporation
101 Continental Blvd.
El Segundo, CA 90245

Xerox's latest incarnation of its Star electronic desktop machine is the 6085 Professional Computer System. Of the three workstations BYTE examined, the 6085 with its proprietary ViewPoint operating system is the most heavily applications-oriented. No programming tools are provided, nor is there a command interpreter comparable to the UNIX shell. Instead, Xerox offers a comprehensive set of applications that are all very consistently integrated into the electronic desktop. (The Xerox Development Environment is available for the 6085 on a limited basis, but BYTE was unable to obtain that system for evaluation.)

The 6085 includes a stunning 19-inch monochrome screen with a resolution of 1184 by 925 pixels, for a density of 80 pixels per inch. The mouse has optical sensors to detect motion over a dotted surface, and two control buttons. The keyboard is a low-profile, 104-key tactile feedback unit with many dedicated function keys such as Copy, Move, Open, Find, and Props (for properties). A separate, compact cabinet houses the processor boards and a 40-megabyte hard disk. On top of the cabinet is a single 360K-byte 5¼-inch floppy disk drive.

Our system came with 1.1 megabytes of main memory, which includes 128K bytes of display memory, and 1.5 megabytes of additional RAM on memory expansion boards. (The 6085 can be expanded to a system total of 3.7 megabytes.) It included a personal computer option board that allows execution of MS-DOS applications inside a desktop window. The system has two serial ports (for communications and a printer) and an optional Ethernet interface (not included in our system).

The system architecture is based on a proprietary Xerox processor called the Mesa. The architecture has a 32-bit address space and a virtual memory space of 2^{32} 16-bit words organized in 256-word pages. It is a stack-oriented machine with a 14-level, 16-bit stack.

The personal computer option board uses an Intel 80186 configured as a coprocessor to the Mesa. The PC subsystem shares the 1.1-megabyte main memory of the Mesa board. When the PC board is not active, all of that memory is available to the Mesa; when a PC emulation window is active, some of the main RAM is dedicated to the PC emulation (up to 640K bytes).

MS-DOS programs can access the floppy disk and hard disk, output to a local printer, and transfer data to and from the Xerox ViewPoint environment. The hard disk can also be set up to emulate multiple floppy disks.

Our system came with MS-DOS version

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3.1 and GW-BASIC. The ROM BIOS was done by Phoenix Associates. The 6085's PC option can emulate 40- and 80-column color graphics modes in addition to the 80-column monochrome mode.

Using the System

Xerox advises customers to leave the system running at all times because it requires over 10 minutes to go through its power-on diagnostics and initialization routines. Once these are completed, the system displays a screen that is blank except for a keyboard icon that skips around within the screen area. Pressing a key causes a logon window to open up.

The system supports any number of individual users, assigning a name, password, and desktop to each one. You can share data and applications between desktops by copying them to and from common areas called *file drawers*.

During operation, you frequently have to pause for the system to complete requests that would be almost instantaneous on other systems, such as opening a document. Xerox explains that the delays are due to the many layers of software that need to be shuffled as you move in and out of various applications.

The user interface closely resembles the Macintosh's, which is to be expected since Xerox was the first company to commercialize the window/icon/mouse interface with its Star system. The major differences are in the Xerox 6085's greater sophistication and complete integration of applications. For instance, you can edit a document consisting of text, graphics, data-driven graphics, and tables in all respects without closing and reopening the document. In the Macintosh, graphics and charts that have been pasted into a document can be resized but not modified using the tools with which they were created. Similarly, text inserted into a MacPaint document becomes a bit image and can no longer be treated as text.

The quality of the ViewPoint applications is very high. The ViewPoint Document Editor offers a complete editing and page layout system with scores of typefaces, including special-purpose symbols for science, mathematics, and office use. "Data-driven graphics" are charts, tables, and graphs based on numeric tables. If the data in the tables changes, the graphics are revised accordingly. This occurs automatically, whether or not the data is explicitly present in the printed document. An equations package allows for entry of in-line or displayed mathematical equations with automatic sizing and prompting for special parts of standard equation types. For instance, when entering a definite integral, the editor prompts you for upper and lower limits of integration. Braces are automatically sized to fit enclosed expressions, getting taller, for instance, if the expression is a quotient.

Coupled with the Xerox 4045 Laser Copier/Printer and appropriate software, the 6085 forms what Xerox calls its Documenter system. At $8995 for a 10-megabyte hard disk, a 15-inch screen, 1.1 megabytes of RAM, and the 4045 laser printer (plus the cost of individual ViewPoint software items), this appears to be an extremely powerful and complete desktop publishing system.

According to the documentation, the 6085 is a foreground/background system that allows processes to execute simultaneously. However, when we attempted to repaginate a 91-page document, the cursor turned into a page counter, and it was not possible to begin any other operations until the repagination was completed. Doing a global search through the document produced a similar result. A Xerox product manager explained that only certain functions such as networking and printing operate in background. On the other hand, operations inside the PC-emulation win-

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Inquiry 224

dow *do* operate independently of what's happening in other windows. For instance, we had a GW-BASIC graphics demo program running in one window while we created a ViewPoint free-form drawing in another, with no apparent degradation of performance in either window.

Transferring files between ViewPoint and the PC-emulation window is accomplished through a data conversion utility. First you specify the direction of the conversion by changing the property sheet of the conversion tool, then you copy the file to the conversion icon.

Text can be copied more easily than that. Any text displayed in a window (MS-DOS or ViewPoint) can be copied directly to another window using the mouse's select button and the Copy key.

In summary, the 6085 with ViewPoint software is a consistently designed electronic desktop system heavily oriented toward people who don't want to use technical programmer-style computer tools. Its applications are powerful and sophisticated, but the operating system is closed off from the user. Programmers interested in Xerox equipment definitely need to look at the Xerox Development Environment system instead of ViewPoint.

Workstation Benchmarks

We ran a variety of tests on the three workstations to test their performance in native mode (68020 for the Sun and Apollo, Mesa for the Xerox) and in PC emulation (80286 for Sun and Apollo, 80186 for Xerox).

Although we've included all the results in a single set of tables for the sake of uniformity, readers should avoid making hard and fast comparisons. In terms of hardware options and working environment, the systems we tested are not necessarily comparable.

Native-Mode UNIX Benchmarks

Native-mode tests were run on the Apollo and Sun machines (see table 1), but not on the Xerox machine since it runs the ViewPoint operating system instead of UNIX, which is required for these tests.

User time is the amount of time a process spends executing nonprivileged instructions (e.g., arithmetic calculations, sorting, searching, and calling user-level functions).

System time is the time a process spends executing privileged (kernel) commands (i.e., system calls) plus some system-level overhead (e.g., context switching between processes).

Real time is total elapsed time. It is often not the sum of the user and system times. The majority of missing time is spent waiting for I/O operations to complete, waiting for a signal from another process, sleeping, or being swapped out on disk while another program is running. Note that the UNIX operating system utility /bin/tim counts real time in 1-second increments and user time in 0.1-second increments. This accounts for some of the inconsistencies in the benchmark timings.

The dread and dwrite benchmarks test the random-access disk read and write implementation; dwrite creates, opens, and writes a 256- by 512-byte file, and the

Table 1: *Benchmark results of Apollo and Sun systems in native mode. Times are in seconds.*

	UNIX Benchmarks (native mode)							
Name	dwrite	dread	fcalle	fcalla	pipe	loop	sieve	scall
Apollo DS3000								
Real	0.8	1.2	0.4	0.2	2.5	1.8	0.95	5.3
User	0.6	1.0	0.3	0.1	1.1	1.6	0.8	5.1
System	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.0*	0.2*
Sun-3/160								
Real	1.10	1.43	0.23	0.033	2.63	1.77	0.63	2.63
User	0.00	0.00	0.20	0.00	0.00	1.53	0.57	0.53
System	0.43	0.30	0.00	0.00	1.37	0.03	0.00	2.03

*System time does not appear in the Apollo benchmarks because the UNIX operating system runs as a user task under Domain/IX nucleus. All system time accumulated in the benchmarks is lumped into user time. The scall benchmark includes system overhead.

Table 2: *Benchmark results of Apollo, Sun, and Xerox systems in an MS-DOS window. Times are in seconds.*

	BASIC					Spreadsheet		System utilities	C Benchmarks (MS-DOS emulation)				
Name	Disk write 40K bytes	Disk read 40K bytes	Sieve	Calc	Paint	Disk load	Recalc	Copy 40K bytes	Sort	Sieve	Fibonacci	Float	File i/o
Apollo DS3000	8.6	6.8	43.2	13.1	7.4	3.3	0.0**	9.0	5.8	2.3	10.1	69.6	285.5
Sun-3/160	25.4 31.4*	24.2 30.0*	38.7	11.7	13.5	5.2 6.6*	2.1	4.0* 5.3	5.1	2.3	9.0	60.5	281.3
Xerox 6085	55.9*	29.8*	114.7	34.0	9.5	4.4*	8.2	7.7*	14.5	7.0	27.4	207.0	404.3*

* Using a 360K-byte floppy disk drive; other disk results used a 1.2-megabyte drive.
** Test was not run on this system.

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dread benchmark reads this file and then removes it.

The fcalle and fcalla (function call–empty and function call–assigned) benchmarks show how much system overhead is required for function calls. The fcalle column shows how long the computer takes using function calls; fcalla shows how long it takes to do the same thing without function calls. Subtracting the latter from the former results in the function call overhead.

The pipe benchmark is a measurement of how long it takes to set up a pipe (an I/O channel that is written into by one program and read by another) and pass 0.5 megabyte of data through it.

The loop benchmark tests long-integer arithmetic and is almost totally processor-bound.

The sieve benchmark is a test of compiler efficiency and processor throughput. It is the time required for one pass through the Sieve of Eratosthenes prime-number generator. System overhead is not very significant in this benchmark.

The scall (system call) benchmark queries the operating system 25,000 times concerning its process identity, using the getpid() system call. Because the program doesn't do much other than system calls, the elapsed time is significant here. System time and user time are less so.

For more information on benchmarking UNIX systems, see "Benchmarking UNIX Systems" by David F. Hinnant in the August 1984 BYTE.

MS-DOS Benchmarks

These tests were run on all three workstations inside a PC emulation window (see table 2). (For the BASIC programs, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.)

In the BASIC disk write and read tests, a 64K-byte sequential text file is written to a blank floppy disk and then read back.

In other BASIC performance tests, the Sieve column shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calc column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. Paint measures how long it takes to paint a convoluted figure.

The spreadsheet tests measure how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The spreadsheet was Microsoft's Multiplan.

The system utilities test measures how long it takes to copy a 40K-byte file from the hard disk to a floppy disk using the MS-DOS COPY command.

The C benchmarks were run using the Manx Aztec C compiler. ■

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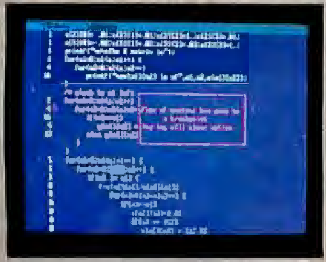
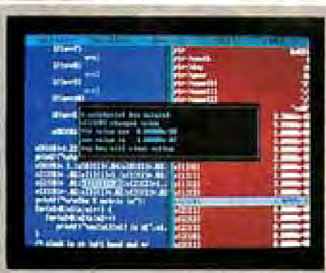
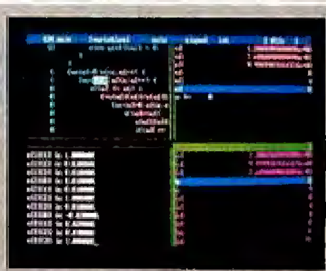


Source window with profile count showing number of times each statement has executed. Pop up message indicates break point has been hit.



Source and variables windows shown side by side. Pop up message indicates that a watch point condition has been satisfied.

Source, variables, and memory window. Memory window lets you view any area of memory using any data type.



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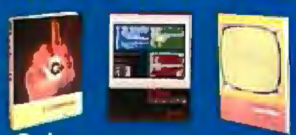

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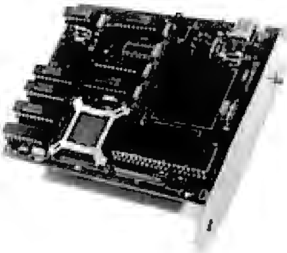

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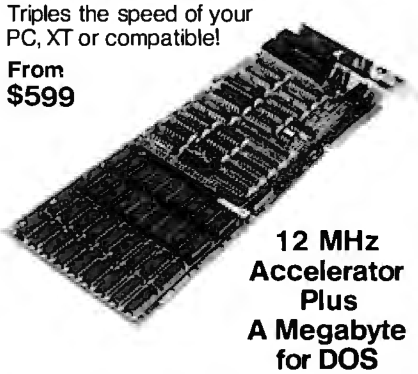

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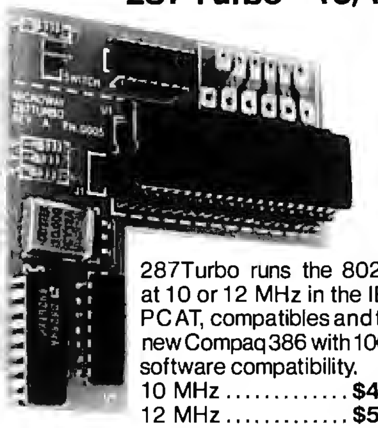

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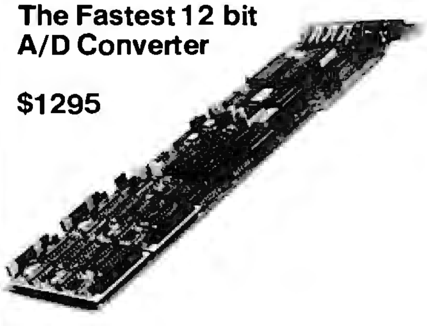

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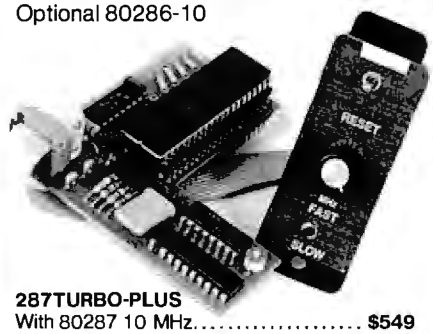

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Steve Ciarcia

Build an Infrared Remote Controller

A custom hand-held infrared transmitter and receiver

In the last few years, I have installed a lot of automatic features in my home and the Circuit Cellar. Besides the sophisticated alarm system, computer-controlled wood stove, and perimeter lighting system (see "Living in a Sensible Environment" in the July 1985 BYTE), the Home Run Control System (HCS) has significantly increased the convenience of living in my house (see "Build the Home Run Control System" in the April through June 1985 BYTEs). I have the usual remote-controlled stereos, TVs, FM radios, etc., but it is the small things like lights that automatically go on and off as I walk through the house and a voice-synthesized central monitoring system that I can call and hear a verbal status report when I'm away that have forever erased any pleasure derived from a manually oriented existence.

Just when I thought I had come to grips with electronic living, I ran into two new problems: automated living user intervention anarchy (ALUIA) and hand-held infrared controller overpopulation (HIROP). Generally speaking, these are high-tech diseases common among gadget-happy technocrats and overzealous inventor-authors who are insane enough to try to install all their designs into one house.

ALUIA is like gridlock. So many things are controlled within an environment that the only way to activate something is through the control system (if you can remember which system is controlling what device at a particular time). Unless you physically intervene, the control sequence will remain as set, and you must live with the consequences. Perhaps you have a timer controlling a series of outside lights, but one night you want them on at different times. Do you reset the automatic timer to a new cycle, override the automatic system manually at each setting, or disconnect the automatic system? The problem with many automatic systems is that they make little provision for unpredicted and unprogrammed user behavior.

In the case of the HCS, I tried to provide for such possibilities. Rather than just a timer that turns lights on and off, for example, the HCS can turn a light on in a room as long as it senses your presence via a motion detector connected to one of its hard-wired inputs. Such a control system adapts itself to your behavior—up to a certain point! It cannot control what it cannot sense, nor can it be expected to accommodate all your wishes through passive sensors. If you want the stereo to go on when you walk into the room, it could be coordinated with the automatic lighting, but would you want it to come on even when you merely pass through the room?

Some automatic control functions are more applicable to lighting than to stereo equipment. Is the only alternative manual control if the system is not fully automatic? Not if it is designed to allow independent user input in addition to automatic control.

This control gridlock comes about when you and the system have different ideas as to what should be happening. Sometimes the only alternative is to design a system with shared control—one that executes a preprogrammed sequence but accommodates itself to selective manual in-

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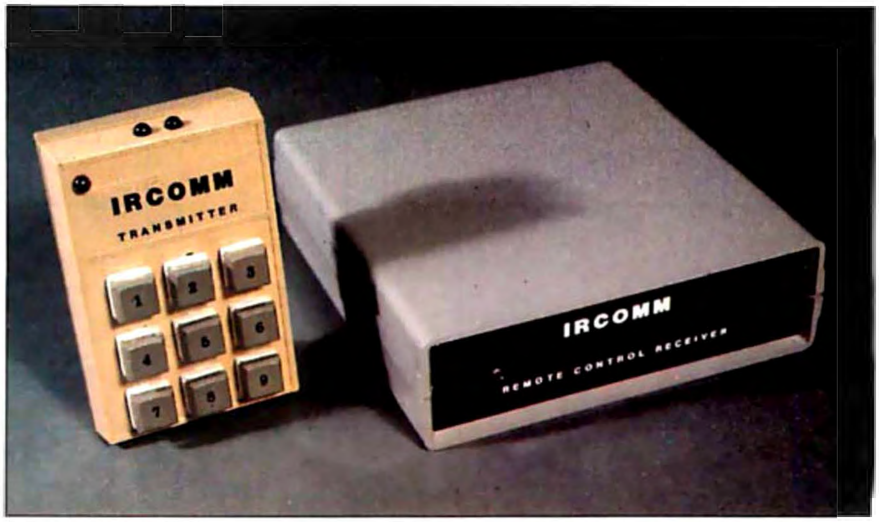

Photo 1: *Enclosed IRCOMM transmitter and receiver units.*

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. The author of several books on electronics, he can be reached at P.O Box 582, Glastonbury, CT 06033.

tervention. By allowing you a means to override or direct the activities of the control system, the system retains the flexibility of independent control in the absence of user directives and lessens its potential for becoming a frustrating obstacle as your needs change.

Perhaps you want the stereo to automatically come on when you walk in the room any time between 5 and 6 p.m., but not at any other time unless you physically turn it on. You could easily program the HCS to use the motion sensor in the room to activate the stereo and lock out execution of the order except between 5 and 6 p.m. But how do you manually turn the stereo on yet still advise the control system of your action? The system needs to know that the stereo should be ON, even if it has been turned on manually. Any well-designed control system like the HCS

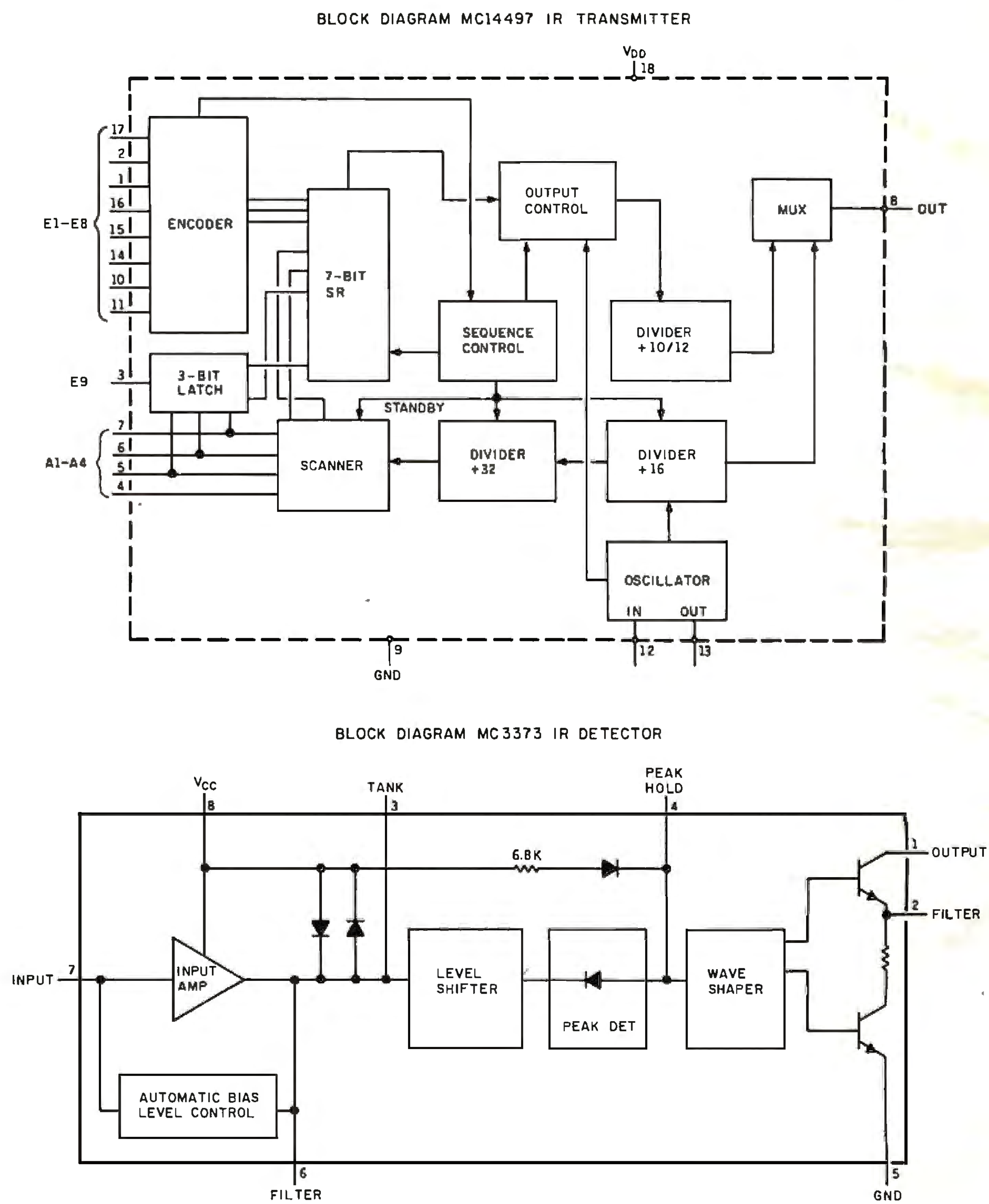

Figure 1: *Block diagrams of the chips used in the IRCOMM.*

periodically "refreshes" or retransmits the current status (ON or OFF) to all controlled devices, reducing concern about false activation/deactivation of the BSR X-10 remote-control modules by transients. The best way to coordinate such automatic/manual control is to do everything through the control system.

I don't expect you to run down to your Circuit Cellar and type a manual override every time you want to turn the stereo on. Since we are intending a direct and specific control action, "turn the stereo on," it only makes sense to use a direct input to the control system similar to a motion detector. A simple push button connected to one of the HCS inputs can turn on the stereo. When you press it, the control system is actually turning the stereo on, and it will coordinate this with its other functions.

While ultimately successful, if you follow this tack, you will soon find that it falls short as an easily implementable procedure. The interest in using a BSR X-10 wireless remote-control device with the HCS in the first place was to eliminate the need for wires. The more convenient alternative would be a wireless remote-control device that communicates specific commands from you to the HCS or other computerized control system. A typical example of such a device is the infrared remote control used with most TV sets.

This month's project is the design and construction of a custom hand-held infrared transmitter and receiver, called the IRCOMM (see photo 1). The transmitter circuit can be constructed as a small inexpensive hand-held controller or expanded to implement a 62-key wireless keyboard. The receiver is equally uncomplicated and intended to provide a convenient link between the user and the home control system.

An unfortunate side effect of creating the IRCOMM is that it adds one more IR remote-control unit to the pile you probably have and contributes to HIROP, as I stated earlier. While not intended as the first of a two-part article, next month I will make amends for contributing to IR remotes on every table and chair with my own form of population control.

Generally Speaking

My primary consideration in the design of IRCOMM was to use it with the HCS. Therefore, hundreds of remote function keys and a 20-mile effective range were of little importance as design criteria. Much like remote controls for TVs or VCRs, the IRCOMM controller needed only to be short-range and command basic functions like "stereo system power ON," "surround sound system power ON," "projection TV ON," "mood lights ON," "entertainment system all power OFF," "room-to-room sound tracking GO," etc.

When we speak of the functions that a remote controller performs, we are actually describing what the device being controlled (a TV, for example) does as a result of your pressing a key on the remote. The remote control is nothing other than a wireless keyboard. When you press a key, a stream of data is transmitted either as an ultrasonic, radio-frequency, or infrared signal. Present-day consumer electronic devices primarily use infrared signaling because of its low cost and limited interference with other remote-controlled appliances (like accidentally turning on the TV in the next apartment).

Consumer electronic devices use infrared signaling because of its low cost and limited interference with other remote-controlled appliances.

Infrared controllers generally use pulse position modulation (PPM) or pulse code modulation (PCM). The actual technique used is significant only to a person designing a receiver/decoder.

In designing the IRCOMM, I tried to keep both my needs and the intelligence

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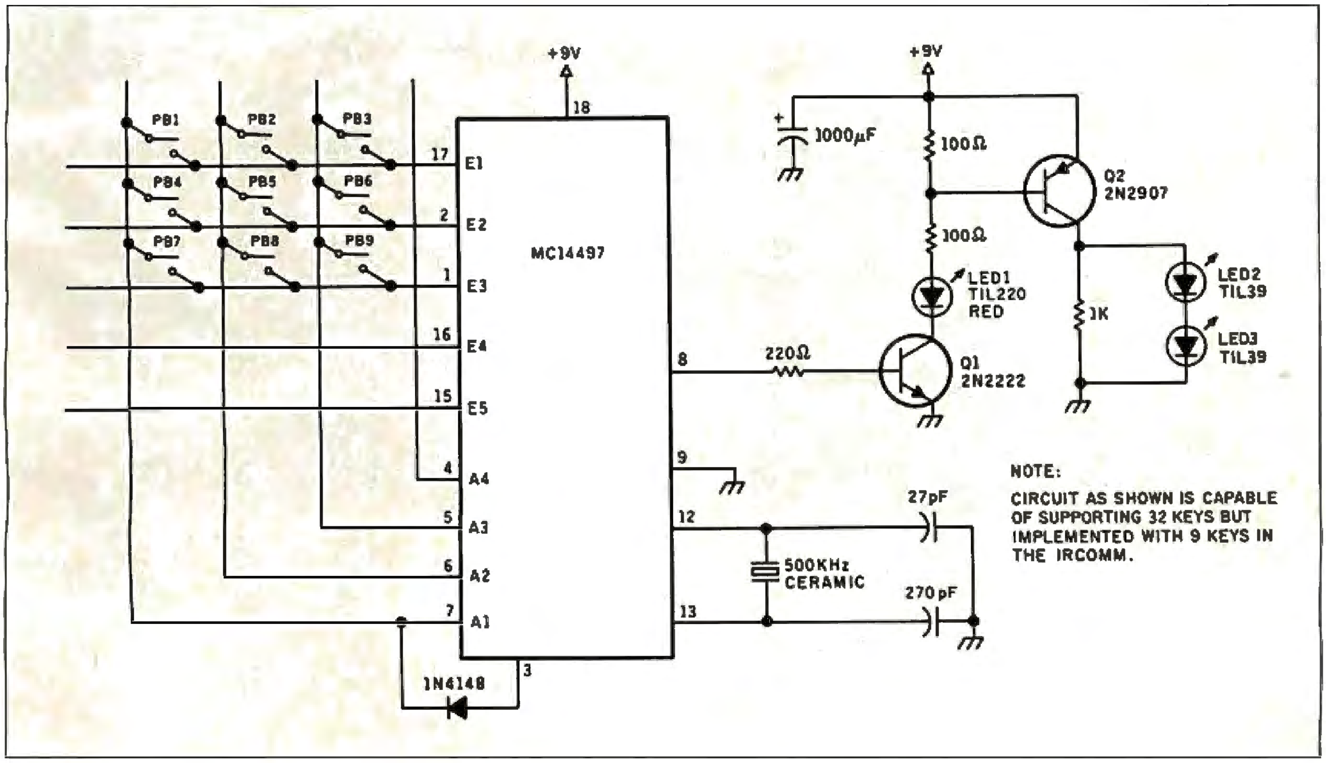
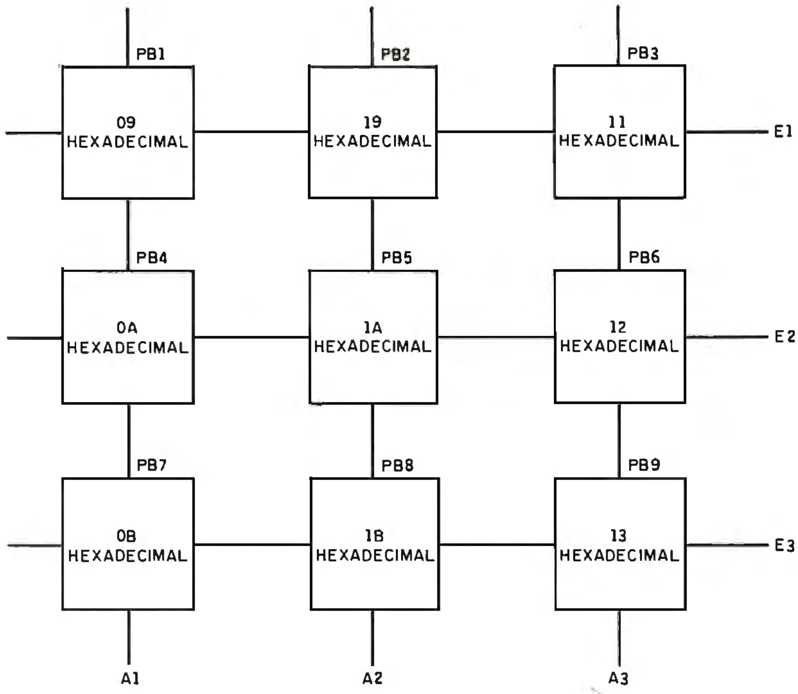


Figure 2: *Schematic of the IRCOMM hand-held transmitter.*



Channel	Code Word						Keyboard		Channel	Code Word						Keyboard	
	F	E	D	C	B	A	In	Out		F	E	D	C	B	A	In	Out
0	0	0	0	0	0	0	E8	A4	32	1	0	0	0	0	0	E8a	A4
1	0	0	0	0	0	1	E1	A4	33	1	0	0	0	0	1	E1a	A4
2	0	0	0	0	1	0	E2	A4	34	1	0	0	0	1	0	E2a	A4
3	0	0	0	0	1	1	E3	A4	35	1	0	0	0	1	1	E3a	A4
4	0	0	0	1	0	0	E4	A4	36	1	0	0	1	0	0	E4a	A4
5	0	0	0	1	0	1	E5	A4	37	1	0	0	1	0	1	E5a	A4
6	0	0	0	1	1	0	E6	A4	38	1	0	0	1	1	0	E6a	A4
7	0	0	0	1	1	1	E7	A4	39	1	0	0	1	1	1	E7a	A4
8	0	0	1	0	0	0	E8	A1	40	1	0	1	0	0	0	E8a	A1
9	0	0	1	0	0	1	E1	A1	41	1	0	1	0	0	1	E1a	A1
10	0	0	1	0	1	0	E2	A1	42	1	0	1	0	1	0	E2a	A1
11	0	0	1	0	1	1	E3	A1	43	1	0	1	0	1	1	E3a	A1
12	0	0	1	1	0	0	E4	A1	44	1	0	1	1	0	0	E4a	A1
13	0	0	1	1	0	1	E5	A1	45	1	0	1	1	0	1	E5a	A1
14	0	0	1	1	1	0	E6	A1	46	1	0	1	1	1	0	E6a	A1
15	0	0	1	1	1	1	E7	A1	47	1	0	1	1	1	1	E7a	A1
16	0	1	0	0	0	0	E8	A3	48	1	1	0	0	0	0	E8a	A3
17	0	1	0	0	0	1	E1	A3	49	1	1	0	0	0	1	E1a	A3
18	0	1	0	0	1	0	E2	A3	50	1	1	0	0	1	0	E2a	A3
19	0	1	0	0	1	1	E3	A3	51	1	1	0	0	1	1	E3a	A3
20	0	1	0	1	0	0	E4	A3	52	1	1	0	1	0	0	E4a	A3
21	0	1	0	1	0	1	E5	A3	53	1	1	0	1	0	1	E5a	A3
22	0	1	0	1	1	0	E6	A3	54	1	1	0	1	1	0	E6a	A3
23	0	1	0	1	1	1	E7	A3	55	1	1	0	1	1	1	E7a	A3
24	0	1	1	0	0	0	E8	A2	56	1	1	1	0	0	0	E8a	A2
25	0	1	1	0	0	1	E1	A2	57	1	1	1	0	0	1	E1a	A2
26	0	1	1	0	1	0	E2	A2	58	1	1	1	0	1	0	E2a	A2
27	0	1	1	0	1	1	E3	A2	59	1	1	1	0	1	1	E3a	A2
28	0	1	1	1	0	0	E4	A2	60	1	1	1	1	0	0	E4a	A2
29	0	1	1	1	0	1	E5	A2	61	1	1	1	1	0	1	E5a	A2
30	0	1	1	1	1	0	E6	A2	62(EOT)	1	1	1	1	1	0	E6a	A2
31	0	1	1	1	1	1	E7	A2	Not transmitted	1	1	1	1	1	1	E7a	A2

Figure 3: *Codes generated by the MC14497 and the IRCOMM keypad.*

of the BYTE readership in mind. What I am presenting should be considered as a model and a sample application of infrared remote control and not as the only way to implement it. The usual article approach to this subject is to buy off-the-shelf remote-control chip sets designed for the TV industry. Such an approach is valid, but it better serves the author than the user. TV remote-control chips are designed for a specific application, and their receivers are often bus or multiplexed output devices. Additional glue logic is frequently added to provide 1-of-24 signal lines or 4- to 16-bit decoded outputs. Whatever the decoding technique employed, the resulting receiver outputs must still be read through a parallel input port. Ever try to find a parallel input port on your IBM PC?

The Circuit Cellar IRCOMM

We aren't intending to use the IRCOMM to mimic a TV remote control, so why bother to spend the money or carry the overhead of decoding circuitry intended for TVs? A better alternative is to merely condition the incoming signal and allow the control computer to decode the signal. Motorola manufactures a pair of general-purpose CMOS IR remote-control chips, the MC14497 and the MC3373, that fit the bill exactly (see figure 1).

Figure 2 is the schematic of the hand-held IRCOMM transmitter. As I have it shown, the MC14497 is hard-wired for use with up to 32 keys, AM modulation, and a logic 1 start bit. The MC14497 is a CMOS biphase PCM remote-control transmitter chip in an 18-pin package. In standby mode it draws a mere 10 microamperes and operates anywhere within a range of 4 to 10 volts. Transmission and internal timing are controlled with a 500-kilohertz ceramic resonator.

The basic configuration of the MC14497 will support 32 keys (described as channel 0 through channel 31). With two additional diodes and switches between pins 3 to 6 and 3 to 5, the capacity can be increased to a maximum of 62 keys. Either option is far more than I needed. Perhaps more as a result of the plastic box I had on hand than any calculated requirement, I ended up with 9 keys (PB1–PB9) connected as shown. If you want more keys, simply add more push buttons at the cross points of the Ex and Ax lines.

The IRCOMM has both infrared and visible outputs when it transmits. A two-transistor driver circuit simultaneously pulses visible LED1 and infrared LEDs, LED2 and LED3. The MC14497 transmits either in FSK (frequency-shift keying) or AM mode. We are restricted to AM transmission because of the receiver I used, so that is all I will address.

Figure 3 shows the layout and hexadecimal codes for the 9-key IRCOMM. Since I arbitrarily selected the matrix lines they do not correspond to channels 0, 1, 2, etc. (Since the receiver cares only *which* nine channels it has to identify—not that they be sequentially ordered—keys can be placed anywhere in the matrix.)

Figure 4 illustrates what the PCM coding looks like as it is transmitted. Biphase PCM is relatively easy to read once you get the hang of it. The most important part in reading PCM is keeping track of the bit times and noticing at what point the 0-to-1 or 1-to-0 logic transition occurs during the bit time. If the pulse burst is sent/received during the first half bit time, the bit is a logic 1. Conversely, if the pulse occurs during the second half bit time, the bit is a logic 0.

When a key is pressed, the transmitter sends an AGC (automatic gain control) burst lasting a half bit time, a start bit (logic 1), and a 6-bit PCM data word. The purpose of the AGC pulse preceding the PCM data is to set up the AGC loop in the receiver in time for the start bit. The 6 data bits are designated as A (least significant bit) through F (most significant bit) and are shifted in LSB first. While each bit is represented as a logic 0 or 1 level pulse having a duration of 0.5 or 1 millisecond, the actual output of the transmitter is a 41.66-kHz pulse burst for the duration of any logic 1 level. Only after the data is conditioned by the receiver will it appear as discrete logic levels.

The IRCOMM repeatedly transmits the same code as long as the key is pressed. When the key is released, a channel 62 EOT (end of transmission) code is automatically sent. Channel 63 is not used.

The fact that the coding is simplified allows some license to be taken with the receiver circuitry.

The IRCOMM Receiver

As you can see, the IRCOMM chip transmits an easily recognizable and repeatable code. Many TV-style IR remote chips send the pulse burst once or send it once and repeatedly transmit the EOT signal. It is easy to read the code from the IRCOMM with an oscilloscope. Try reading your TV remote manually.

The fact that the coding is simplified allows some license to be taken with the receiver circuitry. Rather than the expensive LSI hardware often required in pulse position coding, only the bit timing is relevant. To acquire this data, we merely convert the 41.66-kHz pulse bursts to TTL logic levels through an envelope detector and apply this signal to a computer that monitors the bit timing. I could decode the signal all in the hardware, but if the end result is still to connect it to a computer,

continued

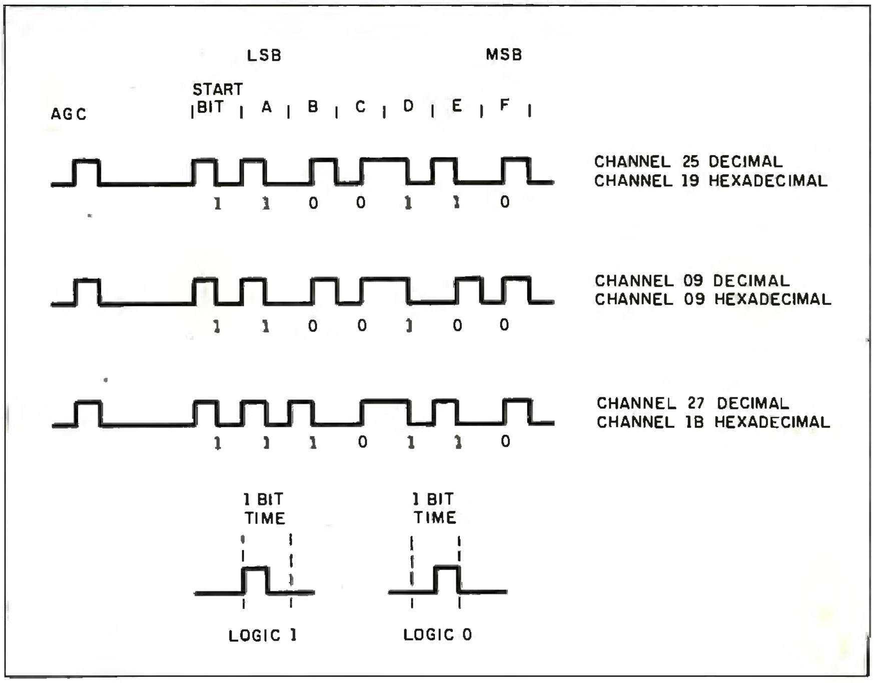


Figure 4: *Biphase PCM bit timing.*

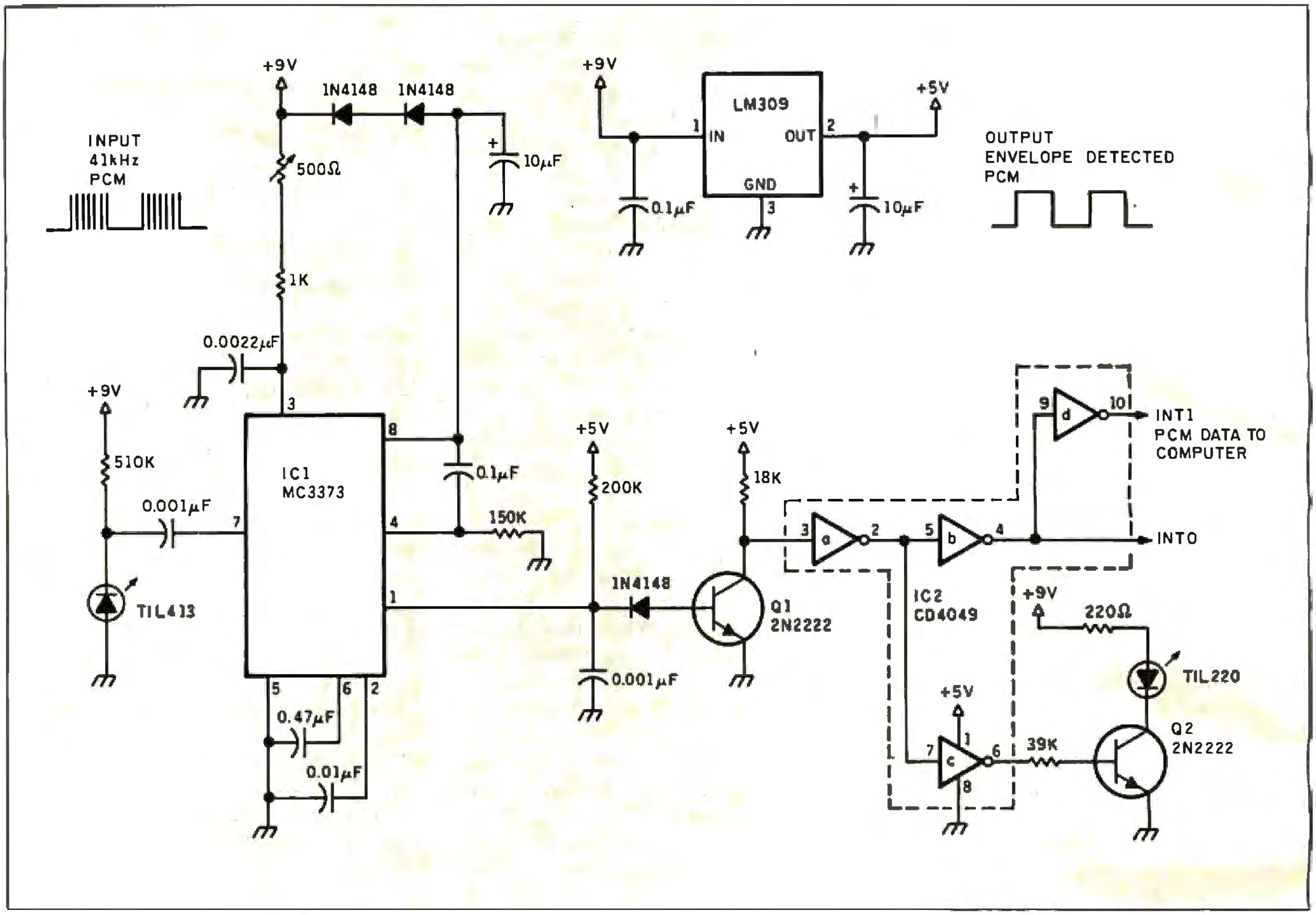


Figure 5: *Schematic of the IRCOMM receiver.*

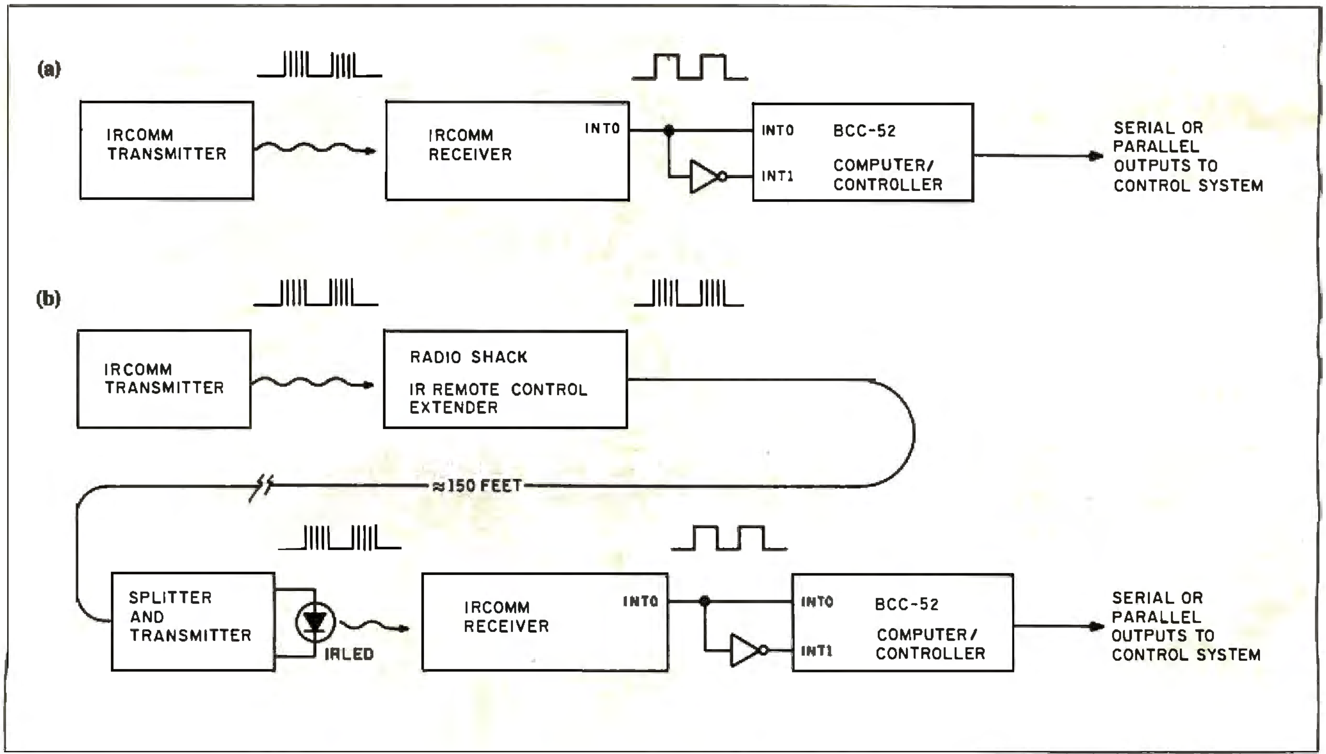


Figure 6: *(a) Direct hookup of the IRCOMM to the BCC-52 computer; (b) hookup using the IR remote-control extender.*

why not use the computer to decode the raw transmission in the first place? I never thought I'd be advocating a software solution, but I support reality.

The Motorola MC3373 wideband amplifier-detector chip is designed for use with infrared pulse-burst transmissions. The entire receiver circuit, shown in figure 5, is a two-chip envelope detector and TTL level shifter. An AC-coupled photodiode receives the infrared pulses from the IRCOMM transmitter and amplifies them. When an infrared signal of approximately 40 kHz is perceived, the output goes low. Q1 inverts this signal and applies it to a series of 4049 CMOS inverters that are capable of driving the LSTTL (low-power Schottky transistor-transistor logic) input load of the computer and lighting an additional visible LED so that you can see that data is being received.

Decoding the PCM in Software

As I mentioned earlier, my intended application of the IRCOMM was to add remote-control features to my home control system by using it to trigger direct inputs to the HCS. Of course, the HCS was not designed with facility for IR remote control, but it does have 16 parallel input lines that can be used to trigger events. To use the IRCOMM with the parallel input of the HCS, however, another computer must be interposed between them. This special-function computer translates the IRCOMM receiver's PCM output into 9 (or 32 if you used that many keys) parallel signal lines that are attached to the HCS. I chose the BCC-52 computer/controller for this task (see "Build the BASIC-52 Computer/Controller" in the August 1985 BYTE). Figure 6a illustrates a block diagram of the connection.

The BCC-52 is programmable in BASIC or 8051 assembly language. To achieve the processing speed necessary to analyze PCM bit times, we must use an assembly language routine. The flowchart of the conversion process is given in figure 7, and a complete source listing of the necessary routine is provided in listing 1. [Editor's note: *The source for LEDPCM.ASM is available on disk, in print, and on BIX; see the insert card following page 328. The listing is also available on BYTEnet; see page 4.*]

I used the BCC-52 because it was convenient and cost-effective. Since it is bus-compatible with a variety of A/D, display, and power-control peripherals that have also been presented as Circuit Cellar projects, this suggests a far more powerful future application for the IRCOMM remote control. The IRCOMM and the computer that decodes the PCM signal are

continued

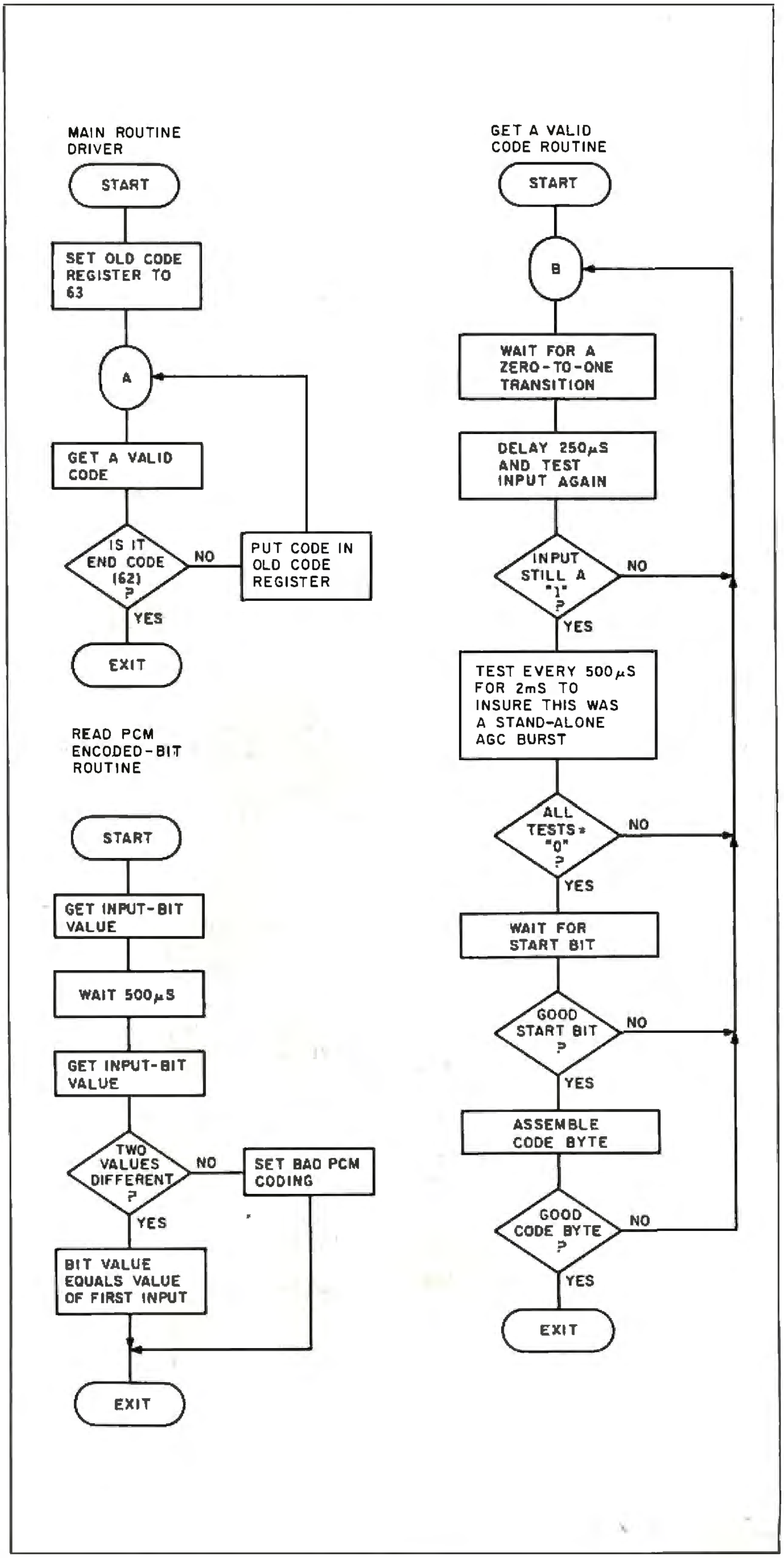


Figure 7: *Flowchart of the PCM data-receiver routine.*

separate, however. I chose to use the BCC-52 so that the complete flow diagram and source code could be presented as an example. It could just as easily be connected to an input bit on the parallel printer port of an IBM PC or other computer. If anyone implements the code for another computer, please upload the routine to my BBS at (203) 871-1988 so that I might share it with other readers.

The 100-byte PCM decoding routine is located at 4000 hexadecimal in an EPROM. The output of the IRCOMM receiver is attached to the INTO input line of the BCC-52.

There are two entry points to the decoder routine: 4000 and 4011 hexadecimal. When you execute a CALL4000H, the software reads the incoming IR data but waits for a channel 62 EOT code before returning to BASIC. The code for the key that was pressed is in memory location 1F hexadecimal. If you execute a CALL4011H instead, the software returns immediately after it receives the first valid PCM signal. This code is stored in location 19 hexadecimal. A three-line BASIC program is all that is required to print the received code using either of these calls.

Print the hexadecimal key pressed code after the EOT is received:

```
10 CALL4000H
20 PHO. DBY(1FH)
30 GOTO 10
```

Print the hexadecimal key pressed code as it is received:

```
10 CALL4011H
20 PHO. DBY(19H)
30 GOTO 10
```

Of course, it would hardly be worth your time to consider dedicating a whole computer like the BCC-52 just to scan one input bit. A far superior way of connecting the IRCOMM is to use the PCM data to trigger an interrupt on the BCC-52. This is accomplished by inverting the PCM data and connecting this signal to the INT1 input in addition to the connection already made. When the IRCOMM key is pressed, the AGC pulse will trigger an interrupt and call the decoder routine. Using the interrupt goto (ONEX1) and the GET command, the keyboard can be scanned on the fly without waiting at an INPUT statement, and fast BASIC programs with input provided either through the keyboard or IRCOMM can be written. The following BASIC program demonstrates the combined use of the IRCOMM and the keyboard. It prints any key pressed, either on the keyboard or the terminal, as it's entered:

Listing 1: *Assembly language listing for the PCM data-decoder routine.*

```
;
; LEDPCM - PCM DATA DECODER ROUTINE FOR READING IR LED
;          CODES USING A BCC-52 COMPUTER/CONTROLLER
;          - WRITTEN BY WILLIAM D. CURLEW
;
; COPYRIGHT CIARCIA'S CIRCUIT CELLAR 1986
;
; READ THE SERIAL IR RECEIVER INPUT. REMEMBER THE LAST CODE
; UNTIL AN END CODE (DECIMAL 62) IS RECEIVED. RETURN THE
; REMEMBERED CODE IN REGISTER 1FH. A RETURNED CODE OF 63
; DECIMAL MEANS AN END CODE WAS THE FIRST THING DETECTED.
;
; ASSUMES AMPLITUDE MODULATION MODE IS BEING USED.
;
         ORG 4000H
LEDPCM   EQU $
         MOV OLDCODE,#INVALID   ; SET UP OLD CODE AS 63
CODELOOP EQU $
         CALL GETCODE           ; GET A CODE
         MOV A,CODE             ; PUT CODE IN A REG
         CJNE A,#ENDCODE,STORE  ; IF NOT END CODE, STORE & WAIT
         RET                    ; RETURN TO CALLER
STORE    EQU $
         MOV OLDCODE,CODE       ; SAVE CODE AS OLDCODE
         JMP CODELOOP           ; AND WAIT FOR THE NEXT CODE
;
; END OF CODE LOOP ROUTINE
;
;
; THIS ROUTINE RECEIVES THE NEXT VALID CODE.
; INVALID CODE GROUPS ARE IGNORED
;
GETCODE  EQU $
WAITAGC  EQU $                  ; WAIT FOR AGC BURST
         CALL SAMPLE            ; GET THE VALUE AT THE INPUT PORT
         CJNE A,#ZERO,WAITAGC   ; WAIT UNTIL IT IS A 0
ONEWAIT  EQU $
         CALL SAMPLE            ; GET ANOTHER VALUE
         CJNE A,#ONE,ONEWAIT    ; IF NOT ONE, WAIT FOR A 1
         MOV B,#1               ; SET DELAY TO 250 US
         CALL WAIT              ; AND WAIT FOR THAT TIME
         CALL SAMPLE            ; RE-TEST INPUT BIT
         CJNE A,#ONE,WAITAGC    ; IF NOT 1, FALSE AGC BURST.
         MOV B,#3               ; SET UP FOR 3 * 500 US
AFTERAGC EQU $
         PUSH B                 ; SAVE ON STACK
         MOV B,#2               ; SET DELAY TO 500 US
         CALL WAIT              ; AND WAIT FOR THAT TIME
         CALL SAMPLE            ; CHECK INPUT VALUE
         POP B                  ; RECOVER COUNT VALUE
         CJNE A,#ZERO,WAITAGC   ; IF 1, FALSE WAIT AFTER AGC
         DJNZ B,AFTERAGC        ; CHECK IF DONE WITH WAIT
;
; RECEIVE START BIT
;
STARTBIT EQU $
         CALL SAMPLE            ; GET INPUT BIT
         CJNE A,#ONE,STARTBIT   ; IF NOT 1, TRY AGAIN
         MOV B,#1               ; SET DELAY TO 250 US
         CALL WAIT              ; AND WAIT FOR THAT TIME
         CALL READBIT           ; DO PCM BIT INPUT
         JC WAITAGC             ; IF INVALID PCM, START OVER
         MOV A,IN1              ; GET BIT VALUE
         CJNE A,#ONE,WAITAGC    ; IF NOT 1, BAD START BIT
;
; READ CODE BITS
```

```
;
READCODE EQU $
         MOV CODE,#00          ; RESET CODE BYTE
         MOV B,#6              ; DO 6 BIT INPUTS
READLOOP EQU $
         PUSH B                ; SAVE B VALUE
         MOV B,#2              ; WAIT 500 US
         CALL WAIT             ; AND WAIT FOR THAT TIME
         CALL READBIT          ; GET PCM BIT VALUE
         JC BADCODE            ; IF INVALID PCM, THROW AWAY CODE
         CLR C                 ; CLEAR CARRY FLAG
         MOV A,IN1             ; GET PCM BIT VALUE
         CJNE A,#ZERO,LOAD1    ; IF BIT=1 THEN DO 1
         JMP ROTATE            ; ELSE JUST ROTATE
LOAD1    EQU $
         SETB C                ; SET CARRY FLAG
ROTATE   EQU $
         MOV A,CODE            ; GET CODE BYTE
         RRC A                 ; ROTATE XTER RIGHT THROUGH CARRY
         MOV CODE,A            ; STORE IN CODE REG
         POP B                 ; RECOVER BIT COUNT
         DJNZ B,READLOOP       ; IF NOT ALL BITS, DO AGAIN
         RR A                  ; ROTATE TWO MORE
         RR A                  ; BITS RIGHT
         MOV CODE,A            ; STORE IN CODE REG
         CLR C                 ; CLEAR CARRY FLAG
         JMP CODEEND           ; AND EXIT
BADCODE  EQU $
         POP B                 ; RECOVER B REG FROM STACK
         SETB C                ; BAD CODE INDICATOR
CODEEND  EQU $
         RET                   ; RETURN TO CALLER
;
; END OF CODEEND ROUTINE
;
;
; THIS ROUTINE RECEIVES A VALID PCM BIT
; CARRY IS SET IF THE PCM ENCODING IS NOT VALID
;
READBIT  EQU $
         CALL SAMPLE           ; GET INPUT VALUE
         MOV IN1,A             ; STORE IN IN1 REG
         MOV B,#2              ; WAIT ANOTHER 500 US
         CALL WAIT             ; AND WAIT FOR THAT TIME
         CALL SAMPLE           ; GET ANOTHER SAMPLE
         CJNE A,IN1,GOODPCM    ; IF 2 INPUTS <>, GOOD PCM CODE
BADPCM   EQU $
         SETB C                ; SET CARRY FLAG (BAD PCM)
         JMP READEND           ; AND EXIT
GOODPCM  EQU $
         CLR C                 ; CLEAR CARRY FLAG
READEND  EQU $
         RET                   ; RETURN TO CALLER
;
; END OF READBIT ROUTINE
;
;
; THIS ROUTINE SAMPLES THE INPUT BIT
;
SAMPLE   EQU $
         MOV A,INPORT          ; READ BYTE AT PORT
         ANL A,#ONE            ; MASK OFF OUR BIT
         RET                   ; AND RETURN TO CALLER
;
;  END OF SAMPLE ROUTINE
;
```

continued

```
10 ONEX1 40
20 A=GET : IF A<>0 THEN
   PRINT A
30 GOTO 10
40 PRINT"IRCOMM INTERRUPT
   RECEIVED" : GOSUB 100
50 PRINT"INTERRUPT
   PROCESSED"
60 RETI
100 CALL4000H
110 PH0. DBY(1FH)
120 RETURN
```

Extending the Capabilities

With most infrared remotes, the range is limited to about 25 to 30 feet. Extending the range beyond that involves more powerful transmitters and more sensitive receivers. While I was considering doing just that, I came across a Radio Shack product called the Video Remote Control Extender that seems to adequately solve the problem.

The Extender (catalog number 15-1289) is an IR repeater. As shown in figure 6b, it consists of an infrared receiver, amplifier, and transmitter. One end, located in a room where you might also use the IRCOMM, is the receiver and the amplifier. At the other end is a splitter box with an attached infrared LED. The splitter is connected to the receiver with antenna wire. When a pulse burst is received, it is amplified and conveyed through the antenna wire to the splitter box where it is retransmitted via that IRLED. It is easy to visualize the HCS mounted in the Circuit Cellar with the IRCOMM and BCC-52 next to it. The Extender would be upstairs in the entertainment room.

More than one Extender can be used (I have three on the IRCOMM). Since their outputs are IRLEDs aimed at the IRCOMM receiver, Extenders from other rooms can also be used with their IRLEDs mounted next to each other all aimed at the IRCOMM.

In Conclusion

I'm becoming as dependent now on the IRCOMM as I am on my automatic lighting. With it, the entertainment room comes alive in a programmed and orderly manner. Without it and the HCS, I bump into cold, dark walls of a house bathed in utter silence.

Indeed, I've solved the problem of coordinating the control of the multitude of electronic boxes in the entertainment room, but I've created an overabundance of IR remotes. The result is that I've created a terminal condition of HIROP.

Next month we'll throw away the IRCOMM and the rest of your remotes and replace them with a single Circuit Cellar IR Master. The IR Master is a

continued

```
; THIS ROUTINE DELAYS 250 MICROSECONDS FOR EACH
; COUNT IN THE B REGISTER
;
WAIT      EQU $
          PUSH B                 ; SAVE B REG COUNT
DELAY250  EQU $
          MOV B,#DELAYCNT        ; LOAD WITH DELAY COUNT VALUE
LOOP250   EQU $
          DJNZ B,LOOP250         ;  BURN UP CYCLES
          POP B                  ; RECOVER COUNTS
          DJNZ B,WAIT            ; IF NOT DONE, WAIT MORE
          RET                    ; RETURN TO CALLER
;
; END OF WAIT ROUTINE
;
; SYSTEM EQUATES
;
; REGISTER ALIASES
;
IN1       EQU 18H                ; FIRST HALF PCM INPUT
CODE      EQU 19H                ; CURRENT CODE
OLDCODE   EQU 1FH                ; LAST CODE READ
;
; CONSTANTS
;
ZERO      EQU  0                 ; ZERO BIT VALUE
ONE       EQU  4                 ; PORT 3, BIT 2 MASK VALUE
DELAYCNT  EQU  111               ; 250 US CONSTANT
ENDCODE   EQU  62                ; END CODE FROM TRANSMITTER
INVALID   EQU  63                ; INVALID CODE SETTING
;
; HARDWARE PORTS
;
INPORT    EQU P3                 ; MEMORY MAPPED INPUT PORT
;
; END OF GLOBAL EQUATES
;
; END OF LEDPCM PROGRAM
;
ZZZZ      EQU $
          END
```

trainable remote controller that has the capacity to retain the command functions of up to 16 (yes, 16!) independent IR remotes. It uses a scrolling LCD to indicate command function and control device. A single execute ("DO IT") key is the only command button.

Circuit Cellar Feedback

This month's feedback begins on page 60. ■

Special thanks to Bill Curlew for his software expertise.

The MC14497, MC3373, and various other components are available from JDR Microdevices, 1224 South Bascom Ave., San Jose, CA 95128, (800) 538-5000. Call for price and availability.

The BCC-52 Computer/Controller is available from Micromint Inc., 4 Park St., Vernon, CT 06066, for $199 plus shipping. To order, call (800) 635-3355; for information, call (203) 871-6170.

There is an on-line Circuit Cellar bulletin board system that supports past and present projects. You are invited to call and exchange ideas and comments with other Circuit Cellar supporters. The 300/1200/2400-bps BBS is on-line 24 hours a day at (203) 871-1988.

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

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

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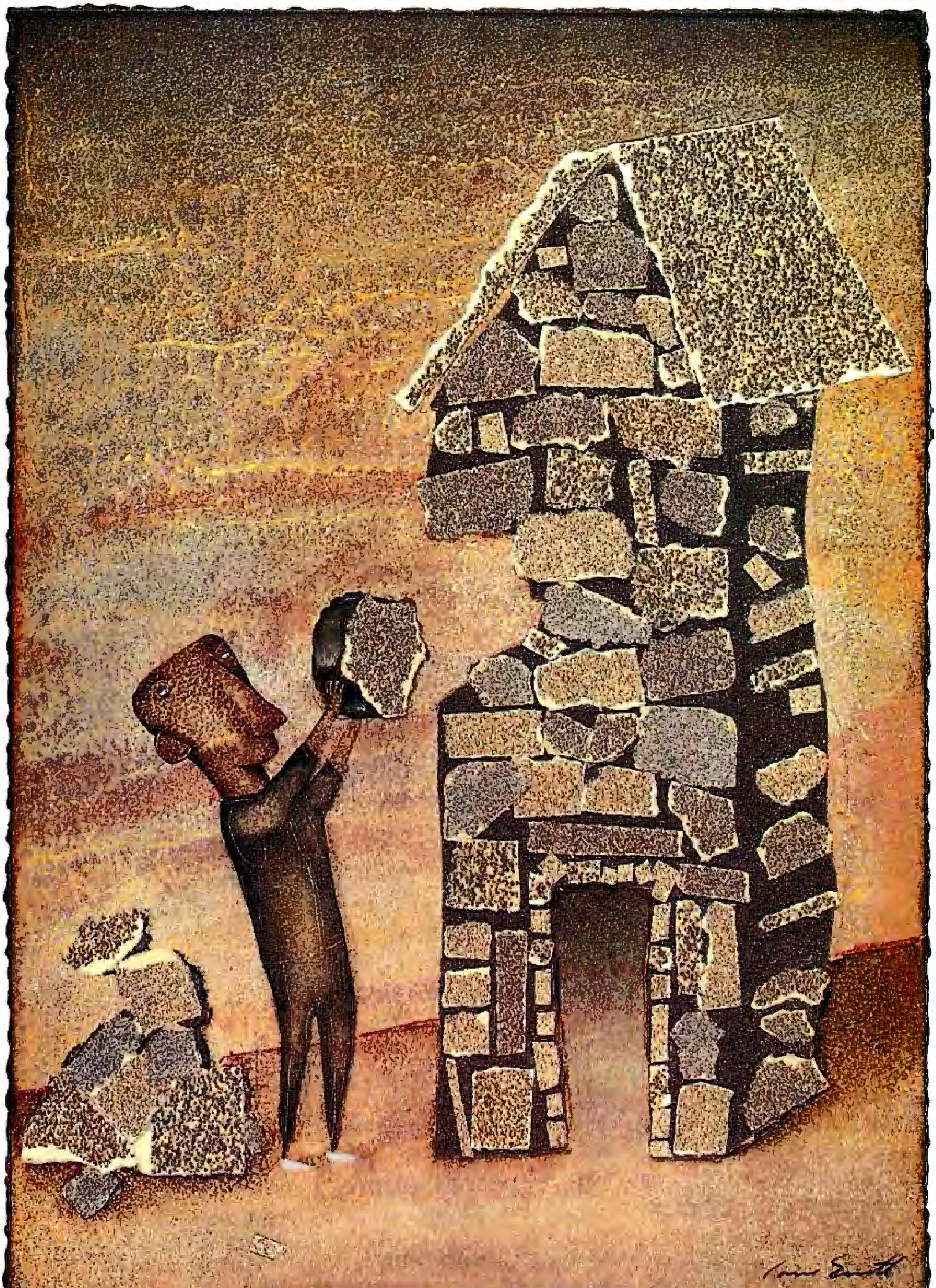

ILLUSTRATED BY LANE SMITH

Arch D. Robison

Illinois Functional Programming: A Tutorial

Construct functional programs with this public domain language

Conventional computer languages are direct descendants of machine language. You can trace the ancestry of features in nearly all computer languages to a machine-level counterpart. Variables are equivalent to storage locations; GOTO and IF statements mimic jump and branch machine instructions. Though these abstractions of machine language free the programmer from machine-specific detail, they still force the programmer to work on the same word-at-a-time level as the machine.

Functional programming, however, puts programming on new foundations. Functional programs have neither the control flow nor the variables of conventional languages. Instead, programs are directly constructed from smaller programs. As a result, functional programming offers a new programming style with advantages that include modular construction, program verification, parallel processing, and optimization.

I've written an interactive functional programming language called Illinois Functional Programming (IFP) that runs under MS-DOS and UNIX. You can write and edit IFP programs with a text editor such as PC-Write and execute the programs interpretively. The IFP interpreter is reasonably compact and fast, and IFP programs execute about as quickly as their BASIC counterparts. Most of the IFP interpreter is based on John Backus's original functional programming paper. (The analogy of variables to GOTOs is from Backus.) The basic syntax is loosely borrowed from Niklaus Wirth's Modula-2.

To run IFP on an MS-DOS-based system, you'll need at least 256K bytes of RAM. Extra memory for a RAM disk is convenient but not necesssary. You'll also need three programs: the IFP interpreter (IFP.EXE), which I've placed in the public domain, a text editor, and a directory lister. You must supply the text editor and directory lister. I recommend PC-Write, which works with IFP under DOS 2.0 and 3.0, and EDLIN, which works only under DOS 3.0. All three programs must reside on one disk, and you must prepare another disk to hold your IFP functions. If you have enough memory, you'll find placing the interpreter, text editor, and directory lister in a RAM disk convenient. For more information on loading and running IFP, see the text box "Running IFP" on page 120.

Structured Data Flow

One of functional programming's advantages is that it gives you greater control of the flow of data. Let's look at the following Pascal program fragment, which computes the inner product of two vectors:

```
S := 0;
for K:=1 to N do
  S := S + A[K]*B[K];
```

At first glance, it appears to be a simply structured program. The S :=0 assignment is followed by a for loop, which controls another assignment statement. Flow of program control into the latter assignment is strictly regulated by the for loop.

Appearances can be deceiving, however. Figure 1 shows the data flow for the same program fragment. The arrows show the various information transfers. Unlike the control flow, the data flow is not well structured. The statement controlled by the for loop can receive and send data around the for loop, thus breaking the hierarchical structure. Furthermore, the variables S and K have more than one arrow going to them, which implies that their values are time-dependent.

While this program example is trivial, a large program may have global variables. Although keeping variables local to procedures eliminates some of the problem, variables are still required to communicate between procedures. Just to understand such large program listings, you must sort out variable interactions and dependencies.

A variable is to data flow what GOTO is to control flow. Just as GOTO allows control to go anywhere, a variable allows data to go anywhere. You can, of course, use scope rules to limit variable interactions, but doing so is merely the same as restricting the scope of a GOTO. The more powerful solution is structured data flow. Just as a GOTO can be replaced by a control structure such as IF...THEN... ELSE or WHILE...DO, a variable can be replaced by a data-flow structure.

Learning the IFP Language

Semantics for IFP are almost identical to Backus's Functional Programming, though the syntax is quite different. The IFP syntax reads from left to right and is block-structured in a manner similar to Pascal. Though the notation is wordy for small programs, it makes large programs easier to read by encouraging an indented style.

The IFP language consists of objects, functions, and program-forming operations (PFOs). Objects are the data structures of IFP. Functions and PFOs correspond to procedures and control structures of conventional languages; however, the

continued

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meanings of functions and PFOs differ radically from their conventional counterparts.

Objects

Objects in IFP are either atoms, sequences, or *bottom*. The latter represents an undefined value (e.g., the result of division by 0) and is written as a question mark (?). Atoms are numbers, strings, or Boolean values. A string must be surrounded by quotation marks if it looks like another kind of atom or contains nonalphanumeric characters. Some sample atoms and their types are shown in table 1.

Sequences are lists of zero or more objects surrounded by angle brackets. Below are some typical sequences.

<a,b,c>
<1 2 3 4 5 6>
< >
<<1 2 3> <apple banana> t>

Either commas or spaces can be used to separate the elements of a sequence. A sequence with no elements is simply called empty. The elements of a sequence can be any object and do not have to be of the same type. Sequences can contain other sequences as elements, so complex data structures can be expressed. Also, IFP sequences are bottom-preserving; that is, any sequence containing ? is itself equal to ?; the sequence *<a,b,?,d>* is equal to ?, for example.

Functions

In IFP, a function is applied to an object to yield another object. The application of function *f* to object *x* is written as *x* : *f*. In other words, *x* is the input to *f*. For example, the application of the cosine function to the number 0 is written as 0 : cos. To evaluate this statement on the IFP interpreter, we would enter show 0 : cos;, and the interpreter would answer 1. The command show indicates that we wish to evaluate an application; the semicolon marks the end of the function.

The IFP interpreter distinguishes two kinds of functions: primitive functions and defined functions. Primitive functions are built into the IFP interpreter; defined functions are created by the user. All functions can be used in the same manner; neither primitive nor defined functions are privileged in any way.

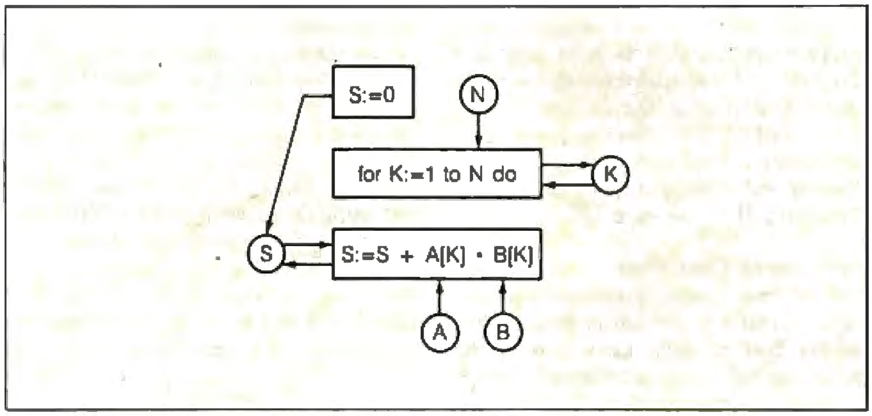

Figure 1: *The data flow of this inner product program written in Pascal is not well structured. The statement controlled by the* for *loop can break the hierarchical structure by sending and receiving data around the* for *loop statement. Compare with the data flow in figure 3.*

Table 1: *An IFP atom can be a number, a string, or a Boolean value. If a string looks like another atom or contains nonalphanumeric characters, it must be enclosed in quotation marks.*

IFP Atoms	Type
banana	string
"The cat in the hat"	string (double quotes)
'hello world'	string (single quotes)
7	number
3.1415	number
1e6	number (million)
"1.414"	string
t	Boolean true
f	Boolean false
"t"	string

Organization

IFP functions are stored in a tree structure analogous to the way in which MS-DOS files are stored. Each node of the tree is either a directory or a function, which is saved as a file. A function is referenced by its path, which is a sequence of names separated by slashes. On MS-DOS systems, the interpreter truncates each name to eight characters and converts all letters to uppercase. Paths follow MS-DOS file-path conventions, except that the separator is a forward slash (/), not a backslash (\). The use of a forward slash is the result of developing IFP on UNIX systems, which use a forward slash as the path separator. Paths may also contain two periods (..) to indicate a move up to the parent directory. Relative paths do not begin with a slash, indicating that the path starts at the current directory. Within function definitions, the current directory is the directory in which the function is defined—that is, saved to disk.

When you use a function from another directory frequently, you don't want to have to spell out the entire path every time. To avoid this, you can import a function into a directory from another directory. To import functions into the current directory, you can create an import file in the directory that is to receive the function. The file must be called %IMPORT, and it must contain declarations of the form FROM *directory* IMPORT $function_1$, $function_2$, . . . , $function_n$. In the example, *directory* is actually the directory path. For example, a typical import file might look like this:

```
FROM /sys IMPORT distl, id, iota,
length, t1;
```

After using IMPORT you can reference any imported function as though it were defined in the directory—you only have to write the function name and not the entire path.

Primitive Functions

Primitive functions (those built into the IFP interpreter) have paths like any other function, except that there is no source definition for the function. Most of these functions, such as +, or, cos, and =, are familiar to programmers. These functions behave the same as they do in most languages.

Functions always have a single input and output. However, either the input, output, or both can be a sequence of objects. For example, 2+3 is written as <2 3> : +,

continued

which gives the result 5.

Structural functions, another kind of primitive function, reorganize structures. For example, the function cat catenates several sequences; <<a b> <p> <x y z>> : cat results in <a b p x y z>. Another structural function is reverse, which reverses a sequence; <2 4 6 8> : reverse results in <8 6 4 2>.

Some primitive IFP functions are subsets of other primitives. For example, the sum function adds any sequence of numbers, while the + function adds a sequence of exactly two elements. Having both makes functions easier to read—providing you choose the function that best represents your intent. Table 2 lists the commonly used IFP primitive functions.

Table 2: *The IFP structual functions assemble, reorganize, and select data. Logical functions return Boolean values. The IFP arithmetic functions work the same as those used in conventional languages.*

IFP PRIMITIVE FUNCTIONS

Structural Functions

Appending

$X,<y_1,y_2,\ldots y_n>>$: apndl → $<X,y_1,y_2,\ldots y_n>$
$<<x_1,x_2,\ldots x_m>,Y>$: apndr → $<x_1,x_2,\ldots x_m,Y>$

Distributing

$<X,<y_1,y_2,\ldots y_n>>$: distl → $<<X,y_1><X,y_2>\ldots<X,y_n>>$
$<<x_1,x_2,\ldots x_m>,Y>$: distr → $<<x_1,Y><x_2,Y>\ldots<x_m,Y>>$

Selecting sections of a sequence

$<<x_1,x_2,\ldots x_m>,K>$: pick → x_K
$<x_1,x_2,\ldots x_m>$: tl → $<x_2,x_3,\ldots x_m>$
$<x_1,x_2,\ldots x_m>$: tlr → $<x_1,x_2,\ldots x_{m-1}>$
$<<x_1,x_2,\ldots x_m>,K>$: takel → take first *K* elements from left end of *X*
$<<x_1,x_2,\ldots x_m>,K>$: taker → take " " " " right " " "
$<<x_1,x_2,\ldots x_m>,K>$: dropl → drop " " " " left " " "
$<<x_1,x_2,\ldots x_m>,K>$: dropr → drop " " " " right " " "

Regrouping—*input* is a sequence of sequences

<<a b c> <1 2 3>> : trans → <<a 1> <2 b> <3 c>>
(transpose a matrix)
<<a b> <p> <x y z>> : cat → <a b p x y z>
(catenate sequences)

Miscellaneous

X : id → *X*
n : iota → <1,2,. . .*n*>
$<x_1,x_2,\ldots x_m>$: length → *m*
$<x_1,x_2,\ldots x_m>$: reverse → $<x_m,x_{m-1},\ldots x_1>$

Program-Forming Operations

User-defined functions combine primitive and other user-defined functions. In conventional languages, functions are combined by storing intermediate results in variables. In IFP, functions are combined by PFOs. Imagine functions as boxes with a single input and output (figure 2a). The PFOs assemble function boxes to form new function boxes. Each component function is a parameter to the PFO. Like its component functions, each PFO has a single input and output. Higher-level functions can be built from the constructed functions in the same manner.

The output of a function can be connected to the input of another function with the composition PFO (figure 2b). Composition is written using a vertical bar; the composition of *f* and *g*, for example, is *f* | *g*. Composition can be defined by the equality *x* : *f* | *g* = *g*(*f*(*x*)). Also, composition is associative, so parentheses are not necessary in expressions such as *f* | *g* | *h*.

The construction PFO ties functions together in parallel (figure 2c). The construction of functions is written as a bracketed list of the functions; for example, the construction of functions *f*, *g*, and *h* is written as [*f*,*g*,*h*].

The output is a sequence, each element of which is respectively the result of applying *f*, *g*, and *h* to the input. For example, <12 4> : [+,−,*,%] yields <16 8 48 3>. (The percent sign denotes division.)

Together, composition and construction are sufficient to define many other useful functions. For example, the cotangent function may be defined as

```
DEF cotan AS [cos,sin]|% ;
```

Another interesting function is id (for identity), which simply copies its input to its output. The identity function permits replication of the input when used in conjunction with construction. For example, you could write a function that squares its input:

```
DEF Square AS [id,id]|*;
```

Constant

Not all PFOs have function parameters; some have object parameters. One such PFO is the constant PFO, which generates constant functions. Constant functions always return the same result when applied to any object that is not ? (bottom). Constant functions are written as an object (the value to be returned) preceded by a pound sign (#). For example, *X* : #<cat in hat> will yield <cat in hat> for any value of *X*.

The exception, of course, is that if the object is undefined, the output will also be undefined. This is another aspect of the bottom-preserving property, in which undefined input always results in undefined output—in other words, garbage in, garbage out.

Constant functions introduce constants into a calculation. For instance, a function that takes the radius of a circle as input and outputs the area could be written as

```
DEF CirArea AS
    [Square,#3.141592] | *;
```

Selector

Selector functions return the *n*th element of a sequence where *n* is a positive integer. For example, <a b c d e> : 2 outputs *b*. There is also a corresponding set of select-from-right functions, written as *n*r. These select the *n*th element of a sequence, counting from the right. For example, <apple banana cherry> : 1r outputs cherry. All selectors return ? if the argument has no *n*th element or is not a sequence.

Apply to Each

The apply-to-each PFO is a distributive form that applies a function to each element of a sequence. It is written as EACH *f* END. For example, <<3 7> <8 5> <2 9>> : EACH * END multiplies each pair of numbers and results in <21 40 18>. The function within EACH may be a more complex function; for example,

continued

Arithmetic Functions

Dyadic functions—*input* ≡ $<X,Y>$

+ → $X+Y$
− → $X-Y$
* → $X \times Y$
% → $X \div Y$
div → greatest integer ≤ $X \div Y$
mod → X mod Y
power → X^Y
min → min(X,Y)
max → max(X,Y)

Monadic math functions—*input* is real number

exp, ln, sqrt, sin, cos, tan, arcsin, arccos, arctan

Miscellaneous

X : add1 → $X+1$
X : sub1 → $X-1$
$<x_1,x_2,\ldots x_m>$: sum → $\sum_i x_i$
X : minus → $-X$

Logical Functions

Comparison—*input* ≡ $<X,Y>$

= → equal
~= → not equal
< → less
<= → less or equal
>= → greater or equal
> → greater

Boolean functions—A and B are Boolean objects

A :~ → not A
$<A,B>$: and → $A \wedge B$
$<A,B>$: or → $A \vee B$
$<A,B>$: xor → $A \oplus B$
$<b_1,b_2,\ldots b_m>$: all → every b_i is true
$<b_1,b_2,\ldots b_m>$: any → at least one b_i is true

Tests—*input* ≡ X

atom → X is an atom
boolean → X is a Boolean atom
numeric → X is a numeric atom
null → sequence X is empty

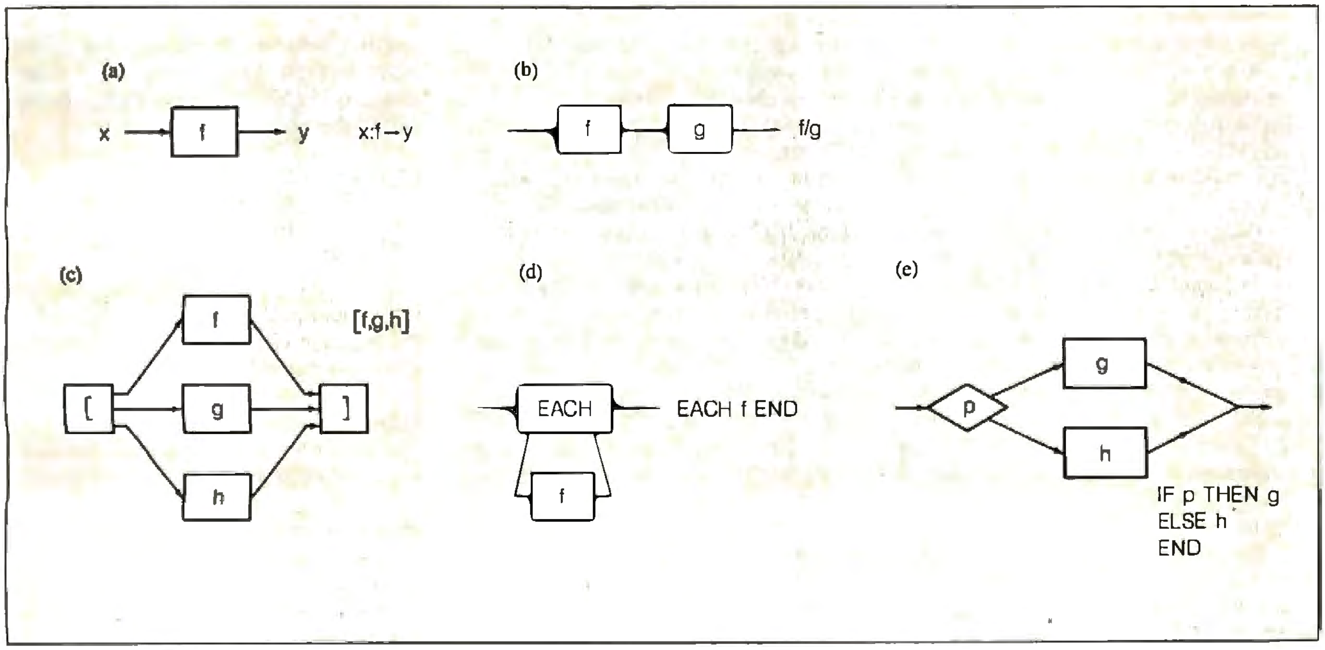

Figure 2: *Each function has a single input and output (a). The composition PFO (b) connects the output of one function to the input of another function. The construction PFO (c) ties functions in parallel to one another. The apply-to-each PFO (d) applies a function to each element of a sequence. The IF. . .THEN. . .ELSE PFO (e) lets you apply conditional functions.*

you can square a sequence of numbers: <2 10 4 3 5> : EACH [id,id] | * END, which yields <4 100 16 9 25>. In effect, the EACH command chops the input sequence into separate objects, feeds each object to the parameter function, and assembles the corresponding outputs (figure 2d).

IF. . .THEN. . .ELSE

The IF. . .THEN. . .ELSE PFO lets you apply conditional functions. It is written as x : IF p THEN g ELSE h END. Interpreted, that function would read, "If $p(x)$ is true, then evaluate $g(x)$; if $p(x)$ is false, then evaluate $h(x)$" (figure 2e).

The level of nesting of conditional forms can be reduced by using ELSIF clauses. For example:

```
IF p1 THEN f1
ELSE
   IF p2 THEN f2
   ELSE
      IF p3 THEN f3
      ELSE g
      END
   END
END
```

can be rewritten as

```
If p1 THEN f1
ELSIF p2 THEN f2
ELSIF p3 THEN f3
ELSE g
END;
```

The ELSE statement can never be omitted, however. If you want to pass the input straight through the ELSE statement, use ELSE id. For example, you can define the absolute value function as

```
DEF Abs AS
     IF [id,#0]|< THEN minus
     ELSE id
     END;
```

If the input is less than 0, then Abs takes the negative of the input; otherwise, the input is returned unchanged.

Filter

The filter PFO filters through elements of a sequence that meet a criterion. It is written as FILTER p END, where p is the criterion expressed as a Boolean function. For example, to filter a sequence for all pairs of equal elements, you could write <<a a> <c d> <x x> <y y> <r g>> : FILTER = END, which would result in <<a a> <x x> <y y>>. The FILTER function is an IFP extension to Backus's Functional Programming. Though FILTER can be done in terms of

continued

Running IFP

Before invoking IFP, you should set two environment variables. Set the EDITOR variable to the name of your favorite editor. The default editor is PC-Write (c:ed.exe). Set the IFPDIR variable to the name of your favorite directory listing program. Normally you can use the AUTOEXEC.BAT file to set these variables. Below is a sample AUTOEXEC.BAT file:

```
set EDITOR = A:edlin.com
set IFPDIR = A:sd2.com
```

To start an IFP session, change your current working directory to a directory on the IFP functions disk. Then execute the program called ifp.exe. Your current working directory becomes your current working IFP module. There is no way to change your current working directory from within IFP; you must leave the interpreter and change directories from the command level of DOS. When IFP is ready, it will respond with the prompt ifp>.

To end an IFP session, enter the command exit at the prompt. All function definitions are kept in disk files, so you shouldn't lose anything when you exit or if the computer crashes.

To edit an IFP definition file, type the command ed *name*, where *name* is the name of the function to be edited. (Since all IFP reserved words are uppercase, it is a good practice to use lowercase or mixed cases for function names.)

The function can be one that is local to the current working module or one that is imported into the current working module. If the function name is neither defined locally nor imported, then it is assumed to be a new local function. The proper syntax of a function definition file is DEF *name* AS *f*;. Definitions are in free format; line breaks are treated as spaces. As in Pascal, matching pairs of (* and *) are utilized to delimit comments.

Do not switch to another file from within the editor. You must always exit the editor to return to the IFP command interpreter first and then edit the next file. Otherwise, the interpreter won't know that its internal copy of a function is invalid.

To apply an IFP function, type the statement

show *object* : *function*;

The interpreter evaluates the result of applying the function to the object. The result is then printed at the terminal.

To list your functions, type dir at the prompt. The directory listing program specified by IFPDIR will be invoked. My directory lister won't work unless I type a trailing slash (dir/). I have not tried any other directory listing program.

To delete a function, type del *f* at the prompt. The function definition file (along with the memory copy) will be deleted. Wildcards are not permitted in the function name. Do not try to delete files with extensions (such as .bak) from within IFP; since filenames are truncated to eight characters, IFP may delete the wrong file.

Tracing Functions

Currently, IFP has a simple program trace mechanism. To trace a function, at the prompt type trace on *f1*, *f2*, . . .*fn*;, where the *f* is the function to be traced. Whenever a traced function is invoked, its argument and result are shown. Also, the argument and result of all called functions are shown. To stop tracing functions, at the prompt type trace off *f1*, *f2*, . . .*fn*;.

When tracing, the interpreter uses ellipses to abbreviate functions. You can set the depth at which ellipses occur by typing depth *n*, where n is a nonnegative integer. The default depth is 2.

There is also a functional form for creating trace functions. Its form is @ *string*.

The function always returns its argument unchanged, and it prints *string:* followed by its argument. For example, <1 2 3> : EACH @banana END will print the following messages:

```
banana: 1
banana: 2
banana: 3
```

This tracing form is for debugging only, since it creates a side effect—the message.

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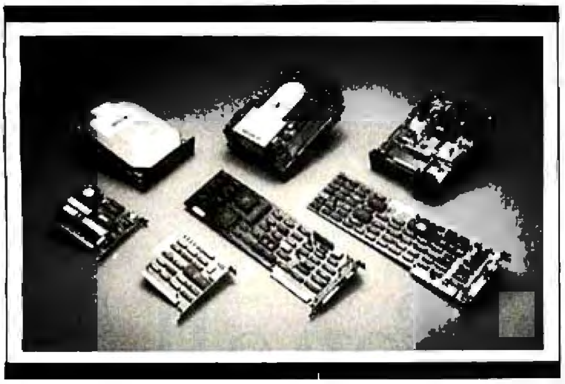

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In IFP, the notion of correspondence is implemented directly as the structural function trans.

other functions and PFOs, it occurs sufficiently often to merit its inclusion as a PFO.

Right Insert

The insert PFO is used to reduce a sequence. It is written as $<x_1,x_2,\ldots x_n>$: INSERT *f* END. For example, INSERT + END returns the sum of a nonempty sequence. The PFO is called insert because if *f* were written in infix notation, it would be inserted between the elements of the sequence. For example, the summation function mentioned above expands as $<x_1,x_2,x_3>$: INSERT + END to yield $(x_1+(x_2+(x_3+(\ldots))))$. The INSERT PFO is much the same as EACH, except that it sends pairs of values to its parameter function.

Functions formed with INSERT PFO are always undefined for empty sequences. This differs from Backus's Functional Programming, in which such functions returned the right identity element of the parameter function. In theory, this is a convenient feature (e.g., summing an empty sequence would yield 0), but it is impractical for the interpreter to know the identity element of user-defined functions. There are so few cases in which the interpreter could know the identity element that we might as well define special functions for those cases, such as:

```
DEF sum AS
    IF null THEN #0
    ELSE INSERT + END
    END;
```

Alternatively, we can append the identity element to the end of the sequence before inserting

```
DEF sum AS
    [id,#0] | apndr | INSERT +
    END;
```

Note that INSERT starts at the right of the sequence. Currently there is no "left insert" that would reduce a sequence starting from the left. We can get the same effect, however, with INSERT and the sequence reversal function: reverse | INSERT reverse | *f* END.

WHILE. . . DO

The last PFO is WHILE. . . DO, which allows indefinite composition. It is written as WHILE *p* DO *f* END;. That is, apply the fewest *f*s required such that *x:f:f:f. . . :p* is true. The WHILE PFO lets us rewrite some recursive programs nonrecursively. For example, consider the recursive function Last, which finds the last element of a sequence by recursively shortening the input sequence:

```
DEF Last AS
    IF tl | null THEN 1  (* case
      of one-element sequence *)
    ELSE
       tl | Last  (* recursive
         case *)
    END;
```

(The tl function takes all but the first element from a sequence; the null function checks if a sequence is empty.) We can rewrite Last nonrecursively as

```
DEF Last AS
```

```
WHILE t1 | null |~ DO
     t1
   END |
   1;
```

(The tilde is the "not" function.) This version of Last keeps taking the tail of the input while there is more than one element left. The WHILE function will then output a one-element sequence for which we take the first element. In the case of Last, we could have also used the insert PFO:

```
DEF Last AS
     INSERT 2 END;
```

Note that the INSERT version of Last works from the back to the front of the input sequence; the WHILE version works from front to back.

Replacing Subscripts and Loops

The von Neumann languages deal with scalar items directly. To handle larger structures such as arrays, loops, and subscripts, you indicate the necessary steps and connections within a computation. Consider adding two vectors *A* and *B* in a Pascal program; you would write

```
for K:=1 to N do
     C[K] :=A[K] + B[K];
```

In English, the algorithm would be stated, "Each element of the result is the sum of the corresponding elements of the arguments." The key word here is "corresponding." In Pascal, the loop and subscripts accomplish the correspondence. In IFP, the notion of correspondence is implemented directly as the structural function trans, which groups corresponding elements. For example, <<*a b c d*> <1 2 3 4>> : trans results in <<*a* 1> <*b* 2> <*c* 3> <*d* 4>>. (The name trans comes from "transpose." If each subsequence represents a row of a matrix, trans transposes the matrix.)

The vector addition program in IFP makes the correspondence and then adds each pair:

```
DEF VectorAdd AS
DEF trans|EACH + END;
```

The input to the IFP program would be a pair of vectors. For example, to add the vectors <1,10,100> and <4,3,2>, we would write <<1 10 100> <4 3 2>> : VectorAdd, which would yield <5 13 102>.

Now you should know enough to write the IFP version of the inner product program listed at the beginning of this article. First, make the correspondence, then take each product, and finally sum the products:

```
DEF Inner AS
     trans |
     EACH * END |
     INSERT + END;
```

The corresponding data-flow graph is shown in figure 3. Compare its simplicity with the graph for the Pascal program.

Scaling a vector demonstrates another common structural function. In Pascal, you would scale vector *A* by scale factor *S* with the following program fragment:

```
for K:=1 to N do
   B[K] := S * A[K];
```

Each element of the input vector is multiplied by the scale factor. Structurally, the scale factor is being distributed over each vector element. In IFP, this distribution is done directly by the distl function. The name distl stands for "distribute from left." It distributes the left argument over each element of the right argument. The

continued

statement <*a* <1 2 3 4>> : distl yields <<*a* 1> <*a* 2> <*a* 3> <*a* 4>>.

You can apply a function to each pair formed by distl with the EACH PFO. The vector scaling function could be written as DEF VectorScale AS distl | EACH * END;. Each resulting pair has the distributed argument on the left side. The mirror image of distl is distr, which distributes the right argument over the left argument. For example, <<1 2 3 4> *z*> : distr results in <<1 *z*> <2 *z*> <3 *z*> <4 *z*>>.

Another important structural function is the outer product. Suppose we want to generate a Boolean matrix that is the result of comparing all elements in vector *X* against all elements in vector *Y*. In Pascal, we would write

```
for J:=1 to N do
  for K:=1 to M do
    C[J,K] := X[J] = Y[K];
```

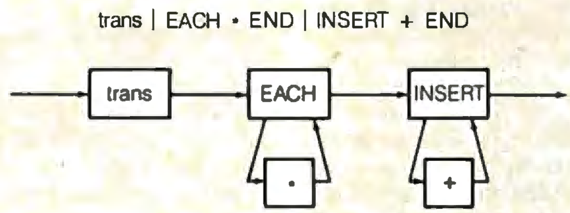

Figure 3: *The data flow of the inner product program is greatly simplified when written in IFP. Compare with the data flow in figure 1.*

Listing 1: *The quicksort algorithm in Pascal has complicated interactions between loops and subscripts that obscure the basis of the algorithm.*

```
(*
 * QuickSort
 *
 * Sorts a sequence of numbers into ascending order using
 * quicksort algorithm.
 *
 * Parameters:
 *      A = array to be sorted
 *      L = index of first element in A
 *      U = index of last element in A
 *
 *)
type Sequence = array [1..100] of real;

procedure QuickSort (var A: Sequence; L,U: integer);

   var J,K: integer;

   procedure Swap (var X,Y: real);
      var T: real;
      begin
         T:=X;
         X:=Y;
         Y:=T;
      end;

   begin
      if L<U then
         begin
            J:=L;          (* A[L] is the partition key *)
            K:=U;
            repeat
               while (J < U) and (A[J] <= A[L]) do J:=J+1;
               while (L < K) and (A[K] >= A[L]) do K:=K-1;
               if J<K then Swap (A[J],A[K]);
            until J>=K;
            Swap (A[L],A[K]);
            QuickSort (A,L,K-1);   (* Sort lower partition *)
            QuickSort (A,K+1,U);   (* Sort upper partition *)
         end;
   end;
```

To write the routine in IFP, you need a structural function that takes all possible pairs from two sequences. Such a function can be defined from functions already discussed. In the Pascal program above, *X*[J] does not change within the inner loop—the *X*[J] distributes across each *Y*[K]. In IFP you can compute all possible pairs by combining distl and distr; for example, you could write <<*a b c*> <1 2 3>> : distr | EACH distl END.

To make the comparisons, you could use two levels of EACH and apply the resulting function to the pair <*X Y*>. Of course, when you have two levels of EACH composed, you can merge. Therefore, you could write the Compare function as the following:

```
DEF Compare AS
     distr |
     EACH
          distl | EACH = END
     END;
```

The outer product function occurs quite frequently, so you might want to define it:

```
DEF Outer AS
     distr | EACH distl END;
```

The simplicity of that definition is another advantage of structural functions. In Pascal, the outer product would be difficult if not impossible to make into a separate procedure. So whenever an outer product is necessary in Pascal, the programmer must rewrite it from for loops. In IFP, you define it only once.

At first glance you may think structural functions are grossly inefficient compared to loops and subscripts. Actually, for an interpreter structural functions are quite efficient for two reasons. First, the sequences are represented internally as shared linked lists, so when the interpreter appears to copy large chunks of data, it really just copies the top levels of the lists. Second, the structural functions are interpreted only once. An equivalent BASIC interpreter must interpret the subscript expressions every time through the loop.

A Larger Program

All the examples so far have been trivial. To show the real power of functional programming, I'll show the quicksort algorithm in IFP. QuickSort sorts a sequence of keys, which in this example are real

Listing 2: *In IFP, the basis of the quicksort algorithm can be identified easily. (Although the algorithms in listing 1 and 2 are not exactly the same, each implements the quicksort idea as simply as possible in the respective language.)*

```
(*
 * QuickSort
 *
 * This function sorts a sequence of numbers or strings
 * into ascending order using the Quicksort algorithm.
 *
 * Examples:
 *
 *  <3 1 4 1 5 9 2> : QuickSort == <1 1 2 3 4 5 9>
 *
 *  <all work no play> : QuickSort == <all no play work>
 *
 * The sequence may not mix strings and numbers.
 *)

DEF QuickSort AS
   IF [length,#2] | < THEN id
   ELSE
      [id,1] | distr |
      [
         FILTER < END | EACH 1 END | QuickSort,
         FILTER = END | EACH 1 END,
         FILTER > END | EACH 1 END | QuickSort
      ] | cat
   END;
```

numbers to be sorted into ascending order. If the sequence contains fewer than two elements, no sorting is required. If the sequence contains at least two keys, then the first element is chosen as the partition key. All elements less than the partition key are picked out and sorted recursively. Likewise, all elements greater than the partition key are also picked out and sorted recursively. The sorted subsequences are then catenated with all the elements that were equal to the partition key.

Listing 1 shows QuickSort written in Pascal. The loops and subscripts obscure the basis of the algorithm—that of restructuring the sequence into subsequences. Listing 2 shows QuickSort written in IFP. Not only is the restructuring basis of the algorithm more obvious, but the fact that all the partition-key comparisons (in the FILTER) can be done in parallel is clear. (Admittedly, the algorithms in the two listings are not quite the same; each implements the basic quicksort idea as simply as possible in its respective language.)

Future Directions

A lot of work is still required to make functional programming more practical than conventional languages. Input and output, graphics, abstract data typing, and efficient compilation require research and development. Backus has described how inputs to functions can be named without losing the structured flow graphs. But despite its current primitive form, functional programming is worth trying. It will give you a new perspective on programming.

Editor's note: *IFP.TXT (the IFP reference manual) is available on disk, in print, and on BIX. IFP.EXE is available on BIX for users with IBM PCs. See the insert card following page 328 for details. Listings are also available on BYTEnet. See page 4.* ■

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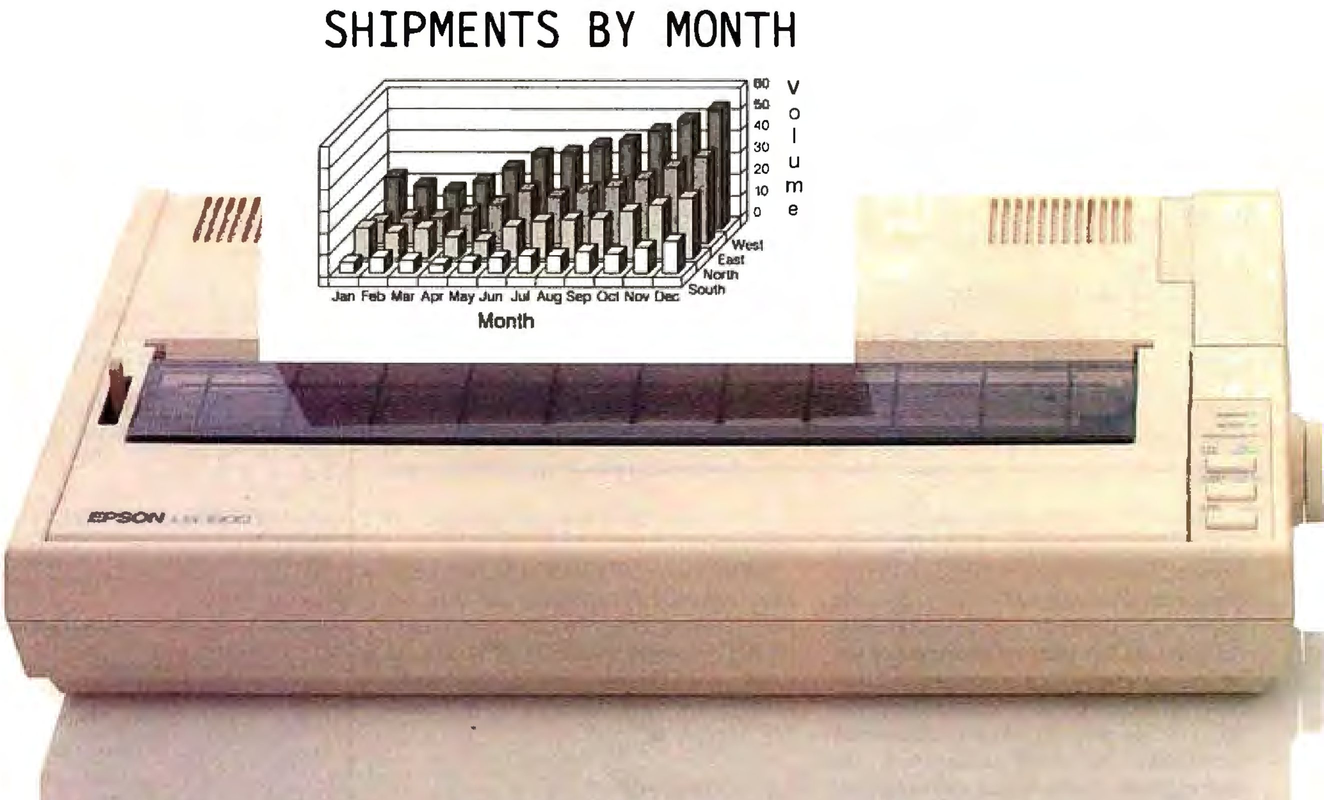
OTHERS PALE B



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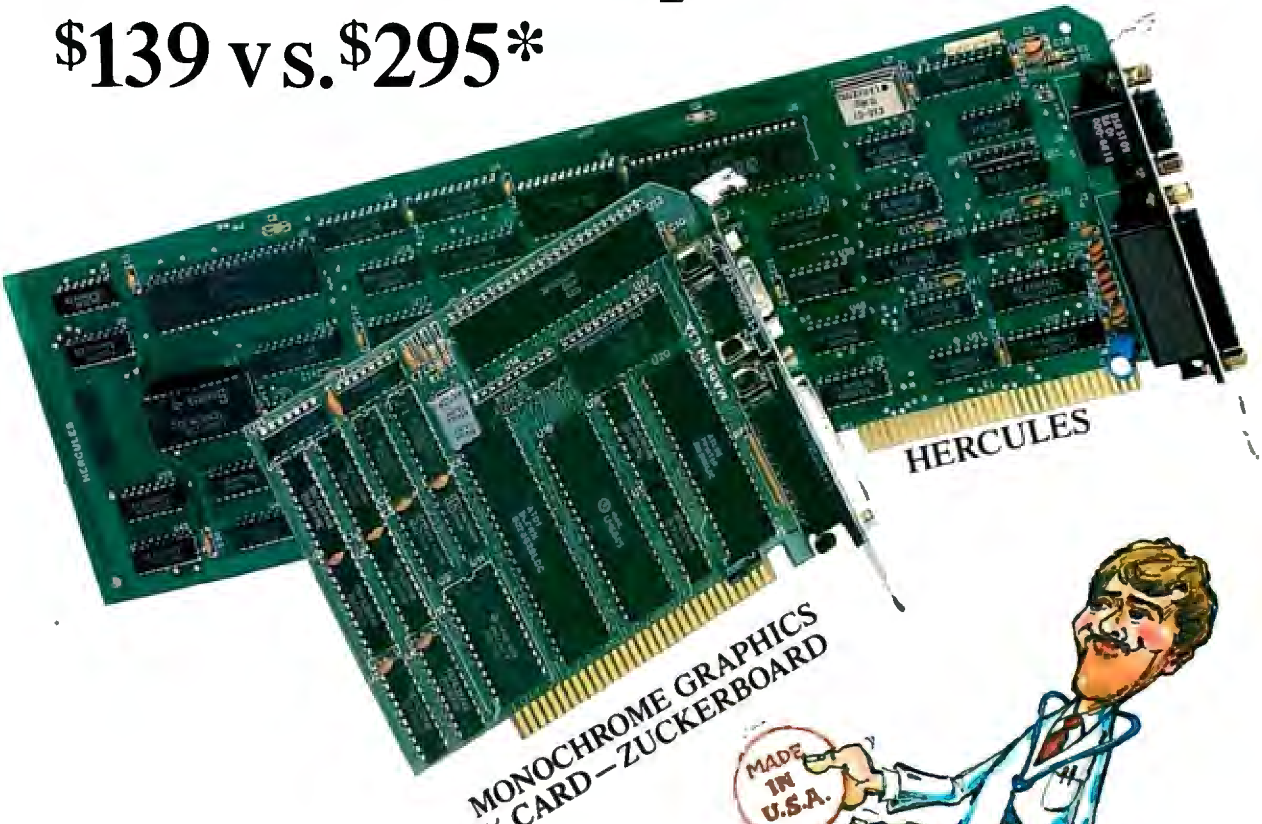

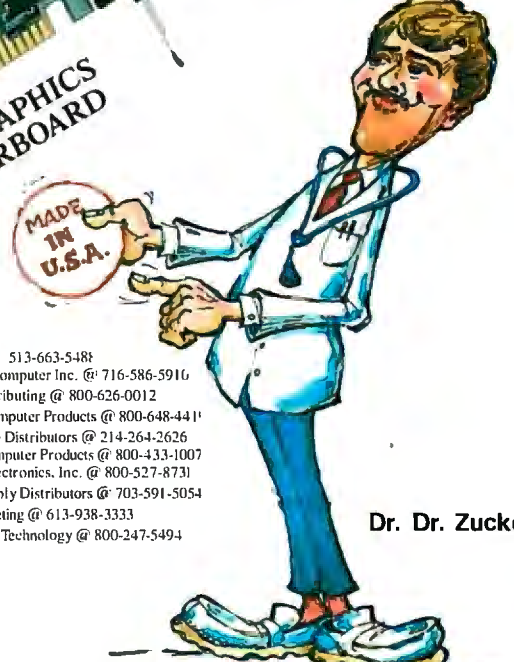

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Inquiry 327

Richard F. Retter and Andrew N. Morelli Jr.

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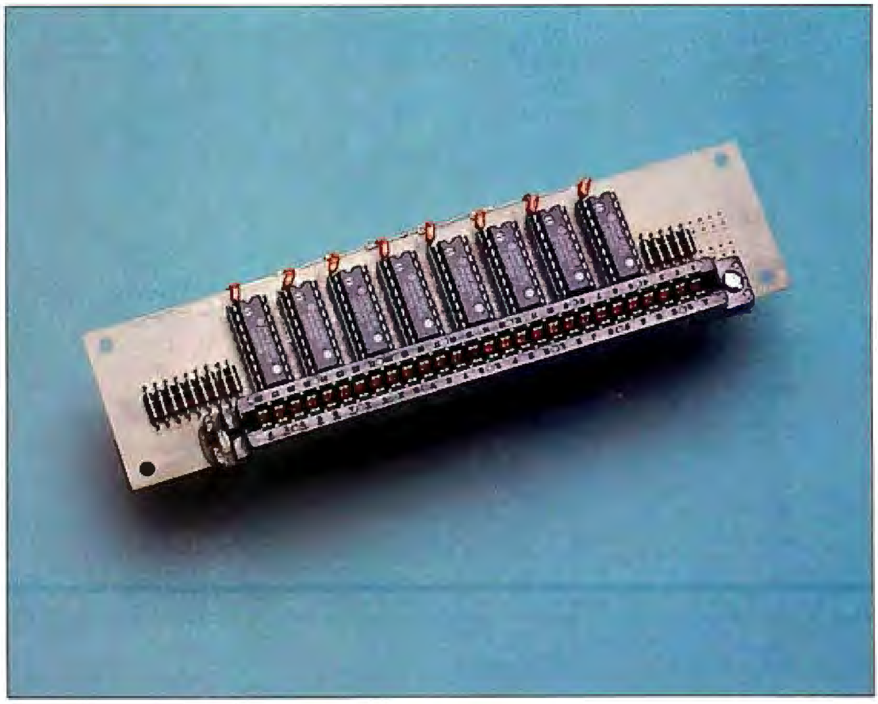

The Amiga comes with the standard 256K bytes of RAM. The optional 256K expansion cartridge retails for $195, but you can build it for about $50.

The first step is to gather all the parts. Most can be purchased from stores such as Radio Shack, and the dynamic RAM chips can be obtained from suppliers such as Microprocessors Unlimited. Another good source of parts is Jameco Electronics. Here's what you'll need:

- One Radio Shack Memory IC PC Board, Cat. No. 276-184
- Eight 18-pin, soldertail, low-profile IC sockets
- Eight 0.01-microfarad, monolithic tantalum capacitors
- Fourteen 39-ohm, 0.25-watt carbon resistors
- One 28/56- or 30/60-contact PC card edge connector, PC mount short-pin type, with 0.156-inch spacing
- Eight 64K by 4-bit dynamic RAMs, 150 ns (Hitachi HM50464P-15)
- Miscellaneous 28-gauge wire-wrap wire

Construction

Assemble the module by following these nine steps:

1. Prepare PC board. Remove the four long ground strips on the Radio Shack board with a razor and pliers. Using a small drill or an X-acto knife, cut all traces marked with an *X* in figure 1.
2. Drill 16 holes for the eight capacitors. (Each RAM chip has one capacitor positioned above it.)
3. Depending on the connector obtained, drill either 56 or 60 holes for the connector. The connector (and thus the holes you drill) must be as close to the edge of the PC board as possible, otherwise you will not be able to insert the RAM chips into their sockets. (See table 1 for connector pin-out.)
4. Prepare the connector (28/56-contact users only). In order to fit the 28/56-contact connector onto the 30/60-finger Amiga bus you will have to cut a groove in the end of the 28/56 connector. The correct end to groove is the high-numbered end—the end closest to contacts 28/FF. A good tool to use for this operation is a Dremel tool. Note the use of a nonconductive nylon screw in the slot cut in the end of the connector. The head of the screw must be filed to fit into the slot cut in the connector. (See the component side of the PC board in the photo.)

Note also that 30/60-contact connectors of the proper type are extremely rare, if not impossible to find. Thus the references to the readily available 28/56-contact connector. Use low-profile sockets and PC mount, short-pin type connector only, to

continued

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PHOTOGRAPH BY PAUL AVIS

Table 1: *List of connector pins and signals.*

CONNECTOR PIN-OUT

Connector Pin#	Description	Connector Pin#	Description
1	Ground	A	Ground
2	D15	B	D14
3	+5 V	C	+5 V
4	D14	D	D13
5	Ground	E	Ground
6	D11	F	D10
7	+5 V	H	+5 V
8	D8	J	D9
9	Ground	K	Ground
10	D7	L	D6
11	+5 V	M	+5 V
12	D4	N	D5
13	Ground	P	Ground
14	D3	R	D2
15	+5 V	S	+5 V
16	D0	T	D1
17	Ground	U	Ground
18	A4	V	A3
19	A5	W	A2
20	A6	X	A1
21	A7	Y	A0
22	Ground	Z	Ground
23	RAS	AA	W/R
24	Ground	BB	Ground
25	Ground	CC	Ground
26	CASU0	DD	CASU1
27	Ground	EE	Ground
28	CASL0	FF	CASL1
29	+5 V	HH	+5 V
30	+5 V	JJ	+5 V

keep the depth of the board to a minimum.
5. Use epoxy to glue the connector to the PC board. Keep epoxy away from the connector leads. Correct orientation is shown in figure 1.
6. Solder the sockets to the PC board. Bend and tack-solder resistors to the board, referring to figure 1 for the proper resistor locations.
7. Place capacitors into board and hold them in place with epoxy or tape. At this point cut all leads to the same length as the RAM socket leads. If this isn't done, the board will stick out too far and the snap-on cover will not fit over the board.

The colored outlines in figure 1 indicate the locations of RAM chips, resistors, and capacitors. The *Xs* indicate etch cuts. Note that one lead of each bypass capacitor is inserted into a hole in the PC board. The other lead is soldered, daisy-chain fashion, to the exposed lead of the adjacent capacitor until the last capacitor is encountered. The exposed lead of the last capacitor (at the end of the daisy-chain) is soldered to +5 volts. Note: If the tantalum capacitors you use are polarized (have a + on one lead), this must be the lead that gets daisy-chained and tied to +5 V. See photo.
8. Solder all wires according to the information given in table 2. Keep all wires short, neatly routed, and as close to the circuit board as possible to reduce crosstalk and noise.
9. Carefully insert the eight RAM chips. Use caution, as 64K by 4-bit dynamic RAMs are extremely sensitive to static.

Installation Notes

Once the board has been completely wired, double-check the wiring using

continued

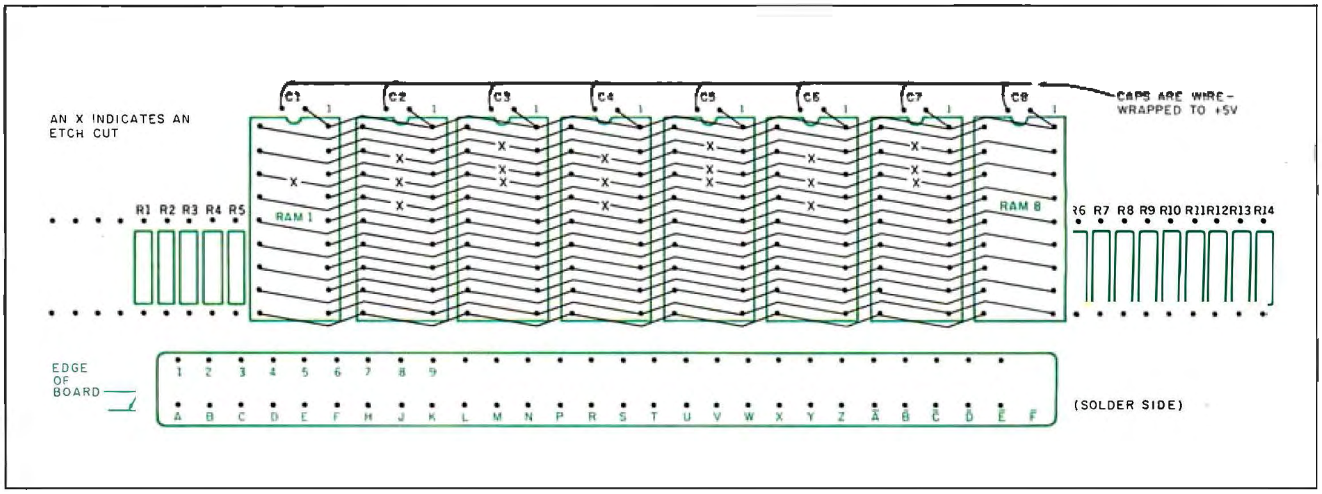

Figure 1: *The printed circuit side of the 256K Amiga expansion RAM board. Colored outlines show the position of RAM chips, resistors, and bypass capacitors. The Xs indicate etch cuts. Note the line at the left of the connector, indicating the correct position of the connector with respect to the edge of the circuit board. This spacing is critical if the board is to plug into the Amiga correctly.*

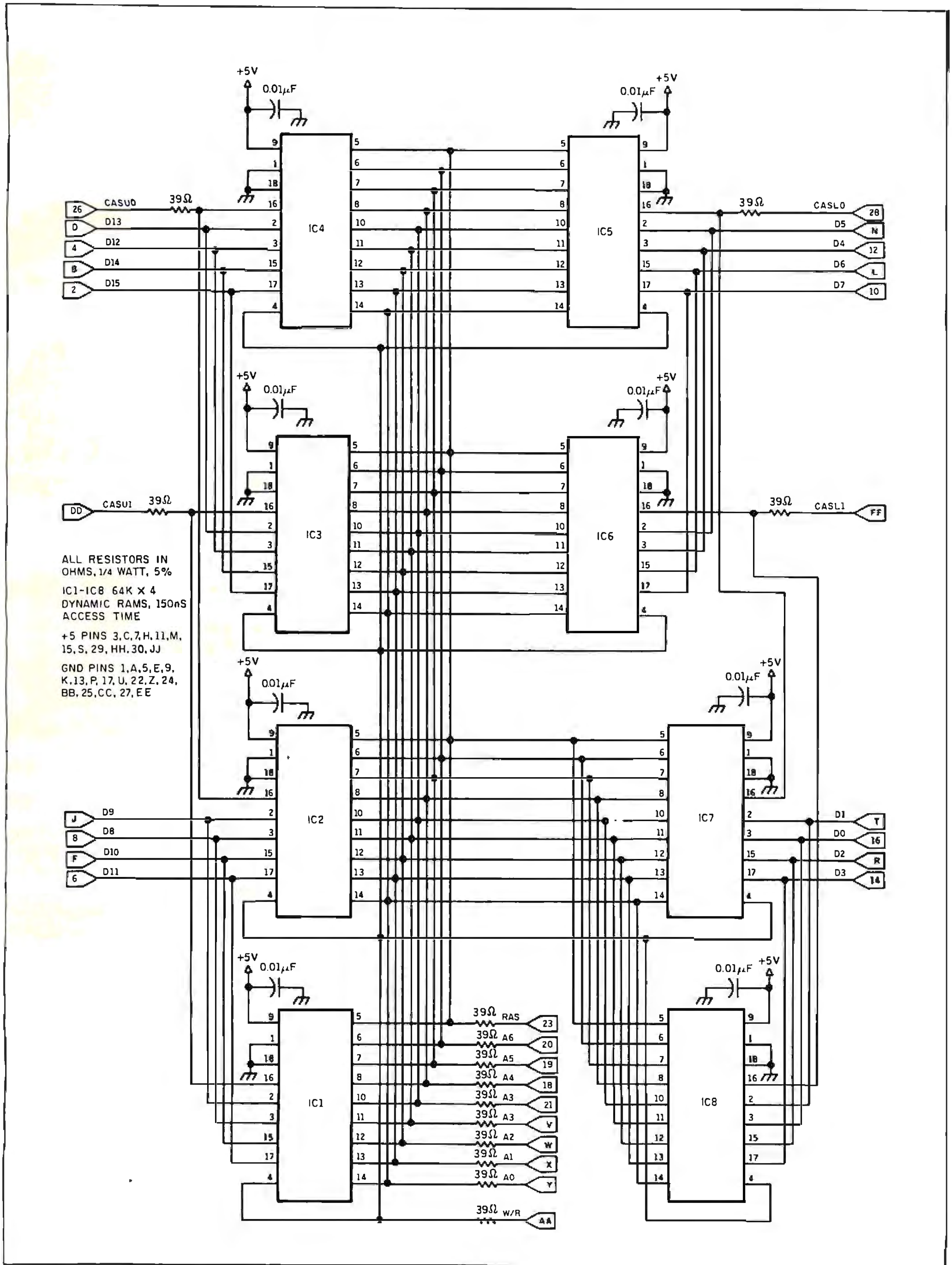

Figure 2: *Schematic diagram for the 256K Amiga expansion RAM board.*

Table 2: *Wire-wrap/solder list.*

FF to R14. R14 to RAM 8, pin 16.	RAM 1, pin 16 to RAM 3, pin 16.
28 to R13. R13 to RAM 7, pin 16.	RAM 2, pin 16 to RAM 4, pin 16.
26 to R12. R12 to RAM 4, pin 16.	RAM 5, pin 16 to RAM 7, pin 16.
DD to R11. R11 to RAM 3, pin 16.	RAM 6, pin 16 to RAM 8, pin 16.
18 to R10. R10 to RAM 8, pin 8.	RAM 5, pin 18 to RAM 4, pin 1.
19 to R9. R9 to RAM 8, pin 7.	
20 to R8. R8 to RAM 8, pin 6.	RAM 1, pin 1 to 5.
23 to R7. R7 to RAM 8, pin 5.	RAM 2, pin 1 to 9.
AA to R6. R6 to RAM 8, pin 4.	RAM 3, pin 1 to K.
	RAM 4, pin 1 to 13.
21 to R1. R1 to RAM 1, pin 10.	RAM 5, pin 1 to 17.
V to R2. R2 to RAM 1, pin 11.	RAM 6, pin 1 to 22.
W to R3. R3 to RAM 1, pin 12.	RAM 7, pin 1 to 24.
X to R4. R4 to RAM 1, pin 13.	RAM 8, pin 1 to 27.
Y to R5. R5 to RAM 1, pin 14.	
	RAM 1, pin 9 to 3.
2 to RAM 3, pin 17.	RAM 2, pin 9 to C.
B to RAM 3, pin 15.	RAM 3, pin 9 to 7.
4 to RAM 3, pin 3.	RAM 4, pin 9 to H.
D to RAM 3, pin 2.	RAM 5, pin 9 to 11.
	RAM 6, pin 9 to M.
F to RAM 2, pin 15.	RAM 7, pin 9 to 15.
6 to RAM 2, pin 17.	RAM 8, pin 9 to S.
J to RAM 1, pin 2.	
8 to RAM 1, pin 3.	RAM 1, pin 18 to C1. C1 to RAM 1, pin 9.
	RAM 2, pin 18 to C2. C2 to RAM 2, pin 9.
10 to RAM 5, pin 17.	RAM 3, pin 18 to C3. C3 to RAM 3, pin 9.
L to RAM 5, pin 15.	RAM 4, pin 18 to C4. C4 to RAM 4, pin 9.
N to RAM 6, pin 2.	RAM 5, pin 18 to C5. C5 to RAM 5, pin 9.
12 to RAM 6, pin 3.	RAM 6, pin 18 to C6. C6 to RAM 6, pin 9.
	RAM 7, pin 18 to C7. C7 to RAM 7, pin 9.
R to RAM 7, pin 15.	RAM 8, pin 18 to C8. C8 to RAM 8, pin 9.
14 to RAM 7, pin 17.	
T to RAM 7, pin 2.	
16 to RAM 7, pin 3.	

table 2 and the schematic diagram in figure 2. If possible, use a continuity tester to measure between the +5-V and ground connections. If there is continuity, you have made a wiring error. If there is no continuity, then test the unit by inserting it into the computer. (Make sure you correctly align the RAM board contacts to the Amiga bus fingers *before* seating the RAM board into the Amiga.)

Turn the Amiga on and wait for the Kickstart prompt. If the Kickstart prompt does not appear, shut the computer off and recheck your work. From the Workbench display, your new RAM memory should be reported at the top of the screen.

Theory of Operation

Since the lines from the computer to the RAM expansion connector are already fully decoded, all connections are straightforward. The computer sends (or receives) 16 data bits at a time. These bits are stored into four of the RAM chips. The CAS (column address strobe) lines, along with the address lines, determine the column address as well as which group of four RAM chips is used. The RAS (row address strobe) lines, along with the address lines, determine the row address.

The CAS and RAS lines, decoded from the address bus in the computer, are all active-low signals. The read/write line is low during the write cycle and high during the read cycle. ■

The following vendors are sources for parts:

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Rene Stolk and George Ettershank

Calculating the Area of an Irregular Shape

An explanation of the algorithm and a demonstration program in BASIC

The need to calculate the area of an irregular shape arises often in technical fields. Examples include the area of a lake for a geographer and the area of a cell for a biologist.

The first step in determining the area is to represent the object with a map, photograph, projected image, or other form. Using a graphics tablet or other digitizing device, you then trace a stylus or cursor over the perimeter of the shape, generating a stream of Cartesian coordinates.

The computer's job is to calculate an estimate of the area enclosed by the sample points. The accuracy of the estimate depends on the density of the sample points with respect to the overall raggedness of the curve; the more irregular the curve is, the more points are needed for a good estimate.

I'll present an algorithm for calculating areas of simple closed curves similar to figures 1a, 1b, and 1c. The algorithm will not, however, measure the area of curves having a crossover as in figure 1d. Such shapes must be broken up into their constituent simple closed curves and analyzed piece by piece.

The Algorithm

Consider the triangle *OAB* in Cartesian space as shown in figure 2a. By inspection, we see that the area of *OAB* equals

$$\begin{aligned}&\text{Area}(OCB)+\text{Area}(ABCD)-\text{Area}(ODA)\\ &= x_2y_2/2+(x_1-x_2)(y_1+y_2)/2-x_1y_1/2\\ &= \tfrac{1}{2}(x_2y_2+x_1y_1+x_1y_2-x_2y_1-x_2y_2-x_1y_1)\\ &= \tfrac{1}{2}(x_1y_2-x_2y_1).\end{aligned}$$

Substitute actual numbers into this formula and you'll find that a triangle traversed in one direction gives a positive result while a triangle traversed in the opposite direction gives a negative result. So to be sure we have a positive area, it is necessary to take the absolute value of the result.

Now look at the more complex shape *ABCD* in figure 2b. Again we see by inspection that the area is the sum of the areas of triangles *OAB*, *OBC*, and *OCD*, minus the area of *ODA*. We can apply the previous formula to each of these triangles, making sure always to move in the same direction, clockwise or counterclockwise. If we do so, the component areas will all be positive or all be negative, allowing us to add them and take the absolute value of the sum.

To illustrate the application of this equation, let's calculate the area of *ABCD* using the numbers shown in figure 2b: $A = (1,4)$, $B = (3,4)$, $C = (4,3)$, and $D = (4,1)$. Substituting into the equation, we know that Area(*OAB*) equals

$$\begin{aligned}&\tfrac{1}{2}\times|1\times4-4\times3+3\times3-4\times4\\ &\quad+4\times1-3\times4+4\times4-1\times1|\\ &= 0.5\times|-8|\\ &= 4.0\ .\end{aligned}$$

Calculating the area of any arbitrary shape (simple closed curves only) is just

continued

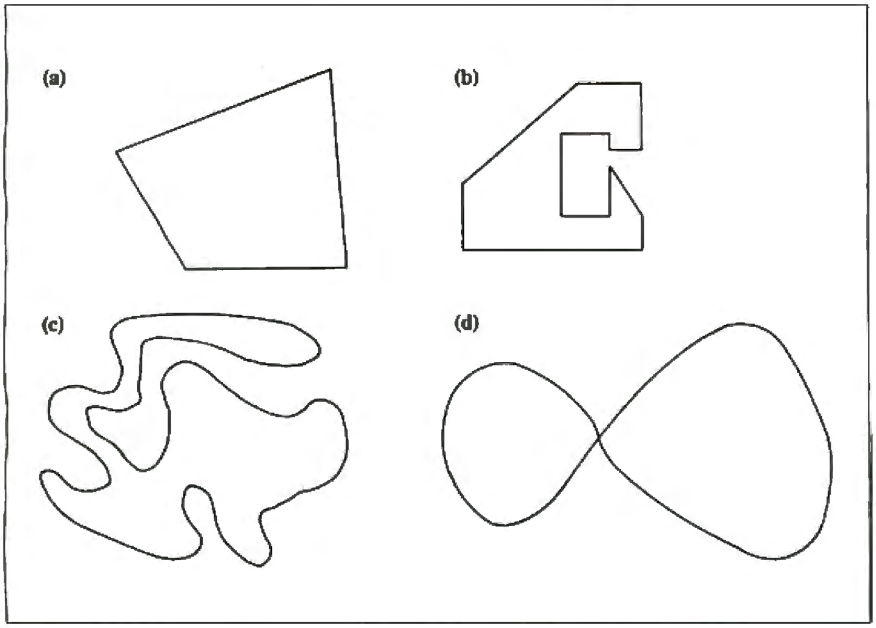

Figure 1: *The algorithm can calculate the area of shapes like these, given a sufficient collection of sample points (shape* d *must be treated as two separate curves).*

Rene Stolk is a systems engineer and George Ettershank is a research biologist. They can be contacted at the Department of Zoology, Monash University, Clayton, Victoria 3168, Australia.

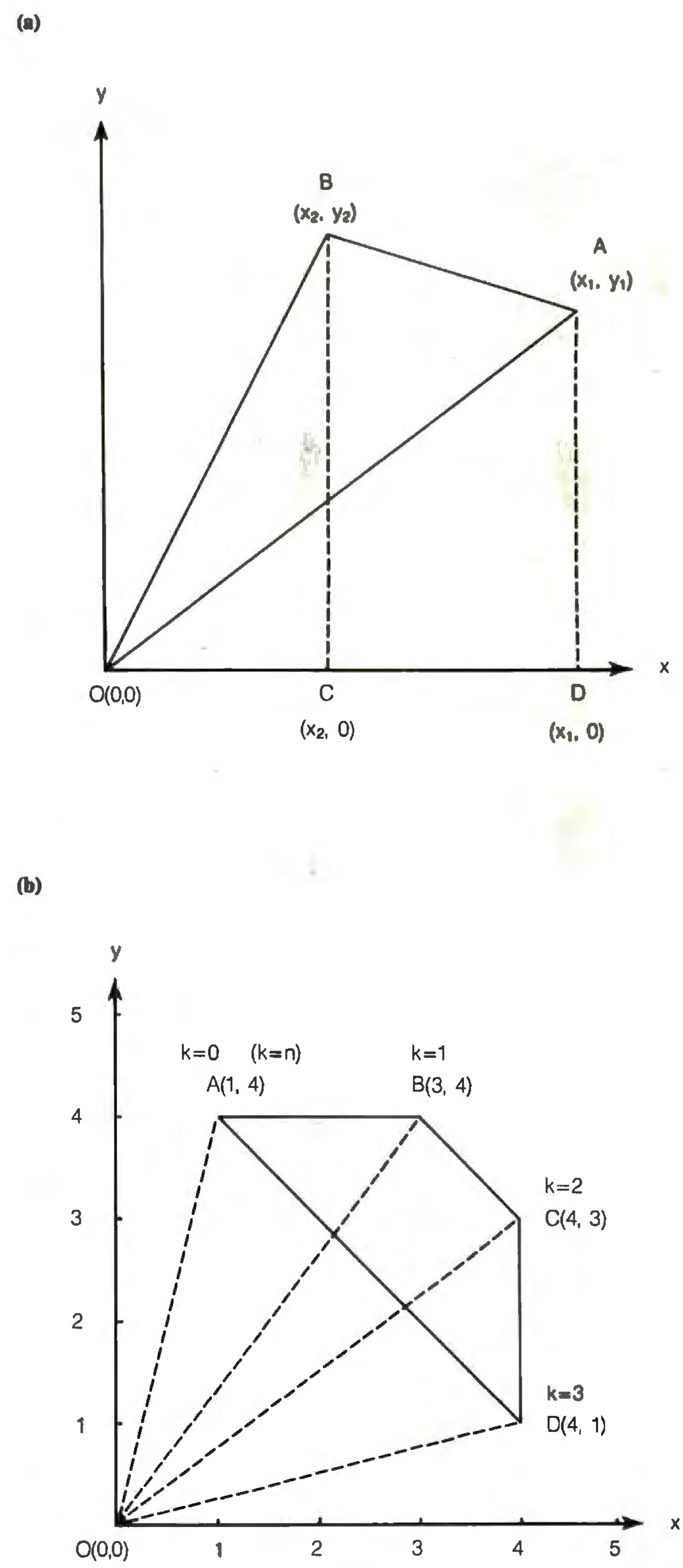

Figure 2: *The area of an irregular polygon can be expressed in terms of triangles and trapezoids whose base and height are known.*

Listing 1: *A BASIC program to calculate the area of an irregular shape, defined by the coordinate pairs given in the* DATA *statements.*

```
10 DIM X(50),Y(50)
20 READ N
30 FOR K=1 TO N
40 READ X(K),Y(K)
50 NEXT K
60 X(0)=X(N)
70 Y(0)=Y(N)
80 AREA=0
90 FOR K=0 TO N-1
100 AREA=AREA + X(K) *
     Y(K+1) - X(K+1) *
     Y(K)
110 NEXT K
120 AREA = .5 *
     ABS(AREA)
130 PRINT "Enclosed area
     is "; AREA
140 END
150 DATA 4
160 DATA 4,3,4,1,1,4,3,4
```

a matter of generalizing our previous formula. If the coordinates of the successive points are taken close together, the shape is split into a series of very narrow triangles, so that even an area bounded by a curved line can be approximated to a high degree of accuracy.

Let $<x,y>$ be a sequence of n points tracing the outline of a simple closed curve C. Define the starting point (x_0,y_0) to be the same as the ending point (x_n,y_n). Then

$$\text{Area}(C) = 1/2 \left| \sum_{k=0}^{n-1} (x_k y_{k+1} - x_{k+1} y_k) \right|.$$

Mathematically minded readers might like to know that the validity of this method can be proved by applying Stokes' theorem to a standard line integral.

The Demonstration Program

Listing 1 is a BASIC program incorporating the area-calculation logic. The program reads a series of x and y coordinates from DATA statements and calculates the area enclosed by those points. The program assumes that the first and last points are connected.

Line 150 specifies the number of data points, and line 160 contains the x,y pairs. The program is set up to handle up to 50 points, but that can be increased by changing the array sizes in line 10. (Nondynamic arrays are used so the program can be compiled by Microsoft's BASIC compiler.) The program is set up to provide single-precision results. For maximum accuracy in the program's result, you can change variables X, Y, and AREA to double precision. ■

Robert J. Sciamanda

Another Approach to Data Compression

Use these BASIC programs to explore the Nyquist sampling theorem

Suppose you have a large quantity of data obtained by hardware measurements, software simulation, or any other method. The numbers may correspond to physical measurements or to values of a known or unknown mathematical function. Do you need to keep all this data? Or can you keep only samples of it and later reconstruct the original data set to within a specified accuracy, using the samples?

I've written a set of BASIC programs that answer these questions by using the Nyquist sampling theorem to find the lowest sampling rate that can be used to reconstruct the original data to a preset degree of accuracy.

The Nyquist sampling theorem says that a finite-bandwidth function can be reconstructed exactly from a set of sampled values:

$$f(n\tau),\ n = -\infty, \ldots, -1, 0, +1, \ldots, +\infty$$

so long as the sampling frequency, $1/\tau$, is greater than twice the highest frequency present in the Fourier spectrum of $f(t)$.

The reconstruction algorithm is given by the "Nyquist sum":

$$f(t) = \sum_{n=-\infty}^{+\infty} \frac{f(n\tau)\sin[(\pi/\tau)(t - n\tau)]}{(\pi/\tau)(t - n\tau)} .$$

Hardware implementations of Nyquist sampling and reconstruction are familiar; the hardware embodiment of the equation above is in fact the low-pass smoothing filter used in digital-to-analog conversion hardware.

In the case at hand, the frequency content of the original function is unknown. However, you can use the Nyquist sum equation to find a suitable value of τ (the sampling interval) through a trial-and-error approach, trying larger and larger values of τ until the observed error of the Nyquist sum exceeds a preset limit.

The BASIC Programs

There are five programs in all. Initially you must run them in sequence.

Listing 1 generates a file named DATA, which contains values from a typical function. The original data values are preceded by count N.

The program in listing 2 reads N+1 values from the file into the array A( ). The program then asks you to specify the accuracy to which this data must be reconstructed.

The software sampling interval L is then set equal to 2, and the Nyquist sum equation is used to reconstruct A( ) from the subset consisting of every Lth item in A( ). If this reconstruction is successful to within the specified accuracy, L is incremented by 1 and the reconstruction process is repeated.

With each iteration of this process, reconstruction is attempted from a subset of fewer data samples until the accuracy requirement fails. The original data count N, the largest successful L value, and the compressed data (every Lth item in A( )) are then written into the disk file CDATA.

Listing 3 reverses the process of listing 2, reconstructing the original data set to within the specified accuracy from the compressed data file CDATA.

The original data count, the sampling interval, and the compressed data are input from CDATA as N, L, and the array B( ), respectively. The Nyquist sum equation is then applied to reconstruct the original data set, which is written into the disk file RDATA.

RDATA is identical in format to the original data file DATA; that is, the first entry is the data count N, followed by the N+1 reconstructed data values.

Listing 4 provides an explicit check of the compression-reconstruction process. After running the reconstruction program (listing 3), run listing 4 to see a side-by-side comparison of the original and reconstructed data sets.

[Editor's note: *BYTE added listing 5, which plots the points from DATA and RDATA on the screen. The listing requires an IBM PC or compatible machine with BASICA and high-resolution graphics.*]

All listings (except 5) were written in Microsoft GW-BASIC for a Zenith Z-150. They should run without modification on IBM PC compatibles and with only minor changes on other computers equipped with BASIC and a disk drive.

Using the test data generated by listing 1 and electing an accuracy of 0.005, listing 2 (the compression algorithm) ran in 45 seconds on a Z-150 and found the largest successful sampling interval to be L = 3.

Will It Work with Real Data?

How much your real data can be compressed by this method—or whether it can be compressed at all—is a function both of your required accuracy and of the frequency content of the data. The more erratic the data variations, the higher the component frequencies and the higher the required sampling frequency.

An important factor contributing to the frequency content of the original data is the smoothness of the transitions to and from the value 0 at the beginning and end of the data domain. The value 0 is pre-

continued

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Listing 1: *A program to generate a data file for testing the Nyquist compression technique. The program evaluates the Gaussian function*

$$10e^{-(5-.2i)^2}, \quad i = 0 \text{ to } 50.$$

```
10 OPEN "O",#1,"DATA"  :REM Make a test data file by taking
20 PRINT#1,50          :REM 51 samples from a Gaussian
30 D=.2                :REM curve centered at i=25.
40 FOR I=0 TO 50
50 A=10*EXP(-(5-D*I)^2)
60 PRINT#1,A
70 NEXT I
80 CLOSE
```

Listing 2: *This program reads the sample data file called DATA, prompts the user for the required accuracy, and then determines whether the data can be compressed and reconstructed using the Nyquist sampling theorem. If possible, the compressed data is written to a file called CDATA.*

```
10 OPEN "I",#1,"DATA"
20 INPUT#1,N           :REM Get data count.
30 DIM A(N)
40 FOR I=0 TO N        :REM Get original data set.
50 INPUT#1,A(I)
60 NEXT I
70 CLOSE
80 INPUT "Enter desired accuracy ";E
90 FOR L=2 TO INT(N/2-.5)
100 W=3.141593/L
110 FOR I=1 TO N       :REM Reconstruct missing values.
120 IF I MOD L=0 THEN 190 :REM Branch at sampled values.
130 G=0
140 FOR J=0 TO N STEP L :REM The Nyquist sum.
150 M=W*(I-J)
160 G=G+A(J)*SIN(M)/M
170 NEXT J
180 IF ABS(G-A(I))>E THEN 210 :REM Sum done; test
     accuracy.
190 NEXT I     :REM If ok, reconstruct next value.
200 NEXT L     :REM Increment sampling interval.
210 L=L-1      :REM Highest successful sampling interval.
220 IF L>1 THEN 260 :REM L=1 means no compression
     possible.
230 PRINT "For an accuracy of +/-";E;"all of this data
     must be kept."
240 PRINT "No compressed data file (CDATA) will be
     generated."
250 END
260 OPEN "O",#1,"CDATA" :REM Create compressed data file.
270 PRINT#1,N,L :REM Write data count, sampling interval.
280 FOR J=0 TO N STEP L :REM Write compressed data set.
290 PRINT#1,A(J)
300 NEXT J
310 CLOSE
320 L$="th"
330 IF L=2 THEN L$="nd"
340 IF L=3 THEN L$="rd"
350 PRINT "Every ";L;L$;" data value has been kept in the
     compressed data file (CDATA)."
360 PRINT "The original data set can be reconstructed to
     an accuracy of +/-";E
```

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Listing 3: *This program reads compressed data from CDATA and uses it to reconstruct the original data by applying the Nyquist sampling theorem.*

```
10 OPEN "I",#1,"CDATA" :REM Compressed data.
20 INPUT#1,N,L         :REM Get count, sampling inverval.
30 K=INT(N/L):DIM B(K)
40 FOR I=0 TO K        :REM Get compressed data.
50 INPUT#1,B(I)
60 NEXT I
70 CLOSE
80 OPEN "O",#1,"RDATA" :REM Create reconstructed data.
90 PRINT#1,N           :REM Write data count.
100 W=3.141593/L
110 FOR I=0 TO N       :REM Reconstruction
120 IF I MOD L = 0 GOTO 190 :REM Branch at sampled values.
130 G=0
140 FOR J=0 TO K       :REM The Nyquist sum.
150 M=W*(I-J*L)
160 G=G+B(J)*SIN(M)/M
170 NEXT J
180 GOTO 200  :REM Sum done; store this value.
190 G=B(I/L)
200 PRINT#1,G :REM Write reconstructed value to file.
210 NEXT I    :REM Go reconstruct next value.
220 CLOSE     :REM Done
230 PRINT "The reconstructed data file is RDATA"
```

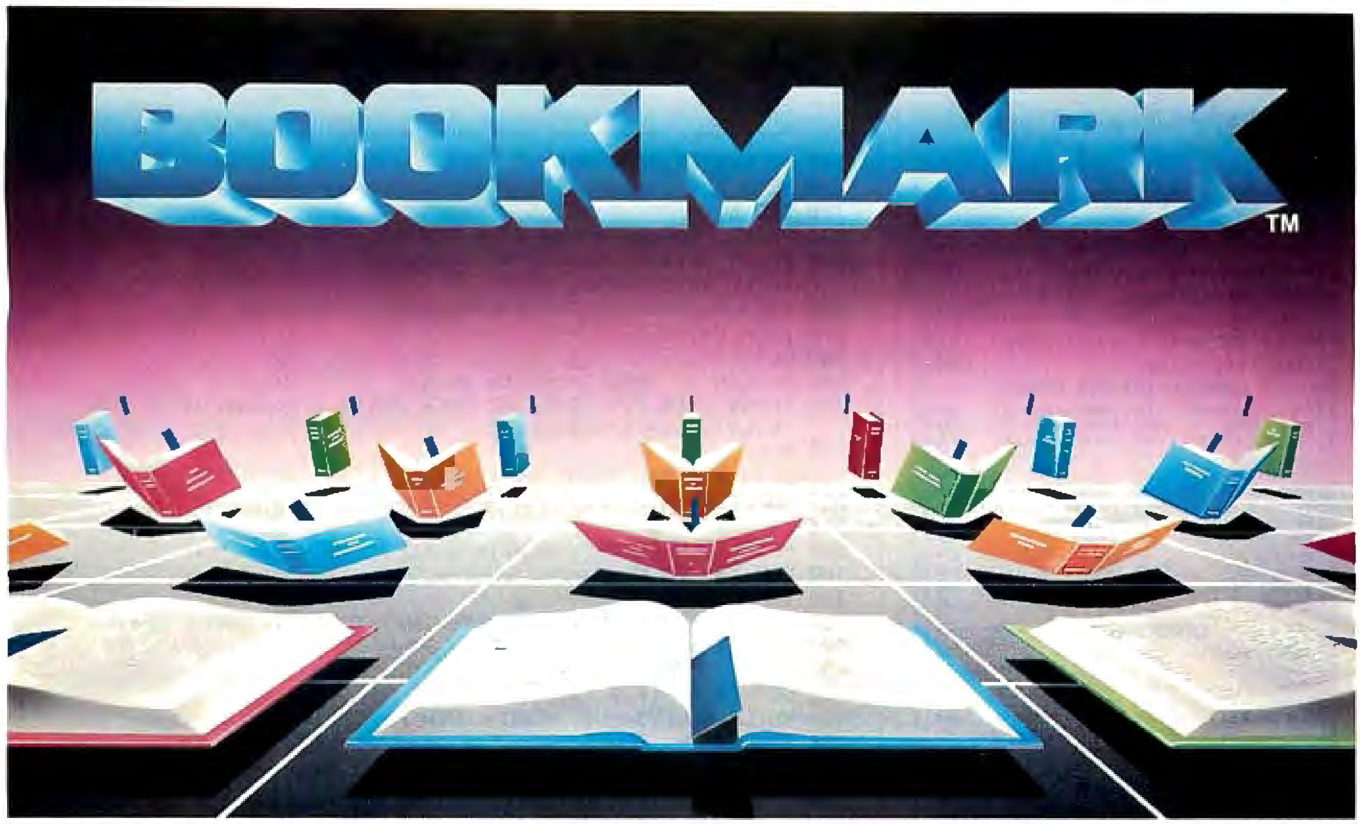
Listing 4: *This program displays data from the original and reconstructed data files.*

```
10 OPEN "I",#1,"DATA"   :REM Original data file.
20 OPEN "I",#2,"RDATA"  :REM Reconstructed data file.
30 PRINT "  DATA          RDATA        Error"
40 IF EOF(1) THEN CLOSE: END
50 INPUT#1,A           :REM Get original data value.
60 INPUT#2,B           :REM Get reconstructed value.
70 ER=ABS(B-A)  :REM Calculate error.
80 PRINT USING "#.#####^^^^  #.#####^^^^  #.####";A,B,ER
90 GOTO 40
```

Listing 5: *This program plots the data from DATA and RDATA on the screen (high-resolution capability required). Note that the scale and offsets may differ for the two plots.*

```
10 SCREEN 0,0,0 :REM Text screen
20 SZ=4-INT(-(640+7)*200/32) :REM Size of graphics array.
30 DIM SC(SZ)          :REM To hold graphics screen.
40 VRES=200: HRES=640
50 REM
60 YES=(1=1)
70 NO=(1=0)
80 SS=NO                    : REM Screen not saved yet
90 FILES
100 LINE INPUT "Name the input file ";FI$
110 IF FI$=NU$ THEN END
120 OPEN FI$ FOR INPUT AS 1
130 INPUT #1,N
140 PRINT FI$; " contains ";N+1; "values"
150 INPUT #1,Y
160 MINY=Y: MAXY=Y
170 FOR K=1 TO N
180 INPUT #1,Y
190 IF Y>MAXY THEN MAXY=Y
```

continued



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```
200 IF Y<MINY THEN MINY=Y
210 NEXT K
220 CLOSE
230 PRINT "Values range from ";MINY; "to "; MAXY
240 PRINT "Press any key to continue";
250 WHILE INKEY$=NU$: WEND
260 YSCALE=(VRES-1)/ABS(MAXY-MINY)
270 XSCALE=(HRES-1)/N
280 CLS
290 SCREEN 2  :REM Graphics screen
300 IF SS THEN PUT (0,0),SC :REM Restore screen if it has
      been saved previously.
310 REM
320 OPEN FI$ FOR INPUT AS 1
330 INPUT #1,N
340 INPUT#1,Y
350 PSET (0,VRES-1-(Y-MINY)*YSCALE)  :REM Plot 1st point.
360 FOR X=1 TO N
370 INPUT #1,Y
380 LINE -(X*XSCALE,VRES-1-(Y-MINY)*YSCALE) :REM Connect.
390 NEXT X
400 CLOSE
410 GET (0,0)-(639,199),SC
420 WHILE INKEY$=NU$: WEND  :REM Hold til key pressed.
430 SS=YES     :REM Screen has been saved.
440 SCREEN 0,0,0       :REM Go back to text screen.
450 GOTO 90
```

sumed for values "before" and "after" the N+1 data values. This is because in the reconstruction of each function value, the Nyquist sum equation requires the use of sampled values over the complete domain of the function, that is, from $n = -\infty$ to $n = +\infty$. When the series is truncated, as it must be in any practical implementation, the algorithm operates as if all the truncated sample values are 0.

In both hardware and software implementations, it is common practice to preprocess the data, using filtering and windowing techniques to limit the high-frequency content. Filtering eliminates or smooths out exceptional fluctuations or discontinuities in the data, while windowing techniques modulate the truncation of the data domain, providing smooth transitions to and from the value 0. Such techniques allow sampling at a lower frequency, but at the risk of doing violence to the data. The trade-off must be made on a case-by-case basis, assessing the extent to which the high-frequency content is artificial, that is, due to noise or introduced by truncation of the data domain.

For the Curious

It is instructive to use the algorithm of the Nyquist sum equation to reconstruct typical functions (truncated sinusoids, Gaussians, etc.) from sample sets extracted at a variety of sampling frequencies to exhibit the so-called aliasing effects of undersampling. These effects are best studied by comparing plots of the original and reconstructed functions.

To create data from a particular function, change listing 1. Note that the first value written to the file must be a count that is one less than the number of data values to follow. For instance, if the file contains 10 values, the count should be 9.

To control the sampling frequency without regard to Nyquist accuracy limitations, change listing 2, lines 80–100, to

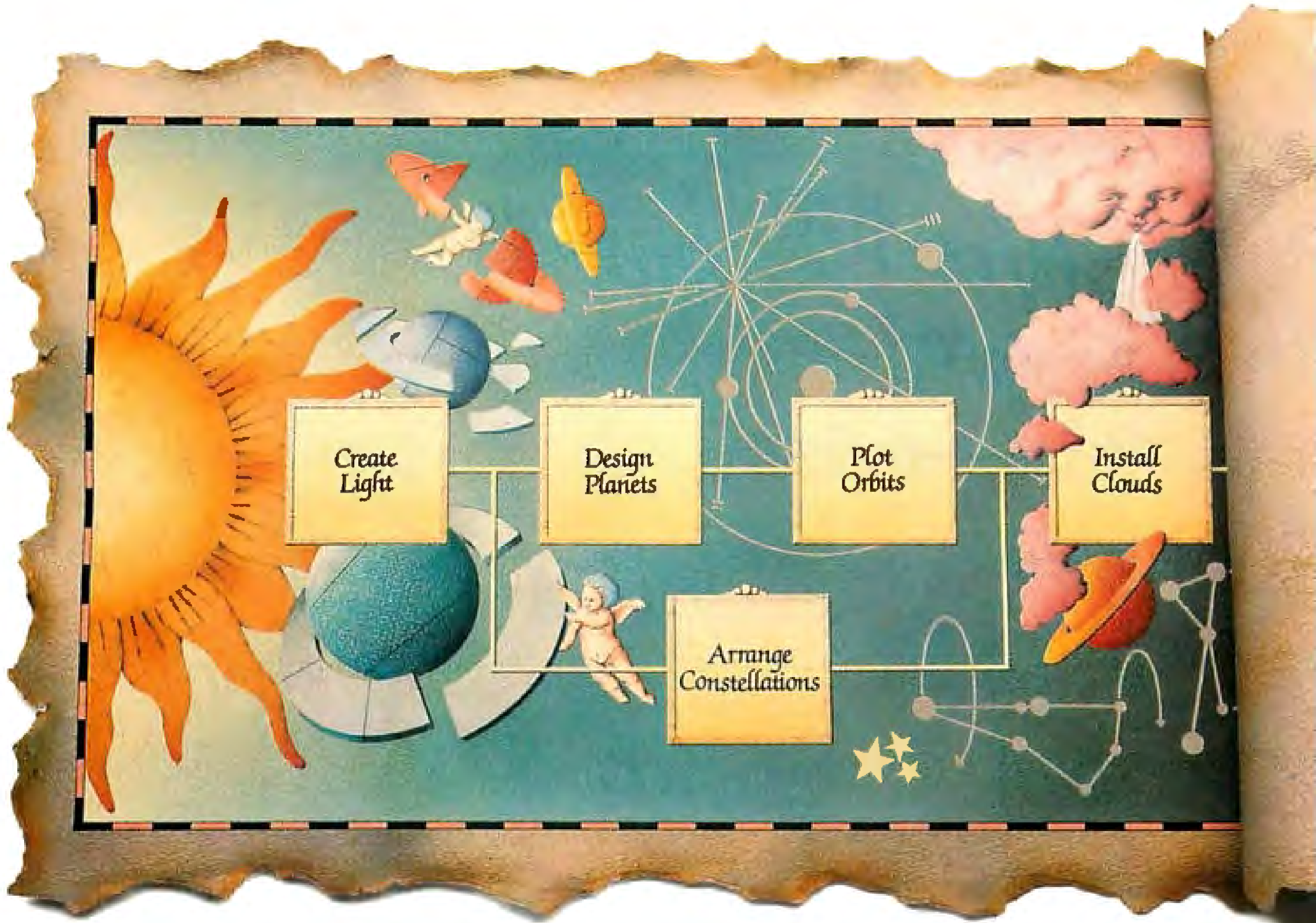
```
80 PRINT "Sampling rate (2 to ";
     INT(N/2-.5); ")";
90 INPUT L: IF L < 2 OR L >
     INT(N / 2-.5) THEN 80
100 OPEN "O", #1, "CDATA"
```

and delete lines 110 through 260 and line 360.

Run the modified program to generate the sampled data file CDATA, then run listing 3 to attempt a reconstruction of the original data. Use listings 4 and 5 to compare the original and the reconstructed data.

Intellectually, the theory behind the Nyquist theorem is intriguing and elegant, and it requires only a knowledge of Fourier transform theory. Carson Chen's "An Introduction to the Sampling Theorem" (National Semiconductor Application Note 236) is a concise and readily available synopsis of Nyquist theory and includes an excellent bibliography. Chen's explanation is included in the *National Semiconductor Data Conversion/Acquisition Databook* (Santa Clara, CA: National Semiconductor Corp., 1984, page 12.46).

On the practical side, the Nyquist technique deserves more attention and development as a software calculation tool, alongside traditional numerical interpolation. ■



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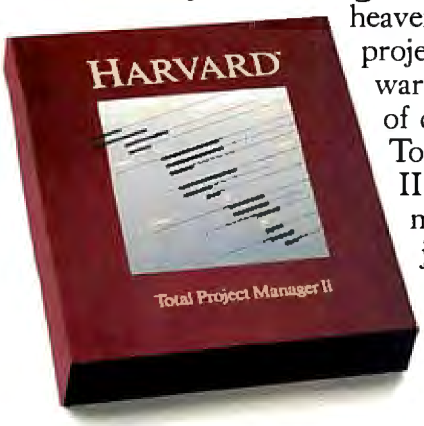

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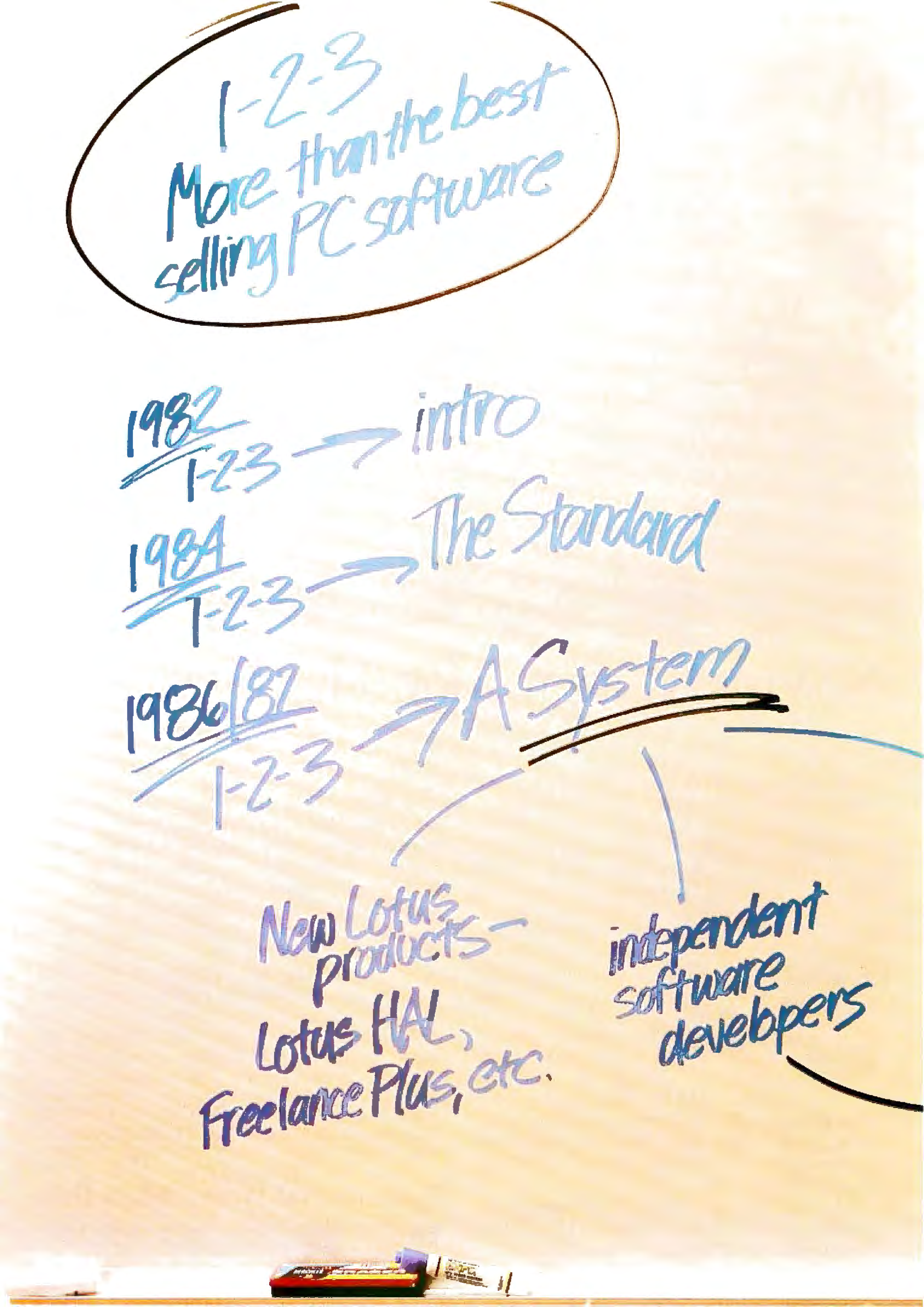
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Educational Computing

IN THIS COLLECTION of articles exploring various aspects of educational computing, you'll find, as we did, that while some authors call for revamping the entire educational process, other authors survey the successes in the field. One thing is certain, no two agree or share the same visions, causes, or needs in applying computer technology to education.

We begin with "Using Computers for Instruction," which presents some unofficial results of the Second National Survey of Instructional Uses of School Computers, commissioned by the U.S. Department of Education in 1985 and conducted that spring. According to Henry Jay Becker, a research scientist from Johns Hopkins University in Baltimore, while successes have been recorded, unexpected trends may unwittingly shape the future unless they are corrected.

Following the survey, BYTE's Donna Osgood focuses on major accomplishments of a sampling of colleges—Reed College, Stanford University, Carnegie Mellon, Drexel University, and Brown University—and shows the different ways these five colleges have used computers. She includes screen shots of programs developed by both faculty and students that are available to all colleges through the Academic Courseware Exchange, explained in an accompanying text box. From these examples, it is evident that educators and students are gaining proficiency in using new techniques to computerize academics.

To further electronic access to post-secondary education, Brock N. Meeks, a teacher in an on-line alternative education program, discusses the real advantages of receiving graduate credit for courses offered on-line in "The Quiet Revolution." This is followed by comments from readers affiliated with universities who responded to the editorial in the September 1986 issue of BYTE, which was a call for improved on-line education.

Shifting focus from college to elementary and secondary educational concerns, "A Hard Look at Educational Software" by Adeline Naiman, director of an educational software firm, charts the reluctance of investors in developing innovative software. She ascertains it is the publishers who have leaped in to fill this void. In the end, Ms. Naiman heralds the birth of a third generation of software applicable to the classroom.

With an eye to the future, we close our presentation with a theoretical viewpoint by Alfred Bork, long known for his work with computers in education. His concerns mirror many of the findings from Becker's survey, bringing our discussion full circle. In "The Potential for Interactive Technology," Bork critiques the current problems found in education, emphasizes a few workable programs, but goes on from there to encapsulate visions for combating the problems he so carefully outlines. Further, Bork calculates the expense of his program and its multinational possibilities.

The conclusions you draw from these readings will undoubtedly reflect your particular interest in the field, whether you attend school, have children in school, or are a teacher, administrator, or a concerned member of the computing community. Perhaps the issues raised here, in conjunction with the successes, will contribute to the pursuit of equality on all fronts in academic computing.

—Margaret Cook Gurney, Associate Technical Editor

Using Computers for Instruction

The results and implications of a national survey may surprise you

Henry Jay Becker

IN 1985 THE SECOND National Survey of Instructional Uses of School Computers was commissioned by the United States Department of Education. The 2331 schools that were included in the study were selected from a sample of elementary and secondary schools, public and private. Schools with higher grade levels and schools that were expected to have more computers were oversampled in order to provide the most detail possible about schools making varied and extensive uses of computers. The raw results were reweighted so that the data shown could be interpreted as coming from a representative sample.

Data analysis for the survey is still in progress and is supported by the Department of Education's Office of Educational Research and Improvement and by a grant from the National Science Foundation. Any opinions expressed in this article are my own and do not reflect the policy of these agencies; no official endorsement should be inferred. The study was conducted in the spring of 1985, and data should be viewed in that context. (For further information, see reference 1.)

Achieving a Desirable Ratio

In the last five years, most schools have begun using computers in their instructional programs. Seven years ago, half of all high schools had no computer at all; and only four years ago, fewer than half of elementary schools had any. However, currently, 90 percent of all U.S. schoolchildren attend a school with at least one computer. The typical high school has more than 20 computers, and the typical elementary school has 6. But these numbers are far short of the resources needed if schools are to provide all their students with a substantial degree of computer-based experience.

Under the right conditions, a typical high school student could use computers to write compositions, memorize facts and vocabulary, understand relationships and concepts in mathematics and science, and write computer programs. Each of these separate uses might occupy from 30 minutes to three hours of computer time per week. Thus, a high school student could profitably use computers for as much as an hour or two per day.

But very few schools have the computer resources to give that much computer time to each student. To provide only 30 minutes of computer time daily to each student, a school would need one computer for every 12 students—assuming constant use of the computers for six hours per day, with no time lost to transitions, scheduling foul-ups, or other interruptions. Such a favorable ratio is available at only 7 percent of high schools and 2 or 3 percent of elementary and middle schools. Most schools can provide a substantial computer experience to some students only by limiting the number of students who have access to computers.

Student Computer Use

Nearly half of elementary and middle school pupils and about one-third of high school students make some use of computers at school. However, many of these computer uses are casual and of short duration. Overall, a typical elementary school student using computers in a particular week uses them for 35 minutes that week, either all on one day or in 10- or 15-minute sessions on different days. During most weeks the student may not use computers at all because elementary schools generally rotate computer exposure among as many students as possible. The typical middle school student using computers has a little more than one hour per week, while the typical high school computer user has nearly two hours. While fewer students use computers in the higher grades, they do so much more intensively.

Figure 1 shows how school computer time and student users are divided among the grade levels from kindergarten through twelfth grade. In elementary schools, both the number of student users and the total amount of use increase every grade from kindergarten to fifth grade. At the middle school level, fewer students use computers, but the total computer time goes up sharply between the sixth and seventh grades. At the high school level, both measures shift sharply. In the ninth grade,

continued

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substantially fewer students spend substantially less time using computers than in the eighth grade. (About the same number of ninth-grade students use computers as kindergarteners.) High school computer use is clearly dominated by juniors and seniors, who make up 60 percent of the high school users and nearly 67 percent of the instructional time available on high school computers.

Comparing these survey findings to a similar survey conducted in 1983, a typical student computer user in 1985 gets about twice as much computer time as a student user did two years earlier, and the number of students using computers at each school has also about doubled. These increases are possible because the number of computers in schools has quadrupled during the two-year period, and each computer is now in use for more hours per week.

Teacher Use

One-fourth of the teachers use computers regularly with students. A much higher proportion of elementary school teachers do so (37 percent in the K-6 schools) than do secondary school teachers (15 percent). However, because schools with older students tend to be larger, roughly the same number of teachers (five per school) use computers regularly during the year at the typical elementary school and at the typical high school.

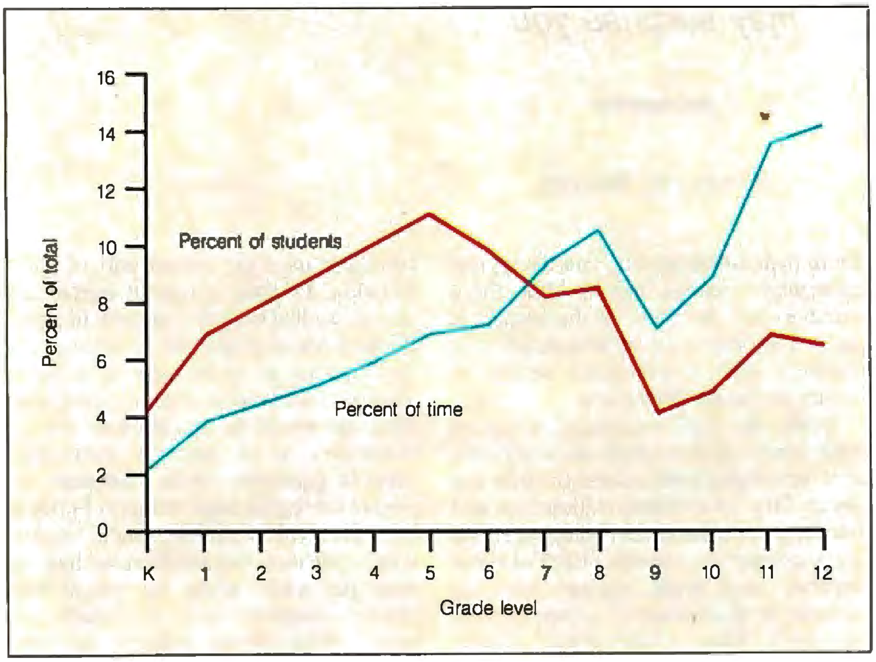

Figure 1: *Distribution of student computer users and computer time use by grade level.*

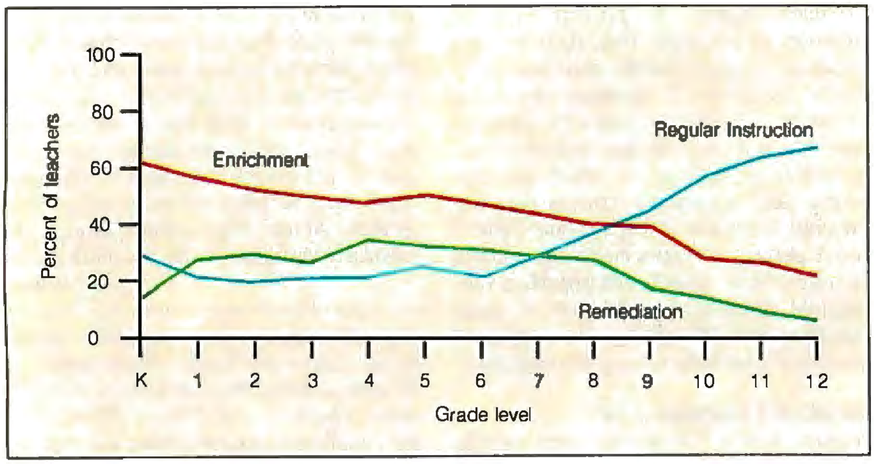

Figure 2: *Function of computer activity for teachers—enrichment, remediation, or regular instruction—by grade level. (Percents may total more than 100 percent because of multiple answers.)*

On the other hand, high school teachers who use computers are much more computer-knowledgeable than their elementary school counterparts. For each school, the survey obtained an estimate of the number of computer-using teachers who are considered expert in each of four aspects of using computers—using some instructional programs, knowing about a wide variety of programs, using word processing or other professional tools, and writing computer programs. Averaging across these four areas of computer-related knowledge, 27 percent of the computer-using teachers from the high schools and 21 percent of those from the middle schools are considered expert, while only 10 percent of those from the elementary schools are.

Major Instructional Uses

The ways in which students use computers differ sharply by grade level, as you would expect. More than 50 percent of the computer time for students in elementary schools involves computer-assisted instruction (CAI) with drill-and-practice or tutorial programs, and only about 12 percent of the time is spent writing computer programs. High school students, on the other hand, spend only 16 percent of their computer time on CAI but fully 50 percent in programming. On the average, across all school levels, student time averages out and divides evenly among CAI, programming, and other academic work (including "discovery learning" and word processing).

How central a role do computers play in instruction at different grade levels? Teachers were asked about their use of computers for one (randomly sampled) class or subject—whether computers are used in that particular class as a regular part of instruction, primarily for enrichment, or primarily for remediation. Figure 2 shows how the responses differ by grade level.

From kindergarten through the eighth grade, computers are used primarily for enrichment. They also play a remediation role from the first through the seventh grades, but remediation is never much more than 33 percent of all computer use. In the secondary grades, computers become integral to class instruction, especially in the eleventh and twelfth grades.

Thus, while more students use computers at the lower grades, those high school students who use them do so more intensively and more often as a regular part of class instruction. However, regular use in high school classes generally involves the computer as the *subject* of instruction rather than as an instructional

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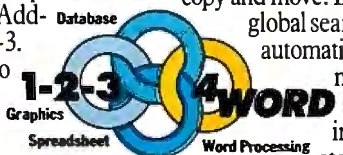

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Boys outnumber girls in using computers before or after school.

medium or a productivity tool. So, regardless of grade level,. only a small fraction of the time is the computer used as a *regular* part of instruction in traditional academic subjects.

Table 1 presents the distribution of computer uses across school subjects for the following three grade groups: early elementary (K–3), late elementary and middle (4–8), and high school (9–12). The teachers were asked which computer activity their students most recently engaged in. The results are weighted according to how much that class used computers during the year, so percentages give the approximate proportion of total use.

In grades K–3, whole-number arithmetic and language arts, including spelling and reading, constitute 77 percent of computer use, which includes the time spent in computer-literacy units where students are engaged in math or language drills. General instruction about computers, programming, problem solving, and writing altogether come to only about 20 percent of the time spent. In contrast, in grades 9 through 12, 50 percent of all computer activity is concentrated in computer programming and computer-literacy courses and topics, while only 13 percent is divided between math and language arts.

More time (18 percent) is spent in business typing and word processing courses at the high school level. Counting only regular computer use in a subject, computers appear to play an even greater role in industrial arts and business education courses than they do in any of the traditional high school academic areas, with the possible exception of science.

Perhaps the most diverse use of computers appears in the late elementary and middle grades. There is substantial use in math and language arts (48 percent), as well as significant use where the computer is the *object* of instruction (41 percent). Middle school once again proves its name as a transition between elementary and high school.

Differences by Sex

Boys use school computers more than girls do, although not everywhere and not in all respects. The survey assessed the proportion of student computer users who are girls for the following kinds of use: before or after school, word processing, elective computer programming classes, computer-game playing, and overall use. Girls constitute roughly half of students using computers for word processing and roughly half of students using computers overall. This parity stretched across all three school levels. In addition, playing computer games involved as many girls as boys in elementary school, but not in middle or high school.

Enrollments in elective programming classes in the middle and high schools were also roughly evenly split between male and female students, with the typical school reporting that programming classes are about 45 percent female. An even higher percentage of girls were in those programming classes that require algebra or higher math as a prerequisite.

Where computers are used either before or after school, boys outnumber girls 3 to 1. At the typical middle school, only 15 percent of the before- or after-school users are girls. Boys also dominate elective programming activities in elementary school and game playing in middle and high school. Girls dominate in high school word processing, most of which occurs in business education courses where girls

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Table 1: *Distribution of computer use by subject and grade level. (Sum of individual entries may not equal subtotal entry because of rounding. Similarly, subtotals may not sum to grand total.) All numbers are percentages.*

Subject (from course title, activity, and software in use)	Grade Levels of Students in Class K–3	4–8	9–12
Mathematics*			
Topics below algebra or unspecified math	42	27	5
Algebra, geometry	0	1	1
Trigonometry, advanced math	0	0	1
Subtotal: traditional math subjects	42	28	7
English			
Language arts and spelling	18	12	4
Reading	17	8	2
Subtotal: language arts	35	20	6
Writing	2	2	3
Word processing in English class	3	3	2
Subtotal: writing	5	5	5
Computers and problem solving			
Math topics: problem solving, Logo, programming activities	3	6	2
Programming** as specific topic or course	2	13	42
Logo as specific topic***	4	5	1
Computer literacy as specific topic or course	6	10	5
Subtotal: computers and problem solving	14	34	50
Business and word processing			
Business, accounting, secretarial, other than word processing	0	0	6
Word processing, not in English class	1	2	12
Subtotal: business	1	2	18
Other subjects			
Science and nutrition	1	3	7
Social studies	1	4	1
Industrial arts and agriculture	0	1	5
Others	2	2	2
Subtotal: other subjects	4	11	15
Total for all subjects	100	100	100

* See also first entry under Computers and problem solving.
** Excluding specific mentions of Logo.
*** Including some general problem solving not classified elsewhere.

make up most of the enrollment.

Individual computer-using teachers were asked to indicate the sex of the three students most affected by their experience with computers in school. About 62 percent of the students identified by elementary school teachers were boys; at the secondary school level, about 67 percent of those mentioned were boys. Moreover, the first person named by each teacher was overwhelmingly likely to be a boy—74 percent of the first mentioned at the elementary level and 78 percent at the secondary level.

However, when asked how computers have affected these students, elementary and middle grade teachers who had named a girl were more likely to say that computers have helped her academically. Male elementary and middle grade nominees were more likely to be affected in terms of behavior and attitudes—such as improvements in self-confidence, self-discipline, or motivation.

Differences by Ability

Higher-ability students are much more apt to use computers. At all school levels, students from the top third of their class are disproportionately included among the most active computer users. Students from the bottom third of their class are well

continued

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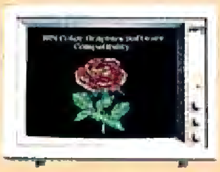

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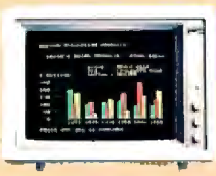

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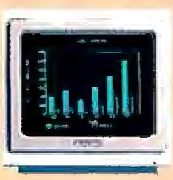

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The effect of computers on lower-ability students is improved behavior and attitude.

represented in elementary school, but not in high school.

Compared to those in the middle third of their class, top-third students use computers more overall, before and after school, and in word processing, and much more in elective programming. Only in playing computer games are the high achievers not dominant.

School computers affect higher- and lower-ability students differently. By far the most frequently reported effect on lower-ability students is improved motivation, self-confidence, and self-discipline. These behavioral and attitudinal consequences are mentioned much less often for higher-ability students, particularly at the high school level. Lower-ability students also receive academic help primarily in developing basic skills in mathematics, reading, and language. In contrast, teachers reported that computers help higher-ability students primarily with higher-order thinking skills, programming skills, writing, science projects, out-of-school activities, career preparation, real-world experience, and other activities—in other words, "high-ability academic direction" (see figure 3).

Computers may affect students of different academic abilities differently in part because such students use computers in different ways and for different school subjects. The pattern of computer use in low-ability classes in grades 4–8 strongly resembles the overall pattern shown in table 1 for all classes in K–3 (see table 2). Three-quarters of computer activity in these classes emphasizes basic math and language arts skills. These classes do not share the emphasis on computer-specific and higher-order skills found at the same school level in mixed-ability classes and even more so in high-ability classes.

Computer programming stands out as the most substantial aspect of computer use by high-ability classes in the middle grades. Programming, computer literacy, and problem-solving activities account for 60 percent of the computer time in these classes. Altogether, two-thirds of the class computer time is devoted to higher-order thinking, writing, and programming activities for high-ability groups. In contrast, these uses take up only about 40 percent of the computer time for mixed-ability classes and less than 20 percent for low-ability classes.

Mixed-ability computer-using classes in the middle grades suffer from a poorer ratio of students to computers than do

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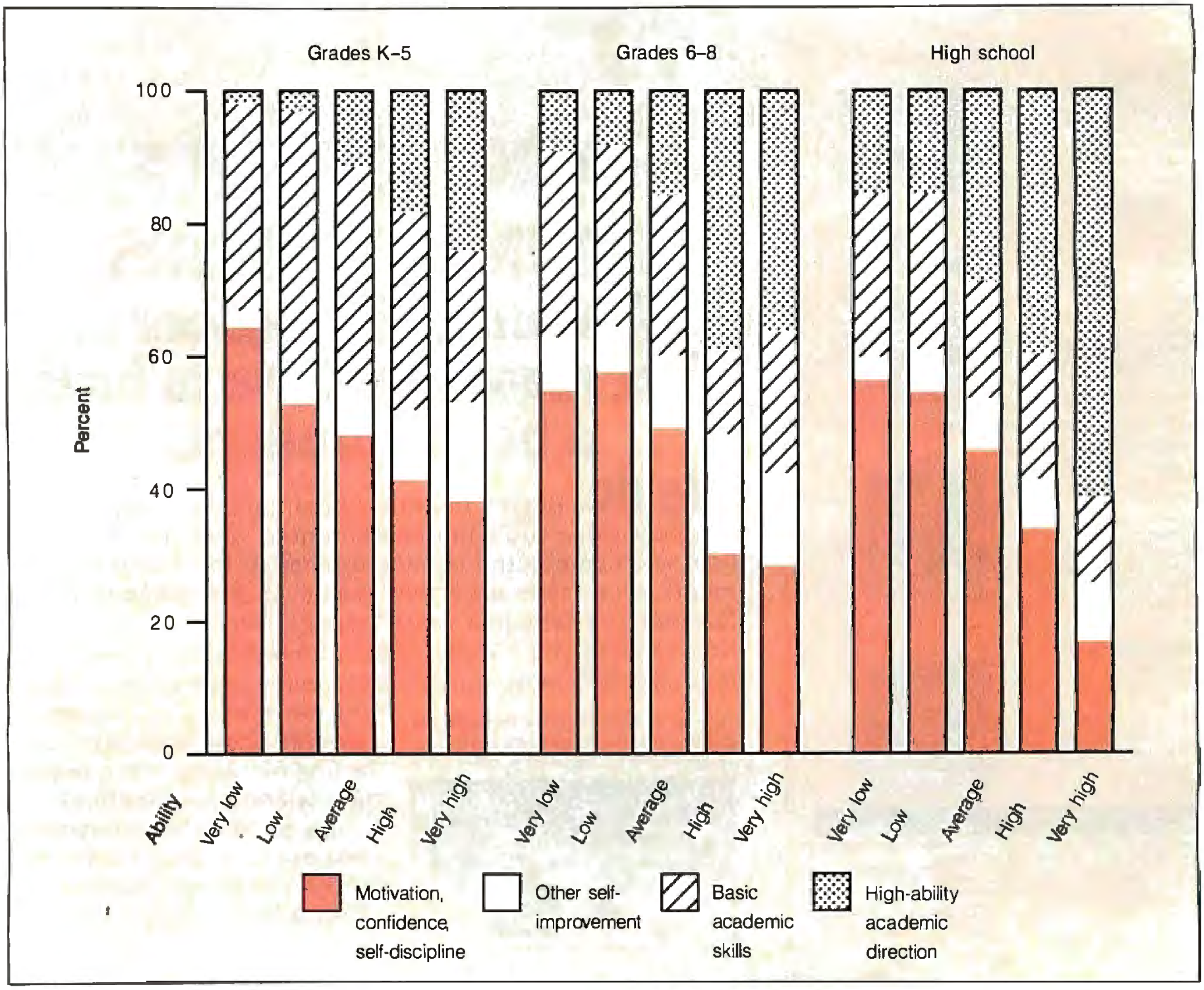

Figure 3: *How the most affected students were helped, by grade level and ability.*

Table 2: *Distribution of computer use by subject and ability level. (Sum of individual entries may not equal subtotal entry because of rounding. Similarly, subtotals may not sum to grand total.) All numbers are percentages.*

Subject (from course title, activity, and software in use)	Grade and Ability Levels of Students in Class: Grades 4–8 Low (29%)	Grades 4–8 Mixed (59%)	Grades 4–8 High (12%)	Grades 9–12 Low (13%)	Grades 9–12 Mixed (78%)	Grades 9–12 High (9%)
Mathematics*						
Topics below algebra or unspecified math	36	27	9	32	1	0
Algebra, geometry	2	1	3	1	1	2
Trigonometry, advanced math	0	0	0	0	1	3
Subtotal: traditional math subjects	38	28	12	32	3	5
English						
Language arts and spelling	20	10	4	16	2	1
Reading	19	5	2	13	0	2
Subtotal: language arts	39	15	6	29	2	3
Writing	5	1	6	4	2	9
Word processing in English class	1	3	4	5	1	5
Subtotal: writing	6	4	10	9	3	14
Computers and problem solving						
Math topics: problem solving, Logo, programming activities	4	6	10	3	1	2
Programming** as specific topic or course	2	14	25	4	50	32
Logo as specific topic***	3	6	8	2	1	1
Computer literacy as specific topic or course	4	12	18	6	5	4
Subtotal: computers and problem solving	13	38	61	15	57	40
Business and word processing						
Business, accounting, secretarial, other than word processing	0	1	0	0	7	2
Word processing, not in English class	2	1	2	6	13	11
Subtotal: business	2	2	2	6	20	13
Other subjects						
Science and nutrition	1	5	2	2	6	18
Social studies	0	6	6	3	1	3
Industrial arts and agriculture	0	1	0	2	7	0
Others	2	3	3	3	2	3
Subtotal: other subjects	3	14	10	9	15	24
Total for all subjects	100	100	100	100	100	100

* See also first entry under Computers and problem solving.
** Excluding specific mentions of Logo.
*** Including some general problem solving not classified elsewhere.

either low- or high-ability classes. The mixed-ability classes tend to be somewhat larger than the gifted classes and much larger than the special-education classes. And they are allotted fewer computers. About 60 percent of the classes in the middle grades use computers in the classroom rather than in a computer lab, and there they have a 20-to-1 ratio of students per computer. So they typically have only one or two computers in their classroom. High-ability classes using computers in the classroom have a median 10-to-1 ratio, and low-ability classes typically have an even better 5-to-1 ratio. In addition, high-ability classes are more likely than either of the other types to use computers outside of the classroom, in a laboratory or library, where the student-to-computer ratio is typically 1 to 1.

Students in high-ability classes, along with their teachers, are more likely to have a computer at their own home than are other middle grade computer-using students and their teachers. Among teachers of the high-ability classes, 47 percent have a home computer compared to 28 percent of the other computer-using teachers. In more than 90 percent of the high-ability classes, at least three students have a home computer. This compares to about 60 percent for the mixed-ability classes and only 20 percent for the low-ability classes (which, however, have fewer students). On the other hand,

continued

substantial experience in formal teacher training does not markedly distinguish computer-using teachers of the high-ability classes from those of mixed- or low-ability classes. They are only modestly more likely to have had 50 hours or more of training in using computers for instruction (32 percent vs. 25 percent).

In high school, low-ability classes continue to use computers primarily for pre-algebra mathematics and language arts skills. The average or mixed-ability classes are heavily concentrated in computer programming, business, and word processing. A much higher proportion of the computer work of the average classes is in programming activities than in high-ability high school classes (50 percent vs. 32 percent). Most of the programming classes in high school are composed of students typically above average in ability, but only a very small minority are composed primarily of very-high-ability students.

Science and writing are two areas where high-ability high school classes use computers more than do average or low-ability classes. Together, science and writing constitute 32 percent of the computer work of high-ability high school classes. Relatively little computer work (5 percent) goes on in advanced mathematics courses outside of programming.

That students in different academic ability groups use computers so differently is not surprising. It reflects the great variety of instructional applications and the different educational needs of students. But certain uses of computers require students to solve operational problems and make decisions without close adult supervision. The less sophisticated the instructional software, the more necessary independent student activity is. To extend computer opportunities that emphasize higher-order thinking and problem solving to less able students requires software that is comprehensive, easy to use, and that fits into what students can do away from the computer while waiting their turn.

However, there are some surprises. The survey found very little use of computers in mathematics classes beginning with algebra and even less in the highest-level mathematics courses. There is neither substantial use of prepackaged or teacher-written software, nor is there much evidence of student programming projects aimed at understanding traditional topics in these mathematics courses. The use of computers in secondary science and social studies courses is mainly limited to advanced high school science courses and middle school social studies courses.

Extension of computer use to greater numbers of higher mathematics, science

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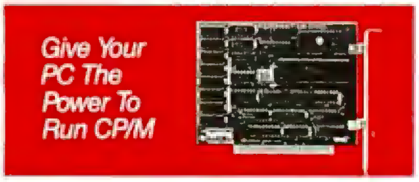

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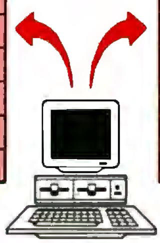

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So far, computers have had a limited impact on learning.

and social studies classes awaits the creation of a greater variety of instructional software for these subjects, materials to integrate software with existing curricular goals, clear demonstration to teachers of the advantages of using computers for these applications, and a larger supply of computers accessible to classes in these subjects.

The Impact of Computers

This study systematically surveyed the entire range of schools and classrooms across the country, looking at major patterns. In terms of statistical patterns, computers so far have had only a limited impact on children's learning in school. Without a doubt, school instruction about computers has substantially increased the number of high-ability high school students who reach an introductory level of computer programming competence before entering college. But whether those programming skills provide college-bound students with opportunities that they would otherwise not obtain is a question that this survey does not explore.

Other major academic consequences at the high school level are harder to identify. Certainly, word processing has become a larger component of the high school business education program. But word processing has not yet become the routine means by which students write English compositions. In high school, computers are not yet major tools in mathematics, science, or social studies classes, although their use in science classes is not unusual.

Despite the dominance of drill and practice in the lower grades, computers have not markedly affected most student learning and practice in language arts and arithmetic. This is due to the limited amount of computer equipment in the schools, the relatively brief experience provided to individual students, and the generally unsystematic use of software at the lower grades. For elementary schools, the actual function of computers is primarily to acquaint students and teachers with a new cultural object. No evidence was found to indicate that school-wide student test scores have been affected by the kind and intensity of CAI that occurs in most elementary school settings.

The ways that students in the middle grades use computers depends a lot on their level of academic performance. Better students in the middle school have opportunities for independent exploration that include programming, problem solving, and some word processing, in addition to the more traditional CAI. The eventual impact of computer-based creative exploration and problem solving among high-ability and average middle grade students is unclear but promising.

From Hacker to Classroom

The modern world has dozens of subcultures, each with enthusiastic devotees to a particular viewpoint. Among computerists, it seems natural to use computers to assist in educating our youth. But social institutions like mass education have their own peculiar "laws" or driving forces. To have a major impact on education, computerists must understand the conditions for successfully intervening into the schooling order. Dealing with schools as they are and not as we might wish them to be is a necessary first step to changing them.

For schools to use the power of electronic information and communication to substantially alter how students learn will require hurdling important political, economic, and social barriers. Reform must overcome the ways that schools provide instruction, the economic realities of school budgets, the magnitude of the effort required, and the need for private-sector suppliers to make a profit.

Funding for school computers and related materials will continue to come from the small proportion of school budgets that is independent of personnel costs and other necessities. Computer-related expenditures already constitute a major portion of the discretionary spending by school systems. Increases in investment in educational technology by schools can occur only if our society is willing to allocate a larger portion of national income to education.

If computer-based activities—whether word processing, spelling drills, algebra tutorials, social studies simulations, or industrial arts applications—are to improve the academic productivity of most young people, these activities will have to take into account the complexities of instructing a heterogeneous mixture of young people in large group settings.

The belief that computers *can* provide benefits and the optimistic expectation that they *are* supplying these benefits have fueled a tremendous growth in the use of computers in schools over the past several years. But in the long run, educators will lose faith in the value of computer-based instruction if objective evaluations begin to accumulate evidence that computers have made little difference in the education of most children and adolescents. ■

REFERENCE

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The Difference in Higher Education

Five colleges meeting the challenge

Donna Osgood

EARLY IN 1984, I wrote an article surveying the status of the microcomputer in colleges around the country (see "A Computer on Every Desk," June 1984 BYTE). I was looking for schools that were getting computers into students' hands in large numbers, outside of computer science and engineering departments. A few pages on each of 15 schools covered the subject thoroughly.

In the past few years, the situation has changed dramatically. To survey all the schools that have put micros on students' desks, and to cover the software developed at those schools, I would have had to preempt this entire issue of BYTE. The pioneering schools I wrote about before have expanded their own involvement with microcomputers and have paved the way for other institutions. Software development has burgeoned. This is not surprising when you consider that some of our best thinkers have gotten their hands on some of our best thinking tools. Here is only a brief sample of what is going on in colleges today.

Each of the five schools profiled here differs markedly from the others in size and academic focus, as well as in approach to computing. They all share a commitment, however, to the idea that putting powerful tools in the hands of students and faculty can make a difference in higher education.

The color version of a program called MirrorBalls designed by Reed student Peter Shirley is a Rascal program that calculates and colors the reflection of the grid on the polished balls.

REED COLLEGE

Portland, Oregon

Watchwords for Reed College's Master Plan for Computing Resources are open access, enhancement of curriculum, and unification of resources. Though Macintoshes are scattered across the campus,

continued

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on faculty desks, in departmental offices, and in public clusters, no one has to buy a computer. No one is required to take a computer course or demonstrate technological literacy, either. Reed administrators believe that open access, making the resources readily available and obviously useful, is the best approach to integrating the computer into the curriculum.

Open access means "virtually unrestricted and uncharged resource use," according to Richard Crandall, Reed's technology plan director. Macintoshes are available without cost to any faculty member. Students can use computers in the seven Information Resource Centers, open 24 hours a day, or they can apply for one of the college's machines, loaned at no cost for a semester to small groups of students chosen by a lottery. Every academic office is also equipped, many with LaserWriters and AppleTalk networks. Typewriters at Reed are an endangered species.

How can a small liberal arts college afford to supply their entire academic population with free access to computer resources? With a lot of help from their friends. Corporations and charitable trusts have contributed money, equipment, and time. These contributions are supplemented and stimulated by software and hardware development at Reed, which provide both income and visibility.

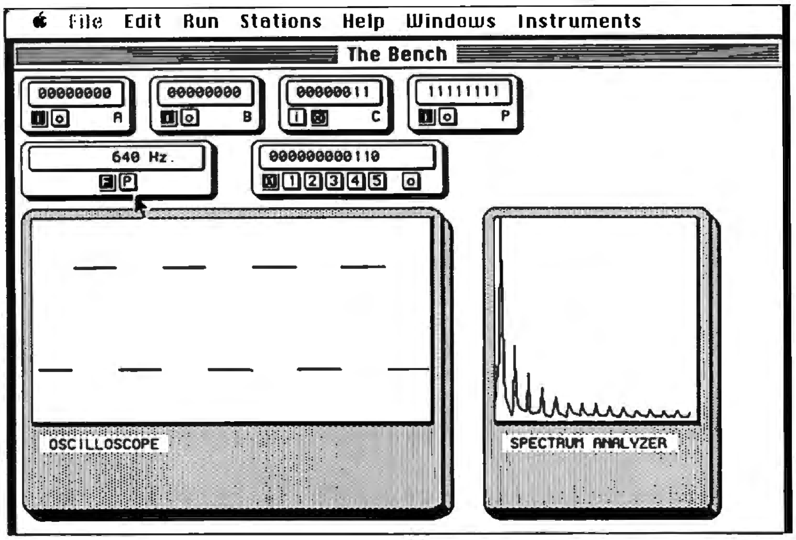

Figure 1: *BenchLab—iconic instrumentation has replaced some physical instrumentation in labs at Reed College in Portland, Oregon.*

Software Development

Reed's Development Laboratory has produced Macintosh software for laboratory interfacing, graphics, and terminal emulation, as well as games that serve both educational and recreational functions. Central to Reed's development effort, however, is Rascal (for real-time Pascal), a hybrid of Pascal and C optimized for the Macintosh. The Rascal Compiler/Development System project has spawned other

Kinko's Academic Courseware Exchange

With the great influx of Apple Macintoshes on college campuses in the past few years has come an outpouring of creative software development. The Mac's graphics and user interface offer a simple and effective way to deliver information. Consequently, faculty in many fields have sought ways to use it to best advantage in their classes.

Software development is expensive, however, and some schools invest a great deal of money, faculty time, and programmer time in producing programs for specific courses. A program developed for Organic Chemistry 101 at one college is likely to be useful in many schools, and the professor who authored the program will be eager to share it with colleagues. If you've found a better way to teach a subject, why not spread it around?

The Apple University Consortium and Kinko's, a national chain of photocopy centers, have established the Academic Courseware Exchange (ACE) to promote this kind of sharing. Courseware developed at colleges and universities across the country is described in the ACE catalog. Programs in biology, chemistry, computer science, engineering, general science, geography, history and politics, humanities, math and statistics, music, philosophy, physics, and sociology are available, along with authoring tools in several subjects. Prices are comparable to textbook costs—between $7 and $13 per disk.

The software distributed by ACE is not a drab collection of drill-and-practice exercises. Each school has contributed its best, and many of the programs are a tribute to academic ingenuity. Most make good use of the Mac's graphics capabilities, and many use sound as well. They have been developed by educators for academic use, and most have been tested and refined in the classroom.

Kinko's handles production, distribution, and marketing of the courseware and pays the author a royalty to help subsidize development costs. Disks can be distributed through any of Kinko's 310 stores, mailed directly, or delivered through a campus bookstore or computing center. Kinko's employs campus representatives to demonstrate software and to let professors know what programs are available that may meet their needs.

The ACE catalog, published in the fall of 1986, lists 56 programs for the Macintosh and 9 for the Apple II. Many were developed at Dartmouth, Drexel, or Stanford, but schools like Franklin and Marshal College in Lancaster, Pennsylvania, and University of the Pacific in San Francisco have also contributed. ACE provides a national forum for these smaller schools that would otherwise not have been able to distribute their software so extensively. It also provides courseware for schools that can't afford software development of their own.

"A computer on every desk" is a reality at a growing number of schools, and many others see microcomputer use mushrooming. Programs like the Academic Courseware Exchange will fuel that growth, providing essential academic software at a reasonable cost.

For a catalog or information, contact Kinko's Academic Courseware Exchange, 4141 State St., Santa Barbara, CA 93110, (800) 235-6919; in California, (800) 292-6640. From outside the U.S., call (805) 967-0192.

languages, like the Problem Solving Interpreter (PSI) and Solver for Implicit Equations (SIMPLE).

Rascal was developed because scientists at Reed needed a real-time language to communicate with laboratory devices. Thus it lends itself to scientific calculations, statistics, and data analysis software as well as data acquisition, display, and laboratory-interfacing real-time applications. Three-dimensional graphics applications and animation models can also be developed using Rascal.

PSI is "a structured syntax, declarationless language, suitable for isolated calculation." It was designed for people who need to solve computation problems common in research and academic work, without spending a lot of time learning to program a computer. It is, according to its documentation, "a good language for the academic worker who must, from time to time, solve isolated problems or verify numerically new conjectures." It is optimized from the user's point of view, not the machine's, trading off machine speed and code efficiency for ease in setting up a problem.

The Computerized Laboratory

Both hardware and software development at Reed have gone into iconic instrumentation, which Crandall refers to as "a new concept in laboratory computing." Data is acquired via The BenchTop Instrument, a laboratory interface device for data acquisition and apparatus control that runs off the Macintosh serial port or any RS-232C port. Results are displayed on the Macintosh, using iconic instruments.

A Rascal application, BenchLab, creates laboratory instruments on the screen, including an oscilloscope, spectrum analyzer, frequency counter, A/D converter, D/A converter, and four I/O ports (see figure 1). The student or scientist can select an instrument from a menu or run all of them at once.

Researchers at Reed have used the BenchTop system in a variety of projects. A chemistry student developed a system to run, display, and store NMR (nuclear magnetic resonance) spectra from a spectrometer. It will print spectra or store them as MacPaint documents. Reed's psychology department uses BenchTop applications for a variety of tests, including reaction-time studies, personality and mood tests, and a Skinner box for experiments in operant psychology. One psychology student has created a psychophysiology laboratory system that records electroencephalogram and heart-rate data.

The college itself uses BenchTop to monitor and analyze energy use in the 24 buildings on campus. An "energy map" displays heat and electric parameters for physical plant personnel.

Picturesque Applications

Rascal's graphics capabilities have been put to good use in a number of applications. MirrorBalls, for example, was originally written in Macintosh Pascal by Reed student Peter Shirley, as part of a thesis on optical ray tracing and the optical nature of surfaces.

In its original form, the program, which calculates the status of every pixel, took 24 hours to run. The Rascal version of the same program takes about 5 minutes. The difference, Crandall says, lies in the fact that "Rascal is a true compiler which generates machine code. So now we have many students doing spectacular programs with Rascal, for tasks that were heretofore impossible or at best time-consuming."

Billiard Parlor, a pool-table simulation, is a popular public domain program that was developed at Reed. Billiard Parlor simulates everything but the smoke in the room and the chalk on your fingers. You can choose your game (pool, billiards, eight ball, snooker, etc.), place balls on the table by hand, choose the direction and force of your shot, and hear the balls click as they strike each other. But don't hit the cue ball too hard or it will hop.

Billiard Parlor is distributed on a disk with a number of other useful and interesting applications, like a MacWrite rescue utility, the Sieve of Eratosthenes, and a speech synthesizer. The disk is available through the Academic Courseware Exchange (see the text box "Kinko's Academic Courseware Exchange" at left).

Not content with the graphics capabilities of an unaided Macintosh, Reed developers have added a color system: SuperChroma. This is a color image processor (Vectrix VX384), a high-resolution RGB monitor connected through the modem port, and software called ColorPaint and OmniPaint. You draw on the color monitor with the mouse as if you were using a MacPaint with 16 million colors.

Beyond the Ivy-covered Walls

The Macintosh has meant more to Reed College than convenient computing power. It has opened the gates of the ivory tower as well. Students and faculty have been involved in the efforts to raise funding for the computing project.

Reed's software and hardware products are distributed commercially and in academic circles. The college is also involved in community computing; for example, every high school in Portland, Oregon, now has a Macintosh, through a joint project in which Apple provided the equipment and Reed provided the staff and the software.

STANFORD UNIVERSITY

Palo Alto, California

As microcomputers began to proliferate on the Stanford campus a few years ago, it was clear that no single standard could be imposed on the diverse population of a major university. Rather than trying to force faculty, students, and staff to adopt a particular computer, Stanford has relied on a sort of guided evolution—encouraging flexible but focused growth. As Michael Carter, director of Instruction and Research Information Systems (IRIS) put it, "What we're trying to do is enhance academic achievement by applying computer technology. Our best bet is to try to focus it a little here, nudge it a little there, lead a little bit over here. With so many really smart faculty members out there, I want to give them enough devices so that they know exactly what they want to do, and then follow them, rather than to control the way they use computers. The trick really is to remove the obstacles so that those people can lead the way."

This strategy has been successful, producing an impressive body of faculty-developed software, stimulating rather than repressing creativity. Microcomputers are available to the Stanford community in large numbers, and an ever-increasing number of faculty are taking advantage of them in presenting information to their students.

Students who need to use a microcomputer in their course work can use any of several public facilities. One cluster of Macintoshes in a library, for example, is available for walk-in users, though students in selected courses get priority. Another cluster, in the student union building, offers terminals connected to the timesharing system, through the university's Ethernet network, SUNet. This cluster also provides DEC Rainbow 100s for word processing, spreadsheets, and programming and IBM PC ATs for graduate student thesis preparation. The Engineering Microcomputer Cluster (called $E=MC^2$) contains Macintoshes and IBM microcomputers.

Stanford also has "interactive classrooms." One has a network of Macintosh Plus computers, with an image-switching system to allow instructor previewing and

continued

common viewing of Macintosh display screens. Another classroom provides IBM PCs with videodisk capabilities, access to SUNet, and local area file service.

Anyone who wants his or her own microcomputer at Stanford can rent one from the Workstation Support Center or buy one at a considerable discount through Microdisc (microcomputer discount), part of the Stanford Bookstore. Microdisc offers hardware and software from Apple, Hewlett-Packard, and IBM, as well as a demonstration area, consulting staff, and a service and repair center. They have sold several thousand computers in the past few years.

The Faculty Author Development Program

Faculty software development for microcomputers has been supported since the fall of 1984 through the Faculty Author Development (FAD) program. IRIS provided equipment, design, and programming help to faculty members, who have completed 36 software projects in a broad range of fields. FAD projects include work in economics, engineering, humanities, library science, mathematics and computer science, medicine, life science, and physical science.

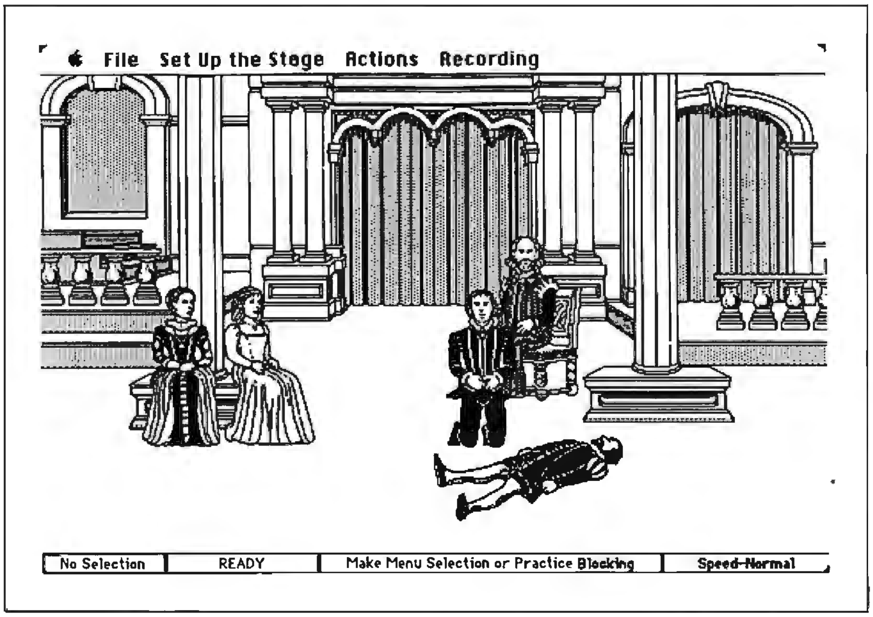

Figure 2: *The TheaterGame by Stanford's Larry Friedlander is a "play processor." By pointing and dragging the mouse you move the characters around on the stage. Their movements can be recorded and played back, synchronized with a voice recording.*

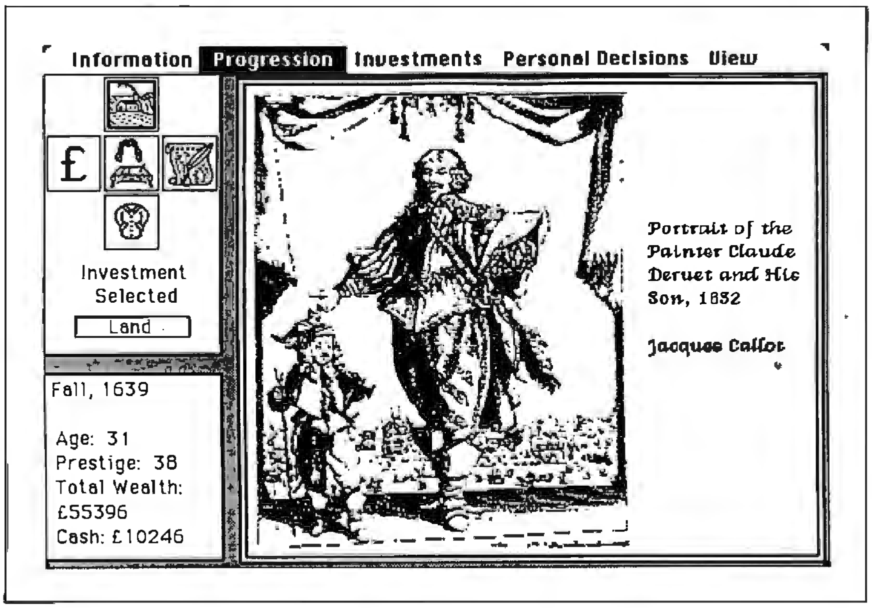

Figure 3: *The Would-Be Gentleman by Carolyn Lougee of Stanford simulates the economic and social life of a Frenchman during the reign of Louis XIV.*

An example of FAD software is The TheaterGame, designed by Professor Larry Friedlander of Stanford's English department. Theater students use it as a sort of "sketch pad," placing and moving characters on the screen to simulate stage blocking, using an interactive animation editor (see figure 2). The animated scene can be recorded and synchronized with a tape recording of the spoken text. The TheaterGame is available through the Academic Course Exchange at Kinko's copy centers nationwide.

The TheaterGame accompanies a videodisk-based interactive instructional system that delivers an archive of theater-history slides, film clips, and tutorials. The videodisk instruction is designed to let the student think like an actor, director, and producer, comparing and analyzing different versions of the same scene, and eventually designing his or her own.

Another program designed through FAD has been popular in the Apple/Kinko's Academic Courseware Exchange. The program, called The Would-Be Gentleman and written by Carolyn Lougee, models the economic and social life of a French bourgeois during the reign of Louis XIV (see figure 3). The player absorbs a history lesson while making economic and social decisions, forging alliances, and managing property, attempting to maximize wealth and prestige over two generations.

A program of interest to mathematics and computer science students, called Turing's World (see figure 4), was designed by two logicians, Professors Jon Barwise and John Etchemendy, in Stanford's department of philosophy.

"Imagine trying to teach Pascal without a computer," says Etchemendy. "Students would write programs, and have to think them through to see whether they would work. Impossible, of course, since many bugs show up only when the program runs. Logicians in computability theory have been in the same situation, trying to teach about Turing machines."

Turing's World (also available through the Academic Courseware Exchange) is used in a second-quarter logic course for students in computer science, math, philosophy, and linguistics. Students are asked to build a Turing machine to compute a certain function or solve a particular problem. Using the mouse and a menu of options presented by the pro-

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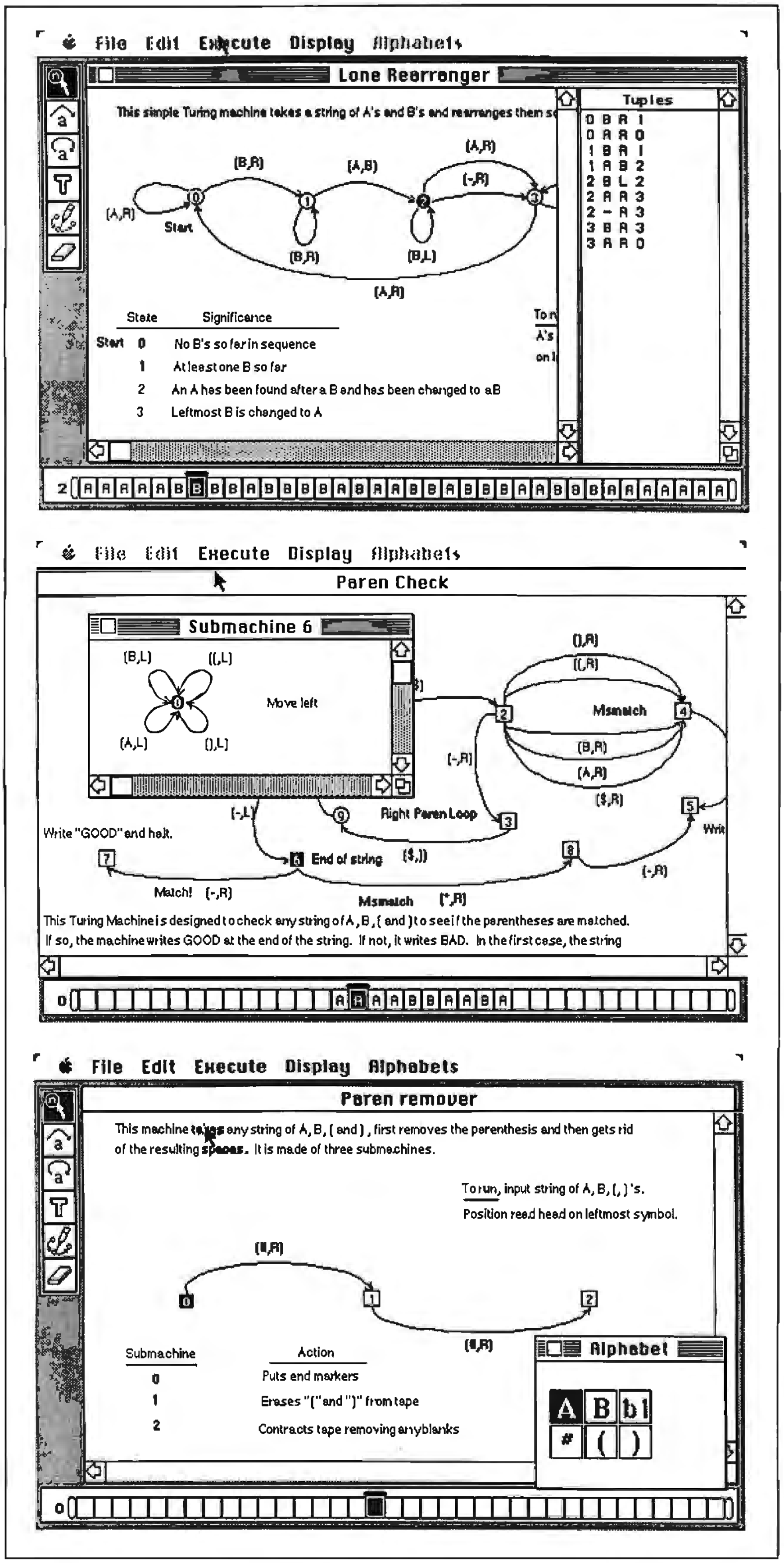

Figure 4: *Turing's World by Jon Barwise and John Etchemendy of Stanford gives users a graphical environment in which to build, debug, and run Turing machines.*

gram, the student draws a flowchart of a machine that will solve the problem. Once it is turned on, the program converts the flowchart into a Turing machine that carries out the appropriate actions, so that the student can see whether it works as intended. If the problem is complex, the student can construct a Turing machine, shrink it, and make it a node in a larger Turing machine. The nesting can go on as long as the Macintosh has memory to support it.

This process of moving from the abstraction to a physical device that embodies the abstract machine makes life much easier for both the student and the instructor. Using Stanford's interactive classrooms, the instructor can display students' work on a screen and then compare different approaches to the same problem.

The Courseware Authoring Tools Project

An approach described by Michael Carter, to remove obstacles so that faculty members can control their use of computers, is being carried a step further with the Courseware Authoring Tools (CAT) project. "Our goal," says Carter, "is a set of tools as easy to use as MacWrite and as immediate as Pinball Construction Set." Rather than working with faculty to develop specific applications for particular courses, they are working to develop tools that are broadly applicable.

Carter believes that "authoring systems in general tend to have a great number of the pedagogic decisions already made." The environment designed through the CAT project should be flexible enough to allow real freedom in courseware design, with 90 percent of the work done by the professor and only 10 percent by a programmer. It will be implemented on machines on the order of Sun workstations or the IBM RT PC.

Stanford's population is so diverse and the needs of faculty members so broad-ranging that no single system will satisfy everyone. According to Barbara Jasinski, manager of the CAT project, "Given our time and resources, we can't develop all the courseware to be used on the Stanford campus. We are trying to pull together a set of hardware and software tools that will help our faculty implement courseware."

The CAT environment may be gathered from several sources—other universities (e.g., Carnegie Mellon's Andrew, MIT's Athena, or Brown's Intermedia), from vendors, and software written at Stanford. "We aren't limiting ourselves to what we could develop here, since our faculty's needs are so varied," says Stanford's Jasinski.

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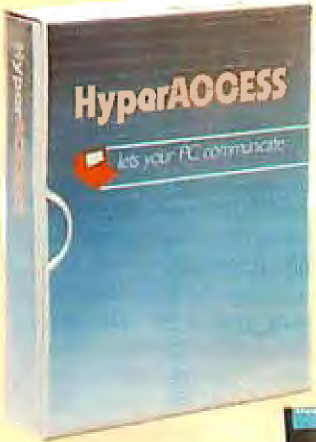

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CARNEGIE MELLON

Pittsburgh, Pennsylvania

The Andrew Project (named for Andrew Carnegie and Andrew Mellon) has been the nexus of a great deal of cooperative effort at Carnegie Mellon University (CMU). The Information Technology Center is charged with designing and developing the workstation environment and the communication system. It is a joint effort of CMU and IBM, with IBM providing staff members as well as money and equipment.

CMU's Computation Center has been responsible for deploying and maintaining the communication system, and the Center for Development of Educational Computing has developed course-related software. In addition, the initial networking effort was an ingenious patching together of several existing technologies, and involved the voluntary cooperation of many departments and university centers, to link 2000 machines in a short time.

According to Andrew's designers, James H. Morris et al., in a March 1986 *Communications of the ACM* article, "The computing paradigm envisioned in Andrew is a marriage between personal computing and timesharing. It incorporates the flexibility and visually rich user-machine interface made possible by the former, with the ease of communication and information-sharing characteristics of the latter." This is accomplished with a Vast Integrated Communications Environment (VICE) campuswide file system that is designed to expand gracefully to network several thousand workstations called VIRTUEs (Virtue Is Reached Through UNIX and EMACS).

However strained the acronym, a VIRTUE workstation is a powerful tool—an IBM RT PC, Sun, or MicroVAX with a couple megabytes of memory, a 1000- by 800-pixel screen, and processing power of 2 to 4 million instructions per second. VIRTUE software includes a window manager with subroutine libraries for text, graphics, and data manipulation; a database subroutine manager; and applications for electronic mail and bulletin boards. (For a technical discussion on Andrew, see "Data Structures in a Bit-Mapped Text Editor" by Wilfred J. Hansen, January.)

In selecting an operating system, Andrew's developers chose Berkeley UNIX for its portability, advanced features, and well-defined standard. Any workstation that supports UNIX will run VIRTUE. UNIX machines are still costly, however; the powerful workstation that a student can afford to buy is yet to come.

The Network

Carnegie Mellon is completing the installation of an 11,000-plug IBM cabling system on which most of the IBM equipment communicates using Token-Ring adapters. The older Ethernet-based network is joined with the Token-Ring Network by routing computers.

File sharing is set up to look to the user like a timesharing system, so that each workstation appears to be sharing a large central file system. Each workstation has a small amount of local file space, but most files are shared. When called for by

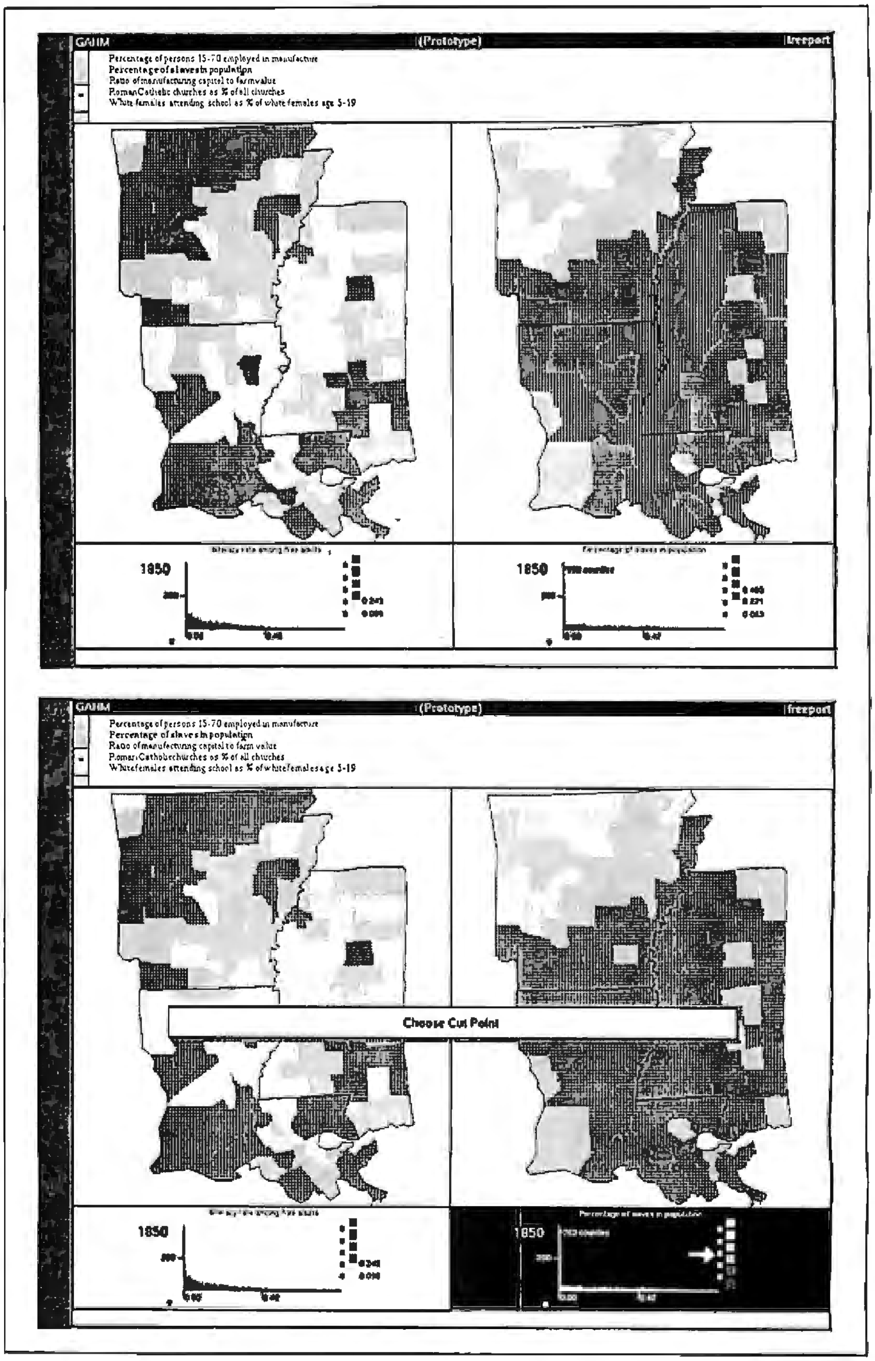

Figure 5: *The Great American History Machine by David Miller of Carnegie Mellon displays census and election data graphically in detailed maps, which can then be manipulated to reveal demographic trends. Shown here are Arkansas, Louisiana, and Mississippi.*

an application program, a file is cached at the workstation. Changes are made to the cached copy locally, and an updated copy transmitted to the appropriate file server only when the file is closed. Presently, 14 file servers, each with a gigabyte of storage, serve a registered user population of about 3100.

Electronic mail and bulletin boards are a natural outgrowth of a campuswide network. In fact, about 300 bulletin boards are available to the CMU population, including Arpanet, USEnet, and lots of local boards. That's a good bit more information than anyone can absorb. "Most of us have thrown up our hands and tried to limit the number of these bulletin boards we see," says James Morris, head of the Andrew project. "We have newspapers and magazines which deal every day with deciding what's worth reading and what's not. That kind of intelligence needs to be added here." Several researchers at CMU are investigating the problem of information overload.

CMU Tutor

To use Andrew's capabilities in their courses, instructors need to develop software in their fields of study. Some faculty members have designed courseware, had it implemented in C, and have used it in their courses. Not many, however, can program in C themselves. Many useful and interesting C programs are left as orphans when the student programmer who wrote the code graduates, and the professor finds that the program needs to be updated.

Building on their experience with Plato, Bruce and Judy Sherwood have developed CMU Tutor, an authoring environment for creating interactive courseware with sophisticated graphics. CMU Tutor makes it easy for an instructor with little prior programming experience to exploit the power of the workstations. CMU Tutor programs can also be compiled and run on IBM PCs and will eventually be available for Macintosh as well.

In a series of one-week workshops at Carnegie Mellon, educators from around the country got a chance to use CMU Tutor and assess its value for their own institutions. Participants were given an orientation on Monday morning and began learning to use CMU Tutor Monday afternoon. By Friday morning, in a show-and-tell session, many had developed significant, graphics-oriented courseware packages.

The Great American History Machine

One application now in use in the history department at Carnegie Mellon takes full advantage of the graphics and processing power that Andrew provides. As shown in figure 5, The Great American History Machine takes U.S. census and election data and displays it on maps that can be manipulated by the user. The program, according to its designer, history professor David Miller, allows historians and students "to take a body of data that has been sitting around in machine-readable form for years, and lets them find patterns in it and develop hypotheses."

For example, a historian working with the 1850 census might examine a variable like illiteracy—that is, the illiteracy rate in the nonslave population. A national map would show, predictably, high literacy rates in the Northeast and a great deal of illiteracy in more rural areas like Arkansas. The deep South, however, shows a very mixed pattern. A historian interested in this point might then compare this map with another that illustrates a different measure of affluence—slaveholding, for instance. The second map appears in a window next to the first.

The match is not too good in this case—the second map distinguishes between counties with slave populations of less than 6 percent, 6 percent to 28 percent, and over 28 percent.

At this point, the power of the program becomes apparent. With a few clicks of the mouse, the user can change the cut points, displaying counties with slave populations of over 50 percent. The maps of the two variables, literacy and slave ownership, now match much more closely. This ability to discern patterns in a body of data is vital to historians and sociologists.

Also crucial is the ability to give students a set of information and a way to look at it and let them construct their own hypotheses. A professor using The Great American History Machine can decide how much preprocessing to do on the data before the students see it. In some classes, it might be appropriate to offer data and analysis, with the conclusions already drawn. More advanced students might deal with the data in its raw form and make their own decisions. Says Miller, "This tool can really bring the computer into the historical profession."

On-Line Grant Proposals

The National Science Foundation has contracted with the Information Technology Center to build an electronic mail system through which researchers will be able to submit their grant proposals. This involves text editors that can handle mathematical formulas, graphics capabilities, and the ability to transfer files from one system to another. The system can extend far beyond grant proposal submissions—it may evolve into a medium in which scientists can exchange information easily, circumventing the slow, cumbersome publishing process.

Drexel University

DREXEL UNIVERSITY

Philadelphia, Pennsylvania

Early in 1984, Drexel University started a massive deployment of Macintoshes to its students. Freshmen that year were required to have access to one, and most of them bought Macintoshes from Drexel, at less than half the retail price. Student response was enthusiastic, and the program has continued with each incoming freshman class. There are about 10,000 Macintoshes on campus now, and by 1988 there will be nearly 12,000.

Students matriculating this year bought a Macintosh Plus and received essential software with it: MacWrite, MacPaint, Excel, MacPascal, MS BASIC, and FileMaker. A terminal emulation package is also available to all students. Anyone who needs help with the Macintosh can call a telephone hotline, use the walk-in consulting service, check with the student-run users group, or simply hang around the public computer cluster and ask.

The open-access public cluster has nearly 100 Macintoshes, supplemented by 15 departmental clusters. All major lecture halls on campus have built-in Macintosh projection units. Two classrooms are set up with 25 to 30 Macintoshes and wall-mounted 24-inch monitors. Professors who want to use the computers for class demonstrations are not limited to these two rooms, however—they can request a mobile Mac-monitor unit.

Distributing course-related software at the beginning of each semester was a problem until recently. Last fall, a file-server system was in place, consisting of a Macintosh Plus with 40 megabytes of disk storage, connected to four 512K-byte Macs with AppleTalk. Students simply find the folder for the appropriate course number and download the files.

Software Development

Drexel's Software Development Group employs a staff of about 40 programmers, both professionals and students, to help faculty members create courseware. So far, about 90 programs developed at

continued

Drexel are in use all across the curriculum. Some of these are also distributed nationally, through the Academic Courseware Exchange.

Allan Smith of Drexel's chemistry department, for example, developed the Molecular Editor with which you can build complex molecules on the screen using 100 or more atoms of any element in the periodic table (see figure 6). Beginning with a collection of basic structures and functional groups, the user can cut, copy, and paste in three dimensions to construct the molecule, and then can rescale it, rotate it on three axes, rotate part of a molecule with respect to another part, or rescale the atoms while leaving the bonds unchanged.

Students can also analyze the molecule, measuring the distance between atoms, the angle between bonds attached to the same atom, or the torsional angle about a bond. Twenty files can be open at once, and the display can flip from one to another. On a 512K Macintosh, this provides an animation feature, running quickly through a sequence of open files. The disk includes an animation of a chemical reaction in three dimensions, as well as sample files of organic molecules, functional groups, inorganic molecules, and crystals.

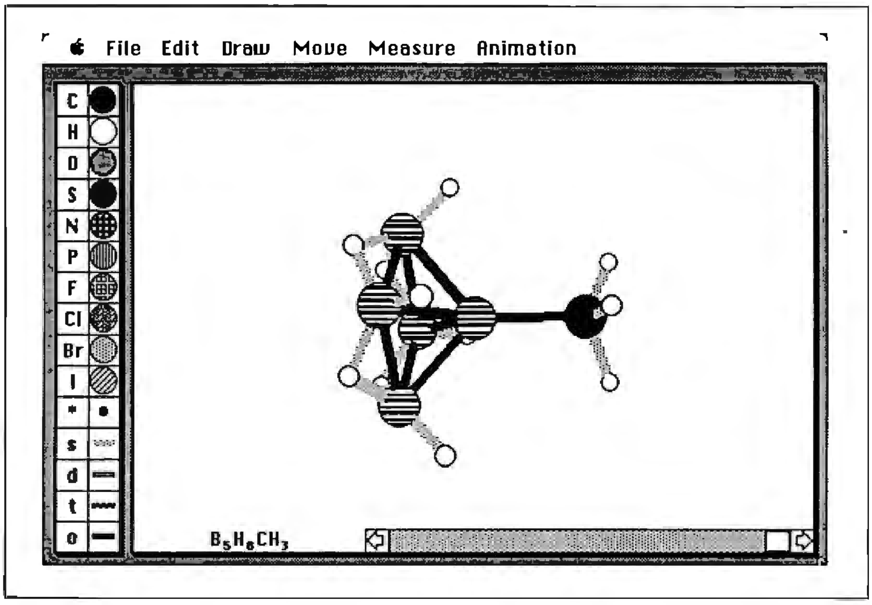

Figure 6: *Molecular Editor, by Allan Smith of Drexel University, allows the user to build and rotate three-dimensional molecules on-screen.*

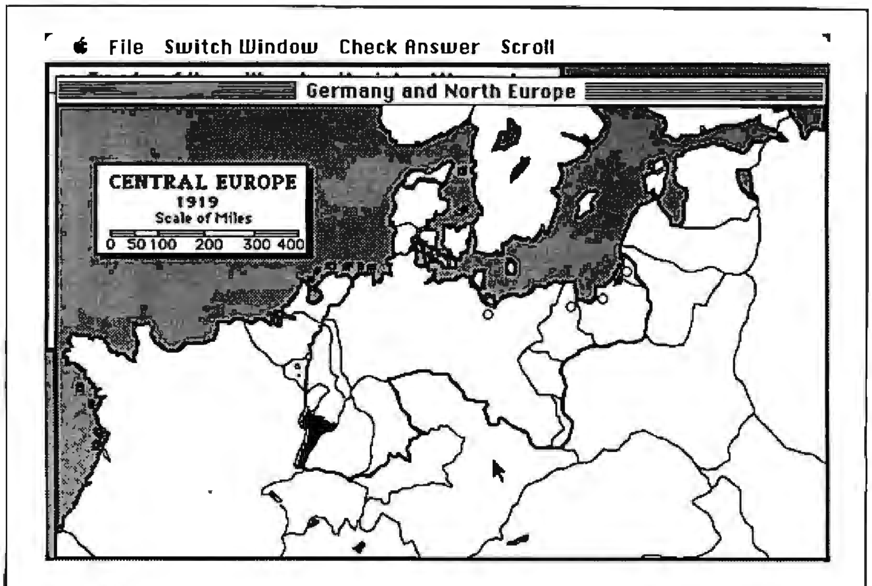

Figure 7: *Treaty of Versailles, by Drexel's Eric Brose, lets students take on diplomats' roles in reshaping Europe after World War I.*

The Macintosh has made some converts among the faculty at Drexel. Eric Brose of the history and politics department was sure he would have no use for the computer in his classes. Now, his Treaty of Versailles program is used at Drexel and distributed through ACE. Treaty of Versailles puts students in the role of the diplomats who reshaped Europe at the end of World War I. Students answer questons about the terms of important treaties, use national, ethnic, and historical information to redraw Europe's map, and participate in a simulation of a meeting at the Versailles Conference. The student diplomats must come to an agreement determining Europe's new national boundaries and must marshal arguments to support their positions, using maps they produce (see figure 7).

Instructors in engineering, who have been accustomed to thinking of microcomputers as toys, are also among the converts. A third of the Macintosh programs developed at Drexel are for engineering classes. Signal Operations by Banu Onaral, for example, is part of a package of programs that offer students an interactive environment for investigating theories and concepts in discrete signals and systems. The computer handles routine display and computation tasks, freeing the student for more thought-provoking exploration.

Students using Signal Operations first generate signals (either point by point or using predefined signals like impulse, step, ramp, exponential, sinusoid, or rectangular pulse). These signals can then be subjected to mathematical operations and algorithms such as time shifting, time and amplitude scaling, rotation about the *x* or *y* axis, logarithm, convolution, correlation, and so on, to create new signals. Students can edit and compare signals and store them to be used with other programs in the package (see figure 8).

The Students

How are students reacting to the ubiquitous Macintosh on the Drexel campus? According to John Gregory of the Office of Computing Services, after the initial excitement subsides, they take it all in stride. "It has become such a standard part of the operation that no one notices it anymore, any more than when they buy new notebooks," says Gregory, a little wistfully.

However disappointing it may be when the program Drexel has worked so hard to implement gets a "but, of course" reaction from the students, Gregory recognizes it as a measure of success. He warns that expectations can escalate rapidly—this year's juniors, who were thrilled with their Macintoshes three years ago, see this

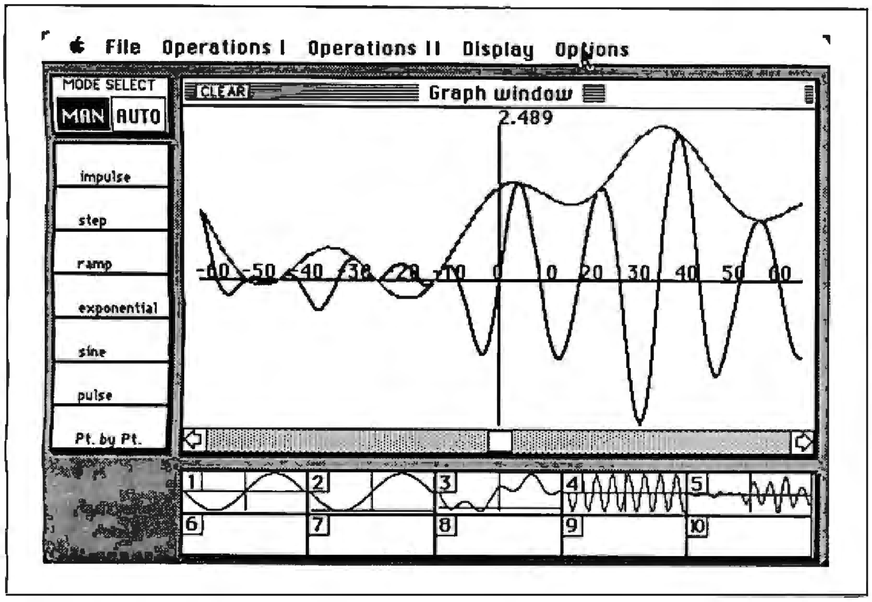

Figure 8: *Signal Operations by Banu Onaral of Drexel lets engineering students create and manipulate signals.*

year's crop of freshmen getting the Macintosh Plus and want a piece of the action. "Institutions saturated with computers need to be prepared for this," he says.

BROWN UNIVERSITY

Providence, Rhode Island

Brown University is in the midst of a 10-year project to design and implement the Scholar's Workstation—"a campuswide network of high-powered, graphics-based workstations for use in research and teaching in the sciences and liberal arts." One stage in this development is represented by the Intermedia Project.

Intermedia

Norman Meyrowitz, head of the Intermedia Project, calls it "a large-scale, object-oriented hypertext/hypermedia system" in a paper presented at OOPSLA '86 (and published under the title "Intermedia: The Architecture and Construction of an Object-Oriented Hypermedia System and Applications Framework" in the OOPSLA '86 Conference Proceedings [New York: Association for Computing Machinery, 1986]). OOPSLA stands for "object-oriented programming systems, languages, and applications."

"Hypertext" is a term coined by Ted Nelson in the early 1960s to connote a nonlinear body of information with "links" between documents that guide readers from one to another. "Hypermedia" is the logical extension of hypertext, encompassing graphics, animation, video, sound, and so on. Blocks, or pieces of documents, can be linked to form multimedia webs of information. The same documents may be linked by different webs.

For example, Shakespeare's works might make up the body of information. An English student might use a web of links from the text of a play to a glossary, to pictures of historical figures, and to explanatory background material. A theater student might access the same body of information through a web linking the text to video clips of a performance, pictures of costumes, and critics' reviews.

According to Meyrowitz, Intermedia is a modeless environment, "a framework for a collection of tools that allow authors to create and link documents from a variety of applications." There are presently five applications available within this framework: a text editor, a graphics editor, a scanned-image viewer, a three-dimensional object viewer, and a timeline editor. (A music editor, a video clip editor, and access to CD-ROM data are in planning.) The user interface is as consistent as possible across applications so that a user has no trouble going from one to another.

Intermedia was developed under the UNIX 4.2 operating system and runs on the Sun workstation and on the IBM RT PC. In the previously mentioned article, Meyrowitz describes the hardware: "The RT PC contains a RISC (reduced instruction set computer) microprocessor rated at over 2 MIPs and a companion memory management unit that handles a 40-bit virtual address space.

"The configurations we use have 3 to 4 megabytes of physical memory, a 100 by 768, 97 pixels per inch, monochrome bit-mapped display, an Ethernet connection to a local area network, and a two-button mechanical mouse. The systems can each support a number of internal hard disks, though for the most part, individual workstations each have a 40-megabyte hard disk to contain only the operating system files. Each LAN has one or more central server machines that contain larger disks and more memory; the Intermedia system code, user documents, and webs are typically stored on the server's hard disk."

System Development

In choosing an operating system, Intermedia's developers looked for features they considered necessary for the next generation of workstations, including support for virtual memory, multitasking, and networking. They chose Berkeley UNIX 4.2, enhanced with Sun's Network File System, that would run on the Suns and the RTs.

Next, Intermedia's developers chose a user interface toolbox and an applications framework. They needed low-level mouse and keyboard handlers, fast graphics, window and menu managers, and so forth. They did not want to design a new applications framework, so they looked for one that would provide a generic application from which a developer could build software. The toolbox and applications framework that met their criteria were Apple's Macintosh Toolbox and MacApp. Meyrowitz points out the obvious problem: ". . . neither the Mac Toolbox nor MacApp ran on an RT PC."

One puzzle piece was supplied by Cadmus Computer Systems (Lowell, Massachusetts), who had CadMac Toolbox implemented in C on a UNIX base. Brown obtained a license to port CadMac to the RT and found an added advantage in the fact that CadMac supported multiple processes. Through special agreements with Apple and Bolt Beranek and Newman (BBN) (Cambridge, Massachusetts), MacApp was ported from Object Pascal to an object-oriented, preprocessed version of C. Using a BBN class compiler, Brown got MacApp running on the RT PC. Intermedia was built on top of CadMac and MacApp.

Materials are now available on the In-

continued

termedia workstations for two experimental classes, one in English and one in biology, and the system is being used on a smaller scale in several other courses. In these early stages of the project, a professor and his assistants put material on the system "by hand," document by document, using Intermedia's text editor, drawing program, etc. Before the text editor was available, they created documents using MacWrite and technicians ported them to Intermedia.

The instructor or user marks blocks within the document that serve as anchor points, then creates links from point to point. The links do not become part of the document but are stored separately, in webs. Several webs may overlay one set of material. Thus, users following one set of links through a body of information need not see the links other people are using.

For instance, a student taking English 32, a survey of English literature, could explore a corpus of material called "Context 32: A Web of English Literature." The student would first see a screen of icons representing individual text, picture, graphic, or timeline documents. Rather than open a particular document, however, the student will click on the icon representing the web, or set of links among the documents. In this case, Browning Web links documents that illuminate the life and works of Robert Browning. A "global map" opens, giving a visual representation of the web (see figure 9).

Users of early hypertext systems often found themselves lost and confused in a maze of documents and links. However, Intermedia's Macintosh-like interface prevents this problem, since users can always find their location on a map, either global or local.

Studying the global map, it is clear that the document representing Browning's literary relations contains the most links to other documents and might be a good place to start. Double-clicking on the icon opens the document and reveals a picture of Browning, with icons representing links. To follow a link, the student can click on the icon and choose "Follow" from the Intermedia menu or simply double-click on the icon.

Choosing the "Biography" icon would display a dialog box explaining that there are two links anchored at that point—a biography and a timeline of the important events of Browning's life. Selecting one of the links opens the document and highlights the portion of the document to which the link refers. Rather than linking an entire document to another document, any selectable portions of the documents can serve as anchor points. Thus, in a text file, a link may be made to an insertion point, a sentence, or any piece of text the link creator chooses.

Creating a link is nearly as easy as following one. You simply define a block to serve as an anchor, choose "Start Link" from the Intermedia menu, open the document to which the link will be made, select a destination block, and choose

continued

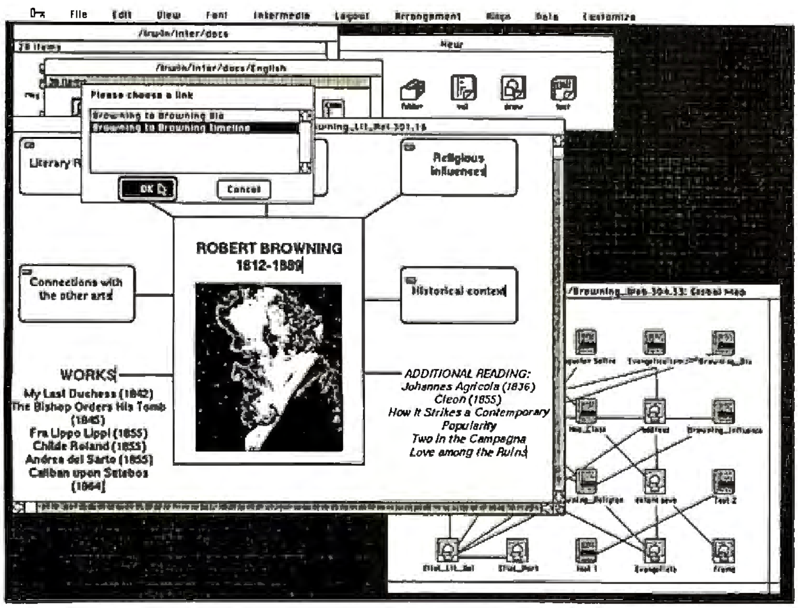

Figure 9: *Students in an English literature survey class at Brown can explore a corpus of information by following links from one document to another.*

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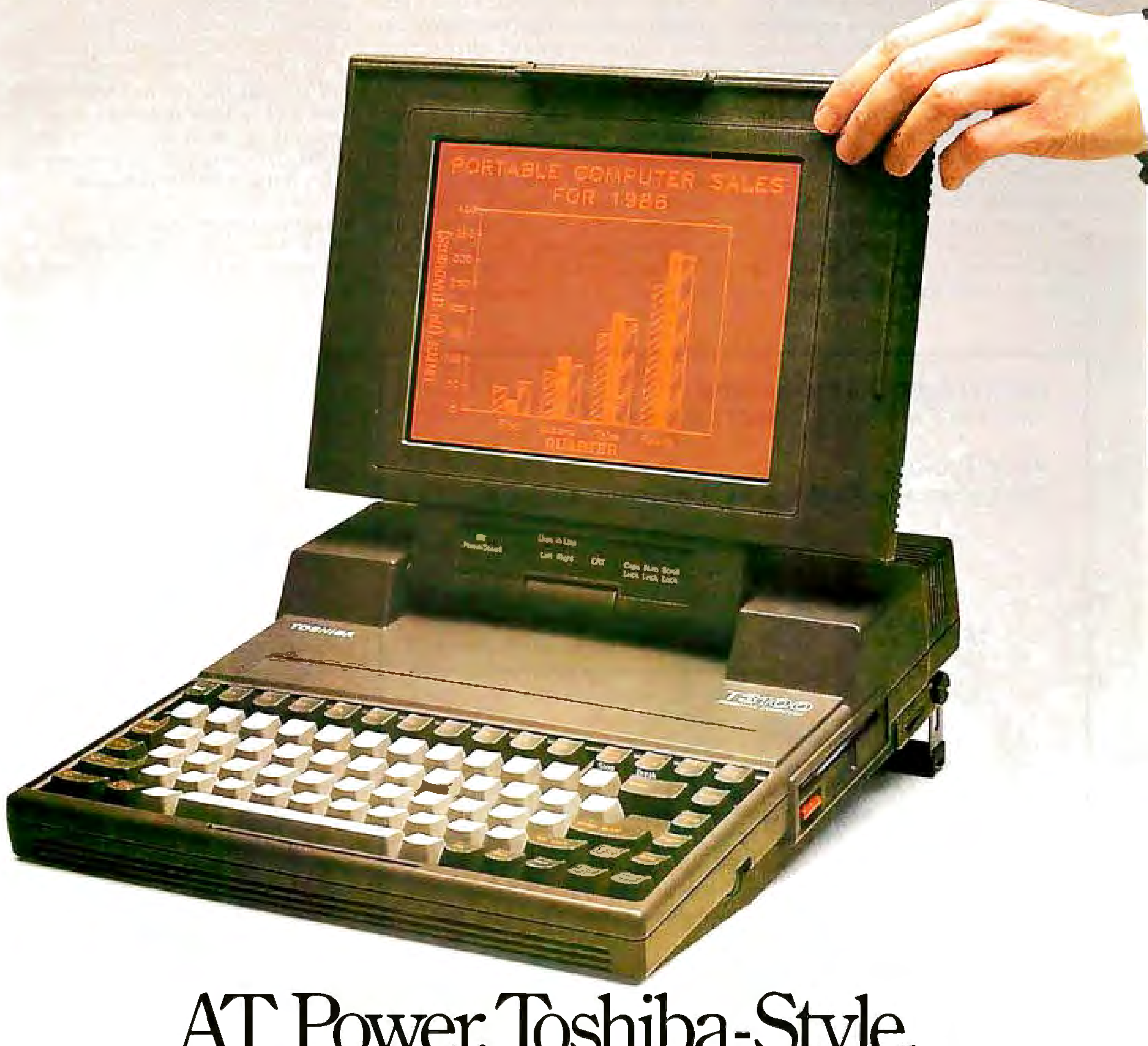

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"Complete Relation" from the menu. The technique is consistent across applications and is intuitively obvious to anyone familiar with a Macintosh-like interface. To prevent the anarchy that would result if many people were creating links in the same body of material, users are assigned privilege levels, with read-only, write, and annotate privileges.

Traversing the web in an English course, a student can see the connections between a literary work and the context in which it was written. He or she may see essays, short informational pieces on the author, time lines of the author's life, pictures, and drawings. The student can get a feel for the artistic, religious, and philosophical background of the author and the times.

"The professor who teaches the English course using Intermedia is concerned that students just read books in a vacuum," says Meyrowitz. "Literature is multicausal, and we want students to become critical thinkers, to understand there are a lot of connections that can't be ignored."

One of Intermedia's great strengths is its flexibility as a pedagogic tool. "We are not designing special-purpose programs that teach a specific subject," says Nicole Yankelovich, who has been instrumental in the development of Intermedia. "We provide tools that can be used in many ways. We've been impressed with the creativity of the faculty in using Intermedia. They have come up with ways of using it that we never considered."

Graphics Capabilities

The biology course makes extensive use of Intermedia's graphics capabilities. Students (and professional biologists) have had difficulty visualizing a three-dimensional object, such as a cell, based on two-dimensional drawings. A student who can call up a digitized electron micrograph of the cell in question, with 3-D models that can rotate and change scale and with links to 2-D drawings, has a better chance of forming an accurate mental picture of the cell. In addition, after following links back and forth between 2-D and 3-D representations, the student is better able to analyze the 2-D drawings in texts or journals and has a better feel for how they would look in three dimensions.

Access to powerful graphics is not the only fundamental change in the biology course, however. Students can also write and store their papers on-line, making links to material stored there to support their arguments. The professor can examine their work at several stages and make suggestions in the outline or the draft phase. This puts the professor more in the role of a collaborator than an instructor, closely simulating the way that professional biologists might work together.

Intermedia's linking system is in itself a pedagogic tool. In one experimental religious studies class, students are submitting their papers on-line. The instructor links his comments to them and creates links among the students' papers, pointing out different approaches to the same argument. An anthropology professor whose students study historical ethnography presents all his students with the same set of documents and asks them each to create a web of links to present a case for their arguments.

"The role of the computer is changing," says Meyrowitz. "It can be your depository, your library, your shoebox full of card files, with an all-encompassing framework in which to organize the information. It used to be that the computer would dictate how information could go in and how it could come out—like a Model T, you could have any color, as long as it was black. Intermedia represents a way for people to harness the power of the computer, rather than letting the computer harness them." ■

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The Quiet Revolution

On-line education becomes a real alternative

Brock N. Meeks

A QUIET REVOLUTION is taking place. It is a revolution of phosphor, integrated circuits, and carrier tones, and it is occurring within the framework of American education. It is fueled by computer conferencing systems, modems, and on-line databases—the counterparts of yesteryear's chalkboards, lecture halls, and libraries. Its participants speak in code, using terms like "telelearning," "electronic university," and "virtual classroom." The ultimate goal of this revolution is a simple one: getting an education without setting foot inside a classroom.

Education outside the classroom is not a new concept. We've all seen the correspondence courses offered on matchbook covers. However, such courses suffer a high attrition rate (better known around correspondence schools as the body count). Academic studies show that 70 percent dropout rates are not uncommon. The major problem is a lack of communication with the instructor and other students. Without this vital motivation, only the most dedicated students complete a traditional correspondence course.

Hallowed Halls of Phosphor

An electronic university exists within the confines of a mainframe computer and is managed by either electronic mail, a computer conferencing system, or both. (For an overview of computer conferencing, see the Theme section of the December 1985 issue of BYTE.) A student attending an electronic university interacts with instructors and other members of the class by using a computer and a modem.

Electronic mail and computer conferencing allow an on-line course to duplicate many of the dynamics found in a traditional classroom. However, on-line courses carry a tremendous advantage: You don't have to be in the same place at the same time. The instructor and students can be in several different states and time zones and "attend" class at any time. International students can also participate in such courses because these electronic classrooms are hooked to packet-switched carrier networks, making them accessible from almost anywhere in the world.

On-line Mentors

TeleLearning Systems of San Francisco operates the Electronic University Network (EUN). During its four-year history, TeleLearning Systems has delivered college-level courses electronically, using telecommunications as the link between instructor and student. However, EUN recently underwent a radical restructuring of its on-line program.

In the old system, courses were delivered on disk, with associated hardcopy reading and study materials. The course disk contained a fixed set of assignments and projects for the student to complete and upload to the instructor. It was classic computer-assisted instruction, with an element of telecommunications thrown in to make the process more convenient. EUN's new structure, 180 degrees from the old system, is aptly called Protege. (Protege refers to both the new program and the software that drives it.)

"The essential idea of the program is to connect protégés with mentors," says James Milokovic, vice president of research and development at EUN and designer of the Protege software. The concept of the Protege program is analogous to a Copernican revolution, says Milokovic. "Instead of the student having to revolve around the instructor being in a certain building at a certain time on a certain day, now the entire program, including the instructor, revolves around the student."

The Protege software is the heart of EUN's new program. It's completely menu-driven and operates on one-key commands. All assignments are completed using the Protege disk. On disk are knowledge templates for performing all course requirements. For example, if you want to send your on-line mentor a question or pose a problem, you simply compose your query in the electronic mail template. To send the note to your instructor, you turn on the modem, hit one key, and your message is automatically delivered. You never enter another keystroke.

Course assignments are now uploaded to the student one at a time. This way the instructor stays in personal contact with

continued

Brock N. Meeks (5830 Bari Ct., Suite B, La Mesa, CA 92041) is a freelance journalist who writes about high technology for several publications. He is also a teacher in Connected Education's Media Studies program.

Besides individual classes, EUN also offers degree programs.

the student. "It is of significant interest to the instructor to know [whether] you work for [a particular company] or are a minister," says Milokovic. This type of personal contact lets the instructor customize the course to the workaday world of the student. For example, besides teaching you the basics of marketing, the instructor may have you apply your textbook learning to how your company really designs its marketing strategy.

Currently, 200 colleges and universities participate in the program that forms EUN and provide EUN with more than 200 online courses. Each university or college develops its own course for inclusion in the EUN course catalog. Credit is granted from the institution that developed the course. If you've taken a course in economics from a professor at Harvard University, then Harvard grants you the credit, not EUN. EUN is simply the link between you and your mentor. If someone looks at your college transcript, there is no difference between a class taken on campus or over the modem. (For more information, see "The Electronic University Network" by Donna Osgood, March 1986 BYTE.)

Besides the individual classes, EUN also offers degree programs: three different M.B.A. degrees from City University of Bellevue, Washington, and four undergraduate degrees from Edison State College in New Jersey.

All courses offered by EUN meet or exceed standard College Level Examination Program (CLEP) requirements. This means your accumulated credit can be transferred to more than 1700 colleges and universities that accept CLEP-level courses. Costs begin at $215 for an average three-credit course and include connect time. The price goes up another $25 to $50 depending on your choice of books.

Teleconferencing

The New York Institute of Technology (NYIT) has established the fully accredited American Open University (AOU) on a VAX-11/730 using the Participate (PARTI) computer conferencing software. Currently, AOU offers 130 online courses and three B.S. degrees in business administration, general studies, and behavioral science. Each degree program requires 120 credits for completion, exactly the same as NYIT's on-campus degree programs require. "These aren't special programs for on-line students," says Ward Deutschman, dean of NYIT's Center for Adult and Professional Education. "Because of accrediting requirements they have to be the same courses offered on campus."

AOU emulates a traditional classroom using teleconferencing. When a course is in session, all interaction among the students and instructors takes place in a course conference. Here, students ask questions and discuss the assignments prepared by the instructor. They can also reply to the comments of other students.

Subconferences, or branches off the main course conference, are also possible. For instance, you might use a subconference when students are working in teams on a particular assignment. "Students often form 'study group' conferences as well," Deutschman said. These on-line study groups allow students to share notes or compare personal observations about the class.

When starting at AOU, you work with a special advisor to develop a background portfolio. This portfolio takes into account any previous college credit, military and corporate training, and life experience. "We don't want to take your time or money for things you've already learned," says Deutschman. After your portfolio is complete, your advisor will work out a degree map that allows you to chart a course of study to complete your degree. If you just want to bone up on a subject or two while accumulating some extra college credits, you can take individual courses.

When you sign up for a class, you receive a course learning package containing a textbook, an extensive (100- to 150-page) course outline, sample tests, quizzes, course objectives, and instructor background information. Once on-line (AOU is on the Telenet packet-switched network), you will find all the support typically available to on-campus students.

For example, AOU students can access the on-line librarian for reference materials. The AOU librarians will look up your request and send you a message explaining where, in your local area, that information is available. If you happen to live in a remote area where extensive library support is unavailable, the AOU librarians can arrange for an interlibrary loan. Students can also talk to counselors and advisors on-line and send private correspondence to the instructor or to other students.

Costs are $85 per credit—which is less than an on-campus course—and most courses are for three credits. "On-line students don't tax our overhead and don't use buildings or electricity," said Deutschman, "so we don't have to charge them as much." Your course fees include six hours of on-line time. If you happen to use more than six hours, you are billed on a prorata basis. "But for what it's worth, [so far] we've never charged anyone for extra time on-line," said Deutschman adding that AOU is more concerned with having students interact on-line—not watching the clock.

Classroom for the World

"We want to be a university to the world," says Connected Education's director Paul Levinson. "Our philosophy is that education shouldn't be tied to a classroom or geographic region," a heady claim for a program that saw its first on-line semester open in September 1985. However, more than a year later, Connected Education has both the statistics and the enrollment to back up that claim. It has already drawn a fair contingent of international students. Last semester Connected Education had students enrolled from Japan, Singapore, and Columbia.

In conjunction with the New York-based New School of Social Research, Connected Education offers graduate and undergraduate courses in the New School's Media Studies program. Levinson says a Ph.D. program is well into the development stage.

Each course offered by Connected Education brings together an expert in a particular field of study and students needing graduate-level course work. All the courses are taught via the New Jersey Institute of Technology's Electronic Information Exchange System (EIES). All courses run on the semester system and are two months long, during which time the students and the instructor discuss various issues relevant to the course topic. An interested student can obtain a detailed course outline and a required reading list before committing to taking a specific course.

Unlike the structured courses taught at AOU, Connected Education courses are propelled by the give and take of daily online dialogue. Although instructors follow a prearranged course outline, they're flexible enough to change the direction of the course according to the needs of the class.

During the course the instructor assigns various projects and reading assignments that the students are required to complete and comment on. Daily participation in the course is encouraged. To obtain a passing grade, each student is required to input at least two messages per week. In reality, students often upload several messages a day—message traffic in Connected Education's courses runs extremely high. Students must also take a midterm and final exam. These exams are in essay

continued

TABLE OF BENCHMARK RESULTS

This table shows the results of the processor/coprocessor speed tests using the April 1986 release of PC Magazine's 'PC Labs Benchmark Tests'. These are public domain programs, and are available on diskette from PC Magazine, or via the PC Magazine bulletin board. These results were obtained by us at PCSG, and are not yet official published PC Magazine figures.

The last line in the table, the Norton System Information Test, is not from PC Magazine, but is part of the popular 'Norton Utilities'. The version we used was 3.1, which is the latest version but may not give identical results to older versions.

	IBM PC	IBM AT	*BREAKTHRU 286*
Clock speed in MHz (IBM PC is 4.77)	4.77	6	8
Empty Loop	1	1.99	3.34
Integer add from memory	1	3.35	4.41
Integer multiply from memory	1	6.06	6.55
Floating point without coprocessor	1	3.33	4.42
Floating point w/8MHz coprocessor	n/a	n/a	1.82
Prime number test	1	1.95	2.85
Lotus 123 macro (640K)	1	2.64	3.69
Lotus 123 macro (256K)	1	1.77	3.54
Norton System Information Test	1	5.73	7.34

In every case but clock speed the numbers indicate how many times faster a test is performed than on a regular IBM PC.

Face-to-Face or Not to Face

In response to an editorial by our editor in chief, Phil Lemmons, concerning the use of computer conferencing in education in the September 1986 BYTE, we received some interesting letters from readers. They raise some important questions on both sides of this issue.

Various comments from these letters are presented here along with some pertinent excerpts from the two papers listed in the bibliography. Please note that these persons are not necessarily spokespersons for their particular universities; their affiliations, however, are given in table A.

What is education?

"Education is about understanding, not information transferral."

—William Kemp

"Education is essentially the conveyance of ideas and information among students and faculty, and there's no reason that many of the courses now taught in traditional place-based institutions cannot be taught effectively via on-line conferencing."

—Paul Levinson

"It is this concept of communications being the fundamental benefit of the classroom environment that underlies the premise . . . that computerized conferencing provides one of the first opportunities to create a true 'virtual classroom'."

—Starr Roxanne Hiltz and Murray Turoff

Does education need the face-to-face encounter?

Computer conferencing lacks the "effective feedback provided in live conversation by facial expressions, posture, gestures, etc. That sort of information is what a good teacher uses to monitor how a class is reacting to what [is being said].

"Face-to-face encounters are very rich in feedback through nonauditory information channels, while all telecommunications systems, from the lowly telegraph to the latest two-way video, are weak in providing [such] feedback. Inexperienced users . . . find sustaining engagement in [such] conversations quite difficult."

This form of education also lacks the "immediacy which being in a live classroom provides. (Immediacy here means information carried by the nonverbal information channels which surround and enrich human speech.) Worst of all, the teacher in a computer conference has no live students providing the constant feedback [that] good teaching requires."

—William Kemp

"Certainly for the technical disciplines, face-to-face contact is unnecessary, perhaps even distracting, and often effectively unavailable in any case in auditorium-sized classes."

—Daniel Mocsny

"Many educators believe strongly that this technology is the wave of the future for remote classroom delivery and an important augmentation of the traditional classroom. [Only] a quarter to a third of the students would prefer the face-to-face environment rather than courses taught or augmented via computerized conferencing" [see figure A].

—Hiltz and Turoff

Aren't graphics necessary?

"Walk into any science or engineering course lecture and observe the chalkboard. Less than half the scribblings can be represented directly by ASCII characters. Instead, one sees a freewheeling set of sketches, graphs, equations, symbols, arrows, etc. The skilled instructor throws it all up there with no apparent effort while conducting a [class]. . ."

—Daniel Mocsny

"Probably one of the single biggest shortcomings of the current EIES system and other computerized conferencing systems now being used for education is the lack of graphics. It is currently difficult to deal with equations and diagrams in these text-oriented systems."

—Hiltz and Turoff

Who finds this method of education useful?

"Even people in urban areas face an analogous problem [to that of those in remote areas]: the two-hour drive in city traffic to reach a one-hour class isn't very practical."

—William Kemp

"Not only can students electronically take part in classes from virtually anywhere in the world, but they can take part at times of their choosing—anytime night or day, seven days per week. This results in people participating at their best, and the consequence is a very rich intellectual experience."

"Issues which might otherwise be neglected or forgotten in an in-person classroom—questions that may occur to students after class hours—are preserved

Table A: *Affiliations of the various contributors to the text box.*

Starr Roxanne Hiltz and Murray Turoff
Computerized Conferencing and Communications Center
New Jersey Institute of Technology
Newark, NJ 07102

Drew Hopkins
Director, Management Information Systems
Thomas A. Edison State College
101 West State St.
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William Kemp
Assistant Dean for Programs and Projects
Mary Washington College
Office of Graduate and Extended Studies
1301 College Ave.
Fredericksburg, VA 22401-5358

Paul Levinson, Ph.D.
Director, Connected Education Inc.
92 Van Cortlandt Park S, #6F
Bronx, NY 10463

Daniel Mocsny, Ph.D.
Postdoctoral Assistant
University of Cincinnati
Department of Chemical and Nuclear Engineering
Mail Location #171
Cincinnati, OH 45221
[Editor's note: *Neither this department nor Mary Washington College currently offer courses via computer conferencing.*]

Jane Robinett
Polytechnic University
Department of Humanities and Communications
333 Jay St.
Brooklyn, NY 11201

John A. Scigliano
Director, Center for Computer-Based Learning
Department of Computer Science
3301 College Ave.
Fort Lauderdale, FL 33314

and woven into the computer conference."

—Paul Levinson

"This application of telematics has many potential advantages compared to other modes of educational delivery, including more active participation by students, convenient access to the electronic classroom at the times and places that can best fit in with the student's work obligations, and increased motivation to work hard on assignments because they will be viewable by other students as well as by the instructor(s)."

"[Students] can take courses from teachers and institutions located far away, which may not be offered by institutions within commuting distance. There are [also] many potential [students] for whom it is difficult or very expensive to become a resident student on a college campus and/or to participate in classes held at fixed times."

"The new technologies are already eroding the geographical monopoly held by many institutions of high education."

—Hiltz and Turoff

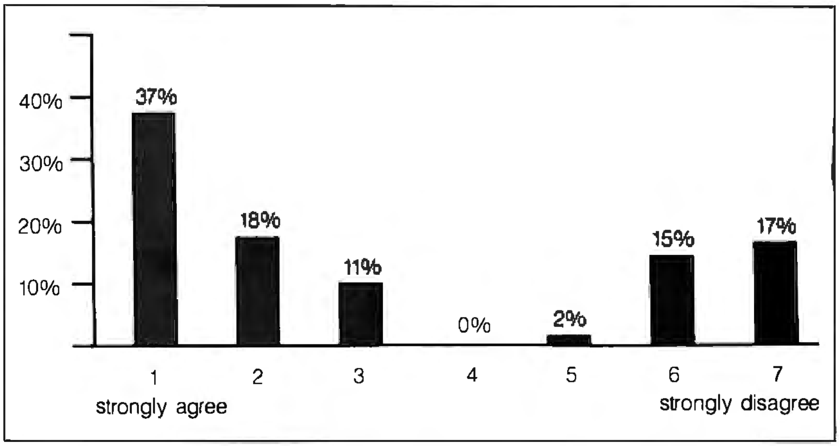

Figure A: *Distribution of responses from students on EIES to the statement: "I would be willing to take courses taught only through EIES with no face-to-face lecture if I had adequate access to terminal equipment at home and/or work."*

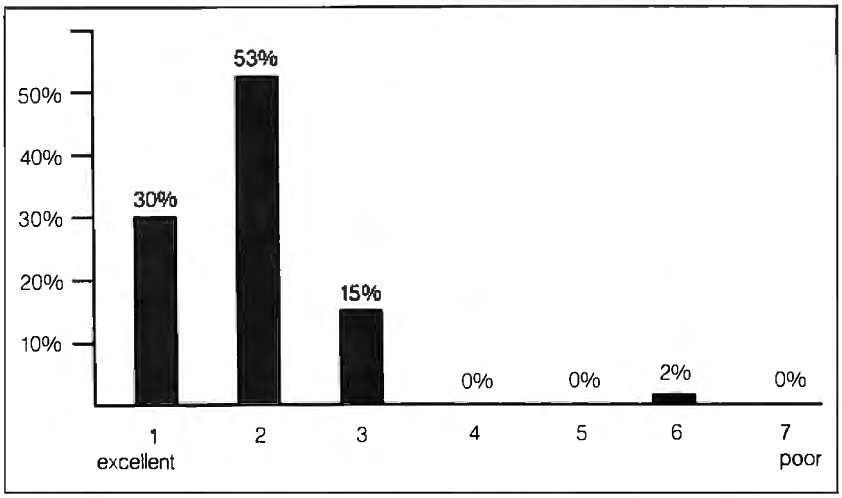

Figure B: *Distribution of responses from students on EIES to the overall performance of their instructors.*

What problems exist in learning to use the system?

"Seasoned users of on-line computer conferencing have learned to adapt their behavior as senders and receivers of information to the low content density of the medium—just as almost everyone has adapted to transferring information over the telephone. But using either medium successfully is definitely an acquired skill."

—William Kemp

"Until course conferencing software is as easy to use and as versatile as a simple piece of chalk and blackboard, the resistance of faculty will be great."

"Conferencing will bring about a restructuring of jurisdictions. First the students [will] stay home, then the faculty."

—Daniel Mocsny

"More than 80 percent of the students enter five or more spontaneous comments during the semester in addition to formal assignments. This represent[s] a level of equality of participation far in excess of normal face-to-face courses."

"There is no doubt that the additional student-instructor interaction of computer conferencing generates more work and time involvement for each instructor on a per-student basis."

—Hiltz and Turoff

Benefits of computer conferencing in education

Through computer conferencing, we can finally obtain "a truly universal university."

—Paul Levinson

"Among the advantages cited by students are increased convenience, more contact with the professors, increased motivation to do a good job on assignments because their peers will see their contributions, and more opportunity to participate in discussions. Instructors cite the ease with which it is possible to team-teach a course or to include 'visiting lecturers' with industrial experience, and the high quality of student contributions, which are generally well thought out before they are entered" [see figure B].

"It has not worked to try to keep an on-line class moving together in lock-step at the same rate through the material in a course, given the asynchronous nature of this medium and the fact that students tend to participate a lot when they have time but only a little when there are other pressing work obligations."

"With this technology, colleges and universities can offer their most outstanding professional talent to students anywhere in the country. What choice

continued

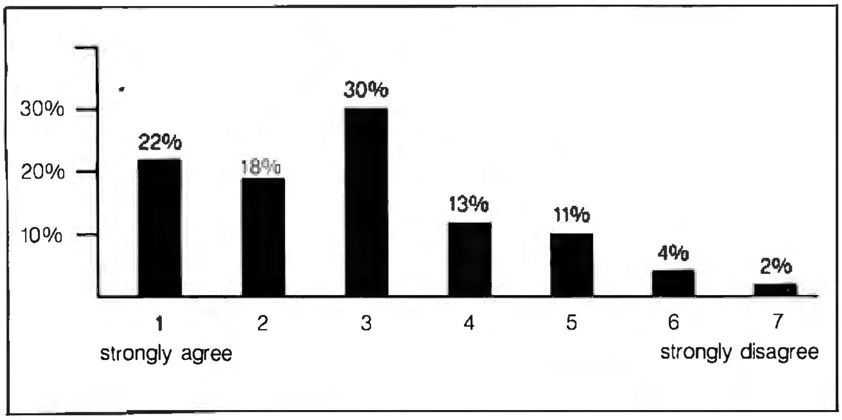

Figure C: *Distribution of responses from students on EIES to the statement: "I learned a great deal more because of the use of EIES."*

will a talented student make: an average professor at a college within physical commute distance, or the same course from a Nobel prize winner at a university 1000 miles away which can offer the course remotely?"

"EIES offers some special features that helped facilitate the educational process. The 'question' feature allowed the instructors to enter questions on-line which required an essay response. Students could not see each others' answers until they had supplied their own answers. Thus the instructors could ask questions that produced overlapping answers, without losing a later student's participation because earlier students had already said part of what a later student had to say [see figure C]. In the face-to-face environment, by contrast, only the first student to answer a question gets tc express a given view. EIES also allows the use of 'pen names' so students can make anonymous comments."

—Hiltz and Turoff

Some other schools involved

Nova University has "been offering on-line degree programs for over three years and [has] over 500 students enrolled in this format."

—John A. Scigliano

At the Polytechnic University, "we have found our students enthusiastic about on-line courses and hope to expand our course offerings in the coming semesters. Computer conferencing is an exciting and powerful educational tool and I sincerely hope that it will be put to wider use in the near future."

—Jane Robinett

"The simulated classroom project [at Thomas A. Edison State College] will eventually allow Edison students throughout the country to earn college credits through the use of the college's existing guided independent-study program. We are adding a computer conferencing mode to facilitate the courses. Edison students, regardless of time and location, will be able to interact with faculty and students, submit projects, review and participate in on-line topics discussion utilizing the conferencing component."

—Drew Hopkins

"Both the University of Michigan and the University of Wisconsin have used conference packages to augment regular courses for a number of years."

—Hiltz and Turoff

form and are uploaded to the instructor.

Connected Education's first semester offered courses such as "Teleworld," an analysis of the social impacts of new media; "Artificial Intelligence and Real Life," which discussed topics such as "Is protein necessary for intelligence?"; and "Propaganda: The Literary Science." Other courses offered range from "Telelaw" to "Politics of the Information Age."

Each course costs $795 and earns three graduate-level credit hours. All on-line connect charges are included, and students receive unlimited time on the conferencing system for class participation. Students have electronic mail and real-time conferencing capabilities as well. Levinson says transfer of Connected Education's credits to other institutions is possible but at the discretion of the receiving school.

On-line Brain Trust

Western Behavioral Sciences Institute (WBSI), a 27-year-old "think tank," offers a unique program designed to help executives and government officials further their management and communications skills in several different areas. "We've developed a program that alerts today's decision makers to the new requirements of leadership," says WBSI president, Dr. Richard Farson. The on-line structure of WBSI's program offers the opportunity for people in leadership to learn from each other, says Farson.

Participants in WBSI's School of Management and Strategic Studies (SMSS), as the program is called, include college presidents, corporate CEOs, national and foreign government officials, military and CIA personnel, best-selling authors, and former astronauts, among others. The program lasts for two years and is divided into four modules of six courses each. Each course is a month long.

Course instructors are drawn from the nation's top experts. For example, Harland Cleveland, dean of the Hubert H. Humphrey Institute of Public Affairs, teaches a course called "The Knowledge Dynamic in a Global Society." Another instructor is Herbert York, director of the Institute for the Study of Global Conflict and Cooperation and U.S. ambassador to the Comprehensive Test Ban negotiations from 1979 to 1981. Combine experts like these with some of the nation's most influential citizens and you have an on-line brain trust that has no equal.

The SMSS program operates much like the Connected Education program. Participants interact with the instructor and others in the course via the EIES conferencing system. The advantage of such a program is that it doesn't take the participant away from the work environment as do some of the high-powered management schools where participants are isolated from their jobs for up to 13 weeks.

Uncommon in the world of electronic learning, WBSI holds a week of face-to-face meetings before each module begins. This allows participants to meet each other and the instructors. This has the particular advantage of building up a strong on-line community that keeps participant motivation high. It also gives new participants a chance to get some individual hands-on training in the workings of the somewhat eclectic EIES conferencing system. This semiannual meeting is so successful at developing relationships among participants that alumni continue to participate in the courses and often act as freelance advisors to "undergraduates."

There is a small catch: the price tag. A two-year stint at SMSS runs $25,000. This is usually paid for by the participant's

continued

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employer. Although the cost is high, it includes all a participant's on-line time for the life of the course. WBSI will even provide you with the computer setup of your choice if you don't already own one. To make class participation easier, WBSI has developed its own communications software specifically designed around the EIES system.

In a review of the nation's leading business management schools, done by the *Harvard Business Review*, SMSS placed in the top five. The review claimed that other management programs should take a close look at SMSS and follow the program, both in "form and content."

On-line Advantage

On-line education holds a decided advantage over traditional on-campus education for several segments of the population. The disabled community benefits from the built-in ambiguity of the medium; when participating in an on-line class, it doesn't matter how long it takes to answer a question or type at a keyboard. Such a class meets on the disabled person's own timetable. Professionals who have little time to attend evening classes but seek to upgrade their education can dictate the time and place as well as learn from an acknowledged expert in the field.

But how credible is this type of education? While opinions differ (see the text box "Face-to-Face or Not to Face" on page 186), tests show that a higher degree of achievement and retention from distance learning courses is possible.

Is on-line education for everyone? AOU's Deutschman sums it up this way, "If a person asked me whether he or she should enroll as an on-campus student or go on-line, I wouldn't hesitate to recommend the on-campus environment. The people we are interested in addressing are those whose schedules, locations, or physical handicaps make it impossible to obtain a conventional college education."

While it is unlikely that this quiet revolution will replace its traditional counterpart, one thing is certain: Computer conferencing will have a penetrating effect on the established system and force it to take a closer look at the goals, methods, and purposes of on-line education. ■

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Inquiry 86

A Hard Look at Educational Software

In the rush to equip schools with computers, we risk ignoring some important issues

Adeline Naiman

WELL OVER A MILLION and a half microcomputers are in use today in public and private elementary and secondary schools in the U.S. Within five years, the student-to-microcomputer ratio is expected to be 14 to 1. The implications for instructional change are profound.

A Brief History

In 1977 we entered the mass computer age, though few in education seem to have noticed. Those who did notice were teachers of science, math, computer science, and technical education who already liked hardware. They recognized that the microcomputer's educational possibilities were revolutionary.

By 1980 school principals were wondering how to procure the funds for computers, which ones they should invest in, and where to place them strategically for the benefit of all.

By 1983 these administrators were using microcomputers for their own management tasks: updating student records, planning bus routes, paying teacher salaries, keeping attendance, maintaining inventories, and making announcements. Also, surveys showed that nearly every student in America had access to a computer for instructional use.

Now almost everyone uses a word processor. Teachers plan new curricula to take advantage of word processors, spreadsheets, databases, and file managers.

How Far We've Come

It is indeed good news that acceptance of computers and enthusiasm for using them in instruction have grown so fast. Schools are institutionalizing and consolidating their purchases. Those that have multiple computers are learning where to station them for maximum effect. Many educational systems have assigned someone to act as computer coordinator. These individuals serve as trainers and troubleshooters within the system and know whom to contact for outside help. They have formed regional networks for mutual support and quick exchange of ideas, resources, and teaching practices. Even maintenance and repair are being systematized so as to be more easily and quickly available and less costly.

Where We Have Yet to Go

Several issues need to be dealt with before the widespread use of computers in the classroom is fully efficient.

First, the state of the art in education hardly reflects the technological advances available. The industry simply doesn't remain static long enough for schools to catch on. Moreover, schools remain conservative about investing in expensive hardware. Once having bought computers, they expect them to last forever. Schools write bidding specifications, entertain proposals, buy all the same machines (often on the basis of lowest price, not the most appropriate functions), contract for maintenance as part of the deal, bolt the computers down to prevent theft, lock on the covers (which makes adding boards very difficult), and only then think about how they're going to use the investment. They've often left no money for software or teacher training, let alone upgrades or replacements.

Second, teacher training lags far behind need. Rarely is it adequate or sustained, nor do all schools have support systems in place. In-service training is usually too little. Where teachers have been told they must use computers, they are often too resentful or intimidated to make much headway without lots of help.

Third, budgets for software are woefully inadequate, so computers find limited applications. Teachers, even when told not to, often copy software illegally, so as to have enough for classroom use. Swapping is common but doesn't necessarily match the teachers' needs or preferences. Some districts have elaborate sharing systems or centralized software libraries. A few use networking within the district or school.

Fourth, computer-based instruction is still viewed as a squashed-in addendum to the ongoing syllabus. There is a need for a whole revamping of the curriculum in many subject areas so as to take advantage of what the computer can offer.

Fifth, there are still not enough computers in schools to provide more than a lab to which teachers can bring their students. Only experimental classrooms show a computer for every child or small group in the room. Moreover, inequity is rife. Computers are bunched in wealthy

continued

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suburbs or in large cities with sizable appropriations for computer-based instruction. Small towns and rural districts, as well as low-income cities, lag behind, except where a state has promoted and supported a computer initiative. More boys than girls are encouraged to take up computer use, except in the lower grades. Minorities are inadequately represented in advanced computer science courses.

Sixth, software is still driven by what most educational publishers have reluctantly had to buy or develop to supplement their textbooks to meet adoption requirements. These multimillion-dollar businesses control the market and determine what children learn. Being businesses, they cannot afford to take risks, so few of them publish innovative educational software.

So what have schools been using on the reported figure of 1.6 million computers in the schools? More precisely, what and how have they been teaching with them?

Help Wanted

In the initial onslaught of the software shortage, a few aficionados wrote their own instructional software. A teacher who could see how to make a computer do something more easily might design a simple program for local use or might collaborate with a programmer or engineer friend. If a colleague wanted to try out the product, so much the better. A few small publishers polished such programs up and offered them inexpensively. Sometimes the programs were full of bugs. Generally, they looked primitive. A great many single-concept science programs began this way.

Other programmers took the educational software and ideas that had already been developed for timesharing systems and rewrote them for micros. Very few of these early programs offered more than a textbook or a workbook, but they fit right into the curriculum and gave the computer something to do that didn't strain its powers.

After a while, complaints began to emerge about the rough quality of the available educational software. As computers gained more memory capacity, authors began to write more polished programs. Many of these were so formulaic that authoring systems were published that allowed teachers to develop their own drills or branching multiple-choice programs. Even when such programs are professionally prepared and are supplied with ornamental graphics and sound, they are what teachers and students have come to describe as dull, at best.

Only when educational software began to look like a commercially worthwhile field did graphics designers, software engineers, and teachers come out of hiding. Conventions evolved about what an ideal program should look like and contain.

Hands-off or Hands-on

When "computer literacy" entered the curriculum, it focused on hardware, not software. It meant courses on "How the Computer Works," "Inside the Computer," "The Impact of Computers on Our Society," or "Our Friend, the Computer." Children were given paper-and-pencil tests on what they learned about computers. We all know youngsters who had to draw the CPU, memory banks, input, ouput, and keyboard. Step-by-step lesson plans were designed by curriculum developers. It is little wonder that many high schoolers now hate computer courses.

Apparently, however, educators thought that was the way to incorporate computer consciousness into the curriculum. But awareness is only a first step in literacy. People don't learn to drive a car by reading a manual.

Practice is the best teacher. We learn

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Right now, teachers want programs that don't require substantial changes in the way they teach.

early that the best way to master a new skill is to have someone show you how to do it and then go off by yourself and plug away until you've got it. (As for motivation and persistence, watch the kids in the video arcades.)

Once teachers began using computers to teach actual subjects, they quickly realized that students loved doing things on the computer, even tedious drills on arithmetic or spelling. In the teachernet, the word got out that the computer was a big motivator, even for the previously unteachable. Of course, a big part of that motivation may have been getting away from the syllabus and letting the students push the keys for themselves.

Software Developers Join Up

While much of the early software did not move far from conventional teaching, its success moved developers to test their creative powers. In this, they were helped by the expanding base of computers in schools and the growing confidence and discernment of teachers.

A whole cadre of elementary teachers, especially those who read *Mindstorms: Children, Computers, & Powerful Ideas* by MIT's Seymour Papert (New York: Basic Books, 1982, softcover), fell in love with Logo. In some school districts, all primary classes featured Logo programming. There were even a couple of Logo schools. Research did not show significant learning gains, but teachers reported that they saw these in their students.

A Second Generation Emerges

Gradually, a second generation of software made its way among the by-now standardized drills. It was designed, often by a team of educators and programmers and graphic artists, to take advantage of the rapid development of professional programmers' tricks and utilities. It brought techniques down from the mainframe and the military. It learned from the insidious addiction of the arcade game and made for snazzier programs.

Much of this gussying up of the old electronic workbook took place because publishers were suddenly enchanted by a newly envisioned home market. Even the textbook publishers who had resisted the new medium hopped on board. They learned quickly from one another and from successful independent developers what software should look like. Commercial software has established its own formulas. Elementary programs look much alike, whether they deal with alphabets, syllables, words, or sentences, or with counting, addition, simple subtraction, or easy multiplication. They resemble one another ("Sesame Street" and "The Electric Company"). All educational software programs are currently designed to conform to educational precepts about how children are known to learn and what they should be taught. While they may seem dull to adults, as any parent knows, children's books written to formula and word list can hold children rapt through countless repetitions.

Starting Early

Where such second-generation programs have made a difference is in preschool. Between television and computer, it would be hard for a toddler to avoid letters and numbers. Kindergarten now has a curriculum, complete with goals and objectives.

But when you start using Logo in kindergarten, what do you do in first grade? More important, what do you do in the fifth grade after five years of turtle geometry and sprites? Logo is a powerful language, designed originally for artificial intelligence purposes, but few teachers take it beyond its openers. Only a few schools keep it going beyond the early grades, so the possibilities for learning to write substantial programs, plan ahead, and debug routines are interrupted. (One Massachusetts system has pulled Logo from its elementary schools and requires it for all middle school students.) Then, when students get into high school, the programming language they learn is BASIC or Pascal.

A hopeful sign is that districts are beginning to spend staff time and budget dollars on creating computer plans for the long haul. This means that they are likely to introduce some continuity in their computer-based programs and a better integration of computing in the K–12 curriculum.

Closing the Gap

For older children, the second-generation software offers ingenious construction sets, problem-solving challenges, a raft of simulations, real-time lab science, and other substantial tools for learning. Some of this is stand-alone software, not tied to an existing syllabus or textbook. It is meant to be used as "enrichment" rather than as a substitute for some portion of traditional instruction. It seems that as the computer finds its own voice, the software that best uses the computer has to ease into the classroom without upsetting the curriculum or unsettling teachers. As teachers get used to programs that are more interesting and that teach better than conventional instructional media, they should begin to teach in different ways.

But right now, teachers want programs that don't require substantial changes in the way they teach. They feel they know how to teach their subjects. They spend their days running the classroom, their nights correcting papers or preparing lesson plans, and their summers working in special programs. Even if revising the curriculum appeals to them, they understandably lack time and energy to tackle such massive change. Nor can schools assign dollars and staff to reexamine their whole curriculum or retrain teachers so as to take full advantage of the new opportunities the computer affords.

So a tension has come to exist between the desire to expand the new technology and the realities, economic and social, of teachers and schools. That tension creates a void in redesigning education. In our free-enterprise economy, you can count on someone leaping to fill any dollar-fringed void. In the computer arena, the leaper is the publishing establishment.

How the Publishers Respond

The leading textbook publishers did not start out wildly enthusiastic about the prospect of publishing software. The reasons are many.

First, their marketing system is already in place and serves a different product well. The salesperson does not need to carry hardware or be sure a working demo computer is available, learn how to use the software and anticipate problems, answer technical questions, and show the teacher how this program fits into the existing subject syllabus. In other words, the seller does not have to educate the buyer.

Second, teachers know how to select textbooks, but criteria for selecting educational software vary. Different arbiters proclaim different standards. Some evaluation guidelines favor teacher-proof automatic programs. Others want open-ended programs that allow the teachers, or even the student, to determine what is taught. Between these two poles is a range of "political" and pedagogical values, and alongside those run the technical criteria that many teachers and school software purchasers don't yet feel qualified to judge.

Third, teachers know how to teach from a textbook. They may follow it exactly or use it as a stimulus and reference for their own teaching plan. Students know how to

continued

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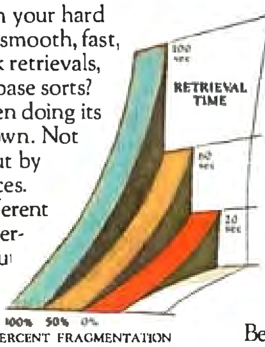

The more fragmented your files get, the longer they take to retrieve.

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Many publishers have realized that they amplify the appeal of their textbooks if they buttress them with floppy disks.

learn from (or bypass) a textbook. Textbooks are a firm medium; software simply is not.

Fourth, good software is expensive to make, is rarely produced on schedule, is never completely debugged before it goes to market, and represents an investment risk. Stand-alone programs are particularly risky, since it is unlikely that teachers will forgo part of their required teaching to make room for a program that doesn't teach the same unit of subject matter better and more efficiently. Add-ons require reshuffling of time slots in the class periods, enough available computers so that students can tackle the same topic within a brief time range, and faith in the product. Monitoring student performance and meeting test requirements are much harder to accomplish with nontraditional material.

So why have publishers bothered to entangle themselves in a web they never made? There are several answers. A few publishers have become enthusiastic about the medium and its teaching potential. Others have been dragged kicking and screaming into the fray as school boards and central administrations increasingly require a computer component for all textbook adoptions. Many publishers have realized that they amplify the appeal of their textbooks if they buttress them with floppy disks.

Keeping the textbook at the core, then, is how publishers have chosen to respond to the challenge. Following the successful textbook-development model, they employ editorial and design teams that work with consultant teachers to produce modest computer programs integrated into their textbooks or series. The software tends to be of the drill-and-practice kind, with some tutorials and occasionally a simulation or a game. More recently, publishers have seen the advantage of incorporating student-management utilities to drum up teacher support.

Yet, except where a federal agency has provided seed money to spur innovative software development for publishers to pick up on, few programs even begin to use the power of the computer. Moreover, standards for what is possible in educational program design seem to be determined by the latest introduction from the commercial hardware manufacturers—more memory, faster speed, better graphics, improved sound output, more attractive appearance or type. It is clear that educational goals alone do not drive the educational-software development process.

Applications Take Hold
Meanwhile, unable to build a strong foothold in markets owned and managed by textbook companies, most independent software companies have gone out of business, or at least out of education. Left in the arena are the handful of independent publishers who did not lose their shirts in the home-market fiasco, who have a good track record among educators, and who can weather the seasonal cash flow associated with selling to schools. Many of their products are the most interesting around. Increasingly, the larger textbook companies are adopting ideas and models these small spearhead companies have pioneered.

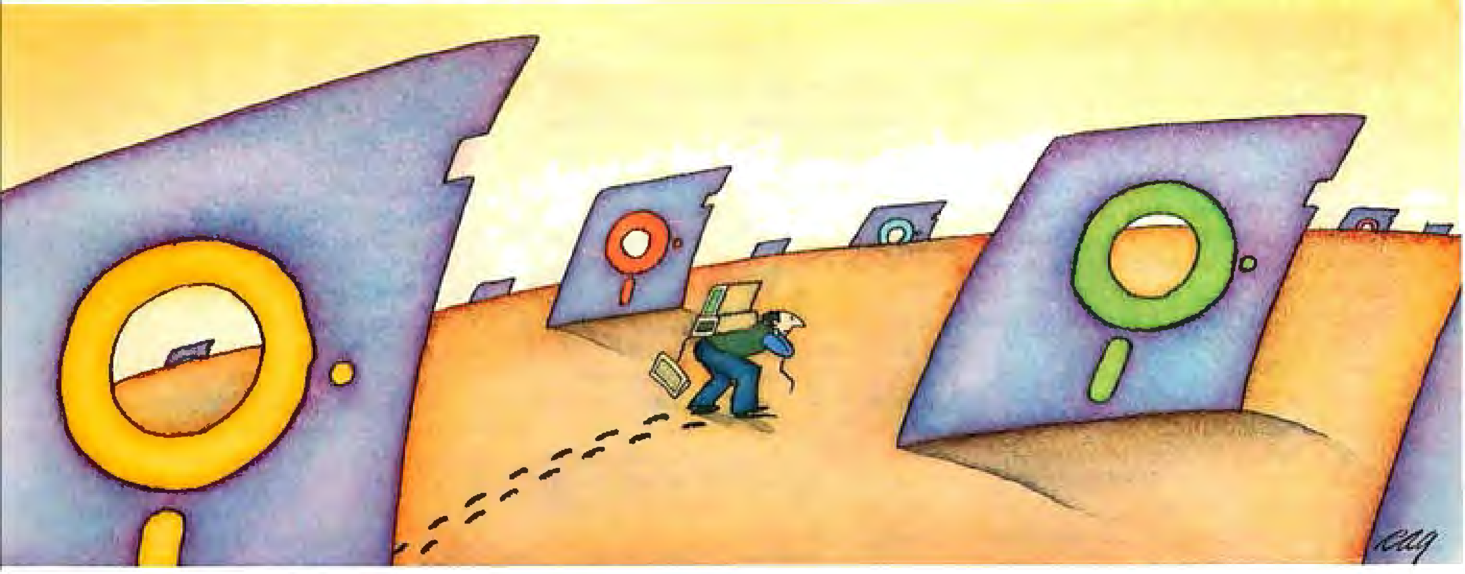
There is also now a prevalent belief that school software is not only a worthy market by itself but also will be what the next wave of home software buyers will want for their kids. So investors are creeping into the educational software field. This will undoubtedly affect the design of programs intended for both school and home.

A Third Generation Is Born
What may forge the link is a third generation of educational software that could not have been predicted half a decade ago. This is the adaptation of business utilities to serve educational purposes. The way personal computers got into many homes and small businesses was as word processors. As the computer came home from the office, spreadsheets took hold, databases solved limited recall, and other such improved efficiency beckoned.

No wonder these commercial boons became incorporated into classroom applications. Academic tools took on the style and ingenuity of office tools. Word processing looks to be the biggest change in the teaching of writing, not to mention spelling, grammar, punctuation, reading, and the whole gamut of language arts.

Database programs now come with templates in social studies up and down the grade levels. Spreadsheets are being applied to the teaching of mathematics. Fast graphing routines have revitalized algebra, and computer graphics support both Euclid and transformational geometry. Lab science can be done the way scientists do it—by recording, analyzing, and

continued



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displaying real-time data from experiments as they occur. Thus, the real world is moving in on the classroom, stimulated by what people enjoy doing most with computers. Schools no longer need wait for educational research to tell them what to do.

Work on Telecommunicating

What is taking hold more slowly than pundits prognosticated is telecommunications. Schools lack the habit of allowing teachers to use telephone connections for instructional purposes, nor do they budget for classroom phones. Teachers find modems hard to use. They are more likely to use a setup with a dedicated computer in the media center—databases have long been library resources. States and districts are pushing telecommunications as a way of networking practitioners and resources. This is a top-down innovation and will take time.

Even networking, that much vaunted cost-saver, appeals more to administrators and computer specialists than it does to teachers, who now prefer the autonomy and manageable complexity of the individual computer. Although many publishers offer networkable versions of their programs, as well as multipacks, they do so to discourage the inevitable illegal copying of copyrighted materials, as well as to cut school costs. Site licenses seem uneconomical for school publishers to manage. The disadvantages of networking include the suggestion of lockstep teaching and the exclusion of much of the most original educational software available. For example, science lab kits that require probes for recording data as experiments happen don't lend themselves to networking. Downloading conventional software may not yet justify the installation costs and cumbersome structure of networks.

Special Education

There is one area in which few teacher holdouts exist and in which the use of the computer for instruction is unquestioned, and that is special education. While little software has been created expressly for use with special-needs children, much of the existing software—including the most innovative—lends itself to use in remedial work, in individualized learning plans, and in one-on-one teaching of mainstreamed children working outside of class with a specialist. This phenomenon cannot begin to touch on the use of computer-controlled devices for children and young adults who are seriously impaired in motor capacity, hearing, sight, or speech. The miracles wrought by such devices, especially for those who have been unable to communicate without them, justify the cost of their development.

It is with those youngsters who could not succeed in learning through conventional means that the computer excels. It provides alternate routes to mastery of essential skills and to self-esteem. It also serves well the children classified under special needs as "gifted and talented." Until recently, the use of computers was greatest among the brightest kids and the learning impaired. For both groups, it has proved a godsend.

When we stop seeing the computer as a new and special introduction into the classroom, most of the doubts and anxieties that still hang on will have disappeared. We must yet help to break down gender barriers as young women move with greater confidence and in increasing numbers into computer-based courses and careers. Eventually, everybody will become computer literate just as we are now "telephone and automobile literate." We learn the fundamentals of our society quickly when they surround us from infancy. And by the time children born today begin school, computers will be a constant presence in their lives. ■

Inquiry 119

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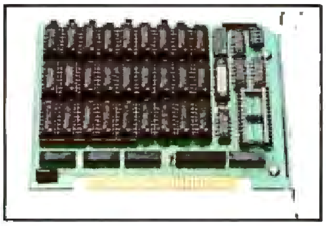

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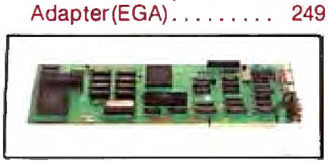

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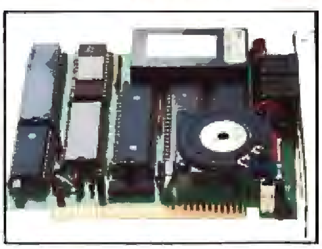

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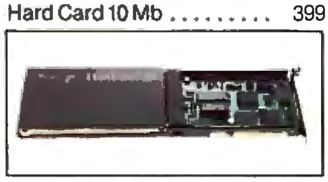

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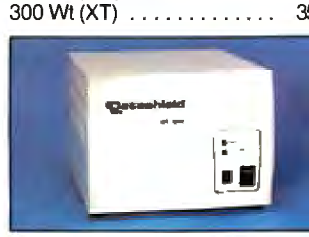

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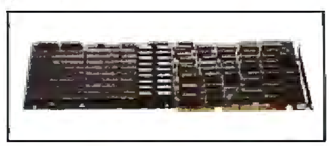

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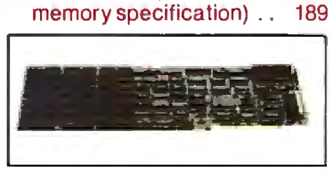

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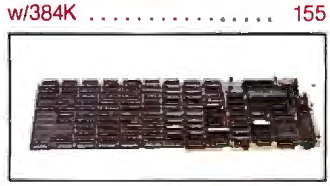

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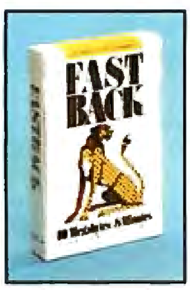

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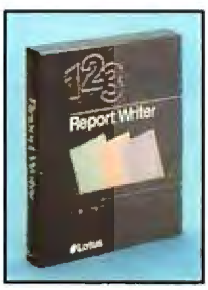

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4

The Potential for Interactive Technology

The future for learning and using technology requires vision and facts

Alfred Bork

COMPUTERS AND ASSOCIATED technology (the videodisk, the compact disk, and sound) can stimulate major changes in our educational system. In the last few years, schools and universities in many parts of the world have acquired large numbers of computers. It is time to assess the situation.

The main advantage of the computer as a way of learning is that it allows us to make learning interactive for all students. We can then pay attention to the needs of each student by individualizing the learning experience.

But the results of computers in learning are disappointing; studies might even show that computers are doing more harm than good. Effective use of computers in learning will not occur automatically. A reasonable chance exists that it will not occur at all unless we readjust our current directions. Just because computers and other modern technology are widely present in schools is no guarantee that this equipment will be wisely employed.

I divide the topic of computers in learning into four major areas. First, I consider several serious problems facing our educational system today. Oddly, they receive little attention in discussions about the role of computers in learning. I will then cover the recent use of computers, visions of future developments in education, and proposals to attain those goals.

Current Problems in Schools

Dozens of reports over the last 25 years have discussed major problems of education. Perhaps the best known, prepared in April 1983 for the Secretary of Education, is *A Nation at Risk: The Imperative for Educational Reform*. This report emphasizes the serious consequences to the country of a poor educational system, as reflected by its title. I will not summarize these reports but rather mention a few critical factors about the current state of classroom education in the United States.

Typical Classes

Most students today do not succeed at the learning task. It has been estimated that in a typical class, only about one-third of the students learn the material well. In a class with 20 or 30 students—common in education in the U.S.—it is almost impossible to give individual attention to the learning needs of each student. The two primary learning modes provided, the textbook and the lecture, do not create active learning possibilities for most students and offer the same learning experience to all students regardless of background, learning style, learning speed, or goals in life.

Poor Results

Declining scores on national and international tests are another measure. For example, recent international mathematics testing shows that U.S. students are far from the top, at all age levels and in all areas of mathematics. Almost all the developed countries rank above us in these tests. Further, illiteracy has now become a serious problem in the U.S., greater than in most developed countries. The indicators in such testing are mostly negative; the problems are increasing.

Decreasing Democracy

The decline in scores becomes even more frightening when we consider the uneven distribution of the quality of education in the U.S. Minority, poor, and rural individuals receive poorer educations than do students from affluent areas. In most states, school districts in wealthy areas spend far more per student than poorer districts. This inequality of opportunity is more likely to be a problem in the U.S. than elsewhere, given local control of school budgets, but it is a worldwide problem. Children may be created equal, but the educational system quickly changes that. We seem to be moving back to a time when education was the privilege of only a few.

Lack of Teachers

Over the next ten years the shortage of good teachers will continue to grow. This decline may well be the dominant visible problem of education during this period. There are several causes. First, we pay teachers very little compared to professions requiring similar education. The average salary of a teacher in the U.S. in 1985, according to the National Educa-

continued

Alfred Bork, developer of highly interactive computer-based material, is professor of computer science and director of the Educational Technology Center at the University at California at Irvine.

It is estimated that about half of the teachers currently in schools will be retiring during the next ten years.

tional Association, was about $25,000. Second, teaching is no longer considered a desirable profession by many people in this country. Third, we train few teachers now. Only about one-fifth of the number of math teachers graduate today as compared to ten years ago. Fourth, our schools of education are, on the average, weak. Fifth, the students currently entering teaching have low test scores on such exams as the SAT. Sixth, it is estimated that about half of the teachers currently in schools will be retiring during the next ten years, primarily because they have reached retirement age.

Hence, we can expect an increasing shortage of qualified teachers in the next few years. Simple solutions will not be adequate for this problem. Educational planning, with or without computers, must pay attention to this decline in both quantity and quality of teachers.

Negative Attitudes

The attitude toward teachers and the teaching profession just mentioned is paralleled by a decline in interest in education in this country. We see many unsuccessful attempts to increase taxes to pay for adequate education.

Of even more concern is the attitude of most students toward learning. Our schools seem to make people less interested in learning. Young children entering school are bright and curious, enjoying much of what they do. A few years later many of them view schools as a type of prison, convinced that the failure to learn is their own problem.

If we are to improve education, we must consider new directions. These directions must recognize that we will soon have far fewer teachers than we currently have. Modern technology, particularly the computer, provides us with the possibility of meeting these problems.

How Computers Are Used Today

To support the belief that computers can lead to an improved educational system, I discuss four examples of existing computer-based learning material: the logic course at Stanford developed by Patrick Suppes, the physics course at the University of California at Irvine, the Writing to Read course, and the Scientific Reasoning Series. These four projects show the role of interaction. Two of them, the courses at Stanford and Irvine, are more than ten years old. The examples use sizable amounts of computer material, mostly with support from print and other media.

The heart of the logic course at Stanford, and of the set theory course that may follow it, is the interactive proofs. Like other good courses of this type, the focus is on getting college students to prove increasingly difficult theorems.

The interactive theorem-provers that support the computer-based course allow students to develop their own proofs, which can then be checked by the computer. Both formal and informal proofs are possible. The detailed feedback to the student is far superior to that provided in most lecture-based logic courses. The expository material is less interactive (not surprising given the ten-year age of this course) but does reflect interesting early use of digitally stored speech. The course has been transported to other locations. Throughout much of its history at Stanford, it has been the only logic course available to students.

At the University of California at Irvine, a physics course was organized around a set of on-line exams, with each exam uniquely generated by the computer. As with most physics courses, the exams are primarily problem-based, but considerable conceptual knowledge is also required. Students stay with an exam until they perform it almost perfectly, in the tradition of mastery learning.

The exams contain most of the learning material of the course. As soon as a student has trouble with a problem on the exam, a detailed learning aid is interactively presented to the student. Often this material is closely related to the difficulty the student is experiencing. A variety of other learning modes are available, but it is possible to learn the material from the exams alone.

Students are also offered a choice of content; two different courses, mostly with different quizzes, are available. Students can choose a conventional course, but three-quarters select the computer course.

A central problem of education for young children is reading and writing. The Writing to Read course, developed by John Henry Martin, is directed at five- and six-year-old children. It is a multimedia course, with extensive use of materials other than the computer.

The course is based on a phonetic system. Children learn to write (i.e., type) the words they can say, and then they can read the words that they type. (Unlike the Initial Teaching Alphabet approach, it has been found that students quickly move to ordinary spelling.)

Writing to Read has had a full summative evaluation, conducted by the Educational Testing Service in Princeton, New Jersey. The results are favorable compared to other ways of teaching reading and writing. Even to the casual observer, the performance of the children at the end of the year is almost amazing; children are typing coherent compositions. The series is available from IBM.

The Scientific Reasoning Series is a collection of ten programs, directed to students of junior high school age and up. Bright elementary students will also be able to use many of them. The aim of this series is to bring students to an understanding of the nature of science.

The tactic is to place students in interactive environments in which they will behave like scientists in developing and testing concepts and theories. These environments are student-supportive, offering aid to students who are progressing slowly. The programs are self-contained, not requiring reading material, teachers, or other programs. The flavor is conversational, with the student playing an active role in the learning process. This series is also available from IBM.

The four projects just discussed illustrate what is possible with sizable developments. They suggest the computer's potential to improve education. But we need to consider further the structure of future educational systems.

Two Positive Visions

We can conceive of computer-based systems of the future that will provide a much better education for all students than our current system does. To follow are two models for future educational systems: mastery learning and the proposals of George Leonard.

Given that future educational systems should perform better than current systems, we should work toward the goal of everyone learning everything well, the goal of mastery learning. This does not imply any reduction of the level of education.

The notion of mastery learning, as promoted by Benjamin Bloom of the University of Chicago and others, has a variety of components. But these are not all possible at the same time in most current educational situations without skilled individual tutors. A student is kept with a given topic until mastery is demonstrated. This demonstration is typically through some type of exam, with the student be-

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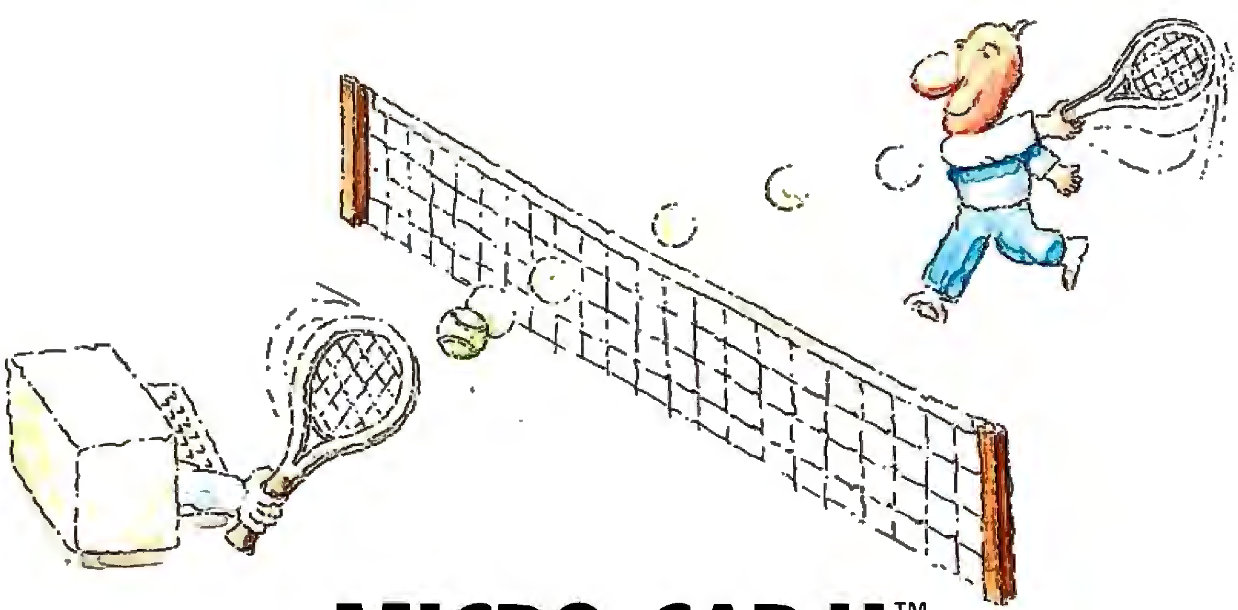

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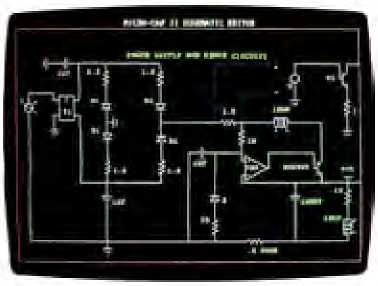

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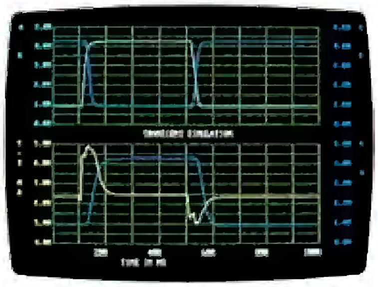

Transient Analysis

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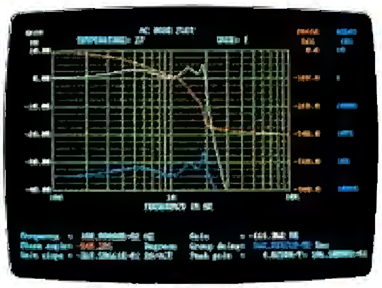

AC Analysis

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ing required to perform almost perfectly on the exam. A student who does not show mastery continues to study the unit, with a variety of learning material provided by the instructor. Several approaches to learning the topic may be required, perhaps reflecting different pedagogical approaches and different media. Students are thus encouraged to learn at their own rate and ability.

In a sense, mastery learning is the application of democracy to education. Not only are people created equal, but we ensure equal education for all. Experience suggests that mastery learning is possible with the use of modern technology.

But mastery learning does not completely specify the structure of schools. In thinking about future educational structures, certain questions must be answered. How many teachers will we have? What are the roles for the teachers? Will schools continue to exist or will part of education move to other learning environments, such as the home or public library? How do we accomplish the nonlearning aspects of schools, such as child care? How do we develop the necessary curriculum material? How do we implement and disseminate desirable changes? What does the daily life of a technology-based school look like?

Few people have developed visions of future schools. But without such visions, meaningful planning to improve education is difficult. Consider George Leonard's approach.

A few speculative views of schools 20 or so years from now have been developed. George Leonard has developed two of these. One is described in his book *Education and Ecstasy* (Dell Publishing, 1968) and the other in an article entitled "The Great School Reform Hoax" (*Esquire*, April 1984). Both of these schools are fully consistent with the goal of mastery learning; both make extensive use of the new interactive technologies; both individualize the learning process and make it interactive for all students. Both are practical visions of an educational system heavily dependent on modern interactive technology.

In *Education and Ecstasy*, Leonard divides the school into two segments, one for acquiring knowledge and one for affective behavior. In the knowledge dome, students work at large three-dimensional displays. The computer has a complete management system; as a student begins to work, the experiences are directly relevant to that student's needs. Brain waves are analyzed to reflect understanding, or lack thereof, in addition to the technical details already in use today. In the socialization component of the school, children work in small groups, with teachers, using encounter-group approaches.

Later, in the *Esquire* article, the two functions of the school are combined into a single program. A greater variety of instructional modes are used. And a major new ingredient is added: Students start each day by planning their schedules for the day, usually in an interaction with the computer.

How To Attain Such Schools

This last section proposes a set of steps that could lead to a future educational system that would be, for most students, far superior to our current one. Although the problems discussed in the first section refer partially to the U.S., the approach suggested could work all over the world, including the developing countries.

To implement the models of George Leonard, the creation of many courses is a critical step in developing a new educational system. Our current courses are inadequate; they were developed before the modern learning technologies were available, they are not interactive and in-

continued

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Current courses are inadequate. They were developed before modern learning technologies were available and do not aim at mastery learning.

dividualized, and they do not aim at mastery learning.

But two factors, and perhaps others, make it difficult to move to extensive immediate curriculum development. First, it is questionable whether we have enough practical experience with computers in learning, particularly with full courses, to jump directly to remaking all courses. The second factor is the difficulty of starting a project of this magnitude directly. Not everyone is convinced that a computer-based educational system is possible and reasonable.

To overcome these problems, and to proceed rationally, I suggest a two-stage approach. We should conduct a trial period to examine the concept of technology-based courses, followed by full development.

The Experiment

The purpose of this experiment is to study the effective use of the computer in education, in a focused way, to furnish information for later development. I propose the development, use, and summative evaluation of about 20 full courses that utilize the computer and associated technology, along with older learning media.

These courses should be diverse in all senses. They should be flexible enough to reflect different approaches to learning, different subject areas, and students of different ages. Courses should use a variety of production systems in the process of development. Their structure should be modular so that students can choose from several levels. All courses should be funded at levels that might lead to higher-quality courses.

We already have a reasonable understanding of the process needed to develop high-quality material, so the focus should be on highly skilled teachers as the heart of the pedagogical design team. These teachers should be given maximum freedom to make the best possible decisions to aid student learning. Further, most or all teacher training materials should be considered as an essential part of the course development itself. The process of implementing each course in the schools should be studied.

The most important part of the experiment will be the extensive evaluation of these courses with typical students, both in the formative sense, during development, and in the summative sense. Summative evaluation should be conducted with at least tens of thousands of students, in a variety of types of schools, comparing these courses in detail with the existing courses in the areas involved. This full evaluation should not be done by individuals associated with the development; competent professional evaluators should plan and manage the evaluation.

Based on our studies at the University of California at Irvine, I estimate that this experiment in the full use of the computer in education will cost about $200 million and will require about five years to complete. After such an experiment, we will have the information we need to remake our educational system and begin its full development.

International Ramifications

An intriguing possibility to consider is multinational development. Joint activities at the University of California at Irvine and the University of Geneva in Switzerland have demonstrated that it is possible to structure computer-based learning material so that it is relatively easy to convert to a new language. Cultural differences may be present, but most of these can be taken care of in the translation process. Some areas may not lend themselves to such development, but in many areas, such as science and mathematics, courses can only benefit from international development. This approach should be particularly important for the developing countries, given their difficulties in developing full-scale educational systems.

Several of us worked at estimating the cost of full curriculum development. Conservatively, we should expect to spend about $10 billion, perhaps over a period of about six to eight years. Another way of viewing this is that we would need to invest 1 percent of our educational costs each year in such development.

If we were to place education's cost as one of national value, the cost is about one-third of that of putting a person on the moon and is about one or two days of the military budget each year. These figures assume only one language; conversion to other languages would be a modest increase.

Education worldwide has major and increasing problems. We have the capability, using the new interactive technology, to ameliorate these problems. But this will only happen if we learn from the past to plan for the future. ■

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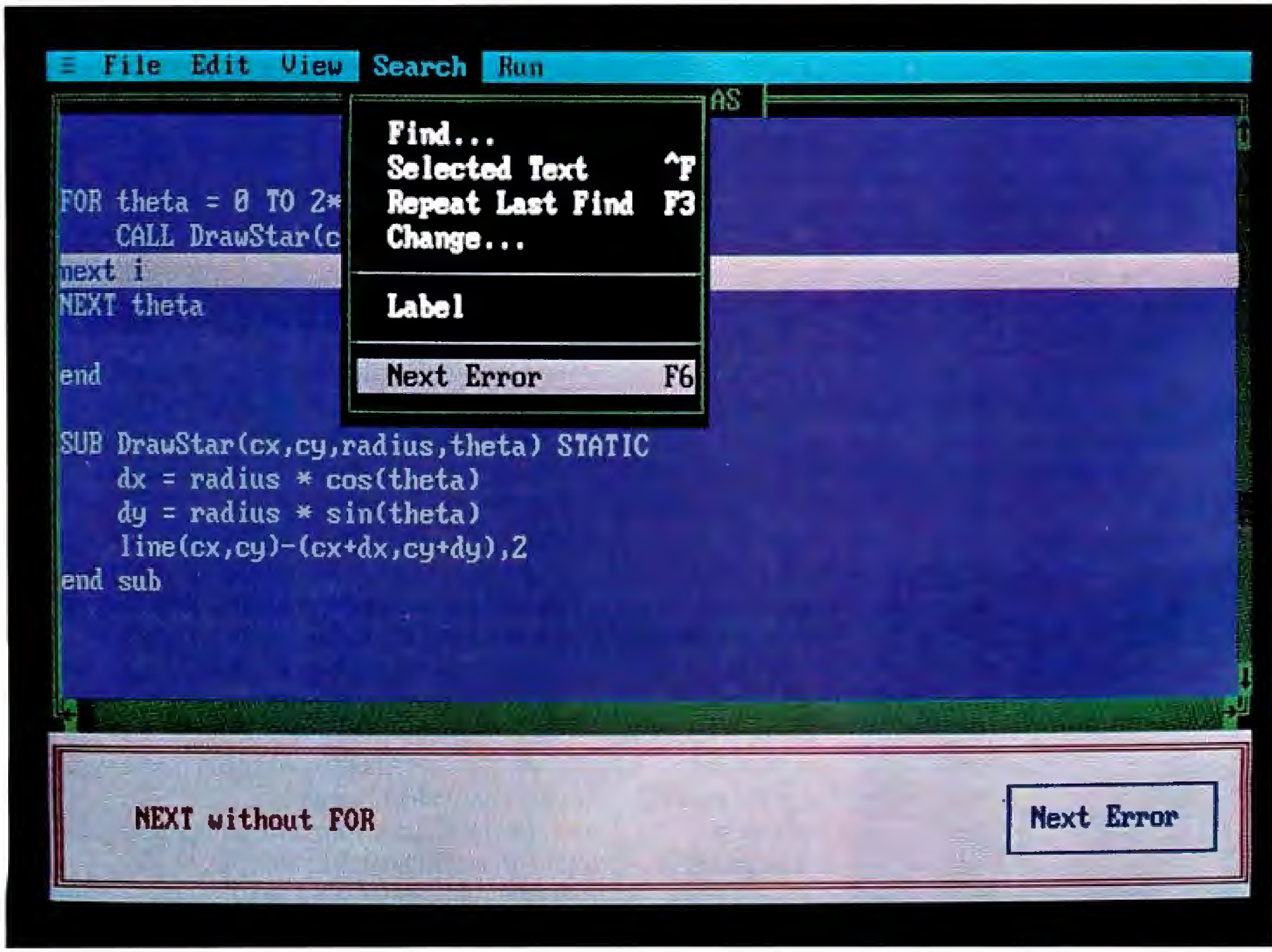

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- Graphics statements including WINDOW, VIEW, DRAW, GET, PUT, LINE, CIRCLE, LOCATE and SCREEN.
- Support of EGA extended graphics modes. NEW!
- BASICA structures are supported including WHILE/WEND, IF/THEN/ELSE, FOR/NEXT, GOSUB/RETURN, and event handling.

Results of Sieve Benchmark	BASICA 3.1	Microsoft QuickBASIC 2.0
Seconds per iteration	78	0.52

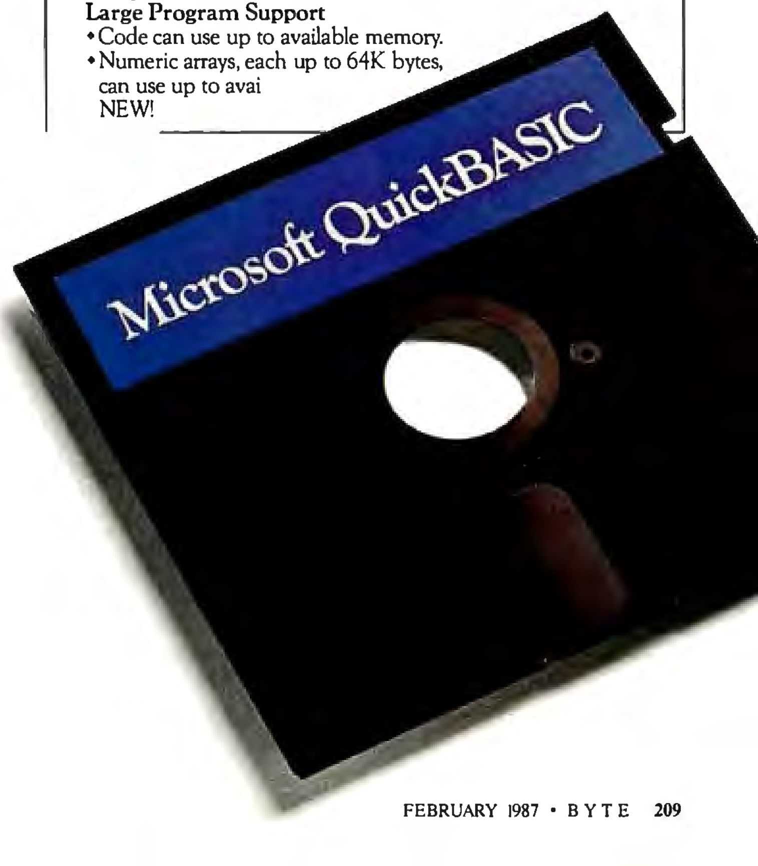
Complete Programming Environment
- Built-in Editor that places the cursor on found errors automatically. NEW!
- Compile entirely in memory at speeds up to 6000 lines per minute. NEW!
- Link routines once when starting a programming session and no need to link again when changing programs. NEW!
- Built-in debugger with single-step, animate, and trace modes. NEW!
- Create stand-alone programs.

Alphanumeric Labels
- Can be used to make your programs more readable. Line numbers are not required but are supported for BASICA compatibility.

Structured Programming Support
- Block IF/THEN/ELSE/END IF eliminates the need for GOTO statements. NEW!
- Subprograms can be called by name and passed parameters. Both local and global variables are supported.

Modular Programming Support
- Separate compilation allows you to create compiled BASIC libraries to use and re-use your programs.
- A library of routines to access DOS and BIOS interrupts is supplied. NEW!

Large Program Support
- Code can use up to available memory.
- Numeric arrays, each up to 64K bytes, can use up to avai NEW!



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Inquiry 329

Reviews

TWO OF THE FIRST available systems running on Intel's 80386 microprocessor are the Advanced Logic Research Access 386 and the Compaq Deskpro 386. BYTE's Stan Wszola and Curt Franklin find that both 16-MHz systems achieve a dramatically high level of performance, though each uses a slightly different design to do so. Both systems, our editors report, make other computers seem impossibly slow in comparison.

For those looking for portability rather than speed, John D. Unger examines four portable computers: the Toshiba T1100 Plus, the Zenith Z-181, the Bondwell 8, and the IBM PC Convertible. Although all four operate as well as full-fledged desktop IBM PC compatibles do, the T1100 Plus has the edge in performance and the Z-181 has the most readable screen.

On the 68000 front, Dave Menconi looks at the Atari 1040ST. Compared with the 520ST, the 1040ST has more memory, a built-in 3½-inch floppy disk drive and power supply, and the TOS desktop in ROM rather than on disk. The 1040ST, Menconi concludes, offers good value despite a few flaws. He also compares two 20-megabyte hard disk drives from Atari and Supra that complement the 1040ST's power.

In a review of ink-jet printers, Robert D. Swearengin examines four units ranging widely in capabilities, size, and price: the Diconix 150, the Quadram Quadjet, the Xerox Model 4020, and the Tektronix 4696. None had problems with clogged ink nozzles or reliability, as was common in earlier ink-jet printers. None was especially fast, but all provide quiet operation and good print quality.

High quality is the hallmark of Microsoft QuickBASIC 2.0, which reviewer Dennis Dykstra finds to be much more powerful than version 1.0. According to Dykstra, version 2.0 offers many of the advantages of an interpreter without sacrificing the speed of a compiler. These features, combined with its full-screen editor and other enhancements, make QuickBASIC 2.0 suitable for serious software developers.

For serious statisticians is Forecast Master, reviewed by Lowell Rosen. A time-analysis package with sophisticated forecasting techniques, Forecast Master is not for beginners, in part because of its inadequate documentation. Technical experts, though, will appreciate its many features, which include state-space and other univariate and multivariate procedures.

Finally, Warren Block surveys public domain programs for the Amiga, which fill the void caused by the relatively small number of commercial programs available for this machine. Block covers UNIX-like utilities and filters, a memory-display program, a presentation graphics program, and word processing and telecommunications software. All are available for a reasonable fee or for free, and all provide useful functions for Amiga owners.

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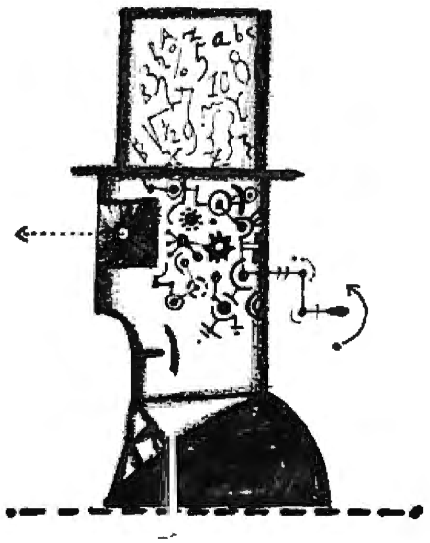
Inquiry 322

REVIEWER'S NOTEBOOK

Ah, COMDEX. Finally a show that deserved attention. There were 80386 systems, motherboards, and turbo boards in abundance, and I was very impressed watching CAD packages change perspectives almost instantaneously. More than 30 systems and boards, ranging substantially in capabilities and price, were displayed by Intel, Compaq, Zenith, and many other companies. Among them were American Computer and Peripheral, Kaypro, Convergent Technologies, Goldstar Semiconductor, Orchid, Quadram, ATronics, Computer Dynamics, Multitech Electronics, PC's Limited, Cheetah International, and Applied Reasoning. Judging from the demos, there is no doubt at all that the 80386's performance will make a substantial difference for software development.

If I had to sum up the show in only a few words (and I do), I'd say that this year the incremental advances in technology that always surface at COMDEX provided us with the clear promise of both more processing power per dollar and of brighter times ahead. The 80386 systems and boards were not the only signs of faster processing. Definicon (31324 Via Colinas #108, Westlake Village, CA 91362, (818) 889-1646) released its new DSI-785 coprocessor system, which holds 16 megabytes of memory and runs at speeds up to 25 MHz. The microprocessor, a Motorola 68020, uses MS-DOS and supports real-time and multitasking operations. The DSI-785 can write to main memory using zero wait states at 16.67 and 20 MHz; it requires one wait state at 25 MHz. The board installs in any IBM PC XT or PC AT.

In Datavue Technical Systems' booth, I saw an IBM PC–compatible system that the company says has an average execution speed of 10 million instructions per second, equivalent to an Intel 8086 running at 150 MHz. Its top speed is 22 MIPS. The system, called the Advanced Personal Computer System, consists of the company's IBM PC compatible hooked to a black box that does all the processing except I/O. The box holds its own power supply and two Datavue boards that plug together and work as an 8086 emulator. The boards are based on the Datavue 86150 microprocessor, compatible with the 8086 instruction set. A company spokesman said that you can't hook the



black box to any PC compatible, but the firm hopes to link it to IBM PC XTs and PC ATs soon. The box alone costs $10,995. Packaged with Datavue's PC-compatible system, prices range from $11,500 to $15,000, depending on configuration. Datavue (4355 International Blvd., P.O. Box 2687, Norcross, GA 30093, (404) 564-5780) plans to ship the system sometime during the first quarter of this year.

Back in the office, there was the usual load of interesting things—perhaps less flashy than the high-powered machines at COMDEX, but useful nonetheless. Merak Industries' Addcard (8704 Edna Dr., Warren, MI 48093, (800) 231-4310) adds four short slots to your IBM PC or compatible for only $79. The card plugs into the fifth expansion slot on an IBM PC and takes advantage of the space between the left disk drive, the power supply, and the fifth slot.

Caucus is an electronic conferencing system from Camber-Roth (243 Hoosick St., Troy, NY 12180, (518) 273-0983). With this software you can set up a conferencing system similar to BIX on your own IBM PC. The conferencing syntax is somewhat different from BIX's, but I was nonetheless impressed with the package's ease of installation and use.

Springboard Software Inc. (7808 Creekridge Circle, Minneapolis, MN 55435, (612) 944-3915) has introduced The Newsroom Pro for the IBM PC and compatibles with 512K bytes of RAM and a color graphics adapter. It lets you create newsletters and distinctive two-column reports quickly and easily. Text automatically formats around graphics and repositions itself when you move the graphics. The package includes more than 2000 predrawn images and effective drawing and editing options.

Another interesting item for the IBM PC is Stay-Res from MicroHelp Inc. (2220 Carlyle Dr., Marietta, GA 30062, (404) 973-9272). A programming tool for BASIC development, Stay-Res allows you to easily make compiled programs memory-resident. Each memory-resident program requires only 7K bytes of DOS memory. At the moment, Stay-Res supports Microsoft QuickBASIC (version 1.0 or 2.0), the IBM BASIC compiler (version 1 or 2), and the Microsoft BASIC compiler (version 5.36). Programs compiled with QuickBASIC version 2.0 will require DOS 3.0 or higher.

I've also been trying Super PC-Kwik, a disk accelerator from Multisoft Corp. (18220 Southwest Monte Verdi Blvd., Beaverton, OR 97007, (503) 642-7108) that provides a flexible disk cache. I tried it for more than a week and noticed some small speed improvement in disk access, though the gain would undoubtedly have been far greater if I had a floppy-based system or had I given the cache more than the 60K bytes I could afford. If you have a Macintosh that you want to speed up, I recommend that you try TurboCharger from Nevins Microsystems (P.O. Box 1249, Capitola, CA 95010, (408) 479-0860). One of our technical editors, Tom Thompson, swears by this disk cache.

For the Amiga there is Impact!, a presentation graphics application from Aegis Development (2210 Wilshire Blvd., Suite 277, Santa Monica, CA 90403, (213) 306-0735). With this package, Aegis has once again tapped the Amiga's graphics abilities. The program's number of features is legion; in addition to the usual ones, you can assemble a slide show with preset pauses.

Finally, some personal news: I am moving on to an exciting new job at Princeton University. There is no joy in leaving BYTE and its top-notch staff, but I have no doubt that the magazine and staff will continue to prosper—my very best to them and to you all.

—Jon Edwards
Senior Technical Editor, Reviews

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The ALR Access 386 and the Compaq Deskpro 386

Stanley J. Wszola and Curtis Franklin Jr.

Two machines that offer high performance and compatibility

The Advanced Logic Research Access 386 (left) and the Compaq Deskpro 386 (right) are two of the first microcomputers available that use Intel's 80386 microprocessor. While still compatible with older software and hardware for the IBM PC XT and PC AT, both computers offer dramatically increased performance.

The Compaq Deskpro 386 was previewed by Tom Thompson and Dennis Allen in the November 1986 BYTE. The ALR Access 386 is newly released. Both computers use the 80386 microprocessor, but each uses a slightly different design to achieve high performance.

Description

The ALR Access 386 is available in three basic configurations. All come with 512K bytes of RAM, a 1.2-megabyte floppy disk drive, one serial and one parallel port, an old-style PC AT-compatible keyboard (see photo 1), and eight expansion slots. The enhanced monochrome version adds a multifunction board with 512K bytes of RAM, an additional serial and parallel port, a 30-megabyte hard disk drive, a Hercules-compatible monochrome graphics card, and a high-resolution (720 by 300 pixels) monochrome monitor. The enhanced color version adds a multifunction board with 2 megabytes of RAM, an additional serial and parallel port, a 30-megabyte hard disk drive, an ALR EGA-compatible video card, and a 14-inch EGA/CGA color monitor. The machine that we reviewed was an enhanced color version that varied from the company's description by having only 512K bytes of RAM on the multi-function board.

The Access 386 is housed in a PC AT-style case that measures 21 by 17 by 6½ inches. The system unit weighs 42 pounds, making system relocation a proposition to be taken seriously. The Access 386 contains space for five half-height devices. The unit that we reviewed had three spaces occupied, two by a Seagate 4038 hard disk and one by a 1.2-megabyte floppy disk drive.

The Compaq Deskpro 386 comes in two different configurations. The Model 40 features 1 megabyte of RAM, a 1.2-megabyte floppy disk drive, and a 40-megabyte hard disk drive. The Model 130 has 1 megabyte of RAM, a 1.2-megabyte floppy disk drive, and a 130-megabyte hard disk drive. The system memory board for both models can be upgraded for a maximum of 10 megabytes. You can add extra memory boards for a total system maximum of 14 megabytes. Two keyboards are available. You can choose either the IBM PC-style 84-key keyboard with a separate numeric keypad and 10 function keys or the IBM RT PC-style 101-key keyboard with a separate numeric keypad and cursor keys and 12 function keys. The unit measures 20 by 16½ by 6½ inches.

Compaq offers two optional monitor/video board combinations. The Compaq enhanced color graphics board and Compaq color monitor combination gives you a screen with 640- by 350-pixel resolution and 16 simultaneous colors out of a palette of 64. This board is compatible with the IBM Enhanced Graphics Adapter. The other combination is the Compaq dual-mode monochrome monitor with an amber or green screen and the Compaq video display controller board. This board is compatible with the IBM Color Graphics Adapter and provides composite and RGB output. The Deskpro 386 also has an I/O card for parallel and serial output.

The Deskpro 386 maintains the same case style as previous Deskpro models. The front panel holds the keyboard connector and security lock and has space for up to four half-height 5¼-inch floppy disk drives. The rear panel includes connections for composite and RGB video output, a serial port (male DB-9 connector), a parallel connector (female DB-25), and a DIN connector for the monitor power interface for a monochrome monitor. The model we reviewed had 1 megabyte of RAM on the system memory board, an 80287 math coprocessor chip, one 1.2-megabyte floppy disk

continued

Stanley J. Wszola, a BYTE technical editor, and Curtis Franklin Jr., an associate technical editor, can be reached at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

drive, one 360K-byte floppy disk drive, a 40-megabyte hard disk drive, and a 40-megabyte tape-cartridge backup unit. The Model 40 weighs 42 pounds.

Under the Hood

When we removed the case from the ALR Access 386, two things initially caught our attention: the two 32-bit bus slots and the section of blue jumper wires snaking across the motherboard. At first glance, the 32-bit slots appear as though they were based on the PC AT slots and use a double-length extender section (see photo 2). According to ALR, this is a proprietary design with no attempt made to conform to any of the preliminary 32-bit bus standards. ALR says that it will offer memory-expansion cards for this bus but has no information on other companies' products that might work in the slots. The jumper wires are a disconcerting touch in a production machine.

The Access 386 has eight expansion slots (two 8-bit IBM PC-compatible, four 16-bit PC AT-compatible, and two 32-bit), of which five are available to the user. Two of the PC AT-compatible slots are filled with a disk controller and a multifunction card. One of the PC-compatible slots holds the display adapter. Since the 32-bit slots are located near the disk drive enclosures, anyone using these slots will face routing disk controller cables either over or under the 32-bit cards.

The Compaq Deskpro 386 is also a unique machine internally. At first glance, the most striking feature is the location and configuration of the system memory board. In contrast to the other 8- and 16-bit slots located toward the rear of the motherboard, the memory board's 32-bit slot is positioned on the right side of the motherboard toward the front of the computer (see photo 3). The power and ground connection slot for the memory board is located at the rear of the motherboard. This places it out of the way of any other board slots. At the time of this review we didn't have any of the piggyback memory boards, so we don't know how wide a fully loaded system memory board is. This 32-bit slot is also a proprietary design without any support from other board manufacturers.

The Deskpro 386 has eight slots: three 8-bit IBM PC-compatible, four 16-bit PC AT-compatible, and one 32-bit. On the machine we reviewed, the hard disk/floppy disk controller card used one 16-bit slot, the parallel/serial card used one 16-bit slot, and the enhanced color graphics board used one 8-bit slot.

Data Storage

Putting a slow hard disk drive on an 80386-based computer is like never taking an exotic racing car out of second gear. Both ALR and Compaq have tried to get around this performance bottleneck by using fast-access drives.

The Access 386 uses the Seagate ST4038, a 30-megabyte hard disk. Using the CORE International Coretest Disk Performance Program to evaluate disk performance, we recorded a data-transfer rate of 165K bytes per second, an average seek time of 36.5 milliseconds, and a track-to-track seek time of 9.9 ms. These are good results for a hard disk. This can be attributed to the hard disk and the Western Digital WD1003-WA2 floppy/hard disk controller board. This is a 16-bit board with a 765 controller chip and other Western Digital chips.

The Deskpro 386 takes hard disk performance a step further. The computer uses the Control Data Model 94208-51 hard disk, a 40-megabyte drive configured as two drives: C and D. Using the same Coretest Disk Performance Program, we recorded a data-transfer rate of 200K bytes per second, an average seek time of 25.7 ms, and a track-to-track seek time of 4.0 ms. This improved performance is due in part to the Compaq Multipurpose Fixed Disk Controller card. This 16-bit board is a combination serial, parallel, floppy, and hard disk controller card. This card has the 765 disk controller chip, but it also has custom LSI chips that handle some drive-control functions and perform address decoding for the hard disk, thereby increasing the speed for data access.

The above times are averages taken from several tests and are only meant to show relative performance. The ALR Access 386 is a good performer, but it is clear that the Compaq Deskpro 386 has a hard disk system that better matches the 80386 in performance.

The Deskpro 386 also includes a 40-megabyte tape cartridge unit. This unit, an Irwin Magnetic Systems Model 145, can store an entire 40 megabytes on one DC 2000 tape cartridge. It can also read a DC 1000 tape cartridge, the type used on previous models of Compaq computers.

Photo 1: *The ALR Access 386 keyboard.*

Expandability

Both computers are capable of significant memory and storage expansion because of their mix of 8-, 16-, and 32-bit sockets for expansion boards.

The Access 386's power supply is rated at 200 watts, sufficient power for almost any expansion. The motherboard has a socket for the addition of an (as yet unreleased) 80387 numeric coprocessor chip. If you need a numeric coprocessor before the 80387 becomes available, ALR offers a small board that contains a high-speed 80287 and plugs into the 80387 socket. Unfortunately, you must remove the hard disk drive to gain access to the 80387 socket.

The Deskpro 386 is equally blessed with room for expansion. Its power supply is also rated at 200 watts. The motherboard has a socket for an 80287 numeric

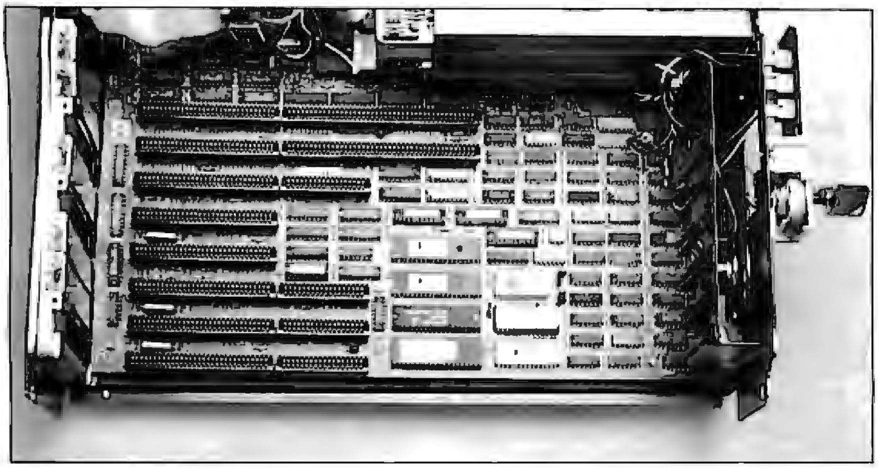


Photo 2: *Motherboard for the ALR Access 386. Note the 32-bit bus connectors on the upper left side near the power supply and the jumpers on the upper right side of the board.*

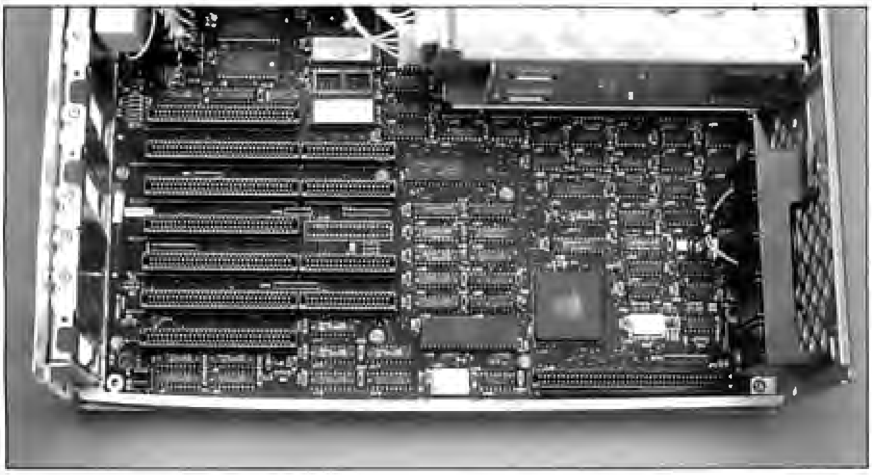


Photo 3: *Motherboard for the Compaq Deskpro 386. The 32-bit bus connector for the system memory board is located in the lower right corner, while the power and ground connectors are in the lower left corner.*

coprocessor chip. The socket is located near the system memory board slot and is easily accessible.

Software

The only software that came with the Access 386 was a setup disk containing programs to set system parameters and the time and date on the internal clock/calendar. We used PC-DOS 3.2 as the operating system and experienced no compatibility problems. ALR will bundle Quarterdeck Office Systems' DESQview 1.3 and an expanded memory manager with the machine.

The Deskpro 386 comes with MS-DOS 3.1, Compaq BASIC 3, and the Compaq Expanded Memory Manager (CEMM). CEMM is a software driver that allows programs to use memory beyond the 640K-byte limit imposed by MS-DOS. CEMM is compatible with the Lotus/Intel/Microsoft Expanded Memory Specification. You can configure the driver to use up to 8 megabytes.

We used several software packages with both computers, including The Norton Utilities, Norton Commander, XyWrite III, Lotus 1-2-3, and Microsoft Multiplan. All the programs operated correctly, and their speeds were significantly improved when running at 16 MHz.

Unlike the ALR Access 386, the Deskpro 386's running speed can be altered to allow you to run software that is timing-critical. The Compaq DOS includes a MODE SPEED command for changing the speed of the microprocessor. The default parameter is Auto, which will automatically switch the speed as required by certain programs. For maximum speed you can set the speed to High, which is 16 MHz. If a program has difficulty running, you can use the Fast mode to reduce the speed to 8 MHz. For even more com-

continued

ALR Access 386

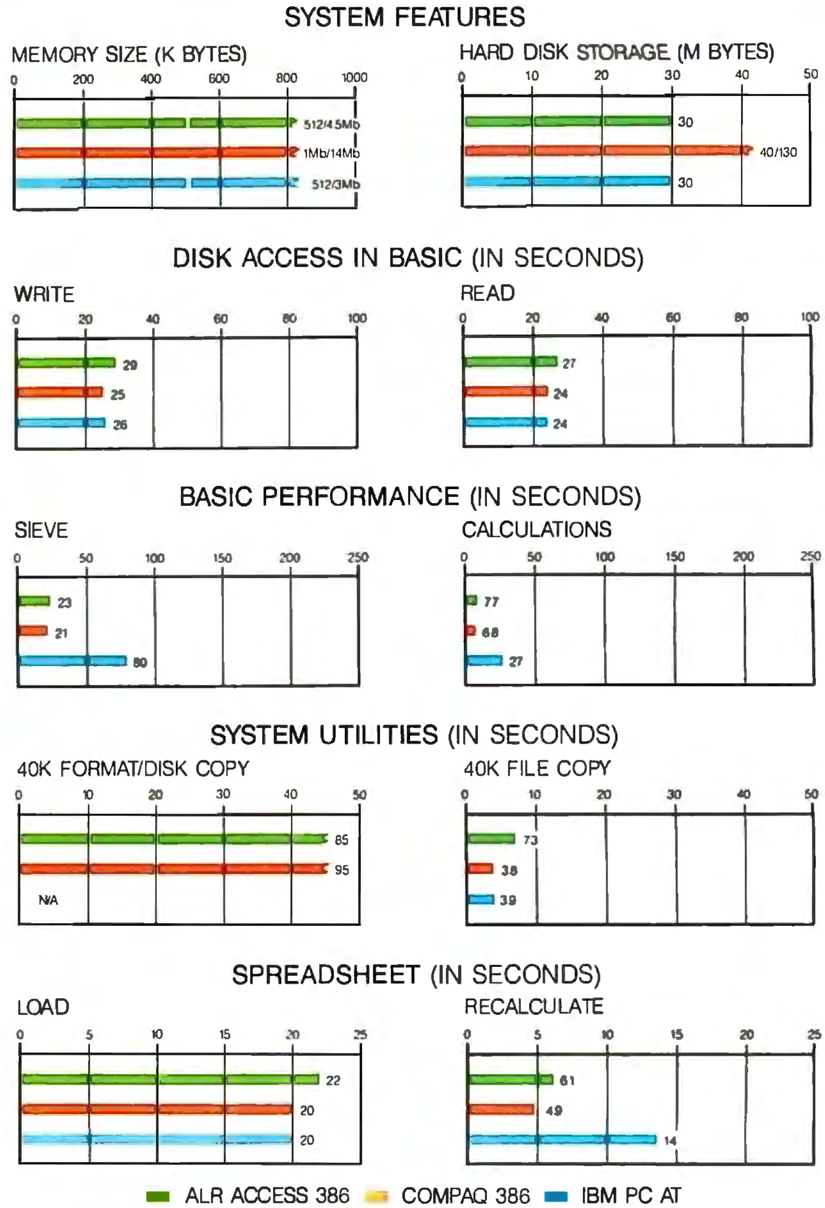
Company
Advanced Logic Research Inc.
10 Chrysler Ave.
Irvine, CA 92718
(714) 581-6770

Size
21 by 17 by 6½ inches; 42 pounds

Components
Processor: 16-MHz 32-bit Intel 80386; socket for optional Intel 80387 numeric coprocessor operating at 16 MHz or 80287 numeric coprocessor module operating at 10 MHz
Memory: 512K bytes of 32-bit interleaved RAM; 32K bytes of Phoenix BIOS ROM
Mass storage: 1.2-megabyte floppy disk drive; 30-megabyte hard disk drive with 40-ms access time
Keyboard: 84-key PC AT-style keyboard with separate numeric keypad
I/O interfaces: RS-232C serial port with male DB-25 connector; parallel port with female DB-25 connector

Documentation
Access 386 user's manual

Price
Basic system with 512K bytes of RAM, 1.2-megabyte floppy disk drive, and one serial and one parallel port: $3990
Enhanced monochrome system with 1 megabyte of RAM, 1.2-megabyte floppy disk drive, 30-megabyte hard disk drive, two serial and two parallel ports, Hercules-compatible monochrome graphics card, and high-resolution monochrome monitor: $5890
Enhanced color system with 2.5 megabytes of RAM, 1.2-megabyte floppy disk drive, 30-megabyte hard disk drive, three serial and three parallel ports, ALR EGA-compatible video card, and EGA/CGA color monitor: $6949



The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Hard Disk Storage graph shows the highest capacity of a single hard disk drive. The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank 1.2-megabyte floppy disk. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graphs show how long it takes to load and recalculate a 25-by 125-cell spreadsheet in which each cell equals 1.001 times the cell to its left.

The spreadsheet used was Microsoft's Multiplan version 1.06. Tests on the ALR Access 386 computer were done using PC-DOS 3.2 and GW-BASIC 3.11. The Compaq Deskpro 386 used Compaq DOS 3.1 and Compaq BASIC 3.11. The IBM PC AT used PC-DOS 3.2 and BASICA 3.2 running at 6 MHz.

Compaq Deskpro 386

Company
Compaq Computer Corp.
20555 FM 149
Houston, TX 77070
(713) 370-0670

Size
20 by 16½ by 6½ inches; 42 pounds

Components
Processor: 16-MHz 32-bit Intel 80386; socket for optional Intel 80287 16-bit coprocessor operating at 8 MHz
Memory: 1 megabyte of 32-bit 100-ns memory on system memory board; 128K bytes of BIOS ROM
Mass storage: 1.2-megabyte 5¼-inch floppy disk drive; 40-megabyte hard disk drive with 30-ms access time
Keyboard: 84-key IBM PC-style keyboard with separate numeric keypad and 10 function keys; 101-key IBM RT PC-style keyboard with separate numeric keypad, cursor keys, and 12 function keys
I/O interfaces: RS-232C serial port with male DB-9 connector; parallel port with female DB-25 connector

Options

XENIX System V/286 base operating system:	$599
Software development system:	$599
Text processing system:	$199
Compaq color monitor:	$799
Compaq dual-mode monochrome monitor:	$255
Enhanced color graphics board:	$599
Video display controller board:	$199
40-megabyte tape cartridge backup unit:	$799
Additional 1 megabyte of RAM for system memory board:	$549
2-megabyte piggyback board with 1 megabyte of RAM:	$849
2-megabyte piggyback board with 2 megabytes of RAM:	$1398
8-megabyte piggyback board with 4 megabytes of RAM:	$2999
Additional 4 megabytes of RAM for 8-megabyte piggyback board:	$2699
360K-byte 5¼-inch floppy drive:	$225

Documentation
Operations guide; MS-DOS reference guide; BASIC reference guide. Optional: two-volume technical reference guide; color graphics board installation and operations guide; maintenance and service guide.

Price

Model 40 with 1 megabyte of RAM, 1.2-megabyte floppy disk drive, and 40-megabyte hard disk drive:	$6499
Model 130 with 1 megabyte of RAM, 1.2-megabyte floppy disk drive, and 130-megabyte hard disk drive:	$8799

patibility, you can set the mode to Common, which reduces the speed to 6 MHz. No matter what speed you set the microprocessor at, the bus will remain at 8 MHz. The speed you select remains in effect until you turn the computer off.

Both computers failed one favorite test of compatibility: They wouldn't run Microsoft's Flight Simulator. Both computers attempted to boot the program but then locked up, and we had to turn them off before we could restart them. We weren't too disappointed; these computers are definitely not game machines.

The future of software for the 80386 looks bright. Already software developers have written development software such as 386/ASM and 386/LINK, an 80386 assembler and linker package from Phar Lap Software (60 Aberdeen Ave., Cambridge, MA 02138, (617) 661-1510). DESQview version 1.3 supports both computers' virtual machine architecture and allows you to run up to nine programs concurrently with multiple windows.

Benchmark Results

There is a danger in using computers such as the Access 386 and the Deskpro 386; most other personal computers seem hopelessly slow in comparison. Judged by most standards of microcomputer performance, the Access 386 and Deskpro 386 fairly fly. They are fast enough to require a reworking of one of the BYTE benchmarks. The 25- by 25-cell spreadsheet loaded so quickly (considerably less than 1 second) that human reaction time became a major variable in timing. To compensate, we used a 25- by 125-cell spreadsheet and still had impressive results.

In a side-by-side comparison of the benchmark results, the Deskpro 386 came out as the faster computer, but not by much. In most tests, the timing difference was only seconds. These differences can be attributed to variations in the hardware design, ROM BIOS, and DOS. For most practical applications, the Deskpro 386 and Access 386 are comparable.

Documentation

The user's manual that comes with the Access 386 is not a glossy color affair, but the production values are not what makes it an unsatisfactory document. Its first major drawback is the lack of an index. Some areas, such as the setting of switches and jumpers, are well covered but difficult to find without an index. Another major drawback is in the emphasis of the documentation. It is very curious that, in a manual for a computer of this type, the keyboard receives more pages than any other topic. The manual does not mention the 32-bit bus, but it does explain the function of the space bar. Another drawback of the documentation is the lack of illustrations. Of the illustrations provided, 28 are of the keyboard, and all are of poor quality.

The beginning of the manual refers the reader to several component manuals for "detailed information on the various subassemblies," but this does not take away the requirement for comprehensive, well-organized documentation covering the computer as a whole. Another flaw is the reference to the use of IBM's BASICA on the Access 386. BASICA will run only on true IBM PC-compatible computers. This is a glaring error that detracts from the quality of the computer.

In contrast, the Deskpro 386 comes with a wealth of information. Standard manuals included with the computer are an operations guide, an MS-DOS reference guide, and a BASIC reference guide. Optional manuals available are a two-volume technical reference guide, a color graphics board installation and operations guide, and a maintenance and service guide. All the manuals are well written, indexed, and thoroughly illustrated. They cover every feature of the computer, operating system, and software.

Summary

There has been a lot of discussion about who needs an 80386 computer. The 80386 systems are ideal for software developers, heavy-duty database users, and computer users who do intense number crunching. They would all benefit from the increased speed and performance. However, the real motivation for buying an 80386-based system is speed. No user likes to wait for a computer.

The ALR Access 386 is a computer that is high-performance in nearly every sense of the word. As one of the first in a new generation of small computers, it shows impressive performance gains while providing compatibility with old, familiar software. With a base price of $3990, the Access 386 would be a true bargain except for two problems: Soldered jumper wires on the motherboard of a computer of this sophistication are of great concern to us, and the poor quality of the documentation is inexcusable. If these two problems are of little concern to you, then the ALR Access 386 offers high-speed microcomputing at a very reasonable cost.

The Compaq Deskpro 386 excels in nearly every capacity. It has a solid design with outstanding performance, and it is backed by the proven support of Compaq. However, all this excellence comes at a high price. The basic Model 40 lists for $6499. A Model 40 comparably equipped to an ALR Access 386 enhanced color system would cost over $8700. You pay for the Compaq quality. ■

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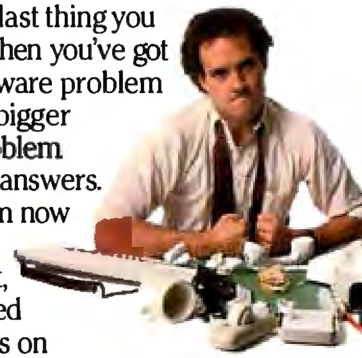

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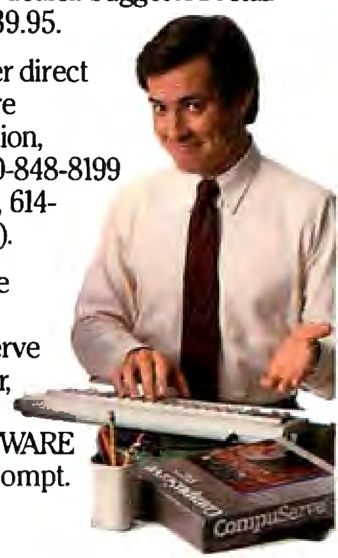

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Four Portable Computers

John D. Unger

IBM PC–compatible offerings from Toshiba, Zenith, Bondwell, and IBM

In this review, I'll compare four IBM PC-compatible portable computers: the Toshiba T1100 Plus (lower right), the Zenith Z-181 (upper left), the Bondwell 8 (lower left), and the IBM PC Convertible (upper right). Perhaps because of their small size, I found these computers to be much more "personal" than the many desktop machines I have used and reviewed over the years. All four use double-sided 3½-inch disk drives that store 720K bytes, and all but the Bondwell come equipped with dual drives. All but the IBM Convertible come with MS-DOS 2.11 and GW-BASIC.

The Toshiba T1100 Plus's standard configuration ($1999) is impressive. It includes 256K bytes of RAM, parallel and serial ports, RGB and composite video ports, an LCD screen, a connector for an external disk drive, and Borland's SideKick program. The unit I reviewed also had an optional internal 1200-bps modem and 640K bytes of RAM (the 640K-byte model costs $2399). The T1100 Plus stands out from the pack in processing speed: It has an 80C86 microprocessor that you can switch between 4.77 MHz and 7.16 MHz.

The Zenith Z-181 ($2399) includes 640K bytes of RAM and the same standard features as the T1100 Plus. The Z-181 also has a backlit display with an aspect ratio like that of a standard CRT display. In addition, the Z-181 includes a ROM-based program called MPM-180, which contains advanced hardware diagnostics, a debugging facility similar to Microsoft's Debug, and other useful system-related utilities.

Unlike the other units reviewed here, the Bondwell 8 ($1295) has only one internal 3½-inch disk drive; a second external drive is available as an option. The system comes equipped with 512K bytes of RAM, which cannot be expanded, and an internal 300-bps modem. The Bondwell 8 also has a communications program called MODEM8 for use with its internal modem. Like the Z-181, the Bondwell 8 uses a backlit LCD.

The IBM PC Convertible ($1995) comes with the least number of standard features. It has only 256K bytes of RAM, which you can upgrade to a maximum of 512K, and it has no I/O ports on its main board. You can add options to the PC Convertible by connecting "slices" of hardware onto the rear of the machine via a proprietary bus. Each slice has an input and an output connector, which allows you to stack slices one behind the other on the back of the machine. Even without any slices added, the IBM is a full two or more inches deeper than the other systems. You should expect to add about $1000 to the base price for extras, including an operating system ($95), to make the PC Convertible comparable to the T1100 Plus or the Z-181 system.

The PC Convertible includes, however, an LCD screen and an icon-based set of programs called Application Selector, which is actually a shell that sits on top of the operating system. The Application Selector provides access to a disk-based series of programs that includes a simple word processor, an appointment calendar, a phone directory and auto-dialer, and a calculator.

Portable Hardware

As befits a true portable computer, three of the machines have a handle for easy carrying; only the Z-181 lacks this convenience. The handles on the T1100 Plus and Bondwell 8 fold out of the front and rear of the case, respectively, and the PC Convertible's handle slides out of the front just beneath the keyboard and doubles as a comfortable wrist rest for typing on a tabletop.

Each machine is a self-contained unit capable of operating continuously for at least five hours on a single charge of its internal nickel-cadmium batteries. However, each laptop uses a different battery configuration. The T1100 Plus has a 9-volt system, the PC Convertible's has 15 volts, the Bondwell 8's has 13.8 volts, and the Z-181's has 18 volts. You can plug or unplug the AC adapter/chargers for the Z-181, the T1100 Plus, and the PC Convertible from their respective computers

continued

John D. Unger (P.O. Box 95, Hamilton, VA 22068) is a geophysicist for the U.S. government who writes graphics software and uses computers to study the structure of the earth's crust.

T1100 Plus

Company
Toshiba America Inc.
Information Systems Division
2441 Michelle Dr.
Tustin, CA 92680
(714) 730-5000

Size
12 by 12 by 2½ inches; screen size: 9 by 4 inches; weight: 10 pounds

Components
Processor: 80C86, keyboard-switchable from 4.77 to 7.16 MHz
Memory: 256K bytes of RAM (standard); expandable to 640K bytes on system board as option; 640K-byte model available
Mass storage: Two 720K-byte double-sided, double-density 3½-inch floppy disk drives
Display: 80-column by 25-row LCD; emulates IBM Color Graphics Adapter in black and white to give 320- by 200-pixel or 640- by 200-pixel monochrome graphics
Keyboard: 81 keys, including 10 function keys; special editing key cluster; numeric keypad selectable on ASCII keyboard
Battery power: 9-volt nicad rechargeable; approximate lifetime: 8 to 10 hours
Expansion: Optional expansion chassis with five IBM PC-compatible slots
I/O interfaces: RS-232C serial port, 9-pin male D-shell; Centronics-compatible parallel port for printer or optional external disk drive, 25-pin female D-shell; IBM PC–compatible RGB video port; composite video port with phono jack; IBM PC–compatible I/O bus

Software
MS-DOS 2.11; SideKick; GW-BASIC

Options
External 5¼-inch disk drive; internal 300/1200-bps Hayes-compatible modem; floppy link card for IBM PC-compatible desktop computer; 384K-byte memory expansion board; five-slot expansion chassis; automotive power adapter

Documentation
User's manual; MS-DOS manual; SideKick manual

Price

256K-byte model:	$1999
640K-byte model:	$2399

Z-181

Company
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 391-8860

Size
11½ by 13½ by 3 inches; screen size: 8½ by 6½ inches; weight: 12 pounds

Components
Processor: 80C88 at 4.77 MHz; socket for 8087 coprocessor
Memory: 640K bytes of RAM (standard)
Mass storage: Two 720K-byte double-sided, double-density 3½-inch floppy disk drives
Display: 80-column by 25-row LCD; emulates IBM Color Graphics Adapter in gray tones to give 320- by 200-pixel or 640- by 200-pixel monochrome graphics; uses electroluminescent backlighting
Keyboard: 75 keys, including 10 function keys; special editing key cluster; numeric keypad selectable on ASCII keyboard
Battery power: 18-volt nicad rechargeable; approximate lifetime: 5 to 7 hours
Expansion: None
I/O interfaces: RS-232C serial port, 25-pin male D-shell; Centronics-compatible parallel port for printer; port for optional external disk drive, 25-pin female D-shell; IBM PC–compatible RGB video port

Software
MS-DOS 2.11; GW-BASIC; MPM-180

Options
External 5¼-inch disk drive; internal 300/1200-bps Hayes-compatible modem; 8087 coprocessor

Documentation
User's manual

Price
$2399

Bondwell 8

Company
Bondwell Inc.
3300 Seldon Court
Suite 10
Fremont, CA 94539
(415) 490-4300

Size
12¼ by 11¼ by 3 inches; screen size: 9 by 3 inches; weight: 11½ pounds

Components
Processor: 80C88 at 4.77 MHz
Memory: 512K bytes of RAM (standard)
Mass storage: One internal 720K-byte double-sided, double-density 3½-inch floppy disk drive
Display: 80-column by 25-row LCD with electroluminescent backlighting; emulates IBM Color Graphics Adapter in shades of gray to give 320- by 200-pixel color graphics or 640- by 200-pixel monochrome graphics
Keyboard: 76 keys, including 10 function keys; special editing key cluster; numeric keypad selectable on ASCII keyboard
Battery power: 13.8-volt nicad rechargeable; approximate lifetime: 4 to 6 hours
Expansion: None
I/O interfaces: RS-232C serial port, 9-pin female D-shell; Centronics-compatible parallel port, 15-pin female D-shell; external floppy disk drive port for optional disk drive; IBM PC–compatible RGB video port; composite video port with phono jack; standard telephone jack for internal 300-bps modem

Software
MS-DOS 2.11; GW-BASIC 2.02; MODEM8 communications software

Options
External 3½-inch disk drive; external 5¼-inch disk drive; serial and parallel cables

Documentation
User's manual; MS-DOS and GW-BASIC user's guides

Price
$1295

IBM PC Convertible

Company
IBM Corp.
11400 Burnet Rd.
Austin, TX 78758
(512) 838-3300

Size
14¼ by 12 by 3 inches; screen size: 10¼ by 3½ inches; weight: 12½ pounds

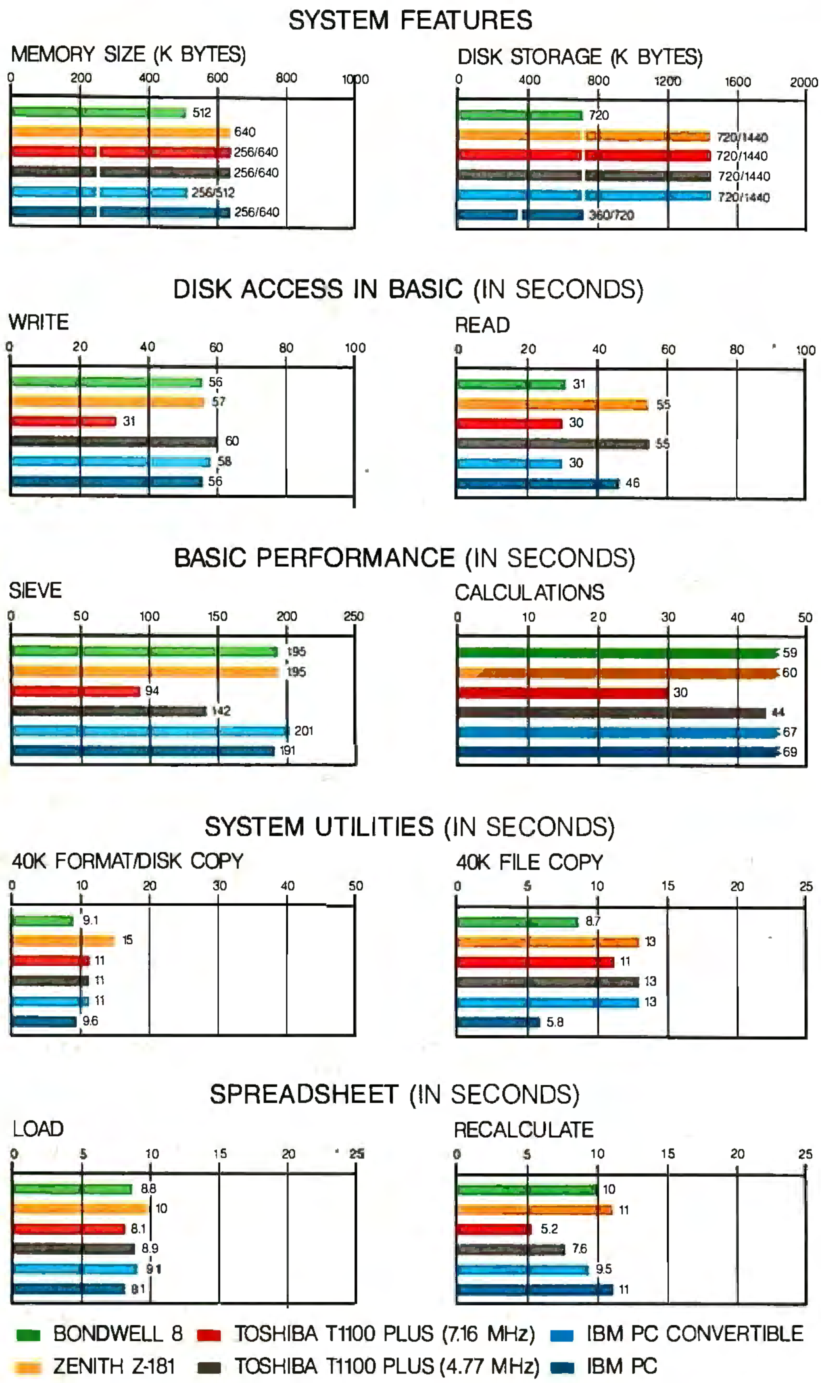
Components
Processor: 80C88 at 4.77 MHz
Memory: 256K bytes of RAM (standard); expandable to 512K bytes on system board as option
Mass storage: Two 720K-byte double-sided, double-density 3½-inch floppy disk drives
Display: 80-column by 25-row LCD; emulates IBM Color Graphics Adapter in black and white to give 320- by 200-pixel or 640- by 200-pixel monochrome graphics
Keyboard: 78 keys, including 10 function keys; special editing key cluster; numeric keypad selectable on ASCII keyboard
Battery power: 15-volt nicad rechargeable; approximate lifetime: 9 to 11 hours
Expansion: Accepts two optional additional 128K-byte memory boards and an internal modem
I/O interfaces: IBM 72-pin proprietary expansion bus; plug for external power supply/battery charger

Software
IBM Application Selector software

Options
PC-DOS 3.2; internal 300/1200-bps modem; dot-matrix printer; serial/parallel adapter; CRT display adapter; monochrome display; color display; automobile power adapter; 128K-byte memory board

Documentation
User's guide; PC-DOS user's guide (optional)

Price
$1995



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 floppy disk drive and the maximum standard capacity for each system. The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graphs show how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The spreadsheet used was Microsoft's Multiplan 1.06. GW-BASIC 2.02 was used for the Bondwell 8, Z-181, and T1100 Plus BASIC benchmarks. IBM BASICA 3.2 was used for the PC Convertible BASIC benchmarks. The system utilities were run using MS-DOS 2.11 or PC-DOS 3.2 as supplied by each company.

Using these systems with certain software can be tedious.

without interrupting normal operations. However, you must switch off the Bondwell 8 before connecting or removing its battery charger.

Each portable has a low-battery-power indicator that gives you plenty of warning when you are running out of power so that you can save your data to disk and turn off the system. The battery life of the individual units varies, but the two computers with backlit LCDs, the Z-181 and Bondwell 8, have the shortest battery life.

Compromising Keyboards

In all these systems, the keyboard is an area of compromise. The main ASCII portions of the keyboards have the same dimensions as a desktop computer keyboard, and the key tops are full-size. Also, all the portables have ten function keys arranged horizontally above the number keys. However, even though the keyboards have all the standard IBM PC key functions, you have to learn new techniques to activate them. Variations creep in where the manufacturers have incorporated numeric keypad and editing keys.

And just when you thought that IBM had its keyboard layout act together, along comes the PC Convertible. On this keyboard the Ctrl key is just below the left Shift key (where the Alt key usually resides) and, for some reason, IBM has put two Alt keys on this keyboard, one at each end of the space bar. Fortunately, the other three manufacturers stuck to a more typical arrangement of the Ctrl and Alt keys. However, just to keep things interesting, Zenith squeezes the Caps Lock key between the *A* key and the Ctrl key.

The T1100 Plus has separate arrow, Home, End, PgUp, and PgDn keys for editing and, like the other systems, several of the letter and number keys on the main keyboard double as numeric keypad keys. The PC Convertible also has separate arrow keys for editing, but you have to use a key labeled Fn to shift the arrow keys to get Home, End, PgUp, and PgDn functions. Except for the PC Convertible's Ctrl and Alt keys mentioned earlier, the Z-181's keyboard otherwise resembles that of the PC Convertible—including the addition of an Fn key. The Bondwell 8 has a special cluster of editing keys in the top right corner that are easy to learn but awkward to reach. Some of the Bondwell 8's keys have as many as four different functions, depending on the Num (number lock) toggle and use of the Shift and Alt keys.

All the keyboards were easy to type on. However, the key caps of the lowest keys on the Z-181 and Bondwell 8 keyboards are more than two inches above the tabletop; I found this arrangement somewhat awkward compared to the one-inch-high keyboard on my AT&T PC 6300 desktop.

Moreover, using any of these systems with certain software can be somewhat tedious compared to using a desktop computer. For example, to activate or leave the memory-resident program Ready! after it has been loaded, normally you simultaneously press the Ctrl and 5 on the numeric keypad—a fast operation on a typical desktop keyboard. But on the T1100 Plus, for example, you have to press Num Lock first to toggle on the keypad, then press Ctrl and 5, and then remember to toggle the Num Lock key back off again.

Display Twists

The quality of a portable's display can make or break the machine's usefulness. Two of the portables, the Bondwell 8 and the Z-181, have backlit screens, while the other two have more traditional LCDs that depend on incident lighting.

To conserve battery power, the Bondwell 8 has a switch to turn its backlighting off. Unfortunately, the readability of the screen is so poor that you must have the backlighting on most of the time. Even with the backlighting on, the gray characters are washed out on the greenish background. Outdoors on a bright day, the Bondwell 8 display is almost as good as the other portables' displays when they are used under the poorest lighting. I was not impressed with the Bondwell 8's screen.

The Z-181 uses a state-of-the-art technology called "supertwisted birefringent," or simply "supertwist," in its LCD that provides bright blue characters on a light gray, almost white, background. The supertwist LCD gives the Z-181 two important improvements over the other displays: increased contrast of the "on" pixels with the background, or "off," pixels, and legibility of the screen from wider viewing angles.

Nothing comes for free. Part of the price you pay for the Z-181's display quality is in decreased battery life. Even though built-in software turns off the backlighting after about two minutes of keyboard inactivity, the Z-181's average battery life is less than that of the other portables. When the computer temporarily turns off the backlighting, the screen is still legible. You simply hit any key to bring the backlighting up to its previous level.

The Z-181 emulates the IBM PC's Color Graphics Adapter display but does only a fair job of reproducing colors as shades of blue and a peculiar blue-brown. The color rendition is very sensitive to the amount of contrast, and the entire range of shades is impossible to achieve at any one setting. The Bondwell 8 is also compatible with the CGA display and, like the Z-181, attempts to emulate colors (with shades of gray), but achieves even less of a range with its display than the Z-181.

The displays on the T1100 Plus and PC Convertible are very similar, with the T1100 Plus having the edge in contrast and low-light legibility. Both display easily read characters as dark gray on a light gray background. Their screens produce good contrast under normal to poor indoor lighting conditions, but I had to turn up the PC Convertible's contrast control to its highest setting much of the time. The character set on the PC Convertible is particularly well designed; it is not up to par with IBM's Monochrome Display Adapter characters because of the LCD's reduced resolution, but it is better than the standard CGA-based character set used by the other portables.

Neither the T1100 Plus nor the PC Convertible attempt to discern shades of gray other than black and white (which they show as dark gray and light gray). This is fine for character displays but makes viewing programs that use color graphics difficult. Both of these portables display 320- by 200-pixel and 640- by 200-pixel graphics, but their character displays also support monochrome attributes such as blinking, high intensity, and reverse video. The T1100 Plus has a memory-resident utility program that allows you to change the screen's display attributes to best suit certain software.

Of the four portables, the Z-181 has the best aspect ratio. The screens on the other portables have aspect ratios (width to height) that range from 2.3 to 1 for the T1100 Plus to 3.1 to 1 for the Bondwell 8 compared to 1.3 to 1 for the Z-181. This means that the Z-181's screen displays graphic shapes virtually the same as a normal CRT, while circles appear as ovals on the T1100 Plus, Bondwell 8, and PC Convertible displays.

You can continuously adjust the T1100 Plus and Bondwell 8 screens from 0 degrees (just barely opened) to about 180 degrees (staring up at the ceiling). The Z-181 opened up to about 150 degrees, but I could tilt the PC Convertible's display only to about 120 degrees, or just beyond vertical. There were situations where I wished I could have tilted the display on the PC Convertible further to improve the legibility and contrast.

Disk Storage and I/O

All four of the portables use double-sided 3½-inch drives and can store up to 720K

continued

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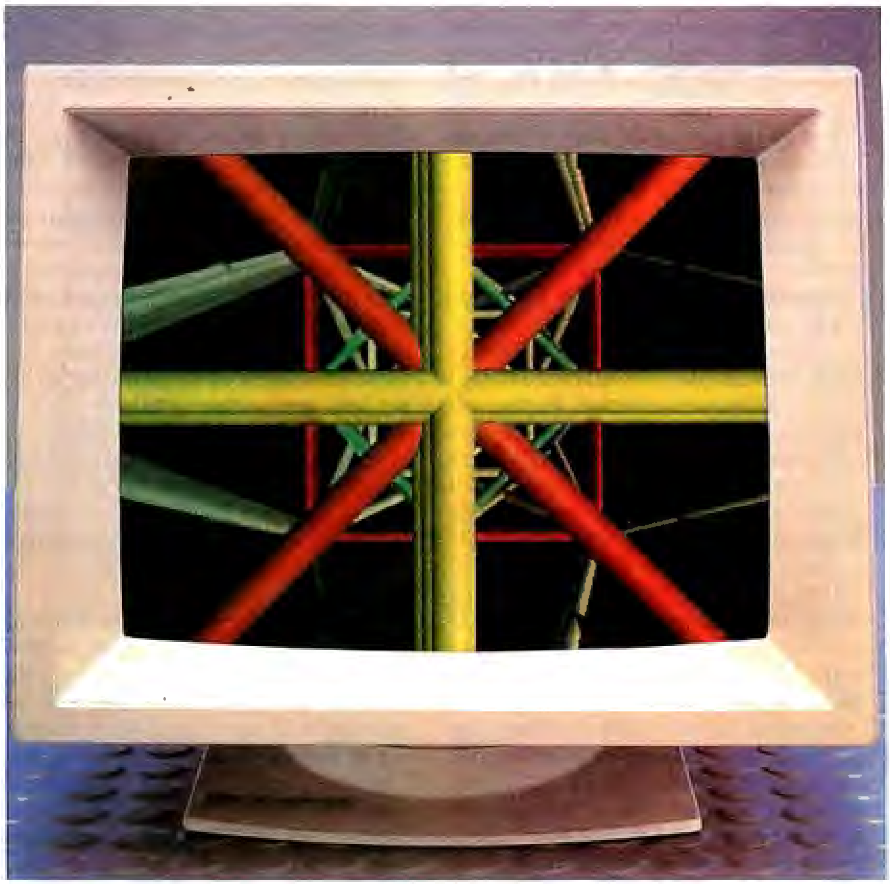

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The biggest source of incompatibility was the displays.

bytes on a single disk. The disk drives on the Z-181 and PC Convertible are located on the top of the computer and face forward. This configuration is more convenient than that on the T1100 Plus and Bondwell 8. These machines have their drives on the side of the case where you can't see if you have a disk in a drive. For some reason, the PC Convertible's drives were much noisier than those on the other computers, but the noise was not a serious problem.

Bondwell, Zenith, and Toshiba offer optional external 5¼-inch disk drives. Rather than providing a 5¼-inch drive for its PC Convertible, IBM offers a 3½-inch external drive for its desktops for transferring data to and from portable and desktop computers. Toshiba included its 5¼-inch drive with my review unit, and I used it extensively to transfer test programs and benchmarks from 5¼-inch disks to the 3½-inch format. In addition to the external 5¼-inch drive, Toshiba also offers an expansion board for your IBM PC-compatible desktop that allows you to use one of the desktop's disk drives as an external drive for the T1100 Plus.

A switch on the T1100 Plus lets you designate the external 5¼-inch drive either as the A or B drive for the system. When the external drive is set as the A drive, the computer will boot from the external drive, thus making it possible to load and run copy-protected 5¼-inch disks. Regardless of the switch setting, you can have only two functional disk drives active on the system at any one time (either the two internal 3½-inch drives or the external 5¼-inch drive and one internal drive).

All the portables except the PC Convertible include serial and parallel ports, but the type of connector used for these ports varies from machine to machine (see pages 222 and 223). The parallel printer port on the T1100 Plus doubles as the port for an external disk drive. A three-position switch on the side of the computer determines whether the parallel port is set up for a printer or for using the external drive as the A or B drive.

All the machines except the PC Convertible have standard RGB ports to attach a color monitor; the T1100 Plus and the Bondwell 8 also have a phono jack with composite video output to connect to an external monochrome monitor. This combination produces shades of gray in color graphics display mode.

Finally, all the portables have provisions for an internal modem. The Bondwell 8 comes equipped with a 300-bps modem, and 1200-bps modems are offered by the other three manufacturers as options. The PC Convertible's optional modem, however, is not compatible with the popular Hayes modem protocol and therefore will not work properly with some communications programs.

Performance and Compatibility

As the benchmark results show, the T1100 Plus running in its 7.16-MHz mode is clearly the performance leader. You should note, however, that the increased clock speed is significant principally for nondisk I/O tasks. Even in its slower 4.77-MHz mode, the T1100 Plus shows the advantage of its 80C86 microprocessor over the 4.77-MHz 80C88 microprocessors used in the other three machines. The T1100 Plus starts up in 7.16-MHz mode, but you can switch it at any time to 4.77-MHz mode or back to 7.16 MHz by pressing a combination of keys. I found no software that did not run in the fast mode; however, I used the 4.77-MHz mode to make some IBM PC-compatible games run slower. See page 223 for the complete benchmark results.

You can improve the number-crunching capability of the Z-181 by adding an 8087 coprocessor to an empty socket on the system board. (My review unit was not equipped with one.) The Z-181 is the only one of the four portables with this option.

All the portables ran my collection of IBM PC software well. However, I had to use the Copy II PC program for transferring copy-protected disks from their 5¼-inch format to the 3½-inch format. The only problem was that Copy II PC formats the 3½-inch disks for only 360K bytes, the same as the source disk's capacity.

The biggest source of incompatibility with IBM PC software was with the portables' displays. Even the most compatible display, the Z-181's, cannot rigorously mimic the IBM CGA, and the PC Convertible and T1100 Plus displays compromise by using monochrome attributes for colors. In addition, the LCDs give a reverse-video effect—dark characters on a light background—that causes Flight Simulator on the T1100 Plus or PC Convertible to look like you are flying at night.

Interesting Options

The PC Convertible has many options available for it, mainly because it comes with so few standard features in its normal configuration. Two options, the 128K-byte memory board ($195) and the 300/1200-bps modem ($450), go inside the unit; all the other options (several can be piggybacked) attach to a connector on the rear of the computer. As mentioned earlier, each slice makes the already large portable deeper and deeper. The most interesting slice for the PC Convertible is a dot-matrix printer ($295) that is only about 4½ inches deep. It operates off of the internal battery pack and provides good-looking hard copy. The printer uses a ribbon to print on standard bond paper, or it can print on special thermal paper without a ribbon installed.

Toshiba has an intriguing option that may appeal to someone who wants to use the T1100 Plus as a double-duty machine—on the desktop and on the road. This option is a self-powered expansion chassis that can accommodate up to five full-length IBM PC-compatible expansion cards. The chassis connects to the T1100 Plus via a special expansion bus. This option is expensive ($999) but is one that might prove practical in some situations.

But the most important option is yours—which should you buy? All four of these portables are real IBM PC-compatible computers. Overall they perform as well as, or better than, their full-size desktop counterparts. In every case, however, the keyboards are awkward for tasks that call for numeric keypad functions or some editing key functions. The keyboards can also be frustrating to use when you have to frequently switch from a desktop keyboard. However, these portable-keyboard compromises are not too difficult to live with.

Either the Z-181 or T1100 Plus would be a good choice, although both would be superior portables if each had the best feature of the other: the Z-181 with a faster processor and the T1100 Plus with a supertwist backlit LCD. If performance is important to your application, then the T1100 Plus would be your best choice. Its 80C86 running at 7.16 MHz makes this machine a clear winner in the benchmark tests.

Only the Z-181 has a display that rivals a desktop's CRT display. Although the PC Convertible and T1100 Plus have about the best nonbacklit LCDs that I have seen, they pale in comparison to the Z-181's supertwist backlit LCD. The Bondwell 8's display is barely adequate and makes an otherwise good portable wearisome to use.

Neither the PC Convertible nor the Bondwell 8 should be considered a great buy. The PC Convertible has no special advantages that offset its larger size and lack of standard features, and although it has no serious shortcomings, you will have to spend almost $1000 over the base price to get the features that come standard on the other machines. The Bondwell 8 would be a bargain were it not for its relatively poor display. ■

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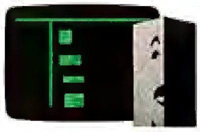

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System Analysts/Programmers like Harriett **easily prototype design changes while interacting with Department Heads. Harriett has prototyped some requested changes in a Mainframe Payables System. With the help of SIMPLE, she has built a test database with data imported from the mainframe and is able to review the check-ledger report, in the Controller's office on her portable computer.**

The Design screen may be painted exactly as you want using SIMPLE's built-in, full-screen editor which offers a wide range of capabilities to aid you—including the ability to delete or insert a character or an entire line, move or copy blocks of information, lasso text or variables, and window to other worksheets in one or two keystrokes. Powerful specification macros are invoked providing application users the ability to pop-up a window and browse through another file, interrupt data entry to perform another program, provide context-sensitive help, and perform conditional processing based on the user's input.

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Dave Menconi

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The Atari 1040ST, like the 520ST, has a powerful 68000 microprocessor, high-resolution color or monochrome graphics, and the TOS desktop for easy handling of programs and files. The 1040ST also has twice the memory (1024K bytes rather than 512K), a 3½-inch floppy disk drive and a power supply that are built in, and the TOS desktop in ROM rather than loaded from disk. [Editor's note: *See the product preview of the 1040ST by Phillip Robinson and Jon R. Edwards in the March 1986 BYTE for more introductory information.*]

The 1040ST does not, as Atari earlier stated it would, come with an RF modulator (a device that would allow you to use the 1040ST with a standard television set) or a graphics coprocessor (a so-called blitter chip). For color graphics you will need the color monitor, for a total system cost of $1199.99. The monochrome 1040ST system costs $999.99.

On the Outside

The 1040ST has three screen resolutions. Low resolution requires a color monitor, allows 16 colors (which you can select from a palette of 512 colors), and has 320 by 200 pixels. Medium resolution also requires a color monitor, allows 4 colors, and has 640 by 200 pixels. High resolution requires a monochrome monitor and has 640 by 400 pixels. There is no overlap between the monitors and the resolutions—the monochrome monitor can't do low or medium resolution, and the color monitor can't do high resolution. Furthermore, if you switch monitors while the system is on, the 1040ST does a warm restart, just as if you had pressed the reset button. Even switching between low and medium resolution has its problems, which I'll discuss later.

The 1040ST keyboard is somewhat spongier than most keyboards with which I am familiar, but I had little trouble adjusting. The keyboard is complete, including a numeric keypad, a set of cursor-control keys, Help and Undo keys, 10 function keys, an Esc key, and a Control key. The layout of the keyboard is quite convenient, especially the cursor-control keys, the Help and Undo keys, and the extra-large Return and Backspace keys. The designers of the 1040ST keyboard, while keeping user-friendliness in mind, also accommodated the more experienced users.

Among the benefits of the full keyboard are the special key combinations that perform useful functions. For example, pressing the Alternate key and the cursor keys allows you to move the cursor around the screen without using the mouse, and pressing the Alternate key and the Insert key has the same effect as pressing the mouse button. This feature lets you use the cursor-control keys even when the program is not designed for that.

The desktop does not take full advantage of several keyboard features. For example, it does not use the function keys, the Help key, or the Undo key. Similarly, the mouse has two buttons, but the desktop uses only the left one. This does, however, leave these unused features available for use by programmers; if the desktop had used them, designers would be stuck using them in the same way or else being inconsistent.

The 1040ST's 720K-byte double-density drive can read, write, and format single-sided and double-sided disks. Surprisingly, all the double-sided modes are slightly slower than their single-sided counterparts.

When the built-in drive turns on, the external drive also turns on, and vice versa. Also, for some reason, my external single-sided drive turned on for a second about once a minute even when the computer was off. Since this doesn't happen when the drive is connected to the 520ST or is disconnected entirely, it must be caused by the 1040ST.

The 1040ST's built-in power supply causes the top of the computer to get a little warm, but the chips inside seem adequately cooled. I left the system on for days at a time with no problems.

Under the Hood

Inside the case, the 1040ST is completely shielded to prevent RF interference.

continued

Dave Menconi (5333 Betsy Ross Dr., Santa Clara, CA 95052) is a software engineer for Computer Resources Inc.

Atari 1040ST

Company
Atari Corp.
1196 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2000

Size
18½ by 11½ by 2¾ inches

Components
Processor: Motorola 68000 with an 8-MHz clock
Memory: 1 megabyte of dynamic RAM; 192K-byte TOS in ROM, not including optional desk accessories
Mass storage: Internal 720K-byte double-sided, double-density 3½-inch drive; system supports a maximum of two floppy disk drives
Display: 12-inch monochrome or color monitor; three modes: 640- by 400-pixel monochrome, 320- by 200-pixel with 16 colors, and 640- by 200-pixel with 4 colors
Keyboard: 94-key IBM Selectric-style QWERTY keyboard with numeric keypad, cursor controls, and rhomboid function keys
Sound: Three independent sound channels from 30 Hz to 125 Hz
I/O interfaces: MIDI-in and MIDI-out ports
Centronics parallel printer port (supports Epson-compatible printers)
RS-232C serial port
Floppy disk port
Hard disk port (10-megabit-per-second DMA transfer rate)
128K-byte ROM cartridge
Ports for mouse and joystick or two joysticks

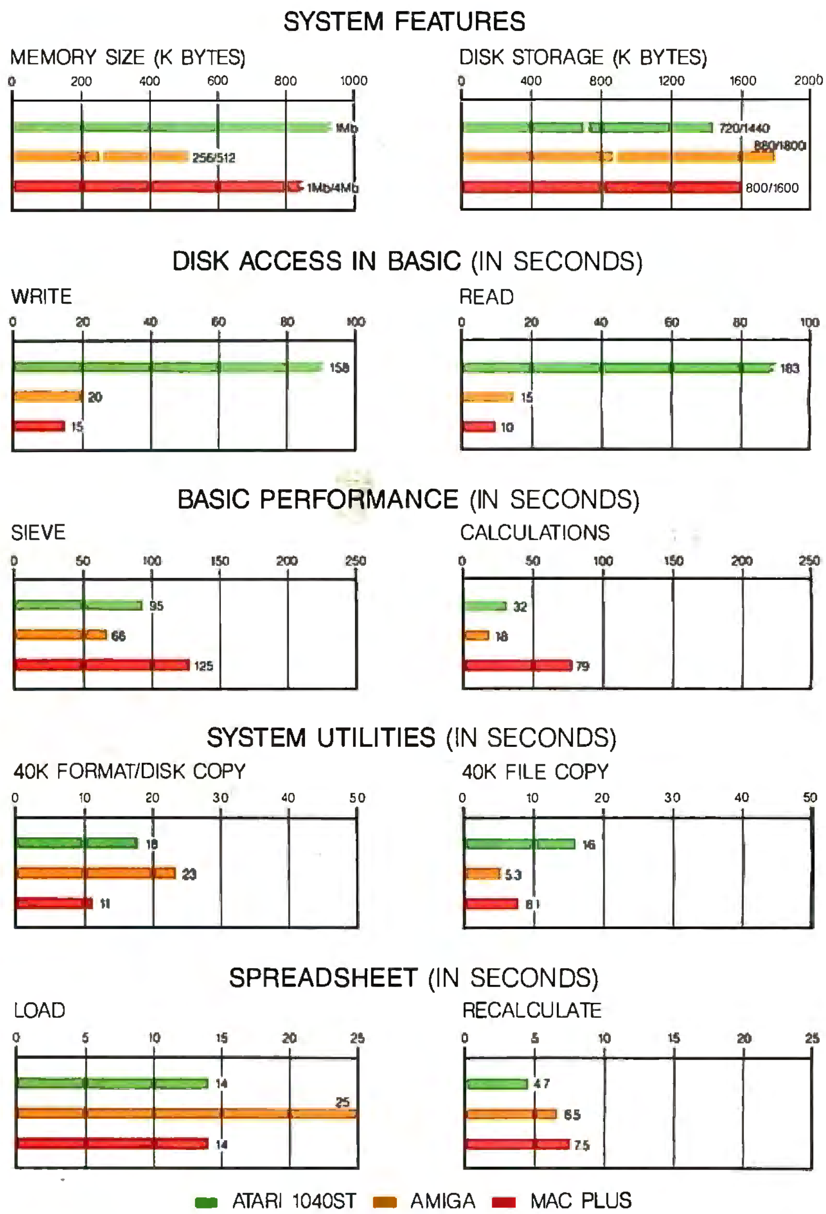
Software
Atari Logo, Atari ST BASIC, 1st Word word processor; NEOchrome graphics editor

Options

SF354 single-sided drive:	$199.99
SF314 double-sided drive:	$299.95

Price

Monochrome system:	$999.99
Color system:	$1199.99



The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single floppy disk drive and the maximum standard capacity for each system. The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a blank floppy disk. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet in which each cell equals 1.001 times the cell to its left. The Atari 1040ST tests were performed using TOS (in ROM), Atari ST BASIC, and Acalc spreadsheet. The Amiga tests were performed using the Workbench, Amiga BASIC, and the Lattice Unicalc spreadsheet. (Amiga BASIC requires a CLEAR ,30000, 30000 command for the Sieve to run.) The Macintosh Plus tests were performed using the Macintosh System and Finder, Microsoft BASIC, and Microsoft's Multiplan.

The power supply and the built-in disk drive are on separate boards that sit atop the main motherboard. The designers put the ROM chips under the power supply board where they can be easily upgraded. Going in deeper than that is a nuisance because of the shield that covers most of the motherboard.

Under the shield are the same parts that the 520ST has, but they are rearranged on a two-inch longer (from front to back) board to make room for another 16 RAM chips and the other components that are built in. The mouse and joystick plug into the keyboard through a hole in the bottom of the case, which makes the mouse harder to take off and replace than that on the 520ST. Despite early plans for an RF modulator, the 1040ST has only a blank space on the board where the modulator belongs.

TOS

The 1040ST's operating system (TOS) desktop lets you run programs, copy files, format disks, and perform all the other essential tasks of using a computer by clicking, dragging, and double-clicking icons with the mouse.

Until just before the release of the 1040ST, TOS was on disk and you had to load it into the system (a process that took half a minute or more) before you could do anything with the machine. Now the entire operating system is in ROM, allowing the computer to boot in 5 seconds (more if there are desk accessories on your initial program disk) and freeing up 200K bytes of RAM for your programs' use.

The desktop allows you to manipulate documents (data files), applications (programs), and folders (directories). Each folder is, in effect, like a separate subdisk drive. Thus, if the folder MAILLST (for your mailing list) on drive A is open, you cannot access any of the other files on drive A. This lets you break up the files into separate directories. Dealing with just the MAILLST files is easier than sorting through all the files on the disk.

Folders are especially useful on a hard disk. Within each segment, the folders break up the files into general categories. Within each folder, subfolders break up the files into smaller categories until the total number of items in a folder is manageable. This organization is one of the major reasons for buying a hard disk.

You can nest folders within folders up to eight deep, although I have never seen directories nested more than six deep, even on a minicomputer. You are limited to 40 folders on a floppy disk. Unfortunately, the system does not tell you when you have exceeded the 40-folder limit. At some point after you exceed the limit, strange things may start to happen to your disk—you may be unable to delete some files, the system may reset when you try to get information about the disk, or some other nasty quirk may develop. In practice, however, this is not much of a problem because you are unlikely to want more than 40 folders on a single floppy disk.

Another quirk is that copying a file to itself damages the directory of the disk. This can happen if you are copying files and you accidentally let go of the mouse button in the same window. The desktop will warn you about the conflict, but if you press Return or click on the OK icon, it will go ahead and possibly ruin the disk. Once again, this is not something that will happen often, but if it happens, the consequences are dire.

Another quirk occurs if you use programs that are in different screen resolutions. Once the system is initialized, you cannot change the resolution. This means that if an application is designed to run in medium-resolution mode and you enter it in low resolution, the application can't correct the problem and switch modes—the best it can do is to give you a message that says, "Please switch to medium resolution," and terminate.

TOS handles this to some degree by remembering the resolution you were in the last time you saved your desktop and initializing the system to that resolution. The only problem with this is that when you are in high resolution using a monochrome monitor and switch to a color monitor, the system switches to low resolution. The difference between low and high resolutions is great enough that they are likely to look very different on your screen, and any applications you run are going to be different, too.

The routines that make the desktop menus, windows, icons, and dialog boxes are easily accessible to programmers. These features can greatly enhance an application's ease of use by putting control in the hands of the user.

TOS vs. the Macintosh Finder

The TOS desktop is very similar to the Finder in the Apple Macintosh but with a few significant differences.

The Macintosh keeps track of what disk is in each drive and keeps strict control over when a disk can be ejected, while the 1040ST has ejection buttons. When you change disks on the 1040ST, you must press the Esc key to update the screen.

The Macintosh lets you move icons around the window at will and view the files in one window as icons while viewing those in another as text. On the 1040ST the icons are arranged for you, and all windows have to be either textual or iconic.

On the 1040ST, the menus pop down whenever the pointer passes over them, and the menu stays down until you click the mouse either in the menu or elsewhere on the screen. In comparison, on the Macintosh you must click on a menu for it to come down.

Another difference is the pause that the 1040ST requires between when you click on something and when you are able to move it. On the Macintosh, you can click on an icon and start dragging immediately; under TOS, you must pause for an instant before moving the mouse.

Taken singly, these differences aren't terribly significant. But as a whole, they show a trend: The Macintosh Finder is intended to be a perfect user interface, while the TOS desktop is designed to be a simple, easy-to-use workhorse.

Software

Unfortunately, relatively little software is available that really makes use of the windows, menus, and icons so characteristic of TOS. Each developer creates his or her own user interface from scratch, and every program will come up with a different way of handling similar tasks.

For example, 1st Word, a TOS-based word processor that comes with the 1040ST, provides two ways for exiting a document: QUIT, which throws away your work (after warning you), and SAVE, which closes your document after saving it. You cannot save the document without closing it. Power failures do happen, and most computer users learn to save their work often, a task made very inconvenient by this program.

Aside from this problem, 1st Word has a full range of features. It supports a large number of printers, several font styles (including bold, italic, and underlined), cutting and pasting, and "what-you-see-is-what-you-get" screen editing.

Unfortunately, the latter feature makes the program somewhat slow. When I conducted the word processor benchmark tests on two hard disks (see the text box "The Atari SH204 and SupraDrive Hard Disk Drives" on page 234), 1st Word was slower than ST Writer (an old-style word processor that uses embedded control characters).

The 1040ST also comes with Atari ST BASIC, Atari Logo, and NEOchrome, a paint program. Atari ST BASIC has some nice features. It starts up with four windows: one for editing, one for listing programs, one for output to the screen, and one for commands. Each of these windows can be resized, moved, activated, or closed by using the mouse. This is a good deal more flexible than the approach taken by other BASICs.

continued

The Atari SH204 and SupraDrive Hard Disk Drives

The extra power and memory of the Atari 1040ST makes the addition of a hard disk drive appropriate. I used the 1040ST that I reviewed with the Atari SH204 hard disk and the SupraDrive from Supra Corporation.

Both the SH204 and the SupraDrive are 20-megabyte drives. Unlike Supra, which makes a 30-megabyte drive, the largest drive Atari makes is the SH204 (it also makes a 10-megabyte drive). But Atari has made provisions for having multiple drives on one system. The drives can be numbered from 0 to 7, so theoretically you can have up to 1600 megabytes of storage on-line at one time. However, the manual is not clear about how you hook two hard disks up, since both the computer and the hard disk have only one plug. In spite of that, the SH204 manual is better than the SupraDrive's, but the latter still has all the information you need.

Neither the SH204 nor the SupraDrive can have partitions larger than 16 megabytes, so the 20-megabyte disk drives must be segmented into two or more logical drives, none of which can hold more than 16 megabytes.

The SupraDrive is 11 inches long and 5½ inches wide, but it needs extra space all the way around to provide for cooling. An annoying trait of the drive is its noise. While the drive is on, it produces a persistent low hum that can be heard for some distance.

The SH204 is 15 inches long and about 8 inches wide—much larger than the SupraDrive. It is also considerably noisier—you can't hear the SupraDrive if the Atari drive is on.

Although the 1040ST's ROMs allow for only 40 folders on a disk, the SupraDrive's boot software installs a patch that allows up to 70 folders. Care should be taken, however, not to exceed this 70-folder limit. If you do exceed it, the disk directory is likely to become very sick and ruin part or all of the hard disk. However, the documentation gives no warning of this danger.

I found both hard disk drives to be well worth their price tags. The increased access speed and expanded storage augment the 1040ST's power considerably. [Editor's note: *For the benchmark results, see table A.*]

Atari SH204

Type
20-megabyte hard disk

Company
Atari Corp.
1196 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2000

Size
15 by 8 by 4 inches; 9 pounds

Features
Chaining of multiple drives

Software
Boot software; format and utilities software

Options
10-megabyte hard disk (SH104) also available

Documentation
User's manual

Price
$799.95

SupraDrive

Type
20-megabyte hard disk

Company
Supra Corp.
1133 Commercial Way
Albany, OR 97321
(503) 967-9075

Size
11 by 5½ by 3¾ inches; 5 pounds

Features
5¼-inch drive with Rodime controller

Software
Boot software; format and utilities software

Options
Also available in 30-, 45-, and 60-megabyte sizes

Documentation
User's manual

Price
$799

Table A: *Comparison of the BYTE benchmarks on the Atari SH204 and SupraDrive 20-megabyte hard disk drives. All times are in seconds.*

	Atari SH204	SupraDrive
Write 64K-byte file (BASIC)	82.00	83.30
Read 64K-byte file (BASIC)	177.00	172.70
Copy 40K-byte file	2.63	3.20
Load spreadsheet (ACalc)	8.89	9.99
Document load		
ST Writer	5.86	5.94
1st Word	9.33	9.88
Document save		
ST Writer	4.67	2.03
1st Word	10.11	7.99

However, ST BASIC's I/O capabilities are limited. As the benchmarks show (see page 232), reading and writing from BASIC, even with a hard disk (see times at left), is very slow.

The Atari Logo program is a simple-looking dialect of LISP and is powerful for all its apparent simplicity. The major feature of Atari Logo is its use of turtle graphics; graphics commands are given from the cursor's point of view, thus greatly simplifying programming.

NEOchrome is a beautiful graphics editor. It is almost worth getting a color monitor just to see the pictures that come with this program. NEOchrome doesn't work with a monochrome monitor. An especially clever feature of the program is the ability to roll selected colors through the color registers, thus giving still pictures the illusion of motion.

1040ST vs. 520ST?

Why buy an Atari 1040ST instead of a 520ST? To begin with, the 1040ST has fewer power cords. A comparable 520ST has two power supply boxes (one for the computer and one for the disk drive) and three power cords (one for each power supply and one for the monitor). The 1040ST has no power boxes and only two power cords. This may not seem like much, but all those cords become tangled very easily, and any decrease helps.

The major reason to get a 1040ST, however, is the extra memory. While the 520ST can, in theory, handle as much memory as a 1040ST (both use the same memory management chip, which can handle 4 megabytes of RAM), the board in the 520ST has no space to hold the extra chips. A number of schemes have been devised for adding chips to the 520ST, either to the top of the existing chips or to the bottom of the board. Unfortunately, soldering that number of chips onto a board with such close tolerances is apparently extremely difficult—even experts have ruined computers. Lately, upgrades that consist of a board that plugs into existing sockets have become available. These look promising, but they are still too new to be sure of. If you want a megabyte of memory in your computer, you are definitely better off buying a 1040ST than trying to add chips to a 520ST.

What would you do with a megabyte of memory if you had it? The simplest use for a large piece of memory is a RAM disk, which makes some of your RAM act like a very fast disk drive and makes almost any program run faster.

Beyond that, most common applications such as word processors, spreadsheets, and database managers should be able to make use of all that extra memory directly, even without the use of a RAM disk. A smart database manager, for instance, would allow you to edit and sort records in memory and would be much faster for databases that fit completely in RAM. A megabyte of memory would also allow you to put a very large database on your computer and manipulate it solely in memory and very rapidly.

Finally, you can do some powerful graphics and voice-synthesis tricks with a megabyte of RAM. For instance, an animation program could buffer the frames that are coming up and thus achieve very good, fast animation.

Conclusion

The Atari 1040ST is an excellent value with just a few problems that mar an otherwise ideal product. These include the lack of an RF modulator that would allow you to use it with a television set, the possibility of damaging disks if you exceed the desktop limit on folders or try to copy a file to itself, and a shortage of software that makes use of the desktop interface. ■

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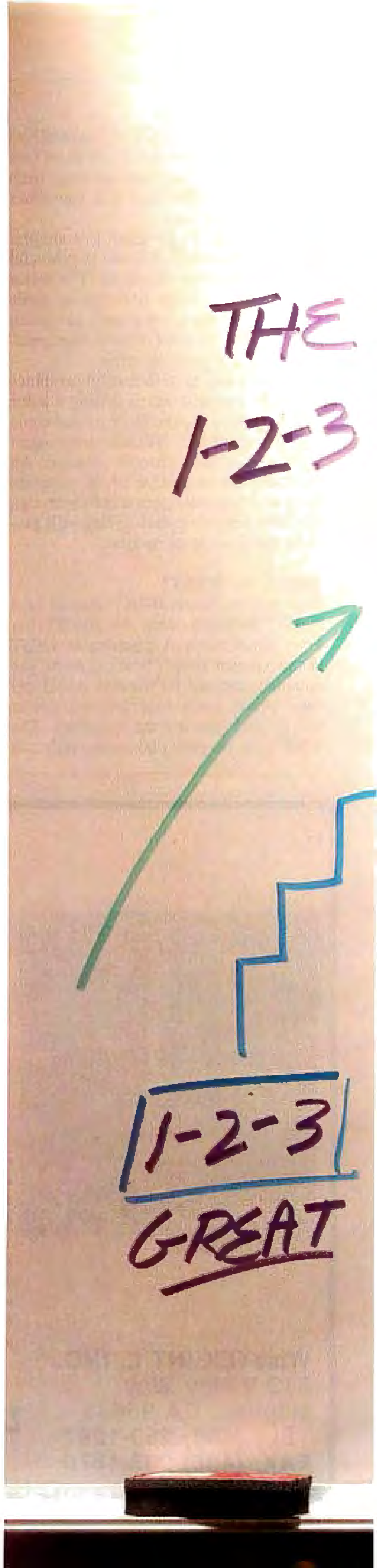
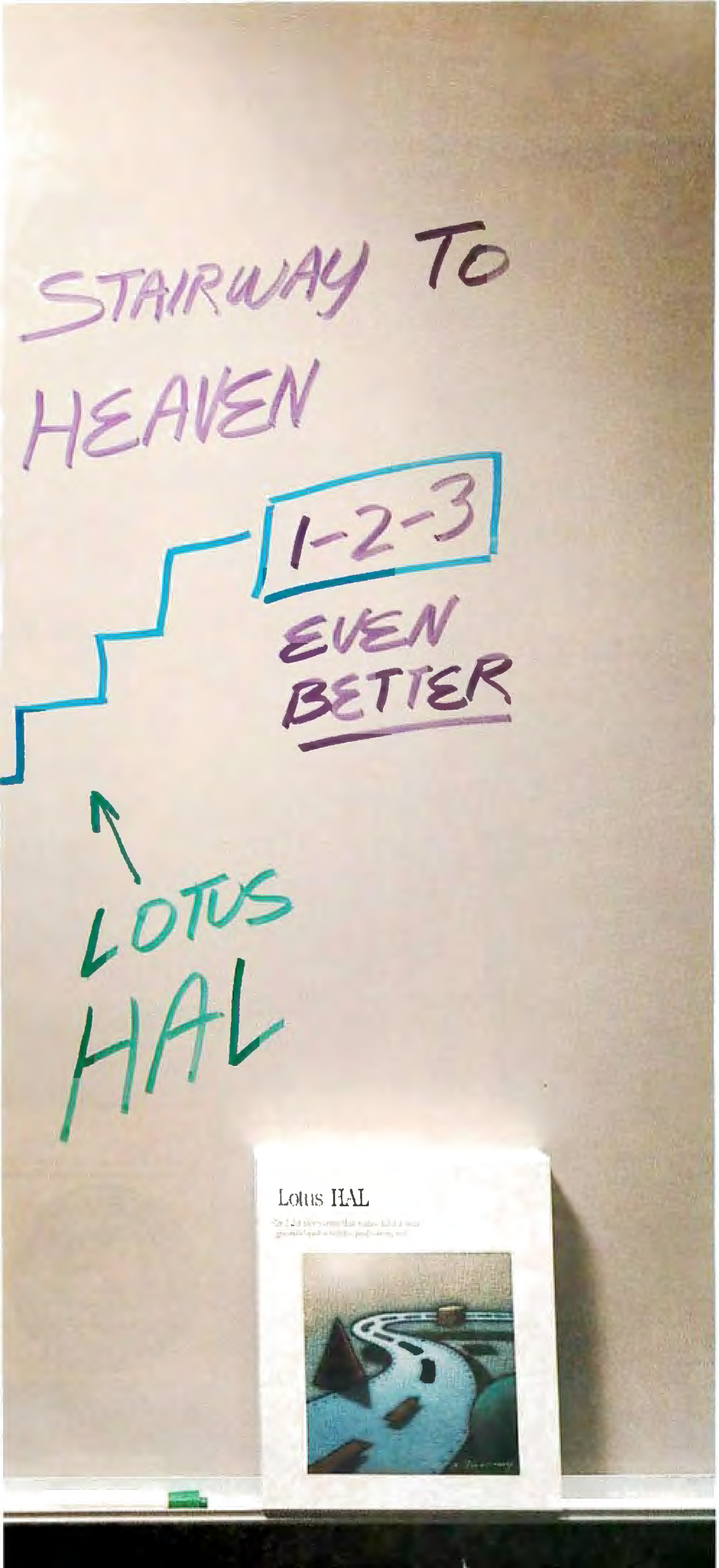
Lotus HAL resides in memory with 1-2-3 and operates with it; a minimum system configuration of 512K is required.

*Lotus HAL does not operate with 1-2-3 for the IBM PCjr (ROM version), IBM PC Convertible or Release 1A for the IBM 3270 PC.





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Four Ink-Jet Printers

Robert D. Swearengin

A look at units ranging from black-and-white portable to full-size color

After several weeks of producing text and graphics with four ink-jet printers that varied widely in price and features, I was favorably impressed with the overall quiet operation and output quality. I experienced no problems with reliability or the clogged nozzles associated with this technology in the past. The four printers that I reviewed are the Diconix 150 (lower left), the Quadram Quadjet (lower right), the Xerox Model 4020 (upper right), and the Tektronix 4696 (upper left).

The Diconix 150 Portable

At $479, the Diconix 150 is more expensive than some other portable printers. But at 3¾ pounds, including five C-size nickel-cadmium batteries that fit inside the platen, it contains more features than many desktop printers—all inside a case that is only 11 by 6½ by 2 inches. In addition to draft, near-letter-quality (NLQ), and script text, it prints italic, emphasized, enlarged, condensed, superscript, subscript, and underlined text, as well as graphics at 1133 dots per line.

A tractor feed is standard, and the printer also accepts single sheets, envelopes, and transparencies through the paper slot in the rear of the machine. The unit comes with a combination AC adapter/charger, and it will produce 150 pages of text on a full charge. Diconix promises to offer an optional serial port. The control panel on top of the unit contains LEDs for power, paper-empty, and on-line status and push buttons for on-line, linefeed, and formfeed functions. By pressing different combinations you can select draft, NLQ, script, envelope mode, battery charging, a self-test, and reverse linefeed. DIP switches under the cover let you set carriage return and linefeed, skip perforation, fonts, IBM/Epson emulation, and international character sets.

To avoid the complicated nozzle-cleaning circuitry found in many ink-jet printers, Diconix used some interesting engineering on this printer. The 12-nozzle print head and the ink supply are combined in a small $9.95 cartridge that snaps onto the carriage. It prints about 500 pages of text; then you simply throw the cartridge away and snap in a new one. This cartridge works very well and eliminates another restraint: Many ink-jet printers require a level surface, and the inkwells must be capped when the unit is moved. This isn't practical for a portable, and the Diconix 150 has no such requirements. As the unit was printing, I picked it up and turned it upside down. No problems occurred, and the print quality remained constant.

The specifications for the Diconix 150 list printing speeds of 150 characters per second for draft and 50 cps for NLQ. Using a BYTE benchmark that printed 50 lines of 60 *A*s, I clocked the printer at 82 cps for draft and 30 cps for NLQ. Otherwise, it performed as advertised.

The printing quality of text is better than the average portable; the draft mode is not very dense, but the printer overcomes this deficiency somewhat with an attractive serif typeface. The NLQ and script modes are quite nice, and the Diconix 150 does excellent graphics with clean lines and good density, although my first bar graph was a surprise. The 12-nozzle Diconix 150 is programmed to accept image data files for 9-pin printers without conversion. As a result, it prints graphics in three-quarter size. Thus, if you want to print a 3- by 6-inch image, you must program it for a 4- by 8-inch image.

The operator's manual is one of the best I've encountered. Sections on setup, operation, commands, and maintenance and the appendix are tabbed for quick reference. The commands section, unlike many, is thorough and easy to understand. Control codes are spelled out in keystrokes and in BASIC.

The Diconix 150 is an extremely versatile printer without the trade-offs normally associated with portables. I couldn't find much to complain about. The printer produced spotty copy initially because I failed to snap the carriage latch completely into place after installing the ink cartridge. After I discovered my mistake and ad-

continued

Robert D. Swearengin (Department of Journalism and Printing, P.O. Box 1930, Arkansas State University, State University, AR 72467) is an instructor of journalism and a freelance writer.

Diconix 150

Type
Portable ink-jet printer

Company
Diconix Inc.
P.O. Box 3100
Dayton, OH 45420
(513) 259-3100

Size
11 by 6½ by 2 inches; 3¾ pounds

Features
Draft, near-letter-quality, script, italic, bold, enlarged, condensed, superscript, subscript, and underlined text
1133 dots-per-line graphics resolution
Tractor feed
Envelope mode
Transparencies
IBM/Epson emulation
120-volt AC adapter/recharger
2K-byte buffer
Parallel interface

Documentation
91-page operator's manual

Price
$479

Quadram Quadjet

Type
Color ink-jet printer

Company
Quadram Corp.
One Quad Way
Norcross, GA 30093
(404) 923-6666

Size
15¾ by 11½ by 4¼ inches; 12½ pounds

Features
Draft, bold, and enlarged text
7 colors
640 dots-per-line graphics resolution
Transparencies
One-line buffer
Quadjet driver software
Parallel interface
IBM screen-dump software

Documentation
38-page operator's manual
19-page software manual

Price
$495

Xerox Model 4020

Type
Color ink-jet printer

Company
Xerox Corp.
475 Oakmead Parkway
Sunnyvale, CA 94086
(408) 737-7900

Size
22 by 13½ by 6 inches; 28½ pounds

Features
Draft, near-letter-quality, italic, enlarged, superscript, subscript, and underlined text
7 colors
240 dots-per-inch enhanced graphics resolution
Transparencies
2K-byte input buffer
4.4K-byte image data buffer
Parallel interface

Options
RS-232C interface: $100

Documentation
80-page operator's guide

Price
$1495

Tektronix 4696

Type
Color ink-jet printer

Company
Tektronix Inc.
P.O. Box 500
Station Y3-314
Beaverton, OR 97077
(503) 627-7111

Size
20 by 13½ by 6 inches; 29 pounds

Features
Draft and underlined text
7 colors
120 dots-per-inch graphics resolution
Transparencies
Additional colors and features with Tektronix terminals
Parallel interface

Options
IBM screen-dump software

Documentation
153-page user's manual

Price
$1795

justed to loading paper from a slot in the rear, the printer was a pleasure to use.

The Quadram Quadjet

A minimum-frills color printer, the $495 Quadram Quadjet produces graphics and text in seven colors. It weighs only 12½ pounds and has a relatively small footprint: 15¾ by 11½ by 4¼ inches. The control panel has buttons for on-line, linefeed, and formfeed control. Two LEDs signal power and on-line status; a third LED signals when you're out of paper, and it blinks during the printer's reinking operation.

The ink is supplied by two cartridges—one for black ($10) and another for yellow, magenta, and cyan ($17). They print 4 million characters and simply plug in under a front panel with no need to worry about spilled ink. A carriage lock on top of the printer caps the four ink nozzles during shipping or long periods of nonuse. When unlocked, it uncaps the nozzles and performs a 10-second reinking operation. You can reink any time that printing quality deteriorates, a feature I did not use because the output remained consistently good. The Quadjet accepts single sheets, transparencies, and rolled paper that fits in a holder under the top cover.

For text, the Quadjet prints average draft-quality, bold, and enlarged type in black. The colors are bright and consistent, and the ones that require more than one jet—red, green, and violet—are considerably denser than the draft copy in black. Quadram rates the printer at 37 cps for draft and 17 cps for bold. My times were 24 and 14 cps, respectively. Color text printed at the same speed as black. The printer does good-quality color graphics at 640 dots per line and is extremely versatile because of the Quadjet driver software that comes with the unit. It programs the printer for a software-independent screen dump from the IBM PC (it's also available for Apple computers and the PCjr), for IDS Prism emulation, and for printing advanced screen modes with the Quadcolor II graphics card. You can also change screen colors for the printout. This is a useful feature if you want to print graphics from a variety of software without worrying about the printer driver. As a nitty-gritty color printer, the Quadjet performs very well in its price class.

The Xerox Model 4020

The $1495 Xerox Model 4020 is larger, heavier, more sophisticated, and offers more features than the two units reviewed thus far. It measures 22 by 13½ by 6 inches, weighs 28½ pounds, and inks with 20 nozzles. The yellow, cyan, and magenta inks use four nozzles each; the black ink

continued

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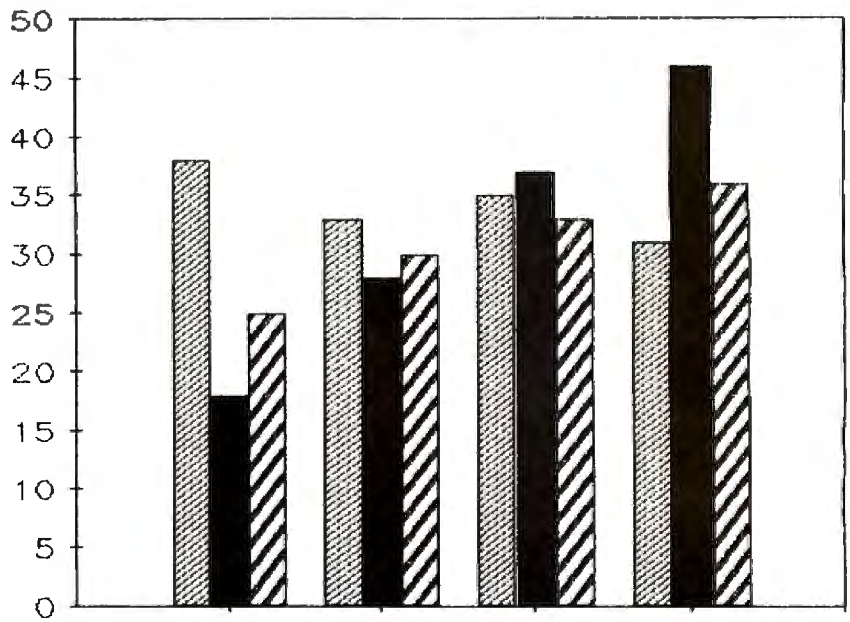
uses four nozzles for graphics and four more for text. A maintenance cartridge fits under a door on the printer front; fluid from this automatically cleans the nozzle system. When you turn the printer on, you hear about half a minute of muted clicks and buzzes as this process proceeds before the Ready light turns on. When you turn the printer off, the cleaning takes about a minute. A button on the back panel initiates a four-minute recovery cycle that flushes the nozzles thoroughly and removes air bubbles from the system if you're having problems with print quality. I performed this recovery cycle at setup and didn't need to use it again.

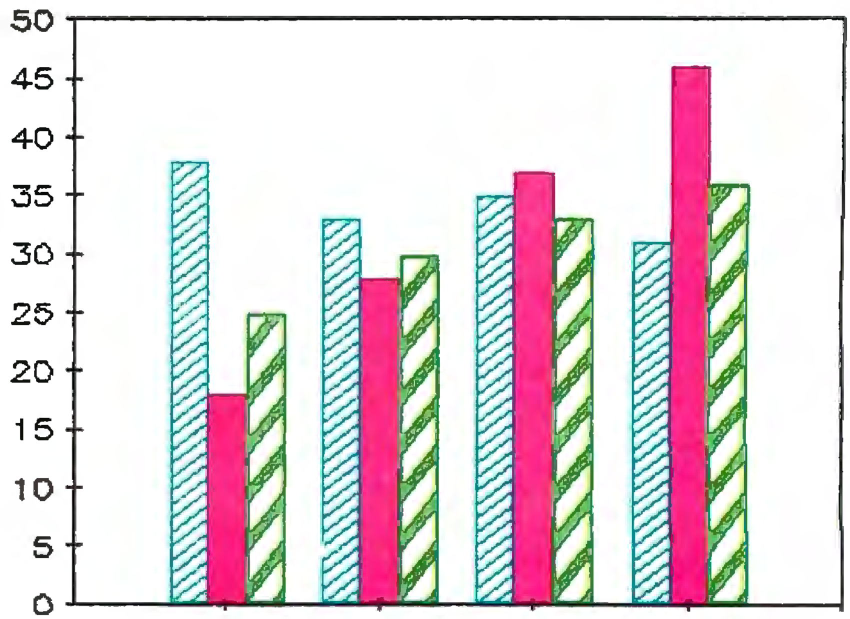
The Model 4020 accepts sheets, transparencies, and rolled paper that fits on a spindle that attaches to the back. The four ink reservoirs are inside the top cover. To replenish a color, you simply plug a cylindrical cartridge into the proper reservoir (they are keyed to avoid mistakes), push down until the seal punctures, wait a few seconds for the ink to drain, and throw away the empty cartridge. This is more trouble than a single multicolor cartridge, but more economical; you don't have to throw away the rest of your magenta and cyan because you're out of yellow. The cartridges come in sets of four and last for about 180,000 characters or 120 pages of graphics with 15 percent coverage.

The front panel contains LEDs for the four ink colors and on-line and power status. Three membrane buttons control on-line, linefeed, and formfeed functions. A small rear panel houses the parallel interface, switches for self-test, recovery, and bidirectional print adjust, and DIP switches. The DIP switches set international characters, draft or NLQ, enhanced graphics mode for Diablo C150 software, margins, print direction, carriage return, linefeed, and fonts. If you select the optional $100 RS-232C interface, an additional DIP switch sets the protocol and data rate.

For text, the Model 4020 prints 10-pitch Gothic and italic, 12-pitch Gothic, and 12-pitch roman, selectable by DIP switch or software, and 17-pitch Gothic, selectable by software only. It also prints expanded, superscript, subscript, and underlined printing. Specifications are 80 cps for draft and 40 cps for NLQ; my times were 58 and 30 cps, respectively. Unlike the other color machines I evaluated, the Xerox Model 4020 slows down to print color; it printed red at 40 cps in its default color text mode (see example at right). It is worth the wait, however. The Model 4020's color text has excellent density and brilliance. For black text, I'd rate the draft quality slightly better than average and the NLQ as outstanding. The 12-pitch roman is an attractive and readable face, although

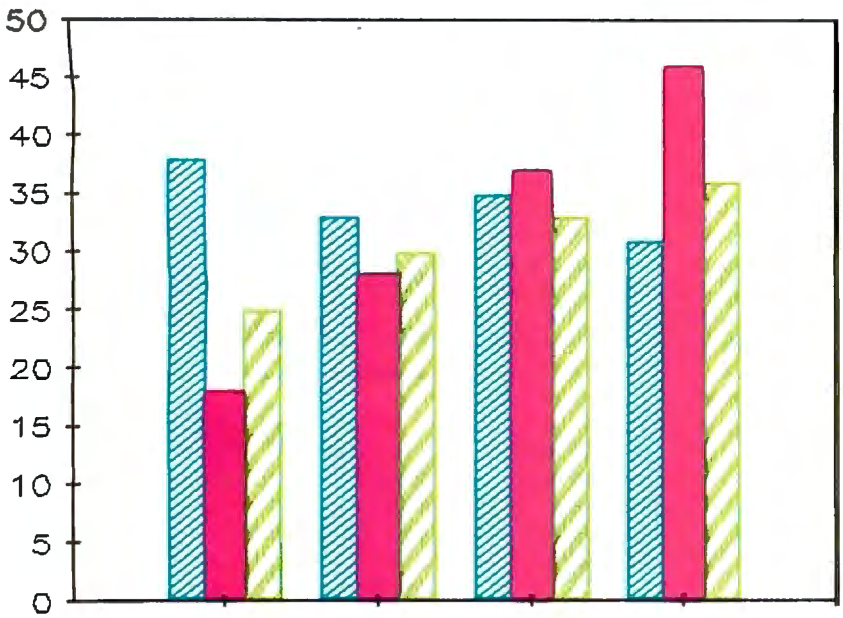


This is the Diconix 150 portable, Draft Quality.
This is the Diconix 150 portable, NLQ.
This is the Diconix 150 portable, Italic NLQ.
This is the Diconix 150 portable, emphasized NLQ.
This is the Diconix 150 portable, Script.

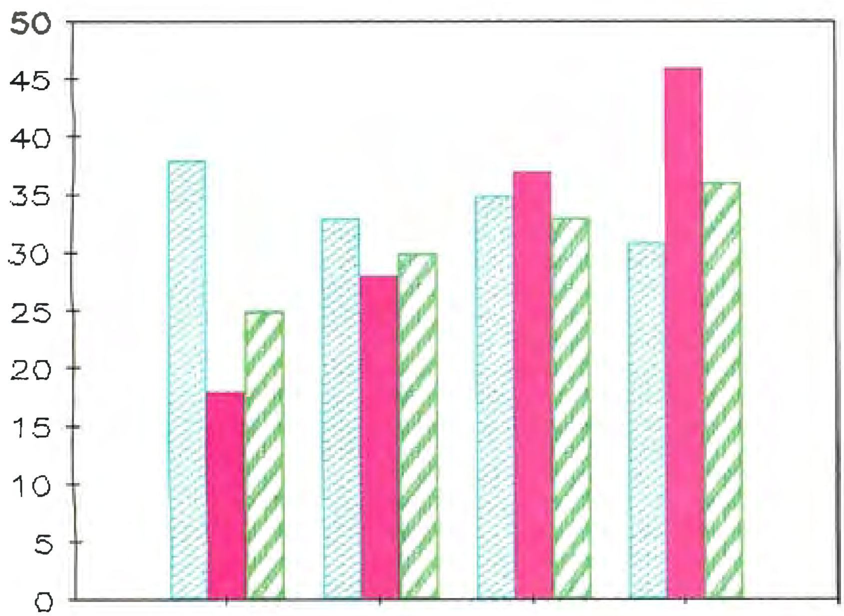


This is the Quadram Quadjet, Draft.
This is the Quadram Quadjet, Bold.
This is the Enlarged.
This is the Quadram Quadjet, Red.
This is the Quadram Quadjet, Green.
This is the Quadram Quadjet, Violet.

Print samples from the four ink-jet printers. The bar chart was generated with Chart-Master on an IBM PC–compatible computer.



This is the Xerox 4020, Draft.
This is the Xerox 4020, NLQ.
This is the Xerox 4020, Italic NLQ.
This is the Xerox 4020, 12-Pitch Roman.
This is the Xerox 4020, Red.
This is the Xerox 4020, Green.
This is the Xerox 4020, Violet.



This is the Tektronix 4696.
This is the Tektronix 4696, Underlined.
This is the Tektronix 4696, Red.
This is the Tektronix 4696, Green.
This is the Tektronix 4696, Violet.

not particularly dense. The graphic quality is excellent, with clean lines and bright colors at resolutions of 120 dots per inch in draft and 240 dots per inch in enhanced mode. The printer accepts the Diablo C150 driver; Xerox publishes a list of more than 50 compatible packages for the IBM PC and compatibles and several more for the Amiga and the Apple II family.

The Tektronix 4696

It's hard to resist the temptation to compare the Tektronix 4696 with the Xerox Model 4020 because both machines obviously came from the same manufacturer. They're similar in size, weight, and appearance, even when you peek beneath the top cover. But they were designed for different applications. Specifically, if your application involves only IBM PCs, this printer is probably not for you, even though it is compatible. It provides fewer features than the Model 4020 at a higher price: $1795. The manual and specification sheet mention only Tektronix 4100-series display terminals and 4400, 4110, and 4120 workstations. A company spokesman confirmed that this is the primary market. If you use Tektronix terminals or a combination of these and IBM PCs, the Tektronix 4696 is worth a closer look.

The maintenance fluid and ink cartridges are similar to the Model 4020's, but I couldn't verify whether the contents are the same. Ink cartridges, good for about 100 pages of graphics, cost $18 for a set of four. The nozzle-servicing sequence was a few seconds shorter on power-up and a few seconds longer on power-down than that on the Model 4020. The front panel contains LEDs for the four ink colors, on-line, and power status, along with membrane buttons for on-line and linefeed functions. Although the printer has no formfeed button, there is one labeled "Media" that lights an LED indicating the printer is in a special mode for transparencies. The back panel contains switches for self-test, recovery, and bidirectional print adjustment. Two DIP switches set the margins and carriage return; two others are for service diagnostics and don't function during normal operation.

The only options for text are draft, underlined, and color, although one of the character sets includes room for a downloadable face. The specifications list the printer speed at 35 cps. I timed it at 29 cps for black and color. The type is an attractive dot-matrix face that is a bit too thin for my taste. The printer accepts the Tektronix 4695 driver and produces excellent color graphics at 120 dots per inch.

continued

Printouts of two complicated color graphs included on the optional IBM screen-dump software are impressive. As with the Quadram Quadjet, the screen-dump software is a plus. It allows you to change colors as well as the size of the printout.

With a Tektronix terminal you can dump 8- by 6-inch portrait formats and 10½- by 8-inch landscape formats with a keyboard button, and you can print continuous images on rolled paper. You can print up to 125 different halftone shades with Tektronix 4100 terminal firmware and more than 130,000 colors and shades with the Tektronix 4510A color graphics rasterizer. The printer will also copy from a terminal's graphics area while the terminal works elsewhere. Unfortunately, I could not run these applications on my micro. Again, I liked the printer, but you really need a terminal to utilize its full potential and justify the price tag.

Graphics

Comparing these printers is difficult, but the ink jets, at least, are a common denominator. I ran the same clustered bar chart, designed with Chart-Master, on all four units. The four-color chart, with three variables and four observations, was 6½ inches wide by 5 inches high—the largest I could get with my 384K-byte memory.

Print quality of the graph was good with all the printers (see the print samples on pages 242 and 243). The Diconix 150 printed a crisp black-and-white version in 3 minutes and 21 seconds. Times for the color printers were 7:01 for the Quadram Quadjet, 3:24 for the Xerox Model 4020, and 2:36 for the Tektronix 4696. On color brilliance, the Model 4020 and the Tektronix 4696 were exceptional—I'd give the Model 4020 a slight edge, at least on this particular graph. The Quadjet was noticeably paler but still quite acceptable with good color. Considering the price of the Quadjet, it compares favorably if you are on a budget and not in a hurry. All four printers produced the same graph on transparencies with no problems.

Software-independent screen dumps were another story. None of the printers had problems with text, but I could not get the Xerox Model 4020 to dump graphics with the Shift-Print key sequence. First I tried a black-and-white chessboard with players on the squares. The Model 4020 made a rough outline of the board, about 4 inches square, using repeated bracket signs. Results weren't any better with a color Monopoly board. The printer dumped an 8- by 3½-inch version, reproducing the color text in black and with no graphics. Nonetheless, the Model 4020 performed nicely when driven with graphics software.

None of the printers had problems with text, but I could not get the Xerox Model 4020 to dump graphics with the Shift-Print key sequence.

The Diconix 150 printed a 4- by 6-inch chessboard in 2 minutes and 44 seconds after I used the MS-DOS GRAPHICS command. However, I could not reproduce the color Monopoly board.

The Quadram Quadjet dumped a good-quality 5½- by 7½-inch chessboard in 6 minutes and 17 seconds. The Tektronix 4696 reproduced a denser version, about the same size, in 1 minute and 27 seconds. The Quadjet printed a 3½- by 5½-inch color game board in 2 minutes with good reproduction. The Tektronix 4696 printed a slightly smaller version, 3 by 5¼ inches, in 44 seconds with brighter colors and better graphics. The printers took longer on the black-and-white image, but the chessboard is quite dense—probably in the neighborhood of 50 percent. The Monopoly game board, with its text and smaller symbols, is probably at or below the 15 percent density average for business graphics.

Generic screen dumps of graphics are questionable. If that's a requirement for your application, you'll want to be sure that appropriate software is available for the printer you choose, and even that is no guarantee when you try to dump from assorted programs.

Conclusions

I encountered no serious constraints with any of the ink-jet printers. They're not particularly fast, although the Diconix 150 compares favorably with other portables I've used. Ink-jet printers are more susceptible to dust and altitude changes, and I suspect they are not the best choice if your printer will be idle for long periods. Finally, ink-jet printers are paper-sensitive; there was a noticeable difference in image quality when I tried one printer's paper in another printer. Furthermore, the paper is treated on one side; if you put it in backward when inserting single sheets, the image quality is terrible.

If these factors don't affect your application and you need a quiet, quality dot-matrix printer, any of these printers are well worth considering. ■

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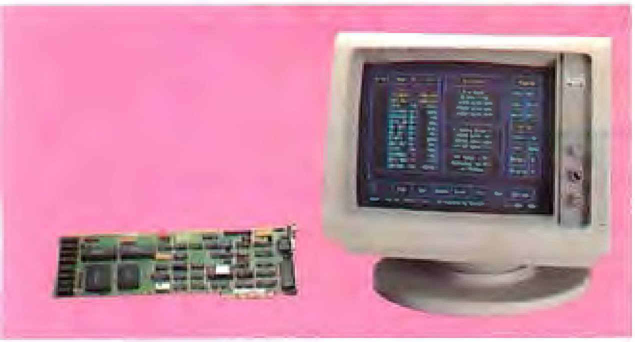

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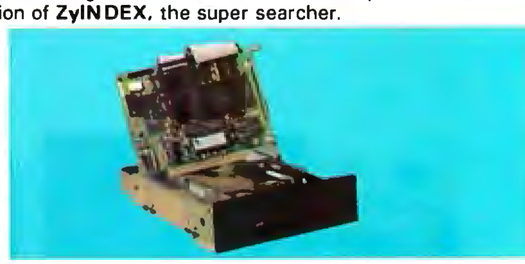

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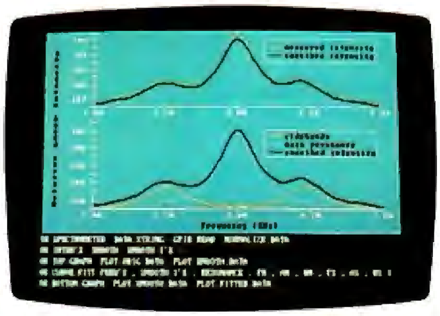

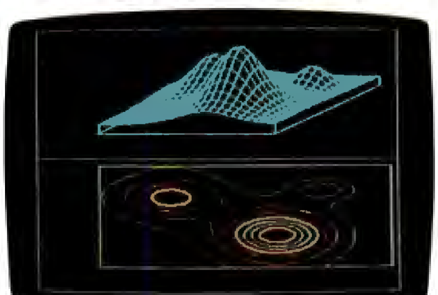

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Inquiry 337

Microsoft QuickBASIC 2.0

Dennis Dykstra

An integrated programming environment with powerful features

QuickBASIC is a program that compiles BASIC source files into machine code. In describing version 1.0 of Microsoft's QuickBASIC, you could pretty much have stopped with that statement. But version 2.0 is much, much more. It is an integrated programming environment that provides many of the advantages of an interpreter without requiring you to give up the execution speed of a compiler. It includes a full-screen editor, a debugger with single-step, animate, and trace modes, a library manager that lets you prepare libraries of compiled routines that you can call from your QuickBASIC programs, and a highly structured language that just might make you forget you ever heard the word GOTO.

Although most QuickBASIC users will probably use the built-in full-screen editor to write source programs, you can actually use any text editor that will produce ASCII files. This includes the editor in your BASIC interpreter, although you must remember to save programs with the ,A option to put them in ASCII format; QuickBASIC doesn't know about tokenized BASIC files.

Comparisons with BASICA

Because Microsoft's BASIC is bundled with most PC-DOS and MS-DOS computers, you might expect that QuickBASIC would be able to compile your BASICA programs unchanged. This is partially true. Most QuickBASIC statements use exactly the same syntax and work exactly the way they do in BASICA. Others, though, have somewhat different syntax or work a bit differently, and a few BASICA features aren't recognized by QuickBASIC at all. On the other hand, QuickBASIC includes certain enhancements that provide much better capabilities for developing structured programs than those provided by BASICA.

QuickBASIC supports both dynamic and static arrays, with static arrays being the default. Storage for dynamic arrays is allocated at run time; for static arrays, it is allocated at compile time. Static arrays require slightly less storage space and can be accessed faster. Dynamic arrays are more flexible because you can redimension them with REDIM or deallocate them with ERASE. Furthermore, QuickBASIC 2.0 allows each dynamic array to use as much as 64K bytes of memory space, with the number of these large arrays in any program being limited only by available memory. This gives your programs access to a lot of in-memory data.

Strings in QuickBASIC can be up to 32,767 characters in length, as opposed to 255 in BASICA. All the BASICA string functions are fully supported. In addition, a new function, SADD, returns the memory address of a string.

You can use the CHAIN statement to transfer control from the currently operating program to another QuickBASIC program, although the ALL, MERGE, DELETE, and line-number CHAIN options available in BASICA are not supported. You can also pass control to any .EXE file by using RUN *filename* (*filename* is a string expression). To execute .COM or .BAT files or a built-in DOS command such as DIR or TYPE, you have to use SHELL *command* (*command* is a string expression), which works the same as it does in BASICA.

Most of the BASICA commands not recognized by QuickBASIC are those that would normally be executed in the interpreter's direct mode, such as LIST and RENUM. Several statements have slightly different syntax in QuickBASIC than in BASICA. In particular, programs that use DRAW, PLAY, and RESUME will probably require some modification before they will compile correctly. DEF USR and USR are not supported at all by QuickBASIC. COMMON, DEF*type*, and DIM statements declaring static arrays must appear at the beginning of QuickBASIC programs. Also, if your program does error trapping with ON ERROR GOTO or event trapping with ON *event* GOSUB, you will have to notify the compiler of this at compile time. Several other BASICA defaults are optional in QuickBASIC so that your executable files can be smaller if you don't need those capabilities. This includes the ability to exit an infinite loop by pressing Control-Break.

All the BASICA graphics statements have been ported over to QuickBASIC. With the exception of DRAW, all are syntactically the same as in BASICA. An enhancement in version 2.0 that will be of major interest to users of enhanced graphics adapters is that QuickBASIC now supports all EGA modes as well as monochrome and color graphics adapter modes. In addition to the new EGA screen modes, QuickBASIC 2.0 provides a PALETTE statement that lets EGA users change the set of colors being displayed.

Several statements are new in QuickBASIC. One useful addition is COMMAND$, which returns a string containing the command line used to invoke the program. You can use this string to determine any parameters that the user may have set when the program was started. LBOUND and UBOUND return the lower and upper bounds of an array; this can be useful when dynamic arrays are passed to subroutines. LOCK and UNLOCK allow users with DOS 3.0 or later to control access to all or part of an opened file. This may be essential in a net-

continued

Dennis Dykstra (Northern Arizona University, P.O. Box 4098, Flagstaff, AZ 86011) is a professor and does software consulting and freelance writing. His latest book is Mathematical Programming for Natural Resource Management *(McGraw-Hill, 1984).*

QuickBASIC 2.0

Type
Extended programming language, BASIC compiler, and programming environment based on IBM BASICA and Microsoft GW-BASIC

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Microsoft Corp.
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
(800) 426-9400

Format
5¼-inch MS-DOS floppy disks

Computer
IBM PC, PC XT, PC AT, and close compatibles with at least 256K bytes of memory, DOS 2.0 or later, and one double-sided disk drive; can be used with or without a hard disk; not copy-protected

Documentation
600-page user's manual; README.DOC and UPDATE.DOC files on disk

Price
$99

work environment where several processes might use the same file simultaneously.

Line numbers are optional in QuickBASIC, and I find that programs are a lot more readable without them. If you need a target for a GOTO or GOSUB statement, you can use an alphanumeric label that can be up to 40 characters long. But you may find that you can live perfectly well without ever using another GOTO. QuickBASIC has structures that let you avoid them altogether, thus allowing you to develop truly modular programs in the tradition of Pascal and C.

Mandate for Modularity

QuickBASIC facilitates modularity through its support of multiline functions, true multiline IF. . .THEN. . .ELSE blocks, named subroutines, local variables, separate compilation of program modules, and a facility for developing user libraries.

One of the limitations of BASICA is that it supports only single-line user-defined functions. QuickBASIC gives you both single- and multiline functions. Any user-defined function is globally available within the module in which the function is defined. Microsoft refers to a module as a single disk file containing a main program, one or more subroutines, or both. A function definition must reside physically above the first program line that invokes it. Thus, you cannot place function definitions at the back of the file, as you can with FORTRAN, for example. Nor can you compile user-defined functions by themselves and then link them with a main program. However, you can put one or more function definitions in a separate file and merge them with the source file at compile time. This is done by placing a compiler metacommand, $INCLUDE, in the source file at the point where the function definitions are to be merged. $INCLUDE is also convenient for merging blocks of statements that will be used in more than one module, such as COMMON statements.

QuickBASIC 2.0 supports true IF. . . THEN. . . ELSE blocks, with no limit on the number of physical lines that these blocks can occupy. Multiple ELSEIF statements give you the capability provided by CASE constructs in Pascal and C.

In BASICA, the CALL *name* statement is used to transfer program control to an assembly language subroutine stored at the address pointed to by a variable named *name*. This address is an offset into BASICA's code segment. The syntax of the CALL statement in QuickBASIC looks the same but is actually quite different. In QuickBASIC, *name* refers to a subroutine name, not a variable. This subroutine might reside in the same module as the calling program (in which case *name* is considered an internal reference), or it might reside in a separate module (an external reference). It can be either a QuickBASIC subroutine or an assembly language subroutine. In BASICA the programmer has to worry about initializing *name* so that it points to the correct address. In QuickBASIC that is the job of the compiler (for internal references) or the linker (for external references).

A named QuickBASIC subroutine (as opposed to a conventional GOSUB) is a contiguous block of code that is normally positioned after the END statement of the main program. The first statement in this block of code must be SUB *name* (*parameter list*) STATIC, and the last statement of the block must be END SUB. Parameters are optional and can be simple variables or arrays; the corresponding arguments of the CALL statement can be simple variables, arrays, or expressions and must agree in type with the parameters. The keyword STATIC is mandatory and indicates that the subroutine is nonrecursive. Recursive subroutines are not supported in QuickBASIC 2.0.

Variables used in a QuickBASIC program are not available to the named subroutines called by that program unless specifically passed to them. Identical variable names in a main program and in a named subroutine refer to different memory locations unless the variable is specifically declared to be shared between the main program and the named subroutine. This applies only to named subroutines, however; any variables used within a multiline user-defined function, except those passed as arguments, are by default global variables. However, you can force such variables to be local to the function by including the statement STATIC *variable list* just below the DEF FN statement. This can cure many debugging headaches.

Variables can be passed to named subroutines in several ways. They can be passed as arguments to the CALL statement or they can be named in a SHARED or COMMON statement. The SHARED statement lists main-program variables that are to be made available to all subroutines residing in the same module as the main program. The COMMON statement is used when the main program and subroutine reside in different modules. COMMON is also used to pass variables to another main program invoked by the CHAIN statement.

When you link separately compiled modules together, exactly one module must contain a main program; other modules can contain named subroutines. Each module is compiled separately using QuickBASIC. This produces an object file for each module with the extension .OBJ. The separately compiled modules can then be linked with Microsoft's Link program (Overlay Linker version 3.06 comes with QuickBASIC) to produce an executable program file with the extension .EXE.

QuickBASIC 2.0 provides a library management capability through a program called BUILDLIB.EXE. Software developers familiar with Microsoft's LIB.EXE will find BUILDLIB.EXE inconvenient because you cannot add or delete individual modules from the library; you simply create the library all at once from the collection of .OBJ files. If you want to add a new module, you recreate the library with both the old and new .OBJ files. To me this is awkward, but users not already familiar with object libraries may find it easier than working with a more flexible, but also more complex, library management system.

More Memory to Manage

One of the limitations that almost every BASICA programmer confronts sooner or later is that both the BASIC source code and all the data have to fit within a single 64K-byte segment. By adopting this limit, BASICA conforms to what Intel refers to as its "small memory model." QuickBASIC 2.0 gives you a "medium memory model" in which 64K bytes are allocated to data alone, and up to 64K of code space is allocated to each source module. Although each module is limited to 64K bytes of code space, you can link separately compiled modules together to form large programs that are limited in size only by available memory. All such modules have access to the single data segment, but only variables declared in COMMON statements or passed as subroutine arguments preserve their values across module boundaries.

Version 2.0 of QuickBASIC provides another improvement that will interest software developers. Dynamic arrays are now stored separately from the 64K data segment. Each dynamic array can occupy up to 64K by itself. Dynamic arrays can be referenced in COMMON statements, and the number of such arrays that you can use in a program is limited only by available memory. This capability will help elevate QuickBASIC to the category of serious development languages.

The Assembly Connection

QuickBASIC 2.0 makes it possible to use assembly language subroutines even if you don't have Microsoft's Macro Assembler. (However, for the greatest speed and flexibility or very large assembly language routines, you will still need the Macro Assembler.) QuickBASIC lets you POKE machine language subroutines into memory and then branch to them by using a CALL ABSOLUTE (*argument list*) statement, where the last argument in *argument list* is an integer variable specifying the offset into the current data segment where the machine language subroutine begins. Version 2.0 also supports BSAVE and BLOAD, so you can quickly save and load large machine language routines and, perhaps more importantly, you can quickly save and load graphics screens directly to and from screen memory.

You can even invoke BIOS and DOS interrupts from within a QuickBASIC program using INT86 and INT86X. These are nearly identical to the interrupt interfaces provided with Microsoft Pascal and C. INT86X lets you change the values of the DS and ES registers; INT86 does not. The format of both interfaces is

```
CALL INT86[X](interrupt,VARPTR
  (regs1(0)), VARPTR(regs2(0)))
```

where *interrupt* is the number of the interrupt being invoked, $regs_1$ is an array of register values to be used as input by the interrupt routine, and $regs_2$ is an array in which register values output by the interrupt routine will be returned. To print the current screen, for instance, you can invoke BIOS interrupt 5 (the PrintScreen service) via

```
CALL INT86(5,VARPTR
  (REGS1(0)),VARPTR(REGS2(0)))
```

with all elements of REGS1 initialized to zero.

The Integrated Environment

In preparing version 2.0 of QuickBASIC, Microsoft clearly paid attention to the enormous success of Borland's Turbo Pascal. QuickBASIC now sports a built-in full-screen editor from which you can compile, run, and debug programs, all without ever leaving the editor. This makes program development very much like using an interpreter, except that the editor is a lot better; through drop-down menus it features commands like Search, Cut, Paste, and the all-important Undo, which are missing from the BASICA editor. The QuickBASIC editor also supports a mouse if you like that kind of interface. On a color monitor, the editor comes up in white text on a blue background, but Microsoft has thoughtfully provided a way for you to change the colors to suit your own taste.

After you have fully debugged a program, you can convert it to executable code (an .EXE file), either from within the editor or from a DOS command line. Doing this from within the editor is much faster, since everything required is already

continued

Table 1: *Results for the standard* BYTE *benchmarks (see BYTE's* Inside the IBM PCs, *Fall 1985, page 195). Two separate compile times are shown. "In memory" refers to compiling from the editor and includes the time required to write an executable file to disk (for QuickBASIC this is not, however, a stand-alone executable file as is produced by ZBasic—the BRUN20 run-time environment must be loaded before it can execute). "Command line" refers to compiling and linking of QuickBASIC programs from the DOS command line to generate stand-alone executable files. "Disk storage" refers to the total space required for the ASCII source file plus the executable file. The Write program measures the time required to write a 64K-byte sequential file onto a blank disk, 128 bytes at a time; Read measures the time required to read this file into memory, 128 bytes at a time. Calc determines how long it takes to do 10,000 multiplication and 10,000 division operations; Calc.INT does the test with integer variables, and Calc.FP does it with single-precision floating-point variables. Sieve measures the time required to execute one iteration of the Sieve of Eratosthenes program to determine all prime numbers up to 13,999. Sieve.INT does the test with integer variables, and Sieve.FP uses single-precision variables. All tests were done on a Tandy 1000 with 384K bytes of memory and two double-sided disk drives running MS-DOS 2.11. All times are in seconds; file sizes are in bytes.*

			Compile times		
Language	Test	Run time	In memory	Command line	Disk storage
QuickBASIC	Write	58.7	5.4	121	33,344
ZBasic	Write	57.7	9.4	—	13,952
GW-BASIC	Write	58.9	—	—	308
QuickBASIC	Read	30.5	5.1	122	33,234
ZBasic	Read	30.5	9.8	—	13,824
GW-BASIC	Read	55.9	—	—	248
QuickBASIC	Calc.INT	1.1	5.3	123	28,698
	Calc.FP	11.1	5.4	123	28,874
ZBasic	Calc.INT	1.1	9.6	—	13,952
	Calc.FP	102.0	9.6	—	14,080
GW-BASIC	Calc.INT	61.8	—	—	384
	Calc.FP	63.0	—	—	307
QuickBASIC	Sieve.INT	1.4	5.9	124	28,794
	Sieve.FP	19.4	5.9	127	29,492
ZBasic	Sieve.INT	1.4	9.5	—	14,208
	Sieve.FP	63.2	10.4	—	14,336
GW-BASIC	Sieve.INT	181.0	—	—	488
	Sieve.FP	205.0	—	—	448

in memory and no link step is needed. But if you are developing a program that will comprise several separate modules, you'll have to compile them independently and then invoke the linker from the DOS command line. People who have used other compilers will have no difficulty with this, but it may be a new experience to BASIC programmers.

Triple Threat

QuickBASIC 2.0 actually provides three run-time systems. One of these is invoked from the built-in editor and, with a compilation speed of up to 6000 lines per minute, is by far the fastest way to compile programs. Programs executed from within the editor run more slowly than those executed from the DOS command line, however; BYTE's Sieve of Eratosthenes benchmark runs only about one-twelfth as fast from within the editor as from the DOS command line. This is still 10 times faster than in BASICA, but you would normally be willing to give up that extra speed only during program development when the interpreter-like environment is helpful.

Aside from the QuickBASIC editor, there are two run-time systems from which to choose, depending on the kind of executable file you want to produce. If you choose to link with BCOM20.LIB, QuickBASIC produces a stand-alone executable file. If you link with BRUN20.LIB, an .EXE file is produced that is substantially smaller (e.g., 2K bytes instead of 28K for the Sieve of Eratosthenes program), but it cannot run by itself. When you invoke the program, it first loads BRUN20.EXE, a run-time environment; BRUN20 then actually supervises the execution of your program.

Both of these systems have their advantages (e.g., CHAINing with COMMON is supported only by BRUN20), and it was thoughtful of Microsoft to provide a choice. All the execution-time results in tables 1 and 2 were obtained by linking with BCOM20.LIB. Linking with BRUN20.LIB would have reduced both disk storage space and link times substantially, but it would have increased run times by 15 to 20 percent. Also, BRUN20.EXE must then reside on your disk, and it occupies 68,396 bytes.

How Quick?

QuickBASIC is well named. Compared with Zedcor's ZBasic, which lists for about the same price and is probably its chief competition, QuickBASIC requires more time to convert a source program into stand-alone executable code. But at run time, QuickBASIC really goes flat out (see table 1). For some benchmark tests it was a dead heat, but for others QuickBASIC was a clear winner.

Both QuickBASIC and ZBasic write to disk at about the same speed as interpreted BASIC, but they read from disk almost twice as fast. For integer runs of the Calc and Sieve benchmarks, QuickBASIC and ZBasic both turned in times as fast as previously reported for Turbo Pascal 3.0 (see the review by Mark Bridger in the February 1986 BYTE) and considerably faster than True BASIC or BetterBASIC (see the ZBasic review by TJ Byers in the May 1986 BYTE). For the Calc.INT benchmark, though, I had to use C=C \ A with QuickBASIC to force integer division; otherwise it ran much slower at floating-point speed. This is something to keep in mind if you need to speed up an integer-intensive routine. When the Calc and Sieve benchmarks were run with floating-point variables, both QuickBASIC and ZBasic slowed down considerably, but QuickBASIC was the clear winner. In the Calc.FP benchmark, in fact, QuickBASIC was nine times as fast as ZBasic, and in the Sieve, three times as fast. Compiled ZBasic was even slower than interpreted GW-BASIC in the Calc.FP benchmark.

[Editor's note: *Execution times for QuickBASIC were made with the error handler (Debug option) turned off. Under that condition, there is no checking for out-of-bound array references, arithmetic overflow, and other errors that may occur at run time. When the error handler is enabled, QuickBASIC execution times are significantly longer.*]

While running QuickBASIC through its paces, I also found that when large arrays are passed from the main program to a subroutine, the subroutine will execute much faster if the arrays are passed in COMMON or SHARED statements than if they are passed as arguments in the CALL statement. A Quicksort subroutine required about 50 percent more time to sort an array of 500 integers when the array to be sorted was passed as an argument.

One set of commands that I expected to execute about as fast in interpreted BASIC as in QuickBASIC is the set of graphics primitives that make the various implementations of Microsoft BASIC such a pleasure to use. Since these commands require relatively little work by the interpreter, I assumed that they would already be pretty much up to speed.

However, I was wrong. All the graphics commands I tested work faster, some of them much faster, in QuickBASIC than in GW-BASIC. To illustrate the typical speedup, table 2 summarizes the results of three simple tests. The first two are tests of full-screen GET and PUT statements, and the third measures the time required to draw a circle in the center of the screen and fill it with a solid color. QuickBASIC executed these commands 3 to 15 times faster than GW-BASIC. The speed improvements, particularly those with GET and PUT, make QuickBASIC a realistic development language for programs that use graphic window overlays.

Table 2: *Time required to execute representative graphics commands in QuickBASIC and in interpreted GW-BASIC on a Tandy 1000. All times are in seconds.*

Test description	Execution time QuickBASIC	GW-BASIC
DIM A%(8001) GET(0,0)-(199,319),A%	0.49	6.09
PUT(0,0),A%,PSET	0.77	4.05
CIRCLE(160,100),90,1: PAINT(160,100),2,1	0.89	3.11

More Than Competent

Although I've never thought of BASIC as a serious development language, I now have to admit that I like QuickBASIC. Microsoft brought BASIC to microcomputers with Altair BASIC, and QuickBASIC represents the company's latest contribution to the evolution of this language. Version 1.0 went far enough that you could see the promise of great things, but not far enough to be really satisfying. Version 2.0 lives up to that promise.

QuickBASIC is now more than just a competent language. It represents an outstanding contribution to the microcomputer world. The documentation is attractively presented and about as comprehensive and utilitarian as any language documentation you'll find. The price is competitive with any full-fledged BASIC compiler for the IBM PC that I know about, and well below most of them. If you like BASIC, you'll like QuickBASIC. If you don't like BASIC, QuickBASIC just might change your mind. ■

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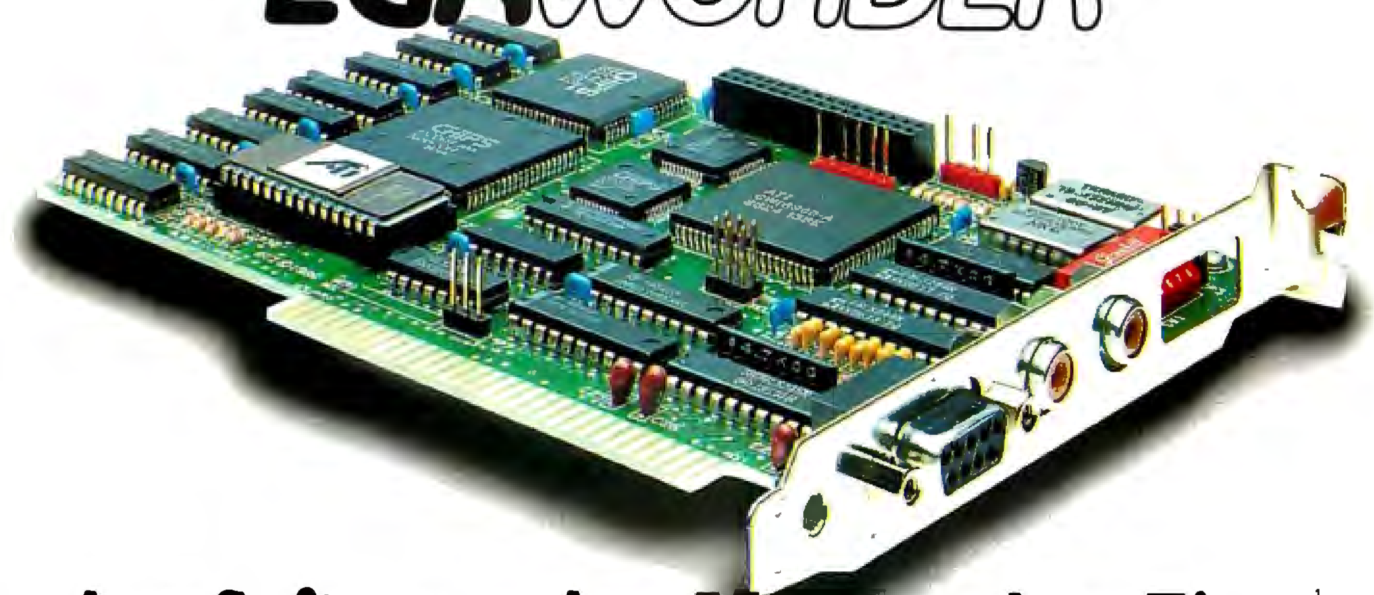

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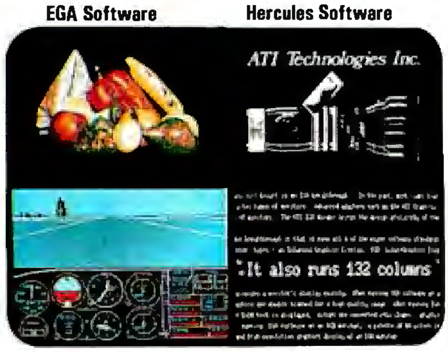
EGA Software — Hercules Software

CGA Software — 132 Column Software

EGA Wonder runs EGA, CGA, MDA, Hercules and 132 Columns on a TTL Monochrome Monitor and Compaq PC Portable[2] . Colors of EGA and CGA are converted into shades, graphics are full screen and no pre-boot drivers are required.

RGB, Composite Monitors, and the IBM Portable PC

EGA Software — Hercules Software



CGA Software — 132 Column Software

EGA Wonder also runs EGA, CGA, MDA, Hercules and 132 Columns on an RGB Monitor, Composite Monitor, and the IBM Portable PC in 64 colors (shades). EGA and Hercules software are interlaced for high resolution text and graphics.[3]

Composite monitor and PC Portable display not shown.

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Automatic Switching Between EGA and CGA Color Modes and Among EGA, MDA, and Hercules Modes	✔	✔	
Runs EGA, CGA, MDA, Hercules and 132 Columns on an EGA Monitor	✔		
Runs EGA, CGA, MDA, Hercules and 132 Columns on an RGB Color Monitor	✔		
Runs EGA, CGA, MDA, Hercules and 132 Columns on a TTL Monochrome Monitor	✔		
Runs EGA, CGA, MDA, Hercules and 132 Columns on a Composite Monitor	✔		
Runs EGA, CGA, MDA, Hercules and 132 Columns on an IBM Portable P.C.	✔		
Warranty	2 Yrs	1 Yr	1 Yr
Suggested List Price	$399	$595	$599

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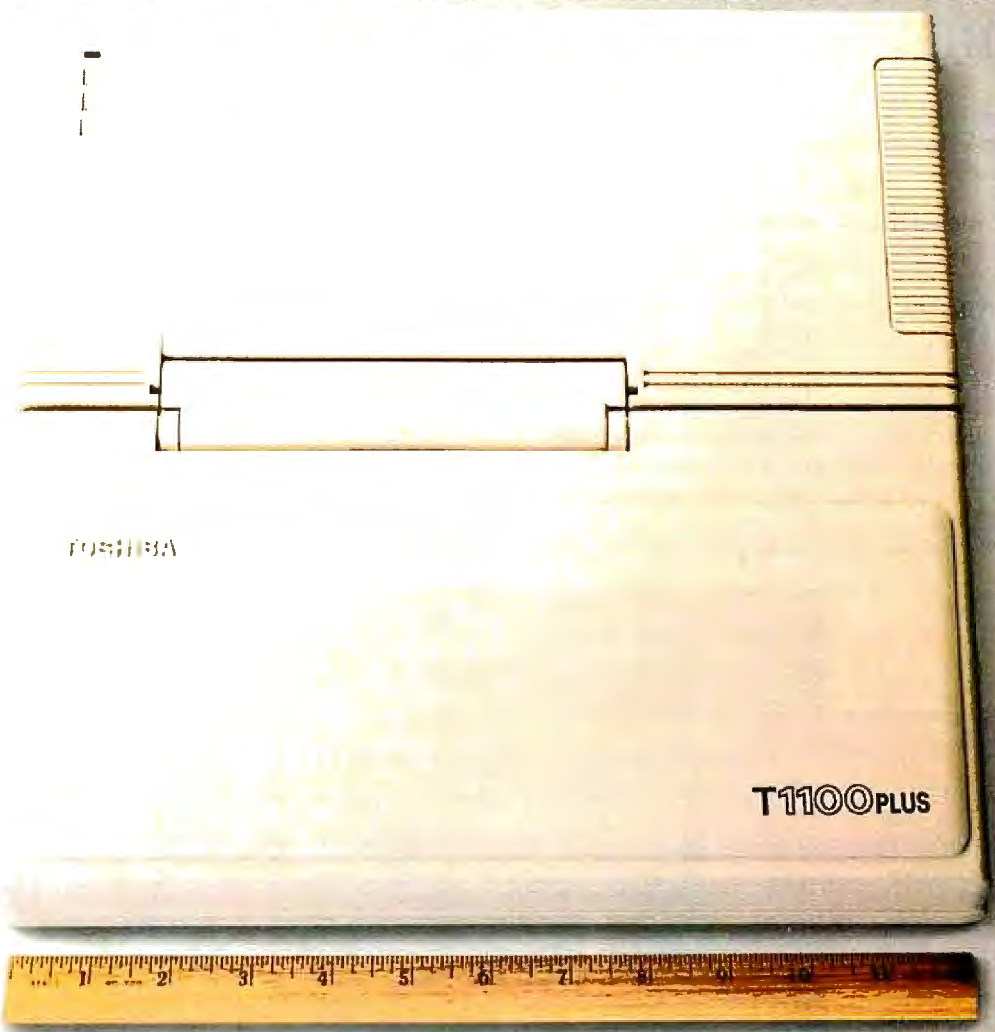

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The T1100 PLUS comes with a long list of standards including dual 720KB 3.5″ disk drives, MS-DOS,[2] serial, parallel and CRT ports, an IBM-compatible keyboard with 81 full-size keys, rechargeable NiCad batteries that last up to eight hours per charge, AC adapter, user's manual, MS-DOS manual and soft carrying case.

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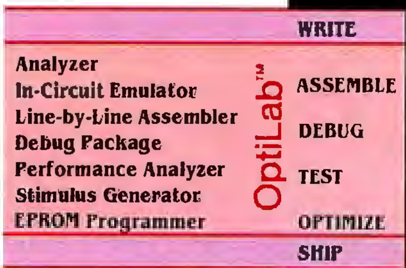

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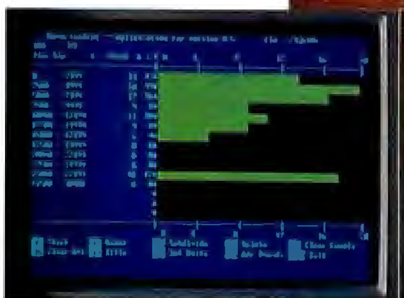

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Inquiry 194

Forecast Master

Lowell Rosen

A state-of-the-art statistical package with lots of power and some flaws

Forecast Master, from Scientific Systems and the Electric Power Research Institute, is a powerful and sophisticated package with many state-of-the-art methods that you will not find in most statistical packages. Some of the techniques are hot out of the math journals.

Forecast Master is not a general-purpose statistical package. If all you care about are means, standard deviations, simple linear trend fitting, and very-near-term ballpark forecasting, then look elsewhere. This program is not for beginners. The reference manual to Forecast Master claims that its methods are "readily accessible to the user who is not also a specialist in statistical forecasting." At best, I think that this statement is wishful thinking. One cannot leap into this program and expect to get the most benefit from it without the prerequisite statistics training and some prior forecasting experience.

Forecast Master is a menu-driven collection of up-to-date and high-tech statistical procedures for performing univariate and multivariate time-series forecasting. This means that you can forecast a company's earnings from its own past history and also make use of other economic indicators such as the consumer price index or the prime interest rate. Good multivariate forecasting capability gives you the same power tools used by the banking houses, Dow Jones, and the U.S. Department of Labor. It gives you firsthand experience with the input-output output theory of economics.

A Plethora of Techniques

Forecast Master is clearly designed for experts in technical analysis who have had prior forecasting experience and a more-than-passing interest in the mathematics of matrix analysis and multivariate data analysis. Its separate procedures include

- multivariate state-space forecasting with up to 10 variables (exogenous and endogenous)
- univariate Box-Jenkins for ARMA (autoregressive moving average) models
- multivariate Bayesian vector autoregression for up to five variables
- univariate exponential smoothing including adaptive time weights and compensation for trends and seasonal effects
- AUTOPRO regression
- multivariate variable parameter regression for time-varying regression coefficients
- econometric analysis using the XII method including trend, seasonal, cyclical, and erratic decomposition
- simple curve fitting including linear, exponential, quadratic, hyperbolic, log, and power curves

Among its preprocessing data transformations are differencing and log transforms to improve statistical stationarity, and it has an excellent capability to define new variables as functions of old ones. All the methods are carefully designed to let you develop your own models, change parameters, explore variations, and finally compare and graph the results of what you did. This is indeed what a professional wants to do, but it can also become a confusing jungle of multiple choices to the uninitiated.

No Roadmap

It is in this jungle of high-tech forecasting techniques that Forecast Master's documentation exhibits its major deficiency. It covers at length the fine points of the math analysis of the different algorithms, but it fails to provide any cross-index of all the methods. Needed are summaries and comparisons in terms of input data requirements, their good and bad points, criteria for use, forecast accuracy, size of the forecast horizon, and basic philosophy of the method. In addition, the documentation fails to give any substantial roadmap to the first-time but intelligent user who has the simple but urgent question, "Which method should I use and trust?"

It is one thing to press computer keys and get a screenful of numbers such as a a Durbin-Watson statistic, Ljung-Box test score, or AIC error statistic (which you may or may not have seen in a statistics course) and another thing entirely to understand the meaning and utility of state-space transition and error matrices and how canonical correlations between past and future can be used for model order determination and more accurate forecasting. The help screens in Forecast Master should have been more useful in this context.

Powerful Forecasting

Econometric analysis of a time series with its seasonal, cyclical, and trend components is the basis of economic time-series forecasting. Likewise, regression techniques have been around for many years, but state-space forecasting is not as widely used, if only because it is so new. Yet it has the capability to be the most accurate of all the techniques. Historically, it is a direct application of the Kalman filtering methods used in engineering and science. The same methods in state-space forecasting can be used for predicting the daily, weekly, or monthly movements in the stock market or the national debt or world trade balances. The Kalman methods are basically iterative, least-squares estimation techniques that constantly adapt to the changing patterns of

continued

Lowell Rosen (7941 Paseo Del Ocaso, La Jolla, CA 92037) is a professor of graduate statistics and management science at National University in San Diego, California. He is also an aerospace scientist with General Dynamics in the Space Systems Division.

Forecast Master

Type
Time-series forecasting statistical package

Company
Scientific Systems
One Alewife Place
Cambridge, MA 02140
(617) 661-6364

Format
Three 5¼-inch floppy disks; not copy-protected

Computer
IBM PC or compatible with 512K bytes of memory and one floppy disk drive (640K and two floppy drives are suggested); IBM-compatible graphics monitor and printer (with graphics capability); MS-DOS

Features
Multivariate and univariate time-series forecasting; menu-operated with graphing

Documentation
142-page reference manual

Price
$795

a time series by continuously monitoring the forecasting errors being made. They can potentially provide the largest forecasting horizons of all the methods.

Data Handling and Display

Forecast Master comes with a collection of data files with which you can start playing the forecast game. They are simple ASCII files representing such things as the quarterly unemployment rate, the M1 money supply, and the quarterly savings rate. They also have associated key files that list the start date and sampling period (e.g., monthly, quarterly) of the data. Any other data that you wish to enter into the program must be on your DOS disk as an ASCII data file.

Once in the program, you must then exercise the menu option to create a key file for the data. You cannot enter, change, modify, list, combine, compare, or delete data from within Forecast Master. There is no data management capability within the program. Instead, the Edit Data File menu option merely bumps you out of the program into a text editor of your choice where you can make changes. This lack of a fast, basic data manager (usually the hallmark of good statistical packages) is a serious deficiency in the program.

The graphics-plotting routines within Forecast Master also offer a strange paradox. On one hand, they are fast and easy to use, but on the other hand they fail to annotate key time information on the graphs. Data is segmented into pages according to the resolution you request and then plotted on the screen of your graphics monitor. You have the capability to move to the next page or back to a previous one. A convenient feature lets you do log, difference, and ARMA deseasonalization transforms on the data before it is plotted. On-screen information includes the name of the data, the scale factors, vertical numbering, and the start and end dates of the data. The horizontal axis, however, shows no dates, just tick marks. If you want to determine the date of a particular plotted point, you have to count possibly hundreds of tick marks.

Accuracy

Once you get used to the menu operation and the data-selection techniques, the program runs quite quickly. Both data selections and forecasts are conveniently remembered from run to run so that comparisons are easy to make. A built-in graphics screen dump to an Epson printer worked fast and flawlessly, providing a hard-copy output similar to the IBM graphics screen dump, but with an apparent higher resolution.

To test the routines, I divided the built-in data files such as the unemployment rates in half, with the first half functioning as the historical set. I could then compare the forecasts with the remaining data. All the forecasting methods yielded excellent short-term forecasts of three to five periods. My particular interest was in how well they would do with extended forecasts beyond one and one and a half years. When using 12-period forecasts on the quarterly unemployment rates, I found that at about the halfway point in the data both Box-Jenkins and the simpler three-parameter exponential smoothing model predicted exponential growth patterns over a three-year period, while the state-space methods predicted first an upswing of four points and then a downswing of the same amount two years later. Of the three methods, the state-space method predicted the correct pattern but led it by one year.

Summary

Forecast Master is a powerful state-of-the-art forecasting package for time-series analysis. It is primarily for technical experts who can best appreciate and use its many features. I like its particular use of state-space technology and the ability to compare forecasts among all the methods. But I don't like the absence of lots of well-documented application examples showing this power, nor its high price. The menus are a bit of a hindrance, but quick nevertheless. The program would greatly benefit from a high-level macro command capability. The deficiencies in the documentation, data management, and graphing are serious though not fatal. I hope a future revision will resolve these matters. ■

Public Domain Software for the Amiga

Warren Block

Public domain software for the Amiga is very important. The number of commercial programs available for the Amiga is relatively small (at least thus far) and, in many cases, this has caused programmers to write programs for specific needs of their own. Many of these programs have made their way into the public domain, and in this review I will describe some of the best. This is by no means a comprehensive list; more public domain material is becoming available every week.

Utilities

The AmigaDOS environment is similar in many ways to UNIX, so it is not surprising that many of the utilities released into the public domain resemble those on minicomputer and mainframe UNIX systems. The majority of these programs are used with the CLI (command-line interface) provided in AmigaDOS, bypassing the icon-oriented Workbench. Take, for example, the SQ and USQ utilities. SQ (squeeze) simply compresses a file, generally resulting in a 20 to 40 percent savings in space. USQ (unsqueeze) reconverts the squeezed file to its original state. The Amiga is first and foremost a graphics machine, and bit-mapped pictures take a lot of disk space. Using SQ and USQ, you can minimize the bites that large files take out of your disks or the time it takes to transfer files by modem.

Another useful utility is WLC (word/line count). WLC counts the words and lines contained in an input file. This is similar to the UNIX wc utility. WLC works equally well with plain text or program source code, and if the text file is in RAM: (the AmigaDOS RAM disk device), it is quite fast.

Filters (programs that take a file and modify it in some way) are common in the current public domain library. Two good examples are CRS, a filter that allows you to add or remove carriage returns from its input file, and Strip, a general-purpose filter that removes control characters of all types from the file that you feed to it. Both are extremely useful when you are attempting to use files downloaded from an on-line service or bulletin board system. Strip also works well to remove control characters from a word processor file if a plain text version of it is needed. These two programs are not flashy, but when you need them, they are welcome aids.

GfxMem is a memory-display program that opens a window on the Workbench screen. This window shows graphically how much memory is being used in both chip memory (the first 512K bytes of RAM) and fast memory (anything above 512K). It can be quite educational to run GfxMem on the Workbench screen together with a drawing program. When you pull down the screen used by the drawing program so the GfxMem window shows, you can see how memory is eaten up during a graphic fill of a shape (the more complex the shape, the more memory is used) and then returned afterward. It is also very handy if you are attempting to multitask several programs at the same time and wish to keep a safe distance below the limit of memory.

Another available utility is MyCLI. This is a program that creates a new CLI window with features not shared by ordinary AmigaDOS CLIs. MyCLI features intrinsic commands; that is, they are always in memory as a part of the MyCLI program itself. You need the Run and Execute commands in the current *c* directory, but with them in RAM:, there is no need for the Workbench disk at all. MyCLI can also send and receive files over the serial port, lets you define the function keys, and allows MS-DOS-style batch files. Overall, MyCLI is an excellent replacement for the standard CLI program, and author Mike Schwartz invites correspondence on the program's performance, so it will most likely improve even more.

Demonstration Software

Quite a few of the public domain programs developed for the Amiga have been, not surprisingly, for the purpose of demonstrating the computer's features. Programs of this type are not very useful except for two things: demonstrating how to write a program for the Amiga (source code is usually provided along with object code), or simply showing what the machine can do. Some are impressive enough to justify their inclusion here, however.

People who doubt the Amiga's animation capabilities are usually convinced by seeing 3DRotate. It draws a three-dimensional wire-frame arrow on the screen and rotates it in three dimensions. The rotation is unbelievably smooth and fast, and the program runs in the 640- by 400-pixel high-resolution mode, so "jaggies" are almost undetectable.

Skewb is another demonstration program, although it has a different twist: It draws one of the Cube puzzles on the screen and then rotates sections of it. Skewb lets you increase the number of small cubes that the large cube contains, up to the point where the cube shown on the screen is made up of 12 small cubes per side, although the program starts to slow down drastically long before that happens.

Flashy Program

Paul Biondo's DPSlide takes a practical approach to graphics. DPSlide displays standard Amiga IFF (Interchange File Format) graphic pictures (like those created by Aegis Development's Images or Electronic Arts' Deluxe Paint programs) in a slide-show-type presentation. The actual pictures to be displayed are determined by a text file that contains information on how long each "slide" is to be shown and what method should be used to bring it onto the display—Pop Up, where the picture just appears; Fade In or Fade Out/Fade In; or Scroll Up, in which the new picture scrolls up the screen, covering the previous one. It is an easy task to create the text file with ED, the AmigaDOS screen editor. You can easily create a professional-looking presentation complete with a feature to pause the display during the show. DPSlide works extremely well, and it is an invaluable addition to any Amiga owner's software library.

Something More Practical

Two types of programs should always be available for a new computer very soon after its release: word processing and telecommunications programs. In the case of the Amiga, Commodore's Textcraft was available quickly to address the need for word processing, but there was no equivalent commercial terminal program. This prompted the creation of several public domain programs. Commercial ones are now available, but the public domain versions have been evolving and getting better in the interim.

One such program, StarTerm, is an excellent example. StarTerm has an impressive list of features, including the ability to communicate at rates of 300 to 9600 bits per second, window or full-screen display, and multiple upload/download options. The program also has function-key definitions, a phone directory, and a start-up preferences file. These are all loaded from disk upon program execution. StarTerm supports auto-dialing with modems that are capable of it and has a well-polished user interface with custom gadgets and requesters. Some unusual capabilities include the ability to automatically adjust files downloaded with the XMODEM protocol to the correct length (thus making "chop" programs unnecessary) and the ability to switch between smooth and normal screen scrolling.

StarTerm can transfer data as plain ASCII text or via the XMODEM text or binary protocols. If you wish to use an Amiga for telecommunications, I strongly suggest you get StarTerm. It is far less expensive than any commercial program

continued

Public Domain Software Contacts

Users Groups:

AMICUS Disks
PiM Publications Inc.
P.O. Box 869
Fall River, MA 02722

Send a SASE and $1 for a listing of current disks available.

AURA (Amiga Users-Raleigh Area)
c/o Ray Cook
1114 Wildwood Rd.
Durham, NC 27704

Request a list of currently available disks.

Other:

Fred Fish
1346 West Tenth Place
Tempe, AZ 85281

Send a mailing label with your address and three first-class stamps for a list of currently available disks. At last count, he had forty disks, most of which were completely full.

DeciGEL allows the use of an MC68010 in place of the MC68000, increasing the speed of math computations and looping.

and just as capable as many. Your conscience may bother you, though, if you use it without sending $15 to the authors (Jim Nangano and Steve Plegge) as they request.

Many people who purchase Amigas are programmers who wish to take advantage of its processor power and speed. Getting program source code into the computer requires a text editor of some sort, but the AmigaDOS ED editor falls far short of most users' expectations, ignoring the Amiga's mouse and menu system and using non-mnemonic control commands.

Now there is a version of MicroEMACS for the Amiga, called MEMACS, which takes full advantage of the Amiga's user interface to provide an excellent programming editor. MEMACS has such useful features as a split-screen display to show different parts of the same program or to allow editing of two or more files at the same time and automatic indentation that greatly simplifies programming in languages like C and Modula-2, as well as keyboard shortcuts that make the use of menus optional.

Other features included in the program are adjustable margins, automatic word wrap that can be disabled, block cut and paste, and search-and-replace features that effectively make MEMACS capable of being used as a word processing program. It wasn't really meant for this purpose, but it works very well for letters and simple documents requiring little text formatting. The implementors of this version of MicroEMACS are Andy Poggio and Rick Wirch, who have given the Amiga programming community this commercial-quality text editor for free.

A small assembly language program called DeciGEL is of note to those Amiga owners who wish to squeeze even more performance out of their machines. It allows the use of an MC68010 in place of the MC68000 microprocessor, increasing the speed of math computations and looping by as much as 50 percent. Along with the DeciGEL source and object code is a text file describing the installation processes for both hardware and software. DeciGEL was written by Scott Turner, and the installation file is by Thad Floryan.

Availability

The first place you should try to obtain these public domain programs is from your local users group. Many groups are out there, and if you live in a relatively populated area there is very likely one near you that has most of the programs I have described.

The rural Nebraska area I live in, unfortunately, has nothing at all in the way of Amiga users groups, so I had to locate some by mail. Addresses for them are listed on page 257 along with instructions for obtaining listings of the software they have available. When contacting any of these people, keep in mind that they are doing this out of sheer kindness and are not making any real profit out of it. Whenever I contact one of these people, I send them some mailing labels with my address preprinted on them to make their lives easier. ■

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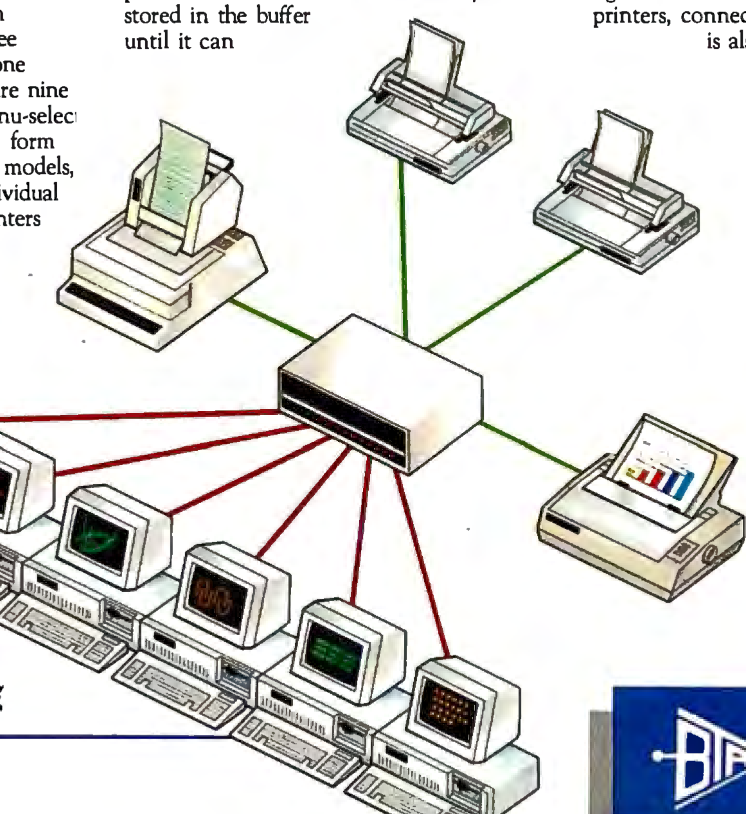

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REVIEW FEEDBACK

Three IBM Clones

I read John D. Unger's review entitled "Three IBM Clones" (November 1986 BYTE), which compared the Kaypro PC, the Epson Equity I, and the Multitech MPF-PC/700 D1, with interest, since I bought a Kaypro PC in June. There are, however, either some errors in the article or differences between the machine that was reviewed and mine.

My Kaypro PC came with MS-DOS 3.2, GW-BASIC 3.1, Mite 4.09, WordStar 3.3, and CorrectStar 3.31a, not the 2.11 versions.

My multivideo board is half-length (in a full-length slot next to the processor board), despite what the manual shows, and there is a switch for two speeds on the rear of the machine below the reset switch. Nothing is mentioned in my user's manual (dated "Preliminary," 10/25/85) about the speeds, but the local dealer said that the switch is for selecting between 4.77 and 8 MHz. The computer seems to run faster with the switch in the Up position, but I have not been able to time it. One game will not load in the Up position, however.

I am very pleased with my choice and use it daily.

W. Kimball Downey
Lynchburg, VA

Quarter-inch Tape Backup Units

I disagree with a few points in Malcolm C. Rubel's assessment of Alpha Microsystems' Videotrax in his review entitled "Four ¼-inch Tape Backup Units" (October 1986).

While admittedly slower than traditional tape backup units, the amount of time that it takes to perform a Videotrax backup could be considered rhetorical. I know people who start a backup procedure just prior to leaving the office for the evening. The next morning they can remove a completely verified backup tape from the machine. The Videotrax system was designed with this unattended operation in mind.

Mr. Rubel neglected to mention that an image backup of a complete 10-megabyte disk using the Videotrax unit takes about 15 minutes. (For that matter, image-mode backup times were not mentioned for any of the reviewed units.) Image-mode backups have been, in my experience, problematic with several ¼-inch systems but work well with Videotrax.

Mr. Rubel seems to favor the concept of the backup device/media as an extension of the system's file structure. While I concede that a serial storage medium can be of value in some applications, I would be quick to point out the conceptual differences between a working tape and a backup tape. Once written, there are only two reasons that you should place backup media in the machine. The first is to perform a restore, and the second is to rewrite the media because all the information on it has become dated. At all other times, the media should be stored in a safe place away from the computer.

Backups should extend over several generations, and the Videotrax unit allows you to do this on an inexpensive and widely available medium. The "no update" capability of the Videotrax tends to force backups into conformity with this philosophy. The idea of the backup software allowing the previous version to be overwritten (as with the Tallgrass TG-4060) gives me the heebie-jeebies.

Creed A. Erickson
Lititz, PA

I read with interest Malcolm C. Rubel's review of ¼-inch tape backup units. I have been using a Tecmar QIC-60 unit for almost two years now and have found Mr. Rubel's assessment to be correct. He states that if you stop a backup in progress, you have to erase the entire tape before you can back up additional data. This is also the case if the backup is interrupted because of some problem. In my application I collect about 5 megabytes of data on a hard disk, which I then add to files already on a ¼-inch tape. However, I don't usually find that I can fill a tape before an error stops the backup and thus prevents additional data from being added to the tape. It is not practical to erase the tape and repeat the process.

One way around this problem is to first copy the data to a "scratch" tape, and if the whole 5 megabytes is successfully transferred, it can be successfully transferred to a permanent tape. It should not be difficult for Tecmar to add a feature to the QIC-60 software to allow the user to erase the last volume on a tape.

N. Kouwen
Waterloo, Ontario, Canada

Turbo Prolog

My initial impression of Turbo Prolog was one of extreme enthusiasm. When I read Namir Clement Shammas's review of Turbo Prolog (September 1986), I read it with keen interest. While parts of his review echoed my enthusiasm, his concluding remarks cast a cloud of doubt over the ultimate utility of the product. He said that because of its nonstandard nature, "Turbo Paslog," as he called it, could not be recommended for the seriously Prolog-minded.

This negative statement unjustly labels Turbo Prolog as a curiosity rather than a real programming tool. Turbo Prolog has its salient points as well as its shortcomings; however, I feel that its strengths far outweigh its weaknesses. There are a few features about Turbo Prolog that I find annoying. The rigid data typing that is required for, I assume, compilation purposes can be a real thorn in the side to a first-time user. And to the seasoned Prolog programmer who is used to an interpretive environment, the quasi-Pascal structure of the data typing, which is not found in standard Prolog, may seem to be a quirky formality. However, what little bit Turbo Prolog gives up in flexibility, it more than compensates in speed and elegance.

I agree with Mr. Shammas that Turbo Prolog's claim to be a superset of the Clocksin and Mellish standard is somewhat of a misnomer. While Turbo Prolog lacks some standard predicates, such a deficiency does not truly reflect Turbo Prolog's ability to tackle respectable Prolog tasks. True, there are several syntactic variations between Turbo and standard Prolog. However, in many cases, I have been able to augment my Prolog library straight from Clocksin and Mellish with little or no modification at all. While Mr. Shammas assails Turbo Prolog's nonstandard nature, he fails to point out that it is many of these nonstandard features that give Turbo Prolog its creative flavor. I agree that if its departure from standardization prevents functionality, then innovation becomes an impairment. But I think that the serious Turbo Prolog programmer can become quite proficient. When coupled with some creativity, the powerful high-level programming features found in Turbo Prolog have the makings for some fine applications.

Marcel G. Davidson
Salt Lake City, UT ■

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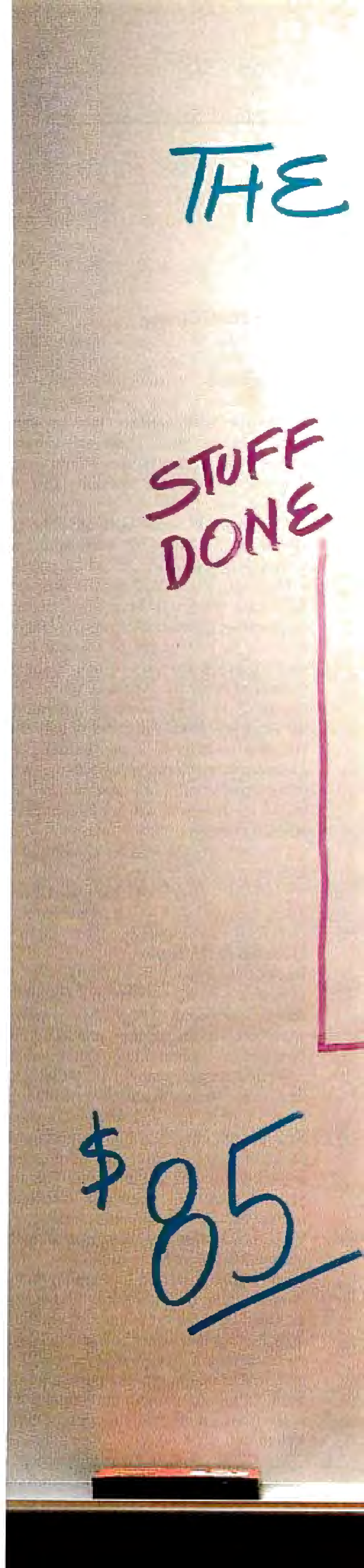

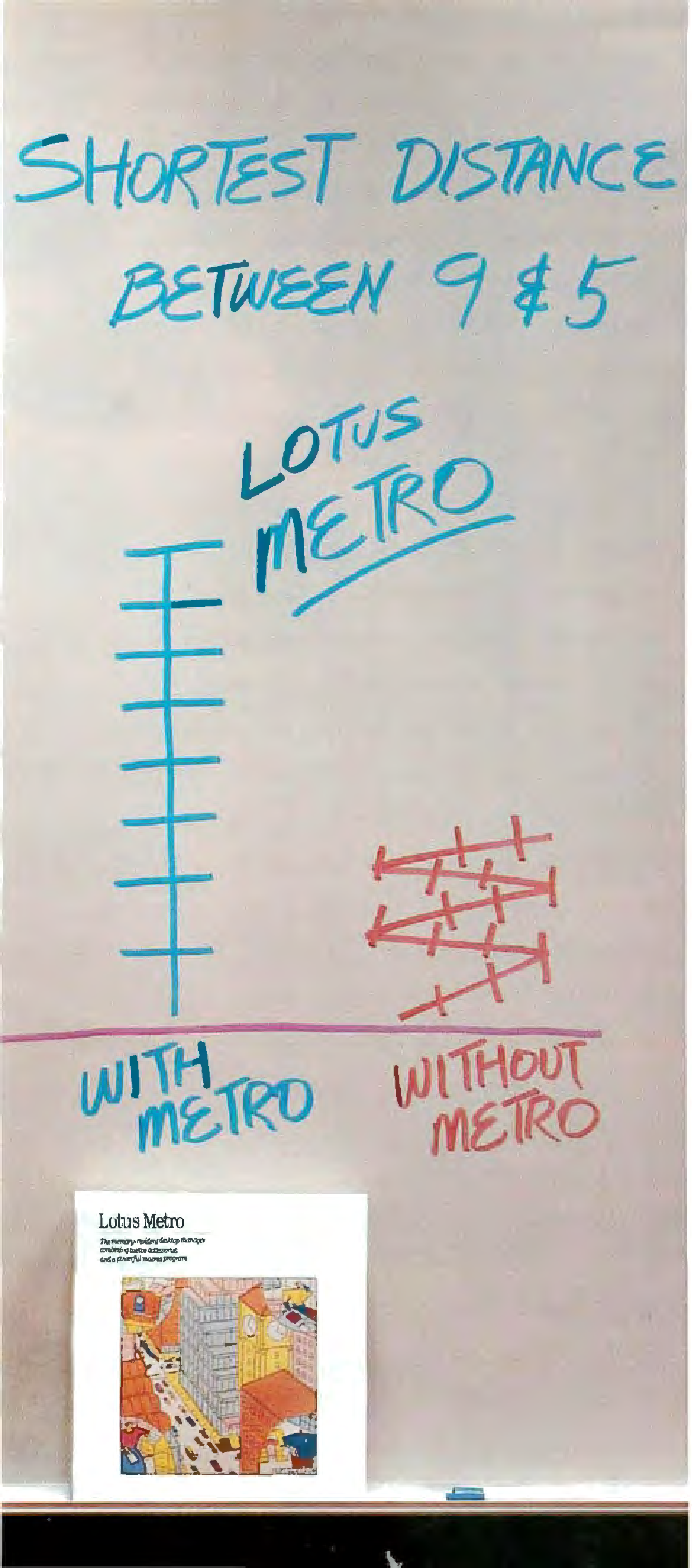
SHORTEST DISTANCE
BETWEEN 9 & 5
LOTUS
METRO
WITH
METRO
WITHOUT
METRO
Lotus Metro

Kernel

AS THE TITLE OF HIS COLUMN indicates, Jerry Pournelle attended the second edition of the Hackers' Conference this month. Held in an inspiring location and blessed with good weather, the conference—attended by most of the giants of the hacker community—was a good experience for Jerry. And he will happily go to the next one. Other happenings this month found Jerry acquiring an Okidata Okimate 20, which is pretty close to a printer for all seasons. Because the Golem is being updated, Jerry did the column using WordPerfect on Big Kat. Jerry gives his views on WordPerfect and also looks at the new version of Q&A.

Dick Pountain recounts some recent developments in the British personal computer industry. After a period where four major companies were producing machines of incompatible proprietary designs by the hundreds of thousands, there are now two major companies pinning their futures on selling IBM clones. In the space of a month in 1986, Apricot and Amstrad both launched IBM-compatible computers. Dick first looks at the Amstrad PC1512 series, which contains possibly the cheapest IBM PC clones in the world. He then evaluates the Apricot Xen-i, which may be the highest-performance and highest-quality PC AT clone in the world.

Ezra Shapiro is starting to experience one of the problems Jerry has found at Chaos Manor—software is chewing up floor space at an alarming rate. In the past month, he has received more than 30 products. This gigantic backlog has caused Ezra to have a significant guilt complex. He thus has decided to deal with several products in a shorter format. The lucky ones this month are Volkswriter Deluxe Plus, GraphicWorks, Highways and Byways, SuperPaint, Puppy Love, and Acta. Try to guess which one Ezra finds to be a real dog.

After having stayed around home for the past few months, Bruce Webster finds himself in the middle of a series of trips. One event he went to was the Apple IIGS Developers Conference. As a result of learning more about how the IIGS works and seeing more of what it can do, Bruce thinks more of this machine than he did a month ago. He is also impressed with the job Apple is doing in general. Bruce's product of the month is MacFORTH Plus from Creative Solutions Inc. He considers it one of the finest FORTH development environments on any system. Bruce also looks at MultiFORTH, Weinberg, and Editing Tools; gives some updates; talks briefly about MIDI; and recommends some books.

It's time for Mathematical Recreations once again. This time around, Bob Kurosaka looks at the base-3 number system, which offers an automatic solution to a classic puzzle. The puzzle involves the mathematics of balance scales.

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A Confederation of Hackers

Jerry Pournelle

Jerry goes back to camp and compares notes with classic hackers

Last weekend I went to Hackers 2.0, the second edition of the Hackers' Conference. The first one was held in 1984 up near the Golden Gate; we had this one in a retreat camp not far from Saratoga, which is a town at the far edge of Silicon Valley. It turned out to be an inspiring location among redwood forests, and to add to the mood the weather was magnificent.

Most of the giants of the hacker community were there: so many that it's impossible to name them all, and insulting to name a few as representative. There were hackers from every era, from the early days at MIT and Stanford to newcomers who work with Apples, PClones, the Atari ST, and the Amiga.

Some incidents: the Long March Beer Run. A companion and I set out for Saratoga (four miles away) for beer. There was an overturned bus on the two-lane highway, making it impossible for us to get past; so, we thought, we'll go the other way, uphill. Twenty-two very twisty miles and 45 minutes later we ended up on Page Mill Road in Palo Alto.

Bill Atkinson and Steve Capps, authors of QuickDraw, came up to me in the dinner line. "Do you think the Macintosh will survive?" they demanded, thus continuing a conversation started two years ago at the first Hackers' Conference.

"With a new keyboard, more memory, faster disk access, and a way to communicate with other machines—why shouldn't it?" was my only possible reply.

They also explained why they used the single-button mouse. "If it has more than one button, people look at the mouse rather than the screen," Atkinson said. "We didn't want them to look at the mouse. Besides, there's nothing you can do with several buttons you can't do with a single-button mouse if the software's designed right." That makes so much sense I want to think about it awhile.

On the first night, someone short-sheeted my bed. On the second, they'd wired a Radio Shack buzzer to scream at me when I, full of good cheer and Philippe Kahn's donated champagne (he paid for the masquerade party), tried to go to bed. Fortunately, I had brought my great double-bladed axe—at the masquerade it was my double-sided double-density hacker's tool—and it was no great problem to disconnect the buzzer.

I also met the original Amiga designers and saw what may be the best educational tools ever invented, namely, a series of animations, narrations, and illustrations that do a better job of teaching physics than anything I've ever seen before. This was developed largely at JPL (NASA's Jet Propulsion Laboratory) and has been on PBS. If I'd had something like this to study in high school and early college, I'd know a lot more about physics now. The computer revolution affects more than just computing.

There were the usual conferences and discussions of copy protection. We're all agreed that information piracy is a growing problem, and there appears to be no ready solution for it. I admit to being a bit scared, since I make my living from intellectual property, and that's becoming hard to impossible to protect. In a very real sense, we're all going to have to depend on ethics—and the last I heard, that isn't even being taught in the schools any longer.

It was an exhausting conference, with all the usual discussions of the future of computing and hacking and society and how hackers can change the world. Impossible to summarize, but more than worthwhile. A good conference. I'll be happy to go to the next one.

More Atari ST

A number of people brought machines to the conference. One of the most popular was an Atari ST brought by Alex Leavens. Alex, incidentally, is working with Mrs. Roberta Pournelle to program her reading instruction program for the ST. He's done about half of it, and I must say it really looks great. Roberta can hardly wait until he finishes, and I must confess mild anxiety myself.

The program incorporates most of what she learned in more than 20 years of teaching reading to illiterates of every age and with every disability. We have every reason to believe it will work: with luck and skill that program could change the world.

The first version requires that someone who can read work with someone who can't: the lessons come up on the screen, the "instructor" pronounces the words in the lesson, and the student follows along. The computer keeps track of lessons and progress and when the student gets things right puts on a light or a music show as a reward.

The next version will, we hope, just about eliminate the instructor. The Atari ST has good enough speech-synthesis hardware to do that. Alas, the speech-synthesis *software* that comes with the ST isn't so hot, and I don't know of anyone with plans to rewrite it. Maybe, though, by the time the first version of the reading instruction program is out something will be done.

The most popular Atari ST software at the conference was a game, StarGlider, which I confess is pretty addicting. It comes with a science fiction novella that's a little overwritten in places, but it reads well enough—and sure sets things up for the game. I've had a bit of trouble learning to use a mouse to control a fighter

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.

plane—I'd have thought a joystick would be better—but people more expert with arcade games than I am say they actually begin to prefer the mouse when they get used to it. One thing I did learn from StarGlider was why the U.S. Navy prefers two-seater fighter planes. It's hard to fly that thin and still go kill targets, especially if you have to guide missiles until they lock on. Anyway, if you like arcade games, you'll love this one.

Incidentally, StarGlider was developed with HiSoft's DevpacST (available from Apex Resources), an assembly language development system Bruce Webster recommends highly (see the November 1986 BYTE). I confess that I've never written a program in 68000 assembly language. Since my publishers are seriously discussing putting out contracts on me ifI don't turn in some novels, it's not likely that I will for a while. Those who do write assembly language programs for the ST seem to like HiSoft's package a lot.

Atari had also finally released the ST version of the old 8-bit Star Raiders. This is a pure shoot-'em-up with only the most rudimentary strategic decisions, but it has absolutely gorgeous graphics. I notice on BIX that even those who hate the program seem to spend a lot of time playing it.

Finally, I have the Epyx version of Rogue for the Atari ST. It has a number of refinements: great graphics, an on-screen inventory visible at all times, graphic representation of strength and hit points, and a whole bunch of other stuff. It's estimated that since Michael Toy first wrote Rogue for UNIX systems the game has cost more than a billion dollars in machine and programmer time wasted. If you like Rogue for any machine, you'll love it for the Atari ST.

Flash

I don't often play Star Raiders, or Rogue, or StarGlider for that matter, mainly because Mrs. Pournelle is using the Atari ST for BIXing. Like most recent converts to BIX she's become an addict, and it's nearly impossible to get her away from the silly machine.

What she's using is a Volks VM 520 modem from Anchor Automation connected to the Atari 1040ST. This is a slim little thing with only one control and no blinking lights, sort of the bare essence of a modem, and it works fine with the Atari ST. The communications software is Flash from Antic Software.

Flash is one of those products I call infuriatingly excellent. Excellent in that it does the job and has just a lot of desirable features. Among other things, it automatically captures everything you've sent and received (at least as much as there's memory for, which in a 1040ST is a lot); a click on the right-hand mouse button and you can go back and review whatever you got off BIX, and if you've got a printer hooked up, you can print all or part of it, too.

Another Flash feature is a rather nice little full-screen editor you can use to compose messages and send them. Actually, the editor is part of the capture buffer: you can compose a message in there, mark it, and send it—Flash sends marked blocks of text. Naturally, you can do the same thing with text you've already received, meaning that it's a lot easier to edit BIX messages in Flash than it is to use the primitive BIX line editor.

Flash can upload and download using Ward Christensen's XMODEM protocols. It has a translation table, meaning that as you send or capture text you can change anything to anything else: very useful if you have a computer with weird internal symbols, such as an Atari XE, which uses ASCII character 155 instead of a carriage return—the translation table can change incoming CRs to the 155 character and vice versa. Flash has a script capability: you can set up a series of commands and events and make them all happen when you log in.

In other words, Flash has plenty of nifty features, so why do I call it infuriating? As usual, it's the documents. If you want to use Flash, you'd better be prepared to read the entire 50-page book not once, but at least twice: unless you're more familiar with these things than I am, you won't understand on the first pass through. And since there's neither index nor analytical table of contents, you've got to read it all to find out what features are available, much less how to use them.

Flash doesn't have terminal emulation (or if it does, I haven't found that out) and lacks a few of the other features of really advanced communications programs; the documents aren't at all clear and in some cases are downright misleading on the more advanced features; but the bottom line is that it took no more than five minutes to set up the Atari ST with the Volks modem and Flash, and Roberta has had no trouble using it. The price is good, too. Recommended, provided you're willing to read the documents twice.

Monochrome

I've always had the Atari ST monochrome monitor, but for one reason or another I never used it; but when Alex Leavens came to visit he brought a copy of Magic Sac, the cartridge that plugs into the side of your Atari 1040ST and lets it run Macintosh programs. Magic Sac requires monochrome, so I fished the monitor out of the back room and plugged it in.

continued

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Incidentally, if you have both color and monochrome for the Atari ST, you want to be careful how you change from one to the other. The safest way, of course, is to turn the computer off while making the switch. You can also disconnect one monitor, reboot while no monitor is connected, and plug in the other one. The reason for this is that the Atari checks on boot-up to see whether you're using monochrome or color, and it sends out voltages sufficient to ruin one monitor if it thinks it's sending to the other.

I understand there's a company making a cable switch device just for the Atari; it will automagically reset the machine if you throw the switch to change from one monitor to the other. I sure wish I had one.

Anyway, we hooked up the monochrome monitor. We in this context are Alex Leavens and I. Alex is the moderator of a couple of Atari-related conferences on BIX, and he knows more about the Atari ST than any Atari employee I ever met. When we got the monochrome display hooked up, I could see why everyone is impressed with it; but, alas, it was too small for me to see very well.

No problem, said Alex; whereupon he proceeded to open up the monitor and tweak the vertical and horizontal amplification until the image filled the entire screen. The result is letters about 10 percent larger, which is to say large enough for me to see. You do pay a penalty, in that screen images are not precisely square any longer. You have to be careful with CAD stuff. For me, though, that larger image far outweighs the shape distortion, which is really so mild I have to look close to notice it.

A lot of Atari ST software will run on both color and monochrome. That includes games like StarGlider, and indeed many StarGlider addicts prefer the monochrome version because it's supposed to give more precise control. Alas, Time Bandit and Star Raiders require color.

The Atari ST with monochrome looks as good as the Macintosh to me, and certainly the image is larger. Quite impressive, especially considering what it costs. More and more Mac software gets ported from Macintosh to Atari ST with Magic Sac; ST owners who don't have monochrome and Magic Sac should seriously consider getting both.

Okidata Okimate 20

This is pretty close to a printer for all seasons. The Okimate 20 is a small—I mean really small, about the size of an Atari ST—dot-matrix printer that can take any of a number of "plug and print" modules to adapt it to your particular computer. Mine came with a module for the Atari ST; but Okidata is sending me modules to let me use it on an Amiga, IBM PC, and Apple IIe.

Each module comes with an instruction book, programs, and cable, all—including instructions—keyed to the particular computer you'll be using it with.

We had the Okimate 20 hooked up to the Atari ST in about 20 minutes. Fifteen were spent getting the paper into the machine. As with a lot of those small dot-matrix jobs, feeding in the paper is a black art. I suppose it gets easier with practice. Meanwhile, I keep eyeing the paper supply, hoping it will last long enough that my blood pressure will be lower when I have to put in new paper. Of course, I had even worse problems with the Epson printer. The only small printer I know that's easy to get paper into is the one from MPI.

Aside from getting the paper in, the Okimate 20 works great. The instructions are incredibly clear, with good illustrations. Some real editorial work went into producing this instruction book. (I have only the one for the Atari ST, but since the printer has been out longer than that computer, I'll assume they've done a good job with the other machines, too.)

Once you get the Okimate 20 hooked up, you're in for a treat. It's quiet. Not as quiet as a laser printer—what is?—but quiet enough that you can be in the same room with it and not go mad.

It also does *great* print quality in document mode. I often get letters from readers asking if editors will read manuscripts printed in dot matrix. I generally say it depends on the manuscript: editors will tackle anything if it's good enough, but the harder it is to read, the better the submission had better be. With the Okimate 20 you needn't worry: I, at least, can't tell its document mode from a Diablo daisy-wheel printer's output. The Okimate has a Courier—more or less—type font, and the letters are black and filled in. The lowercase descenders like j and g really descend below the line, and, in a word, the output is indistinguishable from impact printers.

It does this by a thermal-transfer process. That doesn't mean you need "thermal paper," although in fact the Okimate will print on thermal paper provided you remove the ribbon. (You can even use rolls of thermal paper if you want to.) Thermal transfer means that the 24 dot elements are heated and melt wax off the Okidata ribbon onto the paper. It stands to reason then that the paper has to be smooth, meaning that you can't use high rag-content bond. On the other hand, copier paper works fine, and so does the "computer paper"

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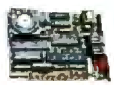

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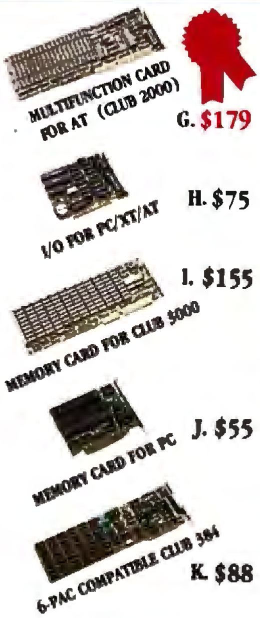

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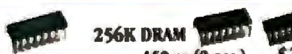

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I bought at my local paper wholesale house. (If you live in Los Angeles and aren't familiar with Kelly Self-Help Paper Company, you're spending too much money on paper.)

The color quality of the Okimate 20 is pretty good, too; better than you'd expect. It takes forever to do a color print, but for making charts and briefing aids this thing is more than good enough. I don't really have much call for color printouts, but back in my business presentation days, I would have paid a lot for the capability.

There's one real drawback to this machine. The ribbons are expensive. Okidata wants $4.99, and according to the manual you'll get only about 75 pages from that. The color ribbons are worse: $5.49 for about 15 color screen pictures—not quite as expensive as a Polaroid color print, but getting there. For that matter, black and white works out to seven cents a page for ribbons alone; add paper and you're up to a dime. Draft quality costs less, of course, but still, it's not all that cheap if you do much printing. These are the ribbon prices given on the order sheet Okidata sends with the machine. I'd suppose that you can find better prices from discount supply houses. Of course, by the nature of the thermal-transfer process you can use the ribbon only once.

On the other hand, if you have a source of thermal paper, you don't need ribbons at all. Moreover, the printer itself sells for $268 not discounted, including one plug-and-print module. You can buy more modules if you want to use the Okimate with other machines. I intend to test it with a whole bunch of different computers; more next time. Meanwhile, I'm really rather fond of the little beast, but I sure hope I can find a cheaper source of ribbons.

WordPerfect

I'm writing this with WordPerfect on Big Kat, the Kaypro 286i AT work-alike. A story goes with that.

A while ago I went up to Silicon Valley, and while there I dropped in to see Bill Godbout, chairman of Viasyn. We got to discussing machines, and it turned out my Golem, the big CompuPro boat-anchor machine that does yeoman service here, was pretty obsolete compared to what they're doing at CompuPro now. Not only that, but there's new stuff coming. I've always been a sort of test station for CompuPro's latest stuff. If I can't make it crash, my son Alex can; and if he can't, it's probably pretty bulletproof.

Consequently, when I drove up to Octocon—a science fiction convention held in Santa Rosa, alas, too infrequently, since it's nearly every writer's favorite

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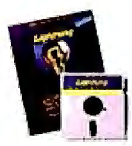

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Inquiry 81 for End-Users.
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convention—I packed the Golem in the back of my car and dropped him off at CompuPro central in Hayward. When we wheeled him in on a cart, one of the receptionists remarked, "Maybe we better start an IV. . ."

So: for the past three weeks I've been without the Golem. Unfortunately, that machine is the only one that can take the 8-inch disks that Zeke II—my *ancient* CompuPro Z80 who has become what amounts to a dedicated word processor—puts out and translate them into PC-DOS format. Alas, the only modem I have is in Big Kat: meaning that unless I can get my column into PC-DOS, I can't send it electronically to BYTE. I suppose I could fall back to sending the column in on paper, but then someone would have to type it in, and no one really and truly enjoys doing things like that.

The bottom line was that I had to write this column, and some other stuff that had to be turned in electronically, on Big Kat. That's all right because I've been meaning to test out some text editors, and there's no better test than to *use* the darned things for practical work.

I'd heard a lot of good things about WordPerfect, so I decided to start with it.

First thing was to install it. That turned out to be harder than I'd thought. The WP documents are a bit confusing. Actually, they're a *lot* confusing. One problem is that there's this little errata sheet inserted into the package, but it's not easy to find, and it corrects a serious omission in the very first thing you do, namely, install your printer. The instruction book looks to be very complete, and it shows you what you should do and what you should see—but when you do that, you don't see what the book shows, because the book omits to say you have to do a "page down" to get the screen pictured in the manual. The errata sheet corrects that, but I didn't find the errata sheet in time; as a consequence, I ceased to trust the installation book.

There were some other misunderstandings: what I was doing didn't seem to be what the book said would happen. Eventually I called WordPerfect Corporation (formerly SSI), WP's publisher. They have an 800 number, but that was busy, so I called the pay number. That turned out to be a mistake: no one I could get on that phone knew anything about my problem. You *have* to use the 800 number and talk to the "technicians." You'd better be determined if you're going to do that.

It's OK: I have the new Zenith Zoom modem, and that has a built-in demon dialer that will keep calling until it gets an answer. That got me past the busy signal. Even then, of course, I got a

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recording, but after about four minutes on hold I had a technician, who was able to take care of my original problems, largely by referring me to the errata sheet. Then I asked how to read in an ASCII file.

She didn't know what an ASCII file was.

Time to read the manual, so I did, to discover that WordPerfect's index is *awful*, and the table of contents no better; but if you are determined, you can find out that WP calls an ASCII file a "text file," and it does—more or less—have a way to read one in. Once you've read it in you need to remove the "hard carriage return" from the end of each line. First, of course, you have to see what *is* at the end of each line, and what WP *calls* that: WordPerfect doesn't use any kind of standard terminology.

Worse, when WordPerfect reads in an ASCII file, it reads a carriage return/linefeed pair as carriage return plus a *space*, meaning that paragraphs separated by two CRs are now separated by CR space CR, meaning that if you're trying to write a search-and-replace macro to convert your ASCII file into a WP file, you'll play the very devil doing it until you discover that.

Eventually I managed. That is: I told WP to search my file (it came off BIX) for "CR space CR" (actually, I told it to search for "[HRt] space [HRt]" since WP thinks a standard ASCII CR is a "hard carriage return," i.e., "[HRt]"). Each time WP found that, it was to substitute the English word PARA; I then went through and told it to change *all* CRs to spaces; and then change all instances of the word PARA to two CRs. The result was a file with the ends of paragraphs marked by CRs and the ends of lines marked not at all. That is a standard WP file, and now I could edit my BIX file.

I was also rather piqued with WP.

However, after that I found WP rather easy to use. It has a number of my favorite features, such as reformatting on the fly when you insert and delete text. Alas, it doesn't do it quite the way WRITE, the CP/M editor I use on Zeke, does it. WRITE simply reformats; WP shoves the right end of the line off the screen and won't reformat the paragraph until the cursor leaves the line you're working on. Ah well, that's sort of good enough.

I thought at first that WP didn't have "delete next word," but that turns out to be another document defect; in fact, Control-Backspace does that nicely, if the cursor is at the beginning of or inside the word. That takes a bit of getting used to, but surely no more than WordStar's Control-T, which does the same thing. WRITE's "delete next word" is more convenient in that it also takes out interven-

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ing spaces and puts the word after the one deleted where you have the cursor; much easier editing that way. Oh, well.

They aren't everything I want, but in fact WordPerfect has a lot of the features I want in a text editor, and a built-in macro generator capability that would let you build more. It has one other good feature: there isn't much on the screen that I didn't put there. True, there's a kind of status line at the bottom that I don't seem to be able to get rid of, but it's not very obtrusive. (And, of course, I have my Perma Power Color Commander, which can change colors of stuff on-screen; if the status line bothers me enough, I can turn it off by changing the status line display color to the background color.)

The bottom line is that I've tried three other famous IBM PC text editors, and I've come back to WordPerfect to write this column; and I have to admit that while it's not WRITE, I could, without a great deal of trouble, use this thing to write books with. It's good enough, and maybe more than good enough.

There are some serious problems, though. First, WP uses hidden codes to format text. There's a command that lets you "reveal" those codes, provided that you can read them; but I for one would greatly prefer the WordStar variety of "dot" commands, so that you can see the darned things. I'd far rather, for instance, do .ce3 to tell the program to center the next three lines, than do Shift-F6, type text, and do that again, and again.

On the other hand, WP is a WYSIWYG (what you see is what you get) editor and attempts to show you on screen exactly what you will get when you print. It apes a sheet of paper rather well, and for people who have no experience in using word processors and computers, it may well be easier to learn than something like WordStar or WRITE. Naturally, dot commands would mess up the WYSIWYG feature, since they take up space on the screen but won't print on paper.

Whether or not you'll like WordPerfect depends in part on how much time you want to spend learning about an editor. WP has a "learn" program. I confess I didn't go through it; the tutorial would have taken all day. Of course, if you're only starting to write with computers, taking all day for a tutorial is a good idea.

Another problem with WordPerfect is the sheer number of commands available. Every function key does *four* different things, depending on whether you press the function key, Alt+function key, Shift+function key, or Control+function key. There's a little template WP provides and heaven help you if you ever lose it. They've tried to do some logical group-

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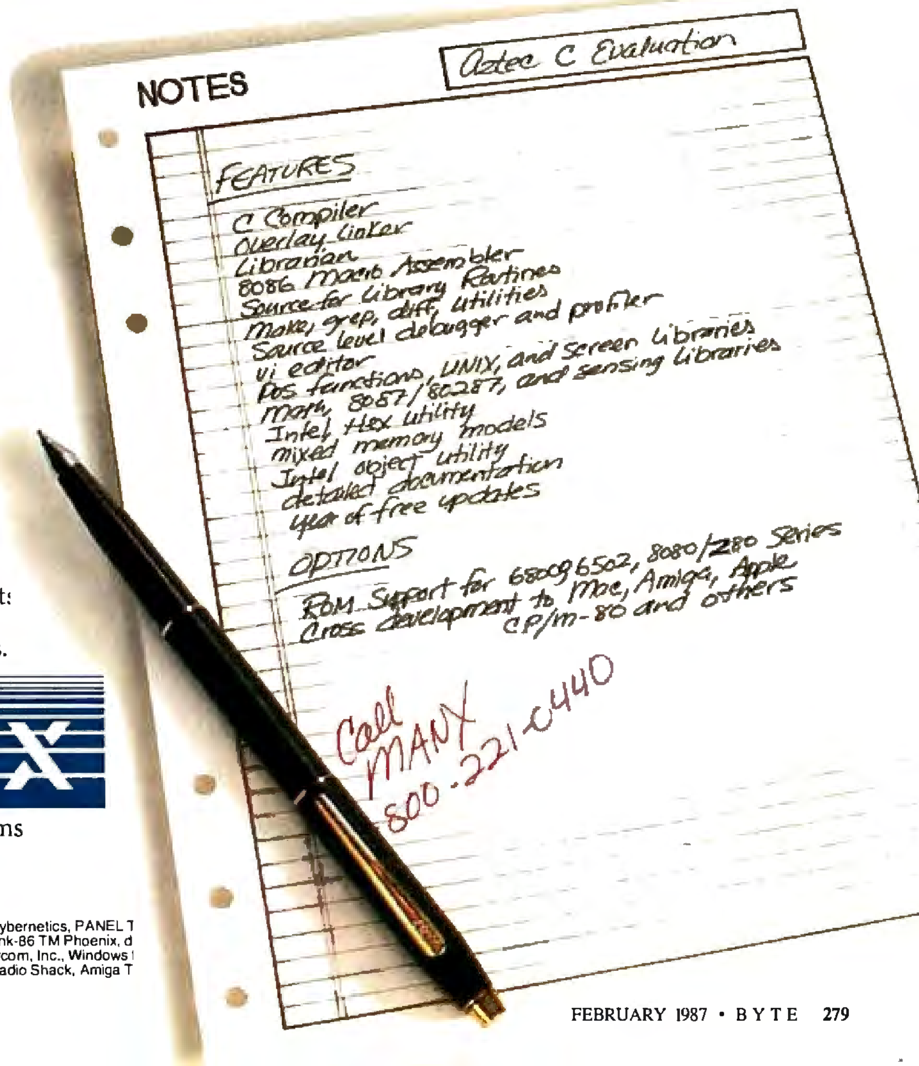

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ing, but it hasn't always worked: the F3 key does "help," "reveal codes," "switch" (to another document; you can work on two at a time with WP), and "screen," which does a bunch of things, including changing screen colors.

This wouldn't be so bad if the WP documents were well organized, but in fact they're wretched. They're divided into a number of sections, and the index, which is rather poor, doesn't make it anything like clear which reference in which section you ought to look at to find out what a command does.

On the other hand, the on-screen help capability is as good as anything I've seen except maybe for EMACS, and indeed WP seems to have borrowed some of its help notions from that programmer's delight. It has one of the nicest spelling checkers I have ever seen; you don't need any instructions to use it. Alas, it seems to put all your additions into one update dictionary, which is going to make it hard for me to use since my novels have alien character names and other stuff that I sure don't need to be in my main dictionary; but it may also be that I simply haven't plowed through the formidable WP documents at sufficient length.

Oof: I just looked at the Spell document and discovered that there seems to be no special dictionary; and it takes about 20 minutes to eliminate words from the dictionary once added. (Not 20 minutes a word, but 20 minutes no matter how many words.) This is not the world's nicest feature.

WordPerfect also has a thesaurus. I can't tell how complete it is, but in trying things at random, I was more than satisfied with it. Neither the thesaurus nor the spelling checker can compete with Word Finder's stuff, but then nothing does, and you can always use Word Finder with WordPerfect provided you've got a fast machine and lots of memory.

WordPerfect has lots of special features like merge and footnotes, none of which I know how to use yet because I haven't needed them; but it's nice to know they're in there, and, given patience to fight my way through the instructions, I make no doubt I'll figure out how to do the job when I have to. Incidentally, I'm not being sarcastic when I say that: the documents are complete, just badly organized; and the technician may not have known what an ASCII file was, but she sure knew WordPerfect. If you've enough patience to get to the company's help service, you'll get help.

On balance, I like WordPerfect better than most other text editors I've tried for the PC. I'm using it, and I'll probably go on using it for a while.

Q&A

When I was last in Silicon Valley, Barbara Clifford and I visited Symantec, which is the company that publishes Q&A. Symantec is run by Gordon Eubanks, one of the old-line hackers from the early days of this industry. Gordon wrote CBASIC, which is still one of the better languages to use. Now he's big business with dozens of employees.

Q&A is an integrated word processor and database program that comes with a file manager and a program you might call "artificially intelligent" called the Intelligent Assistant. I was impressed with Q&A when it first came out. I'm even more impressed with the new version, which has a spelling checker that works as nicely as WordPerfect's and lets you incorporate special dictionaries.

The word processor in Q&A is modeled to a great extent on PFS:Write and somewhat on the IBM Displaywriter. This makes it easy to learn for those who already know those programs and confusing for the rest of us. However, it's no harder to learn than any other, and of course there's a tutorial.

I don't mean to put down the Q&A editor. It has a lot of good features, most more oriented toward business use than text creation; and it's probably good enough that if I were used to it I'd be able to write books with it, and as a matter of fact there's a very strong probability that in future I'll do precisely that. However, the editor isn't really Q&A's strongest feature.

Where Q&A shines is the database management. This program makes it child's play to design a database, and if after you've used the database for a while you discover you didn't have enough categories and need a lot of modifications, that's easy with Q&A, too. And once

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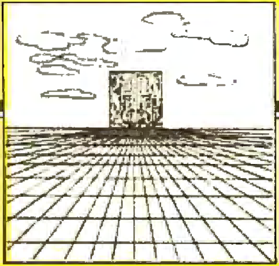

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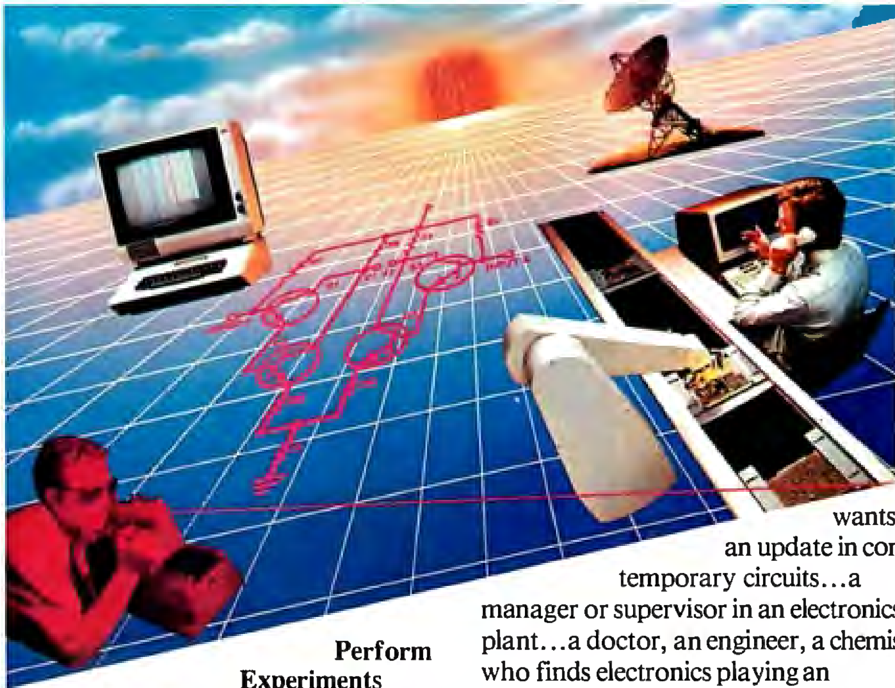

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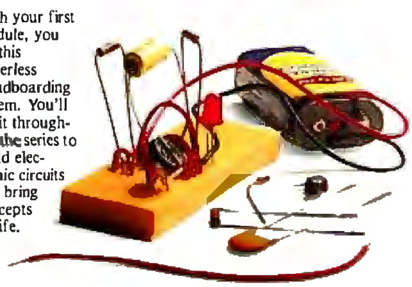

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you've entered your data, it's even simpler to generate special reports.

Indeed, Q&A incorporates notebook and telephone dialer features, so that it can replace much of SideKick.

I just got my latest edition of Q&A, so most of what I know of it comes from watching it demonstrated at Symantec headquarters. What I saw, though, makes me quite eager to get this installed: I intend once and for all to get all of the software and hardware in Chaos Manor entered into a database, and Q&A is the first one of those things I've seen that tempt me to use it.

More on Q&A in the next few months. Meanwhile, I already recommended the original, and the new version has significant improvements. One warning: Q&A eats memory like mad. (When I asked Gordon Eubanks if the new version of Q&A used less memory than the original, he said, "Well, it doesn't use any *more*. . .") If you buy Q&A you get a special offer for a 256K-byte memory board for only $50; that's the best deal in town. You will need that memory. Provided that you have a full-up PC XT or AT, though, Q&A could well be the most valuable program you'll ever own for it.

Short Shrift

It's time for my traditional grab bag of programs I don't really have room to discuss but which shouldn't be ignored.

Broderbund's Print Shop series continues to produce a cornucopia of accessories and utilities to aid microcomputer owners in desktop publishing. So does Fontasy. Prosoft has sent me no fewer than nine volumes of ready-made logos, clip art, illustrations for advertisements, divertissements, and plain fun. Anyone involved in newsletters, whether for social, business, or organization purposes now has no excuse for dull and boring mailers. It's just too easy and cheap to make exciting fliers. All you need is a PC or clone, Epson printer or LaserJet, and some of these programs.

Paul Heckel was at Hackers 2.0, where he gave me a version of his Zoomracks for the Atari ST, which I had seen at an Atari Faire. Zoomracks isn't as fast as it might be on a PC (it's good enough on an AT), but it seems better on the Atari ST. The new version has some additional sort and organize features. It's not an expensive program, it's real easy to learn, and it's pretty useful. I'm having all my Atari ST program collection organized in Zoomracks files. Saves no end of searching for things.

The Zenith Z-181 continues to win favor. It was a sensation at Hackers 2.0. Actually it wasn't: everyone was impressed with the readability of the screen, and the fact that you can have a portable that's a full PC-DOS machine, but most hackers aren't fond of PC-DOS in the first place. Those who do like PC-DOS were pretty excited about the Z-181, and indeed I've noticed I find Zebediah coming with me to more and more places. I've installed WordPerfect, which works quite well. There's supposed to be a simple way to transfer files from Zeb to machines without 3½-inch drives, but I confess I haven't done that yet. Real Soon Now. Meanwhile, if you want a full-function PC-DOS machine you can carry around with you; if you've an urge to run MultiMate, WordStar, or Lotus 1-2-3 on trips; if you want a full database capability on the road; and your arms just aren't strong enough to lug around a Compaq, look into the Z-181. It's quite the most elegant laptop/portable I've ever worked with, and I suspect Zeb will become a permanent fixture here at Chaos Manor.

Winding Down

The game of the month is the Amiga version of Star Fleet I. I only regret that I've

continued

If you like games of the Star Trek variety, you'll love Star Fleet I for the Amiga.

had to start all over as a midshipman; there's no way to transfer my admiral status from the PC version to the Amiga. Incidentally, this is a new version of the game, with a much better player interface. If you like games of the Star Trek variety, you'll love this. I've had some problems with the Amiga version crashing the system, but that started alarm bells at Electronic Arts, and I make no doubt they'll fix things by the time you read this. There's also an Atari ST version.

The book of the month is Kenneth Macksey's *Technology in War* (Prentice-Hall, 1986), only it isn't really; that is, with Barbara Clifford's help I'm just about done revising my own *The Strategy of Technology*, which with any luck we'll be able to turn in before the end of the year. *Strategy* was a textbook at the Air Force Academy and the Air War College for a number of years; some of the professors had it as students and want a new edition, so I've been grinding on it.

The program of the month is FTL Modula-2 for the IBM PC. This thing compiles like lightning, and, better yet, you get the source code to a pretty nifty text editor. I know of at least two hackers who intend to take the FTL editor and modify it to have all my favorite features. They don't think they'll have much trouble, either. Much more on this next month.

I'm out of space, and also just about out of time. Fall COMDEX is next week, and after that I'm on a speaking tour in France and England. Meanwhile, *Storms of Victory: Janissaries Volume III* is about 80 percent completed, and I'm supposed to have it out the door before COMDEX. That's definitely going to take a lot of luck. Things continue to *flow* at Chaos Manor, and I guess I wouldn't have it any other way. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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And More Clones

Dick Pountain

Amstrad and Apricot are pinning their futures on IBM look-alikes

I find it increasingly hard to remember that only two years ago Great Britain had four major personal computer manufacturers, all producing machines of incompatible proprietary designs by the hundreds of thousands. Now we have only two major native manufacturers (not counting the Italian-based Olivetti), and they are both pinning their futures on selling IBM clones. The 68000-based alternatives from Apple, Atari, and Commodore have some presence here but haven't sold as well as they have in the U.S. (even in proportion to the population). The truth appears to be that in the U.K. we buy for price and utility rather than for technical innovation.

The two major companies, Amstrad (Brentwood House, 169 Kings Rd., Brentwood, Essex CM14 4EF, U.K.) and Apricot (U.S. address: 47173 Benicia St., Fremont, CA 94538), could hardly be more different in approach, and their respective IBM-compatible machines typify the differences. Amstrad's base is in budget consumer electronics and hi-fi. The firm entered the home computer market with great success in 1985 by offering good value rather than innovation (see my columns in the January 1985 and March 1986 BYTEs) and eventually swallowed the home market leader, Sinclair Research.

Apricot, on the other hand, started out supplying business computers. In 1985 it decided to move down in price, entering the educational market with a range of sub-£1000 machines that flopped badly. After reaching the very brink of disaster in 1986, Apricot has announced that it is going back to high-price, high-margin products with full professional support. It is trying to return to the "systems-house" approach of selling complete solutions and service rather than commodity personal computers.

In the space of a month in 1986, Apricot and Amstrad both launched IBM-compatible machines. The Amstrad PC1512 series contains possibly the cheapest IBM PC clones in the world—I say possibly because the pricing policy of Taiwanese clone makers exhibits a certain "flexibility." The Apricot Xen-i, on the other hand, may be the highest-performance and highest-quality PC AT clone in the world.

Amstrad PC1512

The PC1512 range includes options of one or two floppy disk drives, 10- or 20-megabyte hard disks, and monochrome or color monitors, with a price range running from £449 and up for one floppy disk drive and a monochrome monitor to £1069 for a 20-megabyte hard disk with a color display. The low price has been achieved in typical Amstrad fashion, meticulously saving costs in design and production engineering, rather than by skimping on quality of materials or essential features.

My first impressions on viewing the machine were wholly favorable. It's housed in a custom injection-molded ABS case, rather than the bent tin favored in Taiwan. Its footprint, at 15 inches square, is considerably smaller than the IBM PC, and it comes with a tilt-and-swivel monitor that encloses the power supply, allowing the whole unit to be supplied from a single power outlet plug (a feature that consumer-conscious Amstrad has insisted on from its first design).

The two alternative monitors differ in price by £150. The color monitor supports the IBM CGA (Color Graphics Adapter) standard, while the monochrome monitor is unusual in also supporting the CGA standard, in tones of gray, rather than the IBM monochrome standard. The color graphics hardware is integrated onto the motherboard, not on a separate card. The unit I tested came with twin floppy disk drives and a monochrome monitor. It was a considerable boon to be able to port my IBM color software directly without worrying about the colors being translated into inappropriate monochrome "attributes"; the tones of gray are all clearly distinguishable. Compatibility with IBM regrettably also extends to the annoying flicker when scrolling.

Text quality on the monochrome screen is merely adequate. A pleasing thin sans serif typeface is used, and sharpness is better than on the IBM color monitor, although well short of the Macintosh or the Apricot Xen "paper-white" monitor quality.

Input is via a "real" keyboard that uses switches, springs, and removable key caps rather than the polymer-bubble technology used on Amstrad's home machines. In feel it's closer to a Key Tronic KB 5151 than to an IBM keyboard, a plus in my book. The keyboard's layout is not up to the latest standards, modeled as it is on the original flawed IBM PC keyboard. It has a few eccentric alterations of Amstrad's own, which do little to enhance it. For example, the Alt and Ctrl keys are placed side by side above the left Shift key, while PrtSc has inexplicably migrated to the main QWERTY area. There is no separate cursor keypad, and the Return and Shift keys have nasty small key tops. One useful innovation is the provision of twin Del> and <Del keys in place of Backspace; the Del> key can be soft-programmed to perform delete-right in your favorite text editor. Num Lock, Scroll Lock, and Caps Lock bear red LED indicators. One weakness, seldom seen nowadays, is that the keyboard appeared to lack full *n*-key rollover; depressing the QWE, ASD, or ZXC combinations simultaneously produces spurious charac-

continued

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ters (although this would cause problems only if you are ham-fisted or a supersonically fast typist).

All PC1512 models come with a built-in Microsoft-compatible mouse. The hardware itself differs from the Microsoft unit, being of all plastic construction with a rubber ball, but the driver software is Microsoft version 5.0 and is 100 percent compatible. Inside the case of the PC1512, the motherboard tells the whole story. It's a single board, occupying only half the case floor area, and it contains fewer than 50 chips, including memory; three large 64-pin gate arrays, made in Italy and bearing the Amstrad name, do the work of most of an IBM PC. Standard memory is 512K bytes in 256K-bit chips; sockets exist to expand the memory to 640K bytes. The CPU is an 8086-2 running at 8 megahertz, which makes the machine more nearly equivalent in speed to an Olivetti M24 (known as the AT&T PC 6300 in the U.S.). A socket for an 8087 math coprocessor board is also provided.

Three full-length expansion slots are arranged side by side at the back of the case, with the connectors emerging from a hatch on the right of the case. No fan is provided since the power supply is in the monitor case. I had no problems with overheating; the main case never became more than lukewarm. Since some scare stories were spread (reputedly by a rival manufacturer) that a PC1512 melted its case when fitted with a token-ring card, Amstrad has announced that all future production of the machines will be fitted with a fan; boss Alan Sugar says this has been done to quell the stories rather than as an admission that there was a problem. There is in any case little incentive to add many cards since the PC1512 already has all the "standard" IBM options built in. Serial port, parallel printer port, clock/calendar, mouse controller, and CGA are all on the motherboard. The EGA is not a likely addition, as it will work only in its lowest-resolution mode on the PC1512 due to the architecture. An internal modem card and extended memory are more likely additions. A shortage of hard disk PC1512s has led some people to add hard cards, but at present prices this is not an attractive option.

The PC1512 contains a nonvolatile RAM (NVR) backed by four pen-cell-type batteries that are contained in an open slot under the monitor base and that last about one year. The NVR stores information like the date and time, RS-232C port parameters, and other setup options. When you boot the machine, it tells you when it was last used. You can alter the parameters by running a program called NVR.EXE, through which you can set the key codes produced by the Del > key, the mouse buttons, and the mouse scaling, among others. This is the only way you can program the mouse, as Amstrad does not supply Microsoft's Mouse Menus software system; it works fine on the PC1512, however, if you have a copy of it. NVR.EXE also sets the size of a RAM disk configured at boot time and permits the choice of foreground and background colors (or gray shades) for the screen. I could easily set up the black on gray that I prefer, without having to mess with ANSI escape sequences.

Amstrad bundles three operating systems with the PC1512: MS-DOS version 3.2, Digital Research's DOS Plus, and the GEM desktop. (It's really more like two and a half operating systems since GEM runs on top of DOS Plus.) DOS Plus can run both CP/M-86 and many MS-DOS programs and can read both disk formats. It permits up to three CP/M-86 programs to run concurrently in the background as long as they don't do screen I/O or share files; this effectively limits the choice to print spooling and some prewritten utilities like an alarm timer. The only application bundled with the PC1512 is a simple-minded GEM drawing program called Doodle.

Programming capability is provided by Locomotive Software's excellent BASIC 2, which runs under GEM and fully supports the windows, menus, and bit-mapped graphics of that interface. In addition, BASIC 2 supports keyed sequential-access files, which makes it highly suitable for writing business programs, and it's very fast.

Apricot Xen-i

It's word-eating time for Pountain. Last April I faithfully relayed Apricot senior management's claim that they would implement IBM compatibility only through a SoftClone software-patching scheme. Even as they were telling me this little white lie, the Xen-i must have been under preparation. Shame!

The Xen-i looks externally just like the Xen that I reviewed last April, so I shall only describe the differences. It uses the same attractively styled case, except that in place of the 3½-inch microfloppy is an IBM PC AT–compatible 5¼-inch drive. Xen-i will normally be supplied with an IBM-compatible monochrome or color monitor, although you can use Apricot's old higher-resolution monitors via a separate video outlet; however, the Xen's excellent paper-white monitor requires an expansion card. Hercules standard (720 by 350) monochrome text and graphics are supported on the motherboard without an adapter. The Xen's fine keyboard, complete with its LCD microscreen, is retained.

Internally, the Xen-i keeps the 1 megabyte of fast 120-nanosecond RAM from the Xen but now drives the 80286 CPU at 10 MHz with one wait state, making it a very fast clone indeed. You can use only 640K bytes of the RAM directly from MS-DOS, but the rest (and any expansion up to 11 megabytes) is available via a built-in page mapper that works to the Lotus/Intel/Microsoft Above Board standard. Lotus 1-2-3, for example, will use the whole megabyte.

Expansion is limited compared to a PC AT's; the Xen-i can accommodate three short cards: two PC AT-type 16-bit cards and one PC-type 8-bit card. These cards lie horizontally in a cage at the rear right (due to the low-profile case) and are the devil's own job to insert. Don't even think about any cards with large protruding devices, as they just won't fit. You can add three full-size IBM PC or PC AT cards, however, if you use an external expansion box.

As with the Amstrad, many of IBM's options already exist on the motherboard of the Xen-i. Clock/calendar, monochrome graphics, serial and parallel ports, disk controllers, and mouse controller—albeit the quirky Apricot trackball/mouse—are standard fixtures. These functions are provided by four huge custom integrated circuits—bearing the increasingly famous CHIPS logo—on the motherboard.

Mass storage is provided by one 360K-byte or 1.2-megabyte floppy disk drive and either a 20-megabyte (HD model) or 50-megabyte (XD model) internal hard disk. The respective prices are £2998 and £3998.

The HD model that I tested came fitted with a Quadram EGA card and Apricot's own EGA monitor—my first serious encounter with an EGA system. This Quadram card has DIP switches to select between monochrome, CGA40, CGA80, EGA1, and EGA2 modes. EGA2 offered the finest resolution with a special, very sharp character set. Unfortunately, it seems you can't select a border color other

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than black in EGA2, which makes working with a reversed screen quite impractical (black characters at the left margin lose their uprights). I tried writing bytes to the CGA border-control port (3D9 hexadecimal) with no success. EGA1 uses a character set indistinguishable from that of CGA mode but still much superior to the IBM's CGA. I found that this mode suited me nicely, providing better color saturation than EGA2 and permitting a colored border.

The Xen-i comes with PC-DOS version 3.2, Microsoft Windows, and GEM. Windows is intended to be the principal operating environment, and it includes the Windows Write and Windows Paint programs. Regrettably, I'm becoming a middle-aged, crusty reactionary and find that I prefer my customized DOS/SideKick/SmartKey/PC-Write/Procomm combination to any windowing environment I've yet tried. My environment worked just fine on the Xen-i, which was unbelievably snappy after my IBM PC.

I played briefly with Xen-Tel, Apricot's telephone management system, which consists of a stylish telephone receiver shaped to fit closely against the Xen-i keyboard and a software package that runs under Windows. Using an Apricot internal modem card (Xen-Tel is not Hayes-compatible), the software allows you to maintain a card index of phone numbers for auto-dialing and also to pull phone numbers out of files created with dBASE III, accounting packages, and other applications. You can create a queue of calls you want to make; Xen-Tel will try them and record which ones succeeded and which ones need to be retried.

Compatibility

Both the Amstrad PC1512 and the Apricot Xen-i showed a high degree of IBM compatibility. The PC1512 balked at only one of the dozens of programs I tried, namely, LMI's PC/FORTH, which is pretty badly behaved; the PC1512 just spat it out and returned to the DOS prompt. It ran plain SideKick, even though it isn't supposed to (there is a special Amstrad version). The only problem I found was that the Notepad's top line didn't clear when I typed in a new filename. The PC1512 ran the IBM version of Turbo Pascal and the Sublogic Jet flight simulator without a hiccup.

The Xen-i ran PC/FORTH perfectly but refused the flight simulator (I believe it doesn't run on the AT either). The only other minor quirk I found was with the resident utility DOSEDIT, which ran but wouldn't allow insertion when editing a command line.

Knowing that communications provides a stern test of compatibility (and neither of these machines has a switchable CPU rate), I swapped my modem cable from my IBM PC to the PC1512 and ran Procomm. To my astonishment, it worked the first time and logged on to BIX perfectly. A similar experiment on the Xen-i failed; Procomm ran all right and appeared to talk to the modem but wouldn't log on to PSS (Packet SwitchStream) despite much fiddling with parameters. This was more in keeping with my expectations about compatibility in communications.

Both the PC1512 and the Xen-i refused to read DOS 2.1 disks from my IBM PC on one or two occasions (the Amstrad issuing a nonchalant "General failure error reading drive b:"). Inspection of the disks revealed nothing out of the ordinary, and my IBM PC continued to read them without a hitch.

The Xen-i uses the highly rated Phoenix BIOS, while the PC1512's BIOS bears an Amstrad copyright notice.

Performance

Since there is so little to say about the software for IBM clones, I devoted longer than usual to benchmarking the two machines. Assuming good compatibility, performance is one of the few distinguishing features of a clone.

As well as running the BYTE BASIC benchmarks in GW-BASIC on the Xen-i and in BASIC 2 on the PC1512, I ran some Turbo Pascal benchmarks that test disk, text screen, and graphics speed. The reasoning was this: Locomotive's BASIC 2 is so much faster than GW-BASIC that those tests mostly compare the speed of the BASIC interpreters. It was thus essential to run some identical programs to detect real differences in the hardware.

The results of the BASIC tests are in table 1. The conclusions you could draw from these figures illustrate the dangers inherent in benchmarking. It would appear that the PC1512 is faster than the Xen-i at running the Sieve and almost as quick doing calculations, also that the PC1512 accesses its floppy disk drives faster than the IBM PC does its hard disk. The real message is that Locomotive's BASIC 2 is more than twice as efficient as GW-BASIC and BASICA.

Running the same .COM file compiled from Turbo Pascal on the various machines shows the hardware performance ratios more clearly (see table 2). These benchmarks, developed for the U.K. magazine *Personal Computer World*, are TrigLog, 1000 repetitions of evaluating cos(sin(arctan(log(x)))); TextScrn, writing and scrolling 1000 20-character strings; GrafScrn, plotting 10,000 points; and Store, storing 1000 20-character records.

continued

Table 1: *The results of the BASIC tests (times in seconds).*

	Apricot Xen-i/GW-BASIC	Amstrad PC1512/BASIC 2	IBM PC/BASICA
Disk Write			
floppy disk	29.3	36.3	56.8
hard disk	9.9	—	41.8
Disk Read			
floppy disk	29.6	31.9	53.6
hard disk	7.1	—	29.1
Calculations	12.5	14.9	70.8
Sieve	45.0	36.9	217.6

Table 2: *Running the same .COM file (compiled from Turbo Pascal) on the different machines shows the hardware performance ratios more clearly (times in seconds).*

	Apricot Xen-i	Amstrad PC1512	IBM PC
TrigLog	12.6	23.4	56.5
TextScrn	33.2	50.6	76.4
GrafScrn	2.0	2.2	5.0
Store			
floppy disk	8.2	10.3	9.5
hard disk	1.4	—	4.7

BYTE U.K.

It seems that for compute-bound tasks the machines perform roughly as 4.5 to 2 to 1 (Apricot to Amstrad to IBM), while on floppy disk-bound tasks they are about equal. On text-screen scrolling, they are all shamefully slow (the Apple IIGS executes TextScrn in 16 seconds). And on graphics, surprisingly, the PC1512 plots points as fast as the Xen-i.

Out of curiosity, I also ran Peter Norton's SysInfo utility on all three machines and received the answers 10.3, 1.8, and 1 for performance ratings of the Xen-i and the PC1512, respectively, relative to the IBM PC. This clearly supports the point made by Stephen S. Fried's article "IBM PC Accelerators" in BYTE's 1986 *Inside the IBM PCs* that SysInfo exaggerates the speed of 80286 machines by about 100 percent.

Subjectively, the Xen-i feels much, much faster than the other two machines; when you load PC-Write on the Xen-i, you're into the editor before your finger leaves the Return key. This appears to be due to the seek time for the hard disk. The Xen-i's Microscribe hard disk finds and transfers data at least three times faster than my modest external hard disk drive; timing the loading of the benchmark TrigLog confirmed that while my disk took 1 second, the Xen-i was too quick to time. The PC1512's floppy disk drive took 4.6 seconds to load TrigLog. Don't scoff at such subjective factors; in my experience they are at least as important as benchmarks. Ergonomic research by IBM has shown that users of interactive computers become frustrated or anxious when system response time exceeds 4 seconds without an explanation; a fourfold speed advantage can make all the subjective difference in the world.

Conclusions

Both these computers are excellent substitutes for an IBM PC. The £449 Amstrad PC1512 is an extraordinary value for the money, and not surprisingly its introduction has thrown the U.K. personal computer market into a turmoil, with crashing software prices and dire predictions of mass bankruptcy among computer dealers. In fact, orders for the PC1512 are so heavy that Amstrad boss Alan Sugar has confirmed that supply will not keep pace with demand until at least spring of 1987. The £2998 Apricot Xen-i, while more than three times as expensive as the Amstrad, is a BMW among clones; it's fast, compact, pretty, supports lots of memory, and should receive a high standard of after-sales service from Apricot. After "mine" was returned to Birmingham, I harbored brutally unkind thoughts toward my poor faithful old IBM PC for several weeks. ■

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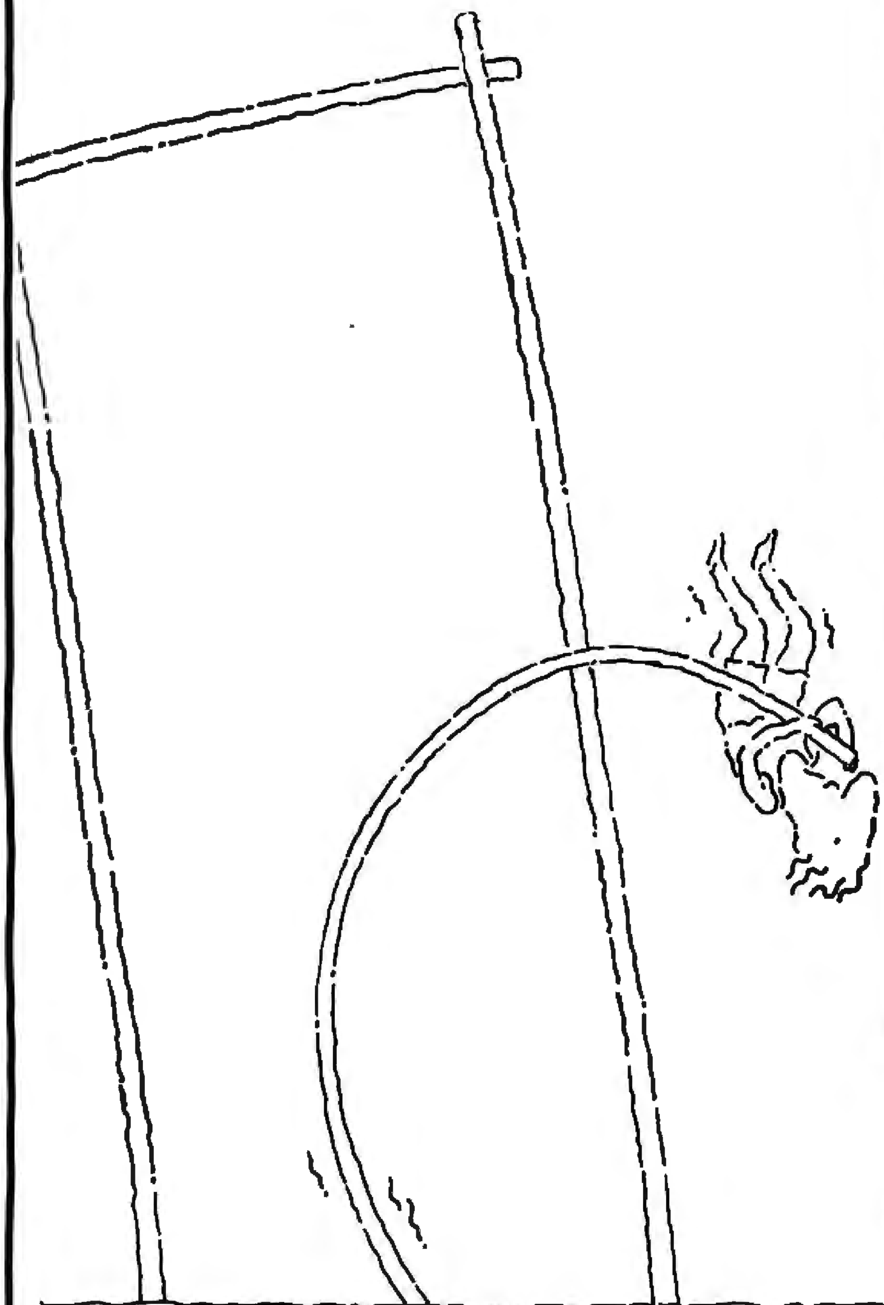

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Miscellany

Ezra Shapiro

New products are winning the battle for space; time to attack

This business is riskier than I would have guessed when I started writing this column a year ago. In the past month alone, I've received more than 30 software products, which are chewing up floor space at an alarming rate. The result is I'm building up a gigantic backlog, and a significant guilt complex about it. There are just *scads* of new products worth writing about. So forgive me if I shorten the format this month, and maybe next, to try to cram a few more items into print.

Old Favorite

Nice things to say about **Volkswriter Deluxe Plus** (Lifetree, $99). Once considered one of the top MS-DOS word processors, Volkswriter Deluxe went off into marketing limbo when Lifetree introduced its successor, Volkswriter 3, about a year ago. Which was sad because Deluxe was a good product—clean, fast, and capable. I'm pleased to report that Lifetree has taken Deluxe out of mothballs, added a nice spelling checker and automatic reformatting, and chopped the price to $99, which now makes Deluxe one of the best bargains in the business. Of course, you don't get all of 3's power: multiple style sheets, automatic hyphenation, scientific character sets, math functions, sorting, decimal tabs, and so on. And I'm not crazy about the way either product maps all 40 function-key combinations without allowing you to reconfigure. But Deluxe is a solid product that drives about 400 printers, coexists contentedly with most memory-resident programs, and does *almost* all you'd ever want to do with a word processor. Recommended.

Why Bother?

I liked ComicWorks on the Mac when I wrote about it last December. I still like it; what troubles me, mildly, is the collateral material that comes with its fraternal twin, **GraphicWorks** (Mindscape, $79.95). The two programs are almost identical, but ComicWorks gives you sample disks of spaceships and monsters, and GraphicWorks has examples of purchase orders and letterheads. If you bought ComicWorks because of the layout capabilities, the object editing, or the wonderful adjustable airbrush tool, you're probably wondering whether to purchase the GraphicWorks artwork disk ($19.95) for your more serious side.

Don't do it unless you're either completely lacking in imagination or extremely lazy. Aside from a nice collection of borders (which you can use as clip art) and blank templates for a newsletter and TV storyboards, most of the GraphicWorks examples are just that—examples—and pretty yucky ones to boot. I wish they'd distributed more *blank* templates. You already get a storyboard and a newsletter with ComicWorks; you don't really need this new assortment.

If you're trying to choose between the two programs, either one is excellent, but GraphicWorks offers a few minor improvements: direct import of MacPaint files, automatic rescaling of bit maps when using a laser printer (so art and text line up properly), and marginally increased speed. As for the art disks, I've always had a soft spot for spaceships and monsters, but I suspect "GraphicWorks" looks better to the bean-counters when you're trying to sneak it through on a corporate purchase requisition.

Getting There

Every now and then I get a program that does something new and unexpected and does it so well that I don't have much to say aside from, "This is fantastic." **Highways and Byways** (New Directions) is such a product, or rather, set of products. It's an automobile routing program for MS-DOS machines; you feed it your starting point and destination, and it calculates the shortest and fastest way to get there, optimized for either speed or distance. The resulting report is a list of major intersections or cities along your route, with mileage and time between them. You can create the equivalent of batch files for routes with multiple stops, and you can generate thorough expense reports based on mileage, lodging, meals, and so on.

It works best on estimating trips of more than 50 miles (a sprawling city is defined as its downtown hub, which can be misleading), but I was amazed at its success in picking out better, faster routes for shorter intervals. In the first five minutes I used the program, it generated a surprising new route between San Francisco and San Jose that cuts three miles off my old method. If you do a lot of driving, the savings could really add up.

I never had to look at the manual (on disk) to run the program; it's intelligently organized and simple to operate. I did look at the documentation when preparing a list of features the program lacked and discovered that New Directions was already planning to cover them. I wanted routes through urban areas, like Los Angeles, and the ability to block off sections of highway that are badly congested. That's coming in the next release.

New Directions sells Highways and Byways either as a full national map for $129.95 or as Western, Central, and Eastern regions at $49.95 each (any two or all three of these can be combined). The total database is a bit more than a megabyte and includes all cities with a population of more than 6000, plus quite a few smaller locations. An annual subscription for updates to the map files costs

continued

Ezra Shapiro is a consulting editor for BYTE. Contact him at P.O. Box 170040, San Francisco, CA 94117. Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

$29.95. I had thought this sort of program was restricted to mainframes or at least minicomputers; not so. I like this product.

Another Paint Program

Ever since Apple decided to stop giving away MacPaint with every Macintosh, the action has been hot and heavy. Now we've got **SuperPaint** (Silicon Beach, $99), which obsoletes both MacPaint and MacDraw, and it throws in a bunch of nifty additional features. It also soundly trounces FullPaint (which I loved in the September 1986 column).

SuperPaint gives you two editing layers, a Paint layer and a Draw layer, with an appropriate set of tools for each. The Paint layer works like MacPaint, the Draw layer like MacDraw (obvious, isn't it?). Clicking an icon shifts between them.

The Paint layer offers the standard toolkit for creating bit-mapped graphics, plus free rotation, skew, perspective, and distort. For close work, you get three levels of enlargement, 2X, 4X, and 8X (pixel-by-pixel FatBits). The Draw layer lets you create discrete objects that retain characteristics for easy repositioning and automatic scaling.

In both layers, you can set line width *and* line height (makes drawing fancy boxes a snap). You can zoom an image and hide the palettes for unencumbered full-screen editing. Circles, rectangles, and other shapes can be drawn either by choosing corner points or by starting from a center point and selecting a radius. If you want to work larger than screen size, all tools scroll the image automatically. Filling a hollow area with a pattern is now limited only by your selection, not by the boundaries of the screen. Finally, for precise control, you can "nudge" an image one screen dot at a time in any direction. You can print either layer independently or print both simultaneously after choosing which layer should appear "on top."

The hottest new feature of SuperPaint is called LaserBits, which lets you edit an image at the 300-dots-per-inch resolution of standard laser printers rather than the Mac's 72-dpi FatBits resolution. LaserBits images are stored as separate files that are incorporated into your artwork at output time.

Reactions? As I've mentioned, this product blows away MacPaint, MacDraw, and FullPaint, and does it for a reasonable price. It does *not* threaten ComicWorks; there are just too many things in that product that SuperPaint isn't intended to do. ComicWorks has layout and object-editing tools outside the scope of SuperPaint, but it's a tougher program to learn and use.

continued

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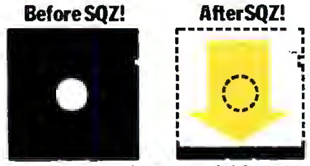

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APPLICATIONS ONLY

I find myself doing my final tweaking with SuperPaint.

What I find myself doing is using ComicWorks to create complex paintings, saving them in MacPaint format, and then doing my final tweaking with SuperPaint. The LaserBits option makes this diddling all worthwhile; I've used it to prepare a couple of pieces that I've dumped out to a QMS PS-800 printer, and the results have been spectacular.

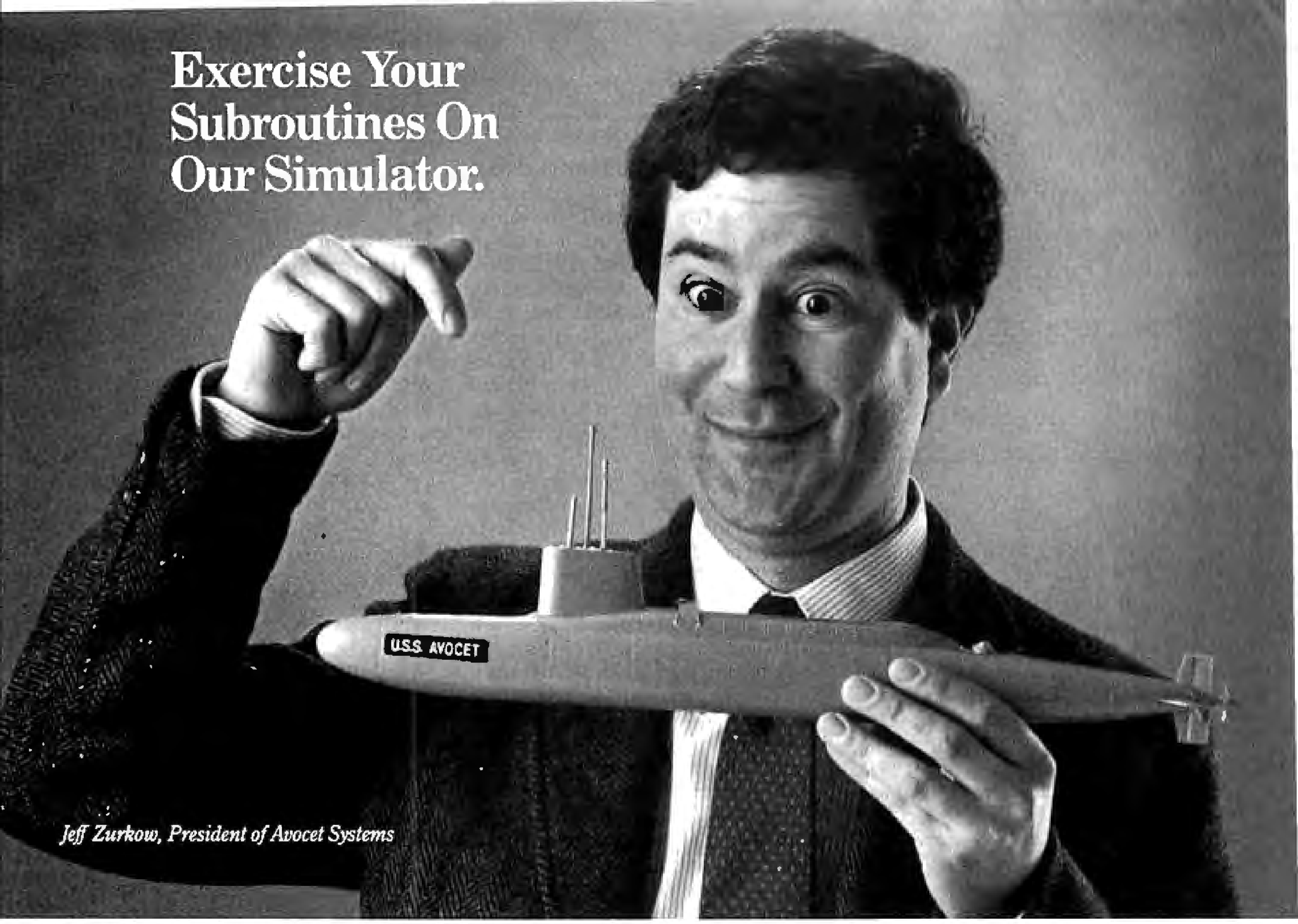
A Real Dog

Supposedly an educational game for the Mac, **Puppy Love** (Addison-Wesley, $19.95) purports to teach structured programming techniques by using the analogy of training a dog. You wait until an animated puppy performs a maneuver on the screen, hit the space bar, and type in a name for the trick. Then you type the name again, and if the dog repeats the trick, you click a bone-shaped icon—he's learned it. The program keeps track of the tricks by listing them in a "journal." How does this teach programming? Well, you can build complex tricks by writing them into the journal, for example, "a double whammy is two backflips followed by a pirouette." You can even use conditional branching and Boolean logic: "IF the squirrel is on the screen DO pirouettes UNTIL it leaves, ELSE do somersaults." When you've taught the dog five tricks, you go to the dog show and try to win prizes; that's the game aspect. Once the mongrel has mastered a routine and won a ribbon, he starts displaying new maneuvers, which you can add to his little performances. The idea is to make the "programs" more complex as you advance from one level to the next.

To be blunt, I think Puppy Love is insipid, boring, badly designed, and not particularly educational. It is impossible to tell what age group the program is aimed at; there is no recommendation on the package or in the manual. I'd guess at early elementary school from the content, but the manual is printed in teeny type and uses words like "choreography."

Operations are not intuitive (Why do you use the space bar rather than the mouse to signal that you want to name a trick?), and you *must* read the manual to get the hang of it because there is no online help. The documentation is a flimsy pamphlet printed on cheap newsprint paper, easy to lose and not very kidproof; one spilled glass of fruit juice and the

continued



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manual turns into papier-mâché.

I'm also irritated by the underlying philosophy of Puppy Love. The documentation explains that while you're training your dog, you'll also be learning how to do "cool computer stuff" (their words, not mine). Well, if the authors of the program assume that kids want to do cool computer stuff, why not just teach them programming? I fail to see the need for this intermediate step, and we've all seen the PBS specials showing the amazing things kids can do with real programming languages. Why do adults seem to feel it's necessary to oversimplify concepts that children are quite capable of grasping? And what about creativity, imagination, the thrill of inventing something that's *yours*, and all those good things? No room for them here; all you get to do is organize events into sequences. The dog can't do anything that isn't preordained.

Finally, what kid with normal drives and interests is going to sit there trying to make this animated mutt do stupid tricks when he or she could be playing a video game or watching *The A-Team* on the tube? I know which *I* would choose.

Since my feelings toward Puppy Love were so violently negative, I sent the program off to Jeremy Stein, a friend in Washington, DC, for a second opinion. At 14, Jeremy is closer to the right age group than I am, and I think his attitude about computers is pretty typical. He took a computer course several years ago and enjoys playing with a Mac when his dad brings it home from the office on weekends, but he's not an obsessed computer nerd.

Jeremy wasn't quite as hard on the program as I was, but he also wasn't particularly enthusiastic. "It took a while to figure out how to make it work," he commented, "and it didn't really teach me anything. The graphics are good, though." When I asked him if the program was entertaining, he said that "it's a game, not a learning program" and "after a while it gets a little bit annoying." He didn't think that many kids would ever want to play the program through to the end. Jeremy was also concerned with the issues of utility and portability. "You can't use it to do anything else," he complained. "With BASIC and Logo you can do more things, and on many computers." He guessed that Puppy Love would be acceptable for children between 6 and 8; beyond that, kids would either find the program "too young" or they'd be too advanced for it.

So Puppy Love gets real low marks. I actively dislike the product; Jeremy merely wouldn't waste his time playing the game. When I voiced my opinion to Lynne Bolduc at Addison-Wesley, she told me the product had been selling like wildfire and that A-W's booth at computer shows had been swamped by *adults*. Makes you think, doesn't it?

Handy Outlining

Acta (Symmetry, $79.95) is to the Mac universe what Ready! is to the MS-DOS scene. It's a simple outline processor that installs as a desk accessory. As such, it can't be compared to More, Microsoft Word 3.0, or ThinkTank 512; it's just too small and limited to be classed with stand-alone programs. But it's handy to have around, particularly if you're chewing up lots of RAM with your main application and can't afford to use Switcher and one of the big outliners. Acta is just fine for "to do" lists or document annotations or simple card filing, and it will hold MacPaint graphics as well as text. File export can be a bit annoying; if you use the clipboard rather than the full "Save as MacWrite," you'll lose type attributes, though you will retain outline indentations. Formatting options are limited, and you'll probably want to massage your output with a word processor. But all in all, it's a decent implementation of the concept..

Treasure Trove

If you use either Microsoft Excel or Works on the Mac, you should get your hands on the catalogs from Heizer Software (5120 Coral Court, Concord, CA 94521, (415) 827-9013). The company sells a huge assortment of effective, low-cost templates and macros for Excel, ranging from biorhythm calculators to statistical analysis macros to full payroll and accounting systems. Most items are between $5 and $20; the most expensive offering is a collection of personal finance tools at $96, and the payroll package is a whopping $67. Nothing here is especially miraculous, but it sure beats having to build this stuff on your own.

The Works templates are sold as four volumes of 12 items at $50 per set, grouped as Tutorial, Small Business, Utility, and Personal Productivity.

Ray Heizer runs his business as an exchange or clearinghouse. Let's say you've written a macro that calculates missile trajectories. You think your product would be useful for others, but you're hesitant to become a part-time software publisher. Ray checks out your work, then you and he set a price for it and it goes into a catalog. Heizer Software takes care of marketing and distribution, and the two of you split the take. It's a nice alternative to shareware, and judging by the scope and size of the catalogs, it works.

I've seen two disks' worth of samples, and I'm impressed. Ray Heizer is obviously a perfectionist; everything is polished and professional. Get copies of the catalogs and see what you think. ■

Items Discussed

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GraphicWorks $79.95
artwork disk only $19.95
Mindscape Inc.
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Northbrook, IL 60062
(312) 480-7667

Highways and Byways $49.95
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New Directions Software
5259 Sepulveda Blvd., #9
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Puppy Love $19.95
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SuperPaint $99
Silicon Beach Software Inc.
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- Heap analysis utility.
- Sample programs.
- Windows libraries.
- Programmer's reference.
- Programmer's utility guide.

System requirements:

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- Two double sided disk drives*
- Graphics adapter card.

*hard disk recommended

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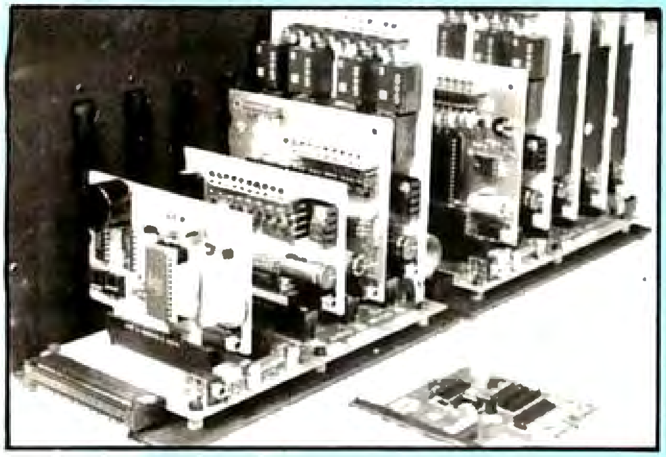
The Amazing A-BUS

NEW



An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

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About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples).

Relay Card — RE-140: $129
Includes eight industrial relays. (3 amp contacts. SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card — RE-156: $99
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The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK).

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A-BUS Prototyping Card — PR-152: $15
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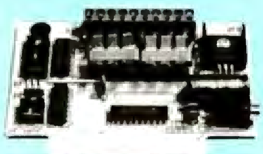
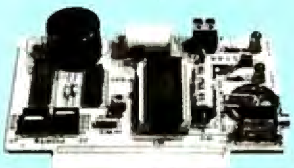
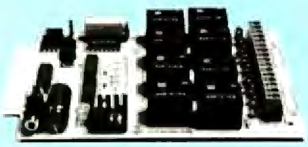


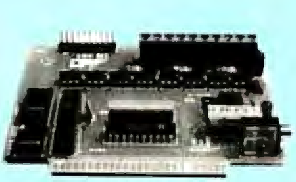
ST-143



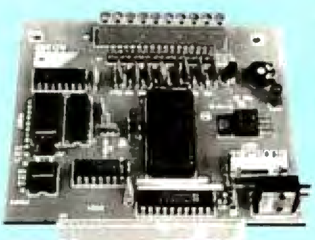
CL-144



RE-140



IN-141



AD-142

Smart Stepper Controller — SC-149: $299
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Breakout Board Option — BB-122: $19
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Journeys

Bruce Webster

A further look at the Apple IIGS, FORTH tools, and updates

It's early November as I write this . . . and I'm glad that I can sit here and do just that. When I came downstairs a while ago to continue working on this column, I discovered that my office door was locked and shut. Unfortunately, the key to that door is missing, and the only other entrance—a window—can't be opened from the outside. It took me 25 minutes and an assortment of tools to get in. Actually, all I needed was a screwdriver and a hammer, but I didn't discover that until some 22 minutes into my efforts. Reminds me of the time I borrowed my parents' car to drive from San Diego to Los Angeles to visit Herr Doktor Pournelle. I was low on gas when I got to L.A. and pulled into a gas station, only to discover that the gas cap had a lock and I had no key for it. But that's another story.

After having stayed around home for the last few months, I'm in the middle of a series of trips. Last week I attended the Apple IIGS Developers Conference in San Jose, followed by the Hackers' Conference in the mountains west of Saratoga. Tomorrow I leave for the Amiga Developers Conference in Monterey, and the week after that is COMDEX in Las Vegas. I'm not complaining, mind you—just a bit harried in trying to take care of other matters between trips.

Apple IIGS Revisited

As mentioned, I attended the IIGS Developers Conference, learned more about how the IIGS works, and saw more of what it can do. Result: I think more of the machine than I did a month ago. I have been concerned that the lack of page flipping or relocation for the super hi-res modes would be a hindrance to high-performance graphics, and there's no question (even by the designers) that the IIGS would have been better off with at least a second super hi-res graphics page. Even so, I saw some impressive graphics demonstrations that reassured me that the IIGS was not as handicapped as I thought. Also, I learned that the IIGS upgrade for the Apple IIe is just a motherboard swap: For $500, you get a brand-new off-the-shelf IIGS motherboard, as well as a new metal pan with the appropriate ports in the back. Since there are a million or two IIe machines out there, I suspect Apple is going to sell a lot of those upgrades.

I directly questioned a number of the engineers about certain design decisions. Three major answers tended to surface: lack of time, lack of margin, and lack of foresight. As happens in just about any design project, many ideas were brought up and discussed, but the production schedule was too tight to allow implementation. Others were discarded because of added cost to the base unit. And some came up too late in the design cycle to be incorporated. The IIGS did not start out as the IIGS; it started out as a smaller and somewhat enhanced IIe, and some aspects (such as the super hi-res mode) were almost afterthoughts. It was only later that the emphasis on high-quality graphics came into play, and by then other design constraints limited what changes the engineers could make to the machine.

The conference itself was well organized, well attended, and well worth the time and money. Sessions were held discussing each of the major aspects of the IIGS: hardware, ROM routines, operating system, development software, marketing, and so on. Handouts galore were given, and some 11 (yes, 11) volumes of technical documentation are being sent to each attendee. Apple's propensity for homemade videos (usually slick slide-based presentations, with some adapted rock song for background) manifested itself in no fewer than five different videos; they also presented the current flock of Apple II and Macintosh commercials.

One particular high point of the conference was the after-lunch talk by Jean-Louis Gassee, Apple's vice president of marketing. Gassee is a candid, entertaining speaker who enjoys throwing out one-liners and highly quotable statements. He spoke freely not only of the IIGS but also of the Macintosh and of the directions in which both were going. His most memorable quote (which may have come from someone else; he gave no attribution): "Work at some level must be a celebration of the human spirit."

That comment summarizes Apple's apparent efforts and direction. I came away from the conference extremely impressed at how well organized and directed Apple is on just about every level. The folks at Apple have a clear idea of what markets they want to go after, what products they will go there with, and just how they will get there. The TV advertisements (by Apple's new ad agency, BBDO) were impressive and effective; I wouldn't be surprised to see a few Clio winners in the bunch. The best word to summarize my impressions of Apple is "professional," in its most positive sense. And they seem to be having a lot of fun doing what they're doing.

If I sound effusive, it's because seeing a company that has its collective act this much together is rare in this industry, and a bit intoxicating. This, of course, could just be a front and Apple might be falling apart internally, but I don't really think so. I think they have learned from past mistakes and are doing a lot of things right. Of course, I still think the IIGS is terribly overpriced, but I suspect market conditions will adjust that, just as they have for the IIe, the Macintosh, the LaserWriter, and so

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Bruce Webster, a consulting editor for BYTE, can be reached c/o BYTE, P.O. Box 1910, Orem, UT 85057, or on BIX as bwebster.

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on. I think Apple will do very well indeed for the next year or two.

IIGS Technical Note: Dithering

As has been mentioned before, the IIGS in its highest-resolution mode (640 by 200) has 4 to 16 colors available. In that mode, each byte represents four pixels; each pixel comprises 2 bits. Those 2 bits yield a value from 0 to 3, which is used to look up the color (a 12-bit value) in the current palette. But the palette actually has 16 entries, in order to deal with 320 by 200 mode. So some clever engineer at Apple, not wanting the other 12 locations in the palette to go to waste, designed things so that the first pixel in a byte (highest 2 bits) indexes locations 0 through 3 in the palette; the next pixel (next 2 bits) indexes locations 4 through 7; the next, locations 8 through 11; and the last, locations 12 through 15. The first pixel of the next byte then indexes back to locations 0 through 3 again. Each group of four colors is called a minipalette.

Well, some of the engineers at Apple—most notably Arthur W. Cabral—discovered that if you used one set of colors for the minipalettes of the even pixels and another set for the minipalettes of the odd colors, you ended up with a consistent mix of 16 colors in super hi-res (640 by 200) mode. This is because of a technique known as dithering. It works because of the combination of side-by-side colors in even and odd pixels.

You might think that the effective horizontal resolution is back down to 320 pixels, since it takes two pixels to make each color. That's right in part, but since text is in black and white, your horizontal resolution for text is only one dot per pixel, and you can get more than 80 columns of text on the screen. The result is that you can have a 16-color display mixed with 80-column text.

What should the minipalettes be? The even ones (0–3, 8–11) should be black, red, green, and white; the odd ones (4–7, 12–15) should be black, blue, yellow, and white. The values of those colors in the palette are (in hexadecimal) black 0000, blue 000F, green 00F0, yellow 0FF0, red 0F00, and white 0FFF.

You can, of course, adjust those shades to come up with different palettes. Also, you can switch to different palettes for different scan lines. I'd be interested to see what you would get if you used different palettes on alternating scan lines.

IIGS Development Tools

I was happy to see representatives from several firms that produce compilers and the like at the IIGS Conference. I have yet to get my hands on any development tools for the IIGS, but I thought I could at least point those of you with interests to the appropriate firms.

First, you should be aware that Apple is developing an Apple IIGS Programmers Workshop (APW) as a parallel to the Mac Programmers Workshop (MPW). APW defines link and object code formats, standard libraries, and so on. It currently includes an assembler (ORCA-16) and a C compiler (from Megamax); a Pascal compiler is planned, but it is uncertain as to who will produce it. Since APW has set some standards, the different compilers and assemblers should produce relatively compatible code.

Bill and Ann Duvall (as well as Jay Friedman) of Consulair Corporation were there. Consulair already has a Mac-to-IIGS assembler/linker that allows you to write and assemble your 65816 programs on a Mac, then transfer the object code over to the IIGS. The price is $195, and it comes with no licensing fees. Since the IIGS is currently hard to come by (and more expensive than a comparably equipped Mac Plus), a product like this makes sense. This way, a development house can get by with just one IIGS as long as it has sufficient Macintoshes for the

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programmers. Consulair is working on a Mac-to-IIGS C compiler, possibly with dual-machine debugging via the serial ports. Look for a full report when I get my hands on something.

Megamax was also represented, and it announced two Mac-to-IIGS compilers, C and Pascal, for $500 each. The spec sheet says that both will support disassembly, in-line assembly, and dual-machine debugging. Requirements are a 512K-byte Mac with two floppies and a IIGS with one (3½-inch) floppy. Again, more info as products come in.

Tom Leonard of TML Systems showed up, announcing TML Pascal for the IIGS. Unlike the other firms' products, his compiler runs directly on the IIGS. It requires 512K bytes of RAM and a 3½-inch (800K-byte) floppy and is APW-compatible. The cost is only $125. Tom claims a high degree of compatibility with TML Pascal for the Mac, which could make ports moderately painless. Inspired by the competition, TML is considering releasing a Mac-to-IIGS cross-development version as well.

Lastly, H.A.L. Labs announced Lisa 816, a native IIGS assembler. The specification sheet was a little sparse on details, but it did indicate full 65816 support, with APW compatibility "to be implemented." The cost is nice at $50.

Product of the Month: MacFORTH Plus

Because of the popularity of the three major 68000-based systems (Macintosh, Atari ST, Amiga) among hackers and developers, many firms that produce compilers and interpreters are working to bring out their products on all three machines. . . a welcome trend for programmers who have to port programs from one machine to another. Some have parallel development systems for MS-DOS computers, and (as mentioned above) a few are expanding to cover the Apple IIGS. I'll be covering those firms and their products, and I'll start this month with Creative Solutions Inc., owned by Don and Christine Colburn.

MacFORTH was the second programming language (and first true development system) available on the Macintosh. It was mentioned in my BYTE review of the Macintosh (August 1984), and my first programming article for BYTE was a go board written in MacFORTH (November 1984). Given how long it took for other native development systems to emerge on the Mac, MacFORTH might have become widely used, but for a few problems. First, FORTH is an arcane language, revered by those who use it and shunned by just about everyone else; the standard line is, "FORTH isn't a language—it's a religion!" On top of that, CSI was requiring stiff licensing fees. In short, developers were asked to pay a lot to use a language they didn't understand. CSI eventually dropped the licensing fee, but by then several C compilers had been released (few of which required fees), and C became the dominant native development language on the Mac. Of course, it would have anyway, but MacFORTH might have had a larger share.

Despite the miscues, CSI is still here and is going strong. Don Colburn, who is chief programmer at CSI, has continued to improve MacFORTH while developing FORTH systems for the Atari ST and the Commodore Amiga. The result is a trio of products: MacFORTH Plus, MultiFORTH for the ST, and MultiFORTH for the Amiga. The continuity of design is evident in the documentation and in the products themselves.

MacFORTH Plus is the latest revision of MacFORTH, which has gone through three levels (I, II, and III) and several versions. It replaces all previous versions and levels and has extensions and performance improvements over all of them. The environment is like a Mac: mice, menus, multiple windows. A built-in Mac-style editor produces regular text files, unlike the traditional block-oriented FORTH files (though you can produce those instead, if you really insist). One window is your regular FORTH command-line window; you can open up to three other

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MS-DOS & MS FORTRAN are trademarks of Microsoft Corporation. Pro FORTRAN refers to IBM PC Professional FORTRAN by Ryan McFarland windows for editing source files. The most useful menu command is Save and Include, which saves the contents of the current editing window out to disk, then compiles that file into MacFORTH Plus so you can test it. If you want to compile just a portion of the file, you can select the code, then press the Enter key. Incidentally, the source code of the editor (which was written by David Sibley using MacFORTH Plus) is included, so you can modify and extend it yourself.

MacFORTH Plus gives you access to the Mac Toolbox and operating system, but it hides a lot of the overhead from you. Event handling, menus, windows, graphics, and other aspects have been simplified through some high-level routines that do a lot of the grunt work for you. For example, listing 1 shows a complete program. It defines and creates a new window (named SHEET). The routine TRACE.FINGER (known in FORTH parlance as a word) draws dots as you hold down the button and move the mouse around. The word FINGER.PAINT does all the event handling needed. The final command (SHEET ON.ACTIVATE FINGER.PAINT) associates the routine FINGER.PAINT with the window SHEET, so that FINGER.PAINT will be executed whenever you click on SHEET. Those of you who have programmed the Mac in other languages will appreciate just how much is being done for you here.

Don Colburn has added some extensions to his FORTH implementation to aid the programmer. You can define local variables within a word's definition. These variables pull their values off the stack as they are referenced. This not only reduces the headache of keeping the stack straight during execution, it actually improves performance and reduces code size in many cases. You can easily declare data structures (equivalent to records or structs) thanks to a number of predefined words. You can even declare multiform structures, which are similar to Pascal's variant records or C's unions.

A 68000 assembler is also part of the package. This is not an assembler in the traditional sense. Instead, it is a set of MacFORTH commands that allow you to directly compile 68000 instructions into your program, using a reverse Polish notation (RPN) syntax, mnemonics, and special key words.

True floating-point numbers are implemented, using the Standard Apple Numeric Environment (SANE) routines on the Mac. You can toggle between having integers (32-bit fixed point) or floating-point values on the stack.

If you've been wondering, yes, you can create stand-alone (turnkey) applications using MacFORTH Plus. The result is an executable file that can be run without MacFORTH Plus. You can also snapshot your working environment, so that you can avoid having to pull in and compile the same language extensions each time you go into MacFORTH.

Another feature of MacFORTH Plus is that it offers multitasking. This was possible (with some hacking) in earlier versions; here, it's fully documented and supported. The demo program, for example, loads in and runs several other programs, each as a separate task within its own window. All are active simultaneously; you can drag the windows around or resize them, and the tasks continue to run.

Perhaps the best feature of MacFORTH Plus is the manual. It is large (450 pages), softbound, and highly readable. It is well written and takes a tutorial approach, with a light sense of humor and lots of short sample programs. It devotes eight chapters to teaching you how to use the Mac Toolbox routines from within MacFORTH Plus and (wisely) does not assume that you own and understand *Inside Macintosh.* I have only two complaints with the manual, both minor. First, it's hard to get it to lie flat without using heavy objects to weigh down one side or the other. Second, as often happens with FORTH-related works, it gets a bit zealous at times about the virtues of FORTH, while gloss-

continued

ing over some of the drawbacks. Even so, this manual is among the best I've seen (and I've had to wade through quite a few).

MacFORTH Plus lists at $299, but there is an upgrade policy for any registered owners of the original MacFORTH versions. Level I owners can upgrade for $129, Level II owners for $49, and Level III owners for $35. The software is unprotected, and there are no licensing fees for commercial products. Instead, CSI makes the standard request that you acknowledge in the program and the documentation that your program was written using MacFORTH Plus. Technical support is provided via newsletters, telephone, and a CSI/FORTH conference on CompuServe (type "GO FORTH" to get there).

MacFORTH Plus has come a long way since the original product I received back in April 1984. I am no FORTH expert, but I suspect it represents one of the finest FORTH development environments on any system. The price is probably too high to encourage casual investigation by purchasers, who might want to look at Mach II FORTH (which costs around $100). Those of you who can afford it, though, would probably be best off going with MacFORTH Plus.

MultiFORTH

MultiFORTH for the Amiga uses the same basic kernel as MacFORTH Plus, but it (obviously) has different extensions to let you use system and ROM routines. The user interface is more along the lines of the traditional FORTH; pull-down menus are not used, though the FORTH environment is within a window that you can resize and drag around the screen. For that matter, the multitasking nature of the Amiga operating system allows you to launch MultiFORTH as a separate task (run MultiFORTH). You can then switch back and forth between MultiFORTH and the regular Amiga command-line interface (CLI). However, since MultiFORTH allows you to directly execute any CLI command with the sequence CLI *command*, and since common CLI commands (such as DIR and CD) are directly implemented, you may not need a separate CLI window.

Like MacFORTH Plus, MultiFORTH/Amiga is set up to work with regular text files (though it, too, can use traditional FORTH block files). The system disk comes with ED, Amiga's standard screen-oriented editor. You might want to consider replacing it with something else; I use TxEd from MicroSmiths Inc. Once I invoke TxEd (using the command cli run e), I resize it to the upper half of the screen—since TxEd does use menus—and resize the MultiFORTH command window to the lower half. I can then edit a source file in the TxEd window, save it out to disk, click in the MultiFORTH window, load the source code into MultiFORTH, and test it. Since TxEd can spawn additional tasks of itself, I can have multiple source files open at the same time, switching between each and MultiFORTH by moving the mouse to that window and clicking. That way, I can build an environment similar to, though not quite as convenient as, MacFORTH Plus.

MultiFORTH/Amiga has the same basic extensions as MacFORTH Plus: locals, structures, assembler, snapshots, turnkey applications, and so on. Floating-point capabilities are implemented by an extension file that makes use of the fast floating-point (FFP) library on the Amiga. Multitasking is supported via the Amiga operating system rather than through MultiFORTH itself.

MultiFORTH/Amiga doesn't have the powerful housekeeping routines for the Amiga to parallel those offered by MacFORTH for the Macintosh Toolbox and OS. In fact, not all library calls are specifically implemented. For many library calls, you must use a generic "call library routine" word, passing values to and from it via the 68000 registers.

MultiFORTH for the ST was implemented by Greg Guerin. It is similar to the Amiga version in many respects but is even less Mac-like. It has no menus or windows and is completely command-line-oriented. The editor it comes with—MicroEMACS—is screen-oriented and makes no use of the mouse. It has all the features and extensions of MultiFORTH/Amiga (locals, structures, etc.), and it has the same types of limitations on calls to GEM routines: not all are directly implemented, but

continued

Listing 1: *A sample program in MacFORTH Plus. (This program is based on a listing appearing in the MacFORTH Plus manual and is used here with permission.)*

```
NEW.WINDOW SHEET                                 \ define new window
" Finger Paint Window"    SHEET  W.TITLE         \ set title
40 40 200 200             SHEET  W.BOUNDS        \ set bounds
CLOSE.BOX SIZE.BOX +      SHEET  W.ATTRIBUTES    \ set attributes
SHEET ADD.WINDOW                                 \ create the window

: TRACE.FINGER  ( -- ) \ define routine; nothing expected on stack
    HIDE.CURSOR                              \ turn off the cursor
    BEGIN STILL.DOWN WHILE                   \ while button is down...
      @MOUSEXY DOT                           \  draw a dot where mouse is
    REPEAT                                   \ end of loop
    SHOW.CURSOR ;                            \ turn cursor back on

: FINGER.PAINT ( activate flag ) \ define routine; flag on stack
    IF BEGIN                                 \ if activated, do loop
      DO.EVENTS                              \ get event code
      CASE                                   \ handle events
        MOUSE.DOWN   OF TRACE.FINGER ENDOF   \ draw if mouse down
        IN.SIZE.BOX  OF ." Resized!" ENDOF   \ write message if resized
        IN.CLOSE.BOX OF 7 SYSBEEP    ENDOF   \ beep if window closed
      ENDCASE                                \ end case statement
    AGAIN                                    \ end loop
    ELSE ." Window deactivated!" THEN ;      \ if deactivated, write msg

SHEET ON.ACTIVATE FINGER.PAINT               \ pass activate flag to F.P
```

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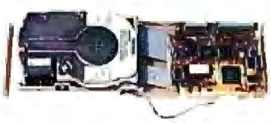

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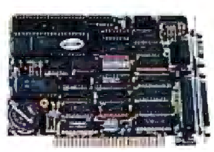

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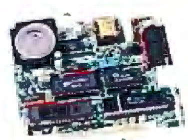

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you can build your own as needed. Floating-point numbers are not implemented in MultiFORTH/ST as of this writing; however, a new version is coming out that may include them.

The manuals for both the Amiga and ST versions are well written and extensive—typically more than 300 pages long. They are in three-ring loose-leaf binders that sit flat and are easy to update. Both use many of the same chapters, notably those that offer a simple tutorial on FORTH and those dealing with MultiFORTH features (chapters 4 through 12). Each manual has sections specific to each machine, listing the calls you can make, but little information is given on how to use them; instead, you are referred to the sample programs and the appropriate technical documentation for each machine. This is probably the single biggest difference between MacFORTH Plus and the MultiFORTH implementations.

Speaking of the manuals, I do find amusing the occasional attempts in the manuals to gloss over some of FORTH's drawbacks, or to even make them appear to be positive points ("That's not a bug, it's a feature!"). At one point, the manual strongly encourages comments and meaningful identifier names, noting how quickly poorly documented code becomes difficult to follow. It then states: "This is a problem characteristic of all programming languages." Maybe so, but most languages I've worked with have an intelligibility half-life measured in months or years, while that of FORTH is often measured in weeks. I have five-year-old undocumented Pascal listings that I can pick up and readily follow. By contrast, when I converted my go board program from MacFORTH to Pascal, I had a difficult time figuring out just what I had been doing, even though I had heavily commented the source and it had been only a few months since I had written it. I should point out that I had previously spent a year or so programming in FORTH for a former employer; I was (and am) not a FORTH expert, but neither was I a novice.

Don Colburn and the others at CSI have worked hard to make MultiFORTH more accessible to those not familiar with block-oriented text files and RPN calculators. They wisely point out FORTH's greatest strengths: the ability to rapidly prototype programs and to extend the language itself. They've created a development environment that makes it easy to switch from the Mac to the Amiga to the ST. And soon you'll be able to switch to the Apple IIGS as well, with a version of MultiFORTH that will be compatible with MacFORTH Plus because of the similarity in ROM routines.

MultiFORTH/ST costs $149, while MultiFORTH/Amiga costs $179; the reasons for the difference in price are unclear. Both versions are unprotected, and there are no licensing fees for commercial products; again, the request is made that you acknowledge the use of MultiFORTH in your program and documentation.

These are both well-done products, but they are not yet up to the standards of MacFORTH Plus. Because of that, I can't give them the same hearty endorsement. However, they are worth considering if you are looking for a tool to explore how the system and graphics routines work on either machine. I recommend that you take a good look at the product and documentation before deciding to buy it.

The Hackers Corner

Some interesting products have come in the mail lately. Allan Bonadio, who has a degree in physics, sent me an equation editor for the Macintosh. The program is called Weinberg (after physicist and Nobel laureate Steven Weinberg), and it allows you to compose rather complex equations far more easily than you could using Word or MacPaint, with special help for representing integrals, summations, fractions, roots and powers, matrices, and tensors. There are actually two programs: a stand-alone ap-

continued

Editing Tools is a combined editor and DOS shell for MS-DOS systems that is written in Turbo Pascal. The editor can have multiple files opened.

plication with full menus and help and a desk accessory, so that you can call it up from within your word processor or paint program. Weinberg produces a standard PICT image, so you can paste it into documents, pictures, and similar structures. It is oriented toward the Symbol (Greek) font, though you can get by with others. Allan sent me version 0.90 (beta), which he is selling for $54.95; it isn't clear if that includes an automatic upgrade. The documentation (which comes on the disk) includes an interesting discussion on the inconsistency of notation in scientific and mathematical circles.

I also received a product called Editing Tools (version 2.0), written by Jiann Jou. The program is a combined editor and DOS shell for MS-DOS systems. The editor can have multiple files opened and maintains a "trash file" where all deletions go, so that you can recover deleted text. The program is written in Turbo Pascal; most routines have been optimized using in-line assembly code, but the original Pascal for each routine remains there in comments. For just $10, you get the program and a 36-page manual; for $25 more, you get all the source code.

Updates

Some months back I wrote about Pascal Extender from Invention Software Corporation. Pascal Extender is a collection of library routines designed to take much of the work and hassle out of programming on the Macintosh. Two versions were then available, one for TML Pascal and one for MacPascal. ISC has now released a version for Lightspeed Pascal, in which its routines are implemented as several units that can be used by your projects. Since source code is included, you can modify these routines to do what you want to. They've also added a number of new routines to all their versions for manipulation of pictures (load, grab, save), printing, zooming windows, and other such items. They also have offered C Extender, an equivalent package for different C compilers. If you're not up to speed on Macintosh programming (and maybe even if you are), you'll find these packages will help you write working Mac-style applications quickly. Pascal Extender costs $89.95; C Extender costs $129.95. They are not copy-protected, source code is included, and there are no licensing fees.

Remember the Alegra memory-expansion box I reviewed back in December? Well, I couldn't bear to send it back, so I bought it. My next hardware investment will be for a set of 1-megabit RAM chips, which will boost my Amiga up to 2.5 megabytes of RAM! More RAM! Now if I could just get a hard disk.

More on MIDI

I am running across additional resources in my quest to become MIDI-literate. For those of you who don't know, MIDI stands for "musical instrument digital interface," and it represents a hardware-and-software standard to allow computers and electronic musical instruments (like synthesizers) to talk with one another. MIDI ports are built into the Atari 520ST and 1040ST, and hardware adapters are available for the Macintosh, Amiga, IBM PC (and clones), Apple II, Commodore 64, and several

continued

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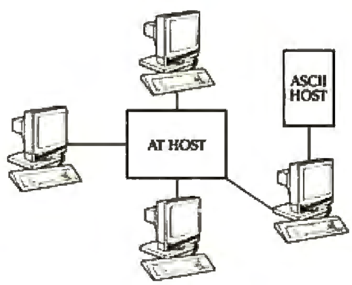

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TeleVideo Systems, Inc., 1170 Morse Avenue, P.O. Box 3568, Sunnyvale, CA 94088-3568 • (408) 745-7760 other families of computers (including some that are made specifically for use with MIDI systems).

I have found (and subscribed to) another excellent periodical: *Keyboard* magazine. *Keyboard* isn't devoted entirely to electronic instruments—it does cover pianos, organs, and music in general—but it's a great source for reviews, ads, and informative articles. Subscriptions cost $19.95 a year (P.O. Box 2110, Cupertino, CA 95015, (408) 446-1105); single issues can be found in most large bookstores.

The best book on the subject that I've found so far is *MIDI for Musicians*, written by Craig Anderton (editor of *Electronic Musician* magazine). The book is published by Ansco Publications and costs $14.95. It's a large softbound book that aims to explain computers, electronic instruments, and the MIDI standard to musicians. It's readable, has lots of diagrams, and is stuffed with bits of information that you would probably have to dig through many different sources to find for yourself. It also includes the official MIDI standard document.

Items Discussed

Editing Tools $10
Dr. Jiann Jou
P.O. Box 460969
Garland, TX 75(
(214) 495-8862

Lisa 816 Assemb $50
H.A.L. Labs
18942 Dallas Ave
Perris, CA 92730

Mac-to-IIGS Assembler $195
Consulair Corporatior
140 Campo Dr.
Portola Valley, CA 94
(415) 851-3272

Mac-to-IIGS C Compiler $500
Mac-to-IIGS Pascal Compiler $500
Megamax Inc.
P.O. Box 851521
Richardson, TX
(214) 987

MacFORTH Plus $299
MultiFORTH for the Amiga $179
MultiFORTH for the Atari ST $149
Creative Solutions Inc.
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Rockville, MD 20852
(301) 984-0262

Pascal Extender $89.95
C Extender 129.95
Invention Software Corporation
P.O. Box 3168
Ann Arbor, MI 48106
(313) 996-8108

TML Pascal for the IIGS $125
TML Systems
4241 Baymeadows Rd., Suite 23
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(904) 636-8592

Weinberg $54.95
Allan Bonadio Associates
1579 Dolores St.
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Books

When I discussed 8086 assembly language programming a few months ago, I had praise for Bob Lafore's *Assembly Language Primer for the IBM PC & XT.* I mentioned, though, that the book was just that—a primer—and I was in the market for a good follow-up text. Well, I've found one: *IBM PC & XT Assembly Language: A Guide for Programmers* (2nd ed.) by Leo J. Scanlon (Brady Communications, 1985). It fills the gap nicely between Lafore's book and a reference manual, taking a tutorial approach but going into more depth. The book is $21.95 and contains an order form for a disk with source and object code of most of the example programs in the book; said disk costs $30.

In my spare time, I teach at the Brigham Young University computer science department. One of the classes I'm teaching this semester deals with data structures—stacks, queues, lists, trees, sets, graphs—and methods of sorting and searching them. The textbook I'm using is not only an excellent treatment of the subject, it's one of the best textbooks I've ever seen, period. It's well written, logically organized, and ideal for self-study on the subject. It uses an abstract data type approach, with implementations done in Pascal. The title is *Data Structures with Pascal and Abstract Data Types*, it's written by Daniel F. Stubbs and Neil W. Webre, and it was published by Brooks-Cole Publishing Company in 1985. The list price is $25.

Hackers Conference

Since Hackers 2.0 (the second Hackers' Conference) has been given a lot of coverage elsewhere, and since nothing really momentous happened there, I don't see much point in going into too much detail here. I do want to acknowledge and thank Glenn Tenney, Brett Glass, and Bob Bickford. Those three put in many hours and much effort, and the result was a great weekend.

Hackers 2.0 was more laid-back than Hackers 1.0—perhaps too much so, but I'm not sure anyone felt like being terribly intense. I did see a few interesting programs demonstrated. Andy Hertzfeld showed me version 0.84 of Servant, his extension on the Mac user interface. He should be done with it by the time you read this. After that, he's thinking of developing for some machine other than the Macintosh. Steve Jasik (author of MacNosy) demonstrated his interactive window-based debugger for the Macintosh; had he sent me a copy a month earlier, he would have beaten out Metascope for best utility of 1986. Look for a review here if and when I get a copy.

My personal highlight of the conference? Probably the four or five hours I spent playing MazeWar+ on a network of seven Macintoshes. I know that sounds a bit frivolous, but it gave me a taste of what's in store some years down the road as networked systems become more prevalent.

In the Queue

Well, the sun is doing its best to rise over the mountains east of me, and I've got to be on campus in a few hours, so it's time to wrap this up. Next month, look for coverage of the Amiga Developers Conference and COMDEX, as well as more multisystem language reviews. With luck, I might have my hands on an 80386-based system by then and give some feedback there. Until then, I'll see you on the bit stream. ■

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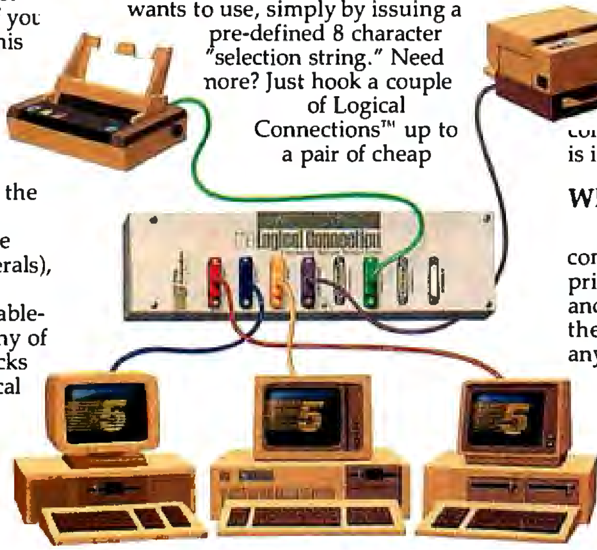

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A Ternary State of Affairs

Robert T. Kurosaka

The base-3 system offers an automatic solution to a classic puzzle

This month we'll investigate the mathematics of balance scales. Our study begins with the natural language of computers, binary arithmetic, but soon moves on to the more exotic ternary or base-3 system. Even there, we'll find that computers come in handy. Consider the balance scale and measuring weights shown in figure 1. We intend to weigh some commodity (say, coffee) to the nearest ounce. The coffee goes in the right pan, and we add sufficient weights to the left pan until the scales balance, giving us the weight of the coffee.

What would be the minimum set of measuring weights needed to weigh at least 30 ounces of coffee? Before proceeding, you are urged to try and solve this warm-up question.

Thinking in familiar decimal terms, our first guess might be a set of eight weights: 10, 10, 5, 1, 1, 1, 1, and 1 oz., respectively. An obvious refinement gives six weights: 10, 10, 5, 2, 2, and 1. However, further experimentation leads to the ideal solution of five weights: 16, 8, 4, 2, and 1, with which we can actually measure any amount up to 31 oz.

First There Were Two

If you're thinking that the last sequence is composed of powers of 2, and thus suggests that the problem is binary in nature, you're right. To see why, look at the binary representation of our 31-oz. maximum weight: 11111_2, which represents the number $1\times2^4 + 1\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0$. Each of the binary digits in the number corresponds to one of our weights. Smaller amounts are weighed by removing one or more of the binary counterweights.

We now have an automatic method for determining which weights are needed to offset a given amount: First convert the amount into binary notation, and then read off the digits. For each 1 digit, we take the correspondingly marked weight. For instance, $28=11100_2$, meaning that we use only the 16-, 8-, and 4-oz. counterweights to offset a 28-oz. portion of coffee.

Our binary analysis also gives us the useful information that with n weights valued at 1, 2, 4, ..., 2^{n-1}, we can counterbalance any amount up to 2^n-1.

Now we'll alter the weighing method to allow weights to be placed in either pan. For instance, to weigh out 3 oz. of coffee, we place the 4-oz. counterweight in the left pan and the 1-oz. counterweight in the right pan, plus enough coffee to balance the scale. The mathematical expression of this is $4 = 1 + c$, with c being the amount of coffee.

What's the minimum set of weights using this "bilateral" weighing method? Experiment with this one and come up with your own guess. (Hint: We can get by with fewer weights than with the "unilateral" system.)

And Then There Were Three

Let's apply a little computer logic to the question. In the unilateral system, a weight could have two possible "states": on the scale or off the scale; that's why our binary model works so well. But in the new system, a weight can have three possible states: in the right pan, in the left pan, or off the scale. This leads us to try a ternary model for the counterweight values: 1, 3, 9, and so forth. By trial and error, we find that using just the weights 1, 3, 9, and 27, we can counterbalance any weight up to 40.

Can we apply the automatic method again for determining which weights will be needed to counterbalance a given amount? Let's try to weigh out 22 oz. of coffee. First convert 22 to ternary notation: $22 = 2\times3^2 + 1\times3^1 + 1\times3^0 = 211_3$. So we place two 9-oz. weights, one 3-oz. weight, and one 1-oz. weight in the left pan, and we place sufficient coffee in the right pan to balance the scale. The corresponding equation is $9+9+3+1=c$.

But there's a problem—we don't have two 9-oz. weights. Furthermore, we're supposed to be placing some of the weights in the right pan; that's the bilateral method.

We don't give up, though. Instead, we mentally add another 9-oz. weight to each pan (even though we really don't have any more 9-oz. weights). The scales still balance, and the equation is $9+9+9+3+1=c+9$. But the left side can be rewritten as $27+3+1$, and it suggests a real solution to the problem: On the left scale, place 27-, 3-, and 1-oz. weights; on the right scale, place a 9-oz. weight and the coffee to be weighed.

Fortunately, it is not necessary to perform this mental juggling act every time with the bilateral method. Ternary notation gives us another automatic process for figuring out which weights to use.

First convert the number (the amount to be weighed out) to ternary. For example, $22=211_3$.

Examine the digits of the ternary number from right to left. Each time we encounter a 2, change it to a -1 and add 1 to the next digit on the left. Continue moving to the left until no more 2s remain. In our example, we'll use delimiters to separate each of the individual digits: $211_3 = (1)\ (-1)\ (1)\ (1)_3$.

The resulting modified ternary "number" is a sequence of 1s, 0s, and -1s. For each 1, place the corresponding weight on the left pan. For each -1, place the corresponding weight on the right pan. Now add enough coffee to the right pan until the scale is balanced.

For practice, apply this automatic

continued

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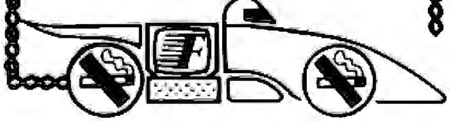

method to the number 46. (Hint: You should end up using a bilateral combination of 81, 27, 9, and 1.)

In general, given n weights valued at 1, 3, 9, . . ., 3^{n-1}, the bilateral weighing method will handle any weight up to $(3^n-1)/2$.

The program in listing 1 incorporates this ternary arithmetic to "weigh" any amount up to $(3^{12}-1)/2$.

With this warm-up completed, we're ready to take on a classic puzzle using a computer-aided approach.

The Counterfeit Coin

We have a set of apparently identical coins containing one counterfeit. The counterfeit is off-weight (either light or heavy). We are to identify the bad coin in

continued

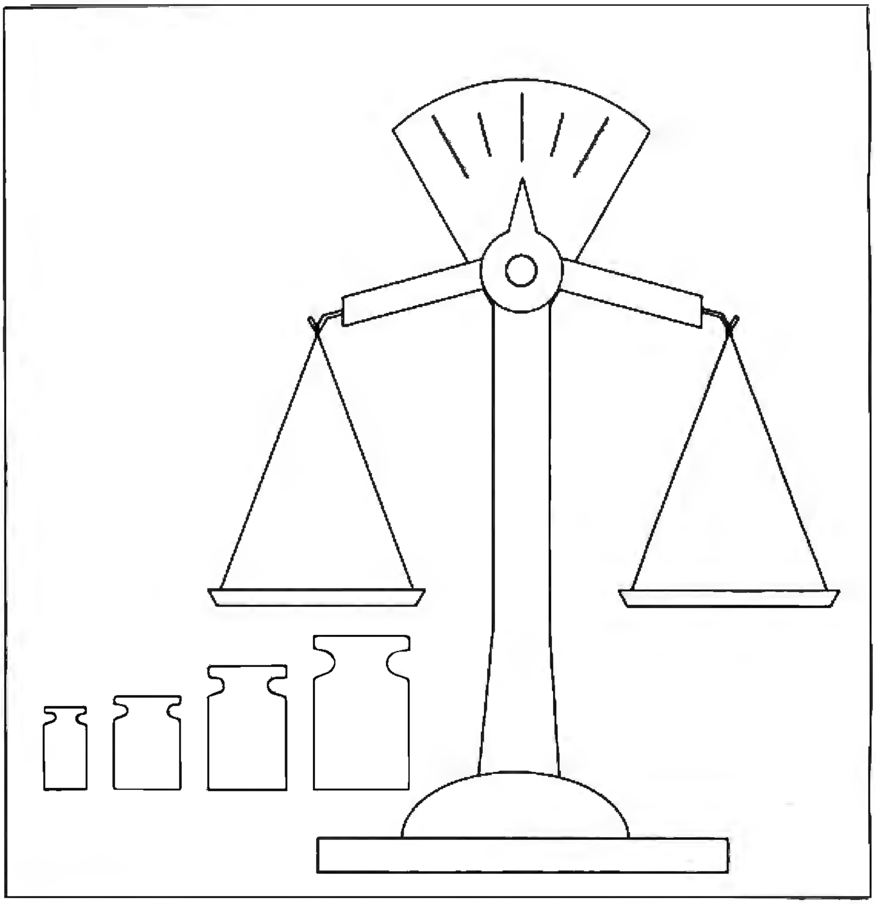

Figure 1: *A set of balance scales with standard counterweights.*

Listing 1a: *BASIC program to verify a weight using ternary-power counterweights. A sample run is also shown.*

```
10 DIM A(12),P(12),N(12)
20 N=12
30 CLS
40 PRINT "We have 12 weights, valued as follows..."
50 FOR W=0 TO N-1
60 PRINT 3^W;
70 NEXT W
80 LARGEST=INT((3^N-1)/2)
90 PRINT "Enter the weight to be verified ( 1 -"; LARGEST;
     ")"
100 INPUT W: W=INT(W)
110 IF W<1 OR W>LARGEST THEN 90
120 SW=W
130 FOR D=N TO 1 STEP -1
140 Q=INT(W/3)
```

continued

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```
150 A(D)=W-3*Q
160 W=Q
170 NEXT D
180 FOR D=N TO 1 STEP -1
190 IF A(D)<2 THEN 220
200 A(D)=A(D)-3
210 A(D-1)=A(D-1)+1
220 NEXT D
230 NG=0
240 PS=0
250 PWR=1
260 FOR D=N TO 1 STEP -1
270 A(D)=A(D)*PWR
280 PWR=PWR*3
290 ON SGN(A(D))+2 GOTO 300,350,330
300 NG=NG+1
310 N(NG)=ABS(A(D))
320 GOTO 350
330 PS=PS+1
340 P(PS)=A(D)
350 NEXT D
360 CLS
370 PRINT "Balance the scales this way"
380 LOCATE 14-PS,1
390 FOR D=1 TO PS
400 PRINT USING "########";P(D)
410 NEXT D
420 PRINT
430 IF NG=0 THEN 480
440 FOR D=1 TO NG
450 LOCATE 12-NG+D,18
460 PRINT USING "########";N(D)
470 NEXT D
480 LOCATE 13,18
490 COLOR 0,7
500 PRINT USING "########    ";SW
510 COLOR 7,0
520 PRINT " -----------      -----------"
530 PRINT "       |_________________|"
540 PRINT "               ^"

We have 12 weights, valued as follows...
 1  3  9  27  81  243  729  2187  6561  19683  59049
     177147
Enter the weight to be verified ( 1 - 265720 )
? 301
     Balance the scales this way

       1
       3
      81              27
     243             301

      |_______________|_
              ^
Ok
```

Listing 1b: *Alternate lines with simplified I/O for BASICs without the LOCATE feature.*

```
380 PRINT "Left side: ";
400 PRINT P(D),
430 PRINT "Right side: ";
450 REM line deleted
460 PRINT N(D),
480 REM line deleted
490 REM line deleted
500 PRINT "??";SW;"??"
510 REM line deleted
520 REM line deleted
530 REM line deleted
540 REM line deleted
```

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a specified maximum number of weighings on a balance scale. No standard weights are available; the coins are to be weighed against each other. We are not allowed to add or remove coins during a weighing.

The simplest version of this problem involves eight coins, of which one is known to be heavy. In only two weighings, find the bad coin. Trying to solve this one will give you a greater understanding and appreciation of what follows.

Now for the big one, involving 12 coins, of which one is light *or* heavy (we don't know which in advance). Using three weighings, we are to find the bad coin and state whether it is light or heavy. Again, you are urged to give this one a try.

Start by numbering the coins from 1 to 12 for reference. Suppose we express those 12 reference numbers in ternary. Further suppose that the result of each weighing (left pan down, right pan down, no difference) could give a new ternary digit, so that after three weighings we are left with a ternary number identifying the bad coin. That would be too easy!

In fact, the method we've sketched out does work, but it's not easy. The preparation is quite complicated (enter the computer to help out).

Preparation Phase

First, for each numbered coin, we need the ternary equivalent *and* the two's complement (also in ternary). To get the two's complement, subtract each digit from 2. (Equivalently, change each 0 to a 2, each 2 to a 0, and leave 1s unchanged.) For instance, coin #1 is 001_3, which has a two's-complement representation of 221_3. Table 1 lists the ternary and two's-complement representations for all 12 coins.

The next step is to classify each of our ternary and two's-complement numbers as either "clockwise" or "counterclockwise." To do so, we read a number's digits from left to right and note the first change of digits. If the change is 0 to 1, 1 to 2, or 2 to 0, the number is clockwise. Otherwise, it is counterclockwise. The "clocks" in figure 2 should clarify these directions. In table 1, clockwise numbers are marked with an asterisk.

continued

Table 1: *In preparation for solving the counterfeit-coin problem, the coins are numbered in decimal, ternary, and two's-complement ternary. ("Clockwise" coins are marked with an asterisk.)*

Decimal	Ternary	Two's complement
1	*001	221
2	002	*220
3	*010	212
4	*011	211
5	*012	210
6	020	*202
7	021	*201
8	022	*200
9	100	*122
10	101	*121
11	102	*120
12	110	*112

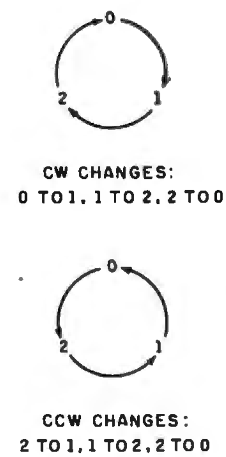

Figure 2: *Illustration of clockwise and counterclockwise digit changes, for use in classifying numbers. A number is clockwise if its first digit change (starting at the left) is clockwise; otherwise, it is counterclockwise.*

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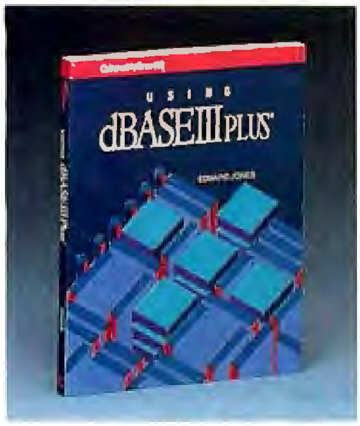

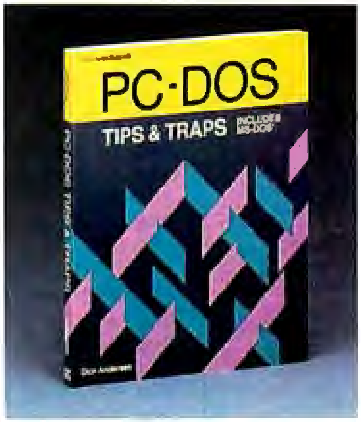

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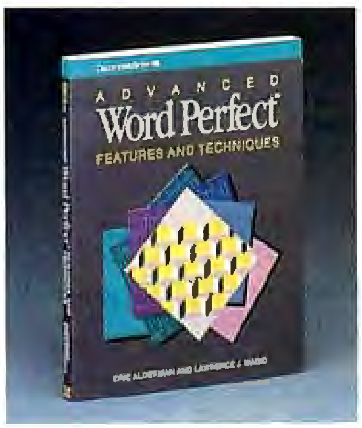

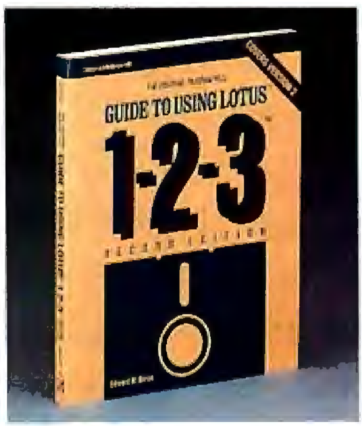

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Listing 2a: *BASIC program to find a single off-weight coin using a balance scale with no standard weights.*

```
10 DIM A(120,5),R(5)
20 REM
30 REM
40 CLS: PRINT "Bad Coin Finder"
50 INPUT "How many weighings are to be allowed (2 TO 5)";N
60 IF N<2 OR N>5 THEN 50
70 C=INT((3^N-3)/2)
80 PRINT "Out of "; C; "coins, exactly 1 is bad (light or
     heavy). I'll find it."
90 PRINT "Numbering the coins";
100 FOR K=1 TO C
110 PRINT ".";
120 D=K
130 FOR J=N TO 1 STEP -1
140 Q=INT(D/3)
150 A(K,J)=D-3*Q
160 D=Q
170 NEXT J
180 NEXT K
190 PRINT
200 FOR K=1 TO C
210 J=0
220 J=J+1
230 DF=A(K,J)-A(K,J+1)
240 IF DF=0 THEN 220
250 IF DF=-1 OR DF=2 THEN 290
260 FOR L=1 TO N
270 A(K,L)=2-A(K,L)
280 NEXT L
290 NEXT K
300 PRINT "Pick out the bad coin number ( 1 to"; C; ") and
     write it down."
310 INPUT "Press Return to start weighing";RT$
320 FOR W=1 TO N
330 CLS
340 PRINT "Weighing #"; W
350 CI=1
360 FOR J=1 TO C
370 IF A(J,W)=0 THEN LOCATE 12-((CI-1) MOD 10), 1+INT((CI-
     1)/10)*8: PRINT J:CI=CI+1
380 NEXT J
390 CI=1
400 FOR J=1 TO C
410 IF A(J,W)=2 THEN LOCATE 12-((CI-1) MOD 10),41+INT((CI-
     1)/10)*8: PRINT J:CI=CI+1
420 NEXT J
430 LOCATE 13,1
440 PRINT   "-------------------------------" TAB(40)
     "-------------------------------"
450 PRINT TAB(16) "|" TAB(56) "|"
460 PRINT TAB(16)
     "-----------------------------------------"
470 PRINT TAB(36);"^"
480 LOCATE 18,1
490 PRINT"Which side is heavier? L=left, R=right,
     N=neither: ";
500 WH$=INPUT$(1)
510 PRINT WH$;
520 V=INT((INSTR(1,"LlNnRr",WH$)+1)/2)
530 IF V=0 THEN 480 ELSE R(W)=V-1
540 NEXT W
550 COIN=0
560 FOR K=1 TO N
570 COIN=3*COIN+R(K)
580 NEXT K
```

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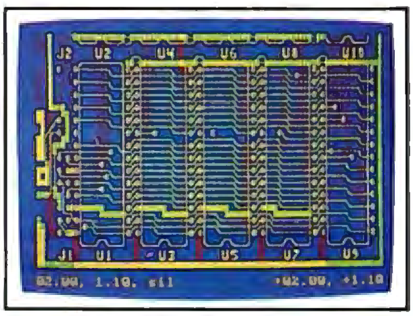

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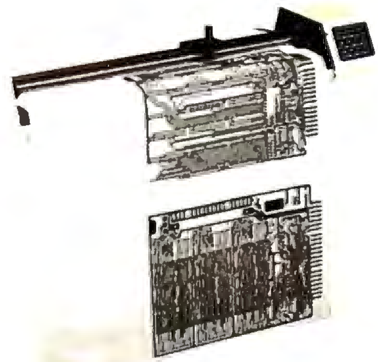

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```
590 LOCATE 18,1
600 PRINT STRING$(80,32)
610 LOCATE 18,1
620 IF COIN>C THEN COIN=INT(3^N-1-COIN)
630 IF COIN<1 OR COIN>C THEN PRINT"Impossible! Please try
      again.": END
640 PRINT "Coin "; COIN; "is ";
650 D=0
660 D=D+1
670 DF=R(D)-R(D+1)
680 IF DF=0 THEN 660
690 IF DF=-1 OR DF=2 THEN PRINT "HEAVY" ELSE PRINT "LIGHT"
700 END
```

```
Bad Coin Finder
How many weighings are to be allowed (2 TO 5)? 5
Out of  120 coins, exactly 1 is bad (light or heavy).
I'll find it. Numbering the coins......................

Pick out the bad coin number ( 1 to 120 ) and
write it down. Press Return to start weighing?

Weighing # 1

 14   33   43   53       23   60   70   80
 13   32   42   52       22   59   69   79
 12   31   41   51       21   58   68   78
 11   30   40   50       20   57   67   77
 10   29   39   49       19   56   66   76
 9    28   38   48       18   55   65   75
 5    27   37   47       8    54   64   74
 4    17   36   46       7    26   63   73
 3    16   35   45       6    25   62   72
 1    15   34   44       2    24   61   71
----------------------  ----------------------
          |                        |
          --------------------------
                      ^
Which side is heavier? L=left, R=right, N=neither: R
```

Listing 2b: *Alternate lines with simplified I/O for BASICs without the LOCATE feature.*

```
350 PRINT: PRINT"Left side: ";
370 IF A(J,W)=0 THEN PRINT J;
390 PRINT: PRINT "Right side: ";
410 IF A(J,W)=2 THEN PRINT J;
430 PRINT
440 REM Line deleted
450 REM Line deleted
460 REM Line deleted
470 REM Line deleted
480 PRINT
510 REM Line deleted
590 PRINT
600 REM Line deleted
610 REM Line deleted
```

The complicated preparation is over, and we are ready to perform some ternary magic.

The Weighing-in

For the first weighing, we place in the left pan every coin whose first (leftmost) digit is 0. In the right pan we place every coin whose first digit is 2. If the left pan goes down (is heavy), we write a 0. If the pans balance, we write a 1. If the right pan goes down, we write a 2.

The second weighing is similar, except we look at each coin's second digit. Into the left pan go the coins whose second digit is 0; into the right pan go the coins whose second digit is 2. After checking the balance, we write down a 0 (left pan down), 1 (balanced), or 2 (right pan down), as before.

For the third weighing, coins whose third (rightmost) digit is 0 go in the left pan; coins whose third digit is 2 go in the right pan. Write down a 0, 1, or 2, as before.

We have now generated a three-digit ternary number. We find the number in table 1 and read off the corresponding coin number from column 1. That's our bad coin. If the ternary number is clockwise, the coin is heavy; if the ternary number is counterclockwise, the coin is light.

Simple? Not at all. But the method works, and it can be generalized to handle problems allowing n weighings of $(3^n-3)/2$ coins.

For instance, if seven weighings are allowed, we can find the one bad coin among 1092 coins. But applying the method manually would be virtually impossible because of the paperwork involved. Which explains why you won't find reference to a 1092-coin problem in any puzzle book.

Nevertheless, the program in listing 2 brings computer power to the task, and it lets us handle any arbitrary number of weighings. The program sets an upper limit of 5 to allow simluation of a scale on the screen.

To raise the limit, replace the value 5 with a larger number in lines 10, 50, and 60. In this case, you will also need to include the alternate lines in listing 2b.

In the program, the computer asks you to pick out the bad coin and write down its number. The computer then simulates each weighing, asking you to tell it which "pan" is heavier. At the end of n weighings, the computer will identify the bad coin by number and specify whether it is light or heavy.

I would appreciate hearing from readers who have comments on these ternary puzzles or can suggest other mathematical recreations involving alternate number systems. ■

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CHAOS MANOR MAIL

Conducted by Jerry Pournelle

Tight Squeeze for Tiny Turbo

Dear Jerry,

I recently purchased an Orchid Tiny Turbo after noting your remarks about Orchid Technology. The Tiny Turbo and a 20-megabyte HardCard gave my Compaq portable the facelift it needed.

A few comments on the Tiny Turbo. Documentation for the installation in a PC is okay, but it is almost nonexistent for Compaqs. Slot configuration and processor location on the portable make installation of the unit akin to putting 10 ounces of turbo in a 9-ounce can. I even scored the connector ribbon during installation as a result of the extremely tight fit.

The Tiny Turbo works as advertised. I'm very happy with the performance, but very distressed about the installation. Knowing this, I would probably not buy it again.

Steve Boesch
Mountain Home, ID

Hadn't tried an Orchid product with a Compaq; I'm not surprised it was a tight fit, and, indeed, I'm amazed you could do it at all. Thanks for writing.—Jerry

Henry's Inspiration

Dear Jerry,

Your description of Little Computer People (November 1986), and the BYTE staff's treatment of Henry, made me think of a short story that might well have been the inspiration for this program.

It was published in a large book of short stories called *Alfred Hitchcock's Ghostly Gallery.* It involved two people who take a job housesitting for a man who is going out of town for a few weeks. Before leaving, he warns them to stay away from a mysterious covered birdcage in his room.

However, the housesitters became curious and find inside the birdcage a scene much like the one described: a small house like a doll's house, with a newspaper on the front porch written in an unintelligible language. There also seems to be someone living in the house.

For some reason, much like the BYTE staff, the housesitters eventually begin treating the residents of the house in an unkind way. Eventually they move out, I think to be replaced by some noisy and messy tenants. The man who owns the house eventually returns and becomes angry at the housesitters; the tenants of the doll's house in the birdcage, he says, are "The Little People" who brought him good luck, and whom he had spent many years convincing to live in the house.

Since the book was widely available at a time and targeted for an age group that would have exposed it to many of the people who are now programmers, I wonder whether this story had some direct or indirect influence on the creation of the program? In any case, it was a very good short story.

Eric Roskos
Bellevue, WA

That's a famous story, and I've been trying to remember who wrote it; either Robert Bloch or Ted Sturgeon, I'm sure.

As I recall, the newspaper was in English, but the headlines were unintelligible. "Fotspath Marches on Feswick," or something. Alas, my Little Computer People don't do anything so interesting. In fact, we've turned them off. . . .—Jerry

Double Rainbow

Dear Jerry,

In your discussion of NEC's V20 chip (June 1986), which enables PCs to run CP/M as well as the conventional MS-DOS, you mention that replacing the 8088 with the V20 doesn't work with "partial clones" like the DEC Rainbow. I'm sure that's true, but, of course, the DEC Rainbow comes equipped with *both* the 8088 and the Z80, and so it happily runs both MS-DOS and CP/M.

Thanks for the tip about the Workman and Associates catalog. Having access to both CP/M and MS-DOS is a good deal.

Robert Leopold
Livingston, NJ

Right; I'd forgotten that. The Rainbow had the potential to be quite a machine in its day, but DEC determined on a marketing philosophy that utterly doomed it. From what I hear, they didn't really learn their lesson, either.

Barry Workman assures me that CP/M is not at all dead. For that matter, I'm writing this on a Z80 CP/M 2.2 machine. —Jerry

OS-9

Dear Jerry,

I was surprised to read in your usually civil column that BIX has an OS-9 conference moderated by a fanatic determined to tell you more than he knows about the operating system. I have not had the pleasure of meeting Jim Omura in person, but judging by his postings to USENET's net.micro, 6809, net.micro.68k, and mod.os.os9, he appears to be reasonably knowledgeable.

Concerning the price of OS-9 for the Atari ST, it is *not* Microware that determines the price, but TLM Systems, the company that did the port and that is selling it. If messages on CompuServe's OS-9 SIG are to be believed, Microware thinks TLM is charging too much, too. So do I, but I don't have much control over things of that sort.

James Jones
West Des Moines, IA

I've already apologized to Jim Omura; my remark was intended to be funny, but it was a bit heavy-handed. Omura is an enthusiast and will tell you a lot. . .

When OS-9 licensing fees get somewhere reasonable, we may see it more widespread.—Jerry

Spreadsheet for Sundog

Dear Jerry,

In the May 1986 BYTE, you said: "I swear I was tempted to set up a SuperCalc spreadsheet on Big Kat and record the Sundog information on that, until sanity prevailed." I guess I am insane, because I did just that on Appleworks. It was easier to read than my handwritten notes.

By the way, I was one of the beta testers for Universe II (Apple version). On the Apple, it uses the mouse and the Apple Pascal 1.3 desktop library. It's a little slow and there are a lot of disk accesses, but it looks nice, and the game plays well.

Harry Erwin
Shelton, CT

I've got Universe II for the Atari ST and I've been afraid to play it; I fear I may become addicted, and I'm out of time just now. I also have an IBM PC copy. Universe I on the PC almost drove me crazy until I discovered the trick of using SuperKey to create a whole bunch of macros; then I could set up my travel orders and go out for coffee while the machine flew me around.

I may yet do a spreadsheet for Sundog. Incidentally, there are some really nifty Sundog tips on BIX.—Jerry ■

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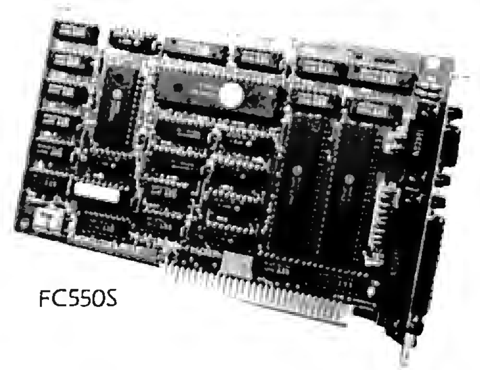

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AMIGA

Both discussions in the Amiga window feature software. In the first, low-level control of the parallel port is the subject of debate. In the second, the ever-popular question of implementing data structures in assembler is addressed.

PARALLEL TIMING

amiga/tech.talk #749, from clirakis (Christopher Lirakis), Sun Nov 2 12:49:23 1986.

Hello. I am interfacing some stuff to the parallel port and I find that I have problems reading information using the ROM kernel routines. I currently have an ADC hooked up. As I understand it, my device is supposed to generate ACK and the Amiga will respond with DRDY. I find that I get DRDY pulses at any old time after I give my ACK. What is the scoop here? Does anyone know? Is it due to the multitasking?

I would also like to know if you can set the bits POUT, BUSY, and INT. I see a routine to read their status, but it would also be nice to set them.
Thanks, Chris.

amiga/tech.talk #752, from jdow (Joanne Dow), Mon Nov 3 00:37:56 1986. A comment to message 749.

On INPUT from the peripheral device to the Amiga, pin 10 acts as DRDY and pin 1 acts as ACK. That is, you signal pin 1 and read pin 10 for the handshake return. You must open the parallel port in your program for output before this has a prayer of working, as you're likely set up in printer device mode, output. And until you issue the turnaround by opening the port for write, you can forget about using it for input mode. <@_@>

amiga/tech.talk #756, from clirakis, Mon Nov 3 19:52:32 1986. A comment to message 752.

What you are telling me sounds like it is the total opposite of what I read. Open the port for write? I want to read data. Does the Amiga look for a pulse on pin 1? ACK is attached to the F input of the 6522 VIA. This input is used to interrupt. I assume that the driver is meant to respond to that. I am confused?
Chris

amiga/tech.talk #757, from jdow, Mon Nov 3 22:18:48 1986. A comment to message 756.

The pin functions are labeled for a standard Centronics parallel port write-only function. The ACK and DRDY functions reverse for a read. You must open the parallel port for a read from your device. Then the pin functions should be reversed by control software for the port. It sounds like you are trying to short-circuit the OS for this function. This likely has left DRDY in a low-impedance driver mode and ACK in a high-impedance receive mode. As you are trying to drive DRDY and monitor ACK, your circuit would not work.

This would lead to stray pulses on ACK and strangeness on DRDY. DRDY might do funny things as the serial port functions. <^_^>

amiga/tech.talk #760, from laars (Dean Kriellaars), Wed Nov 5 08:28:10 1986. A comment to message 756.

Don't even open the parallel port. It's just too much trouble! Go right to the 8250's. Specifically, address 0xBFE101. All you do is hook up the A/D and this function:

```
 #include <exec/types.h>
 #include <exec/tasks.h>

extern APTR MemPtr; /*Pointer to start of Allocated
Memory*/

extern int CurMem;       /* Size of Allocated Memory */

Get_Par_Data()
{
    register int x,Smax;
    register short a,b;
    register unsigned char *Inptr;
    register unsigned char *Mptr;

   Inptr=0xBFE101; /* Look in Hardware Manual under
CIAA
                     Address Map */

   Mptr=MemPtr;     /* Assign to Start of Allocated
Memory */
    Disable();
    Smax=CurMem;                /* Memory Size */
    for(x=0;x<Smax;x++)
     {
       *Mptr=*Inptr;
       for(a=0;a<b;a++,a--,a++);     /* Wasting Time
Loop*/
       ++Mptr;
      }
    Enable();
}
```

And that's it!

amiga/tech.talk #759, from clirakis, Tue Nov 4 18:43:16 1986. A comment to message 757.

Excuse my denseness. I am still confused. Thank you for your patience. 1) I open the parallel port for read. 2) I pulse the ACK line low when my data is ready to be read. 3) I await Amiga response on DRDY. You suggest: 1) Open the parallel port for read. 2) Pulse DRDY low when data is ready to be read. 3) Wait for acknowledgment on ACK. If this is true, then the hardware manual speaks falsely in its timing diagrams.
Chris

amiga/tech.talk #765, from jdow, Thu Nov 6 21:49:30 1986. A comment to message 759.

When the Amiga is writing, the Amiga pulses DRDY. Then the peripheral pulses ACK. When you open the port for read, then the peripheral should signal ACK from the peripheral and the Amiga should reply on DRDY. This will not be set up unless you use the AmigaDOS open for read. (It should be then; that port is the one Carl Sassenrath is using for MAS-20 disk.) <@_@>

amiga/tech.talk #767, from clirakis, Sun Nov 9 11:15:54 1986. A comment to message 765.

Hello again. I have been experimenting. During the last week I have read some conflicting data. I now believe I have it right. In the programs I have been using, I have always opened the parallel port using the proper calls, based on C and the chapter in the RKM on parallel port. Once opening the parallel port and trying to do reads I find that the data in the hardware manual is correct. The object to be read must generate

continued

a low pulse on ACK to tell the Amiga it is ready to transfer data. The Amiga responds on DRDY. Although this does work, there are some random pulses generated on DRDY also; this I can see on a scope. It seems that the Amiga does reads, or at least tries to do something with the data direction register associated with the parallel port. Why do I believe all this? I have tried to do the reverse (i.e., pulse DRDY and look at ACK). This did not work for me. I also find it unusual that anyone should suggest this. According to the hardware manual, the ACK pin is attached to the F input of the 6526 chip. This is the input that will FLAG the interrupt flag in interrupt/mask register of the 6526. This may be set to do a hardware interrupt, if desired. I believe that this is how the kernel uses the flag. The DRDY is said to be attached to the PC on the same chip. This goes low after any port B, which is the parallel port access, either read or write. As I read it, this is only an output, not an input, so, unless either of these pins is tied to something else that goes the reverse direction internally, then the system is set up only for DRDY out and ACK in.

So, I still don't know why I get other random pulses on DRDY. I assume it has to do with the driver under v1.1 DOS. I guess I wait for v1.2 since I am not a software jock. Does what I have stated make sense?
Chris

---

amiga/tech.talk #769, from jdow, Mon Nov 10 03:11:53 1986. A comment to message 767.

Ah, 1.1 is the problem indeed. I bet that the times it pulses are when the serial port is in use. They interact under 1.1. This is fixed under 1.2 and is why Redmond's parallel-port-driven MAS-20 is not yet in release. As soon as 1.2 is public, look for that drive to appear. <@_@>

---

amiga/tech.talk #766, from jdow, Thu Nov 6 21:50:17 1986. A comment to message 760.

And if you do that, there are NO GUARANTEES that your code will work on future machines. If that is no problem, fire away! <@_@>

---

amiga/tech.talk #771, from tholloway (Tim Holloway), Sat Nov 22 14:43:22 1986. A comment to message 760.

... And it will serve you right if the port is at a different address in the Amiga 500 and 2500 machines.

[Editor's note: *References in this section to AmigaDOS use version 1.1. Version 1.2, which corrects many of the problems mentioned, has since been released.*]

I/O REQUEST STRUCTURES IN ASSEMBLER

---

amiga/amiga68000 #88, from cheath (Charlie Heath, MicroSmiths Inc.), Sun Oct 12 23:43:42 1986.

How do you reference the substructure fields in assembler? For instance, for a C statement like

```
tr->tr_time.tv_secs = 1;
```

What is the equivalent assembler statement? The statement

```
move.l  #1,TV_SECS(A0)
```

creates only the substructure offset (in this case, 0 instead of 32).

Thanks- ...cheath

---

amiga/amiga68000 #90, from ksalmon (Ken Salmon), Mon Oct 13 01:34:31 1986. A comment to message 88.

Charlie, having already covered this ground using the timer in assembler, here goes:

The devices/timer.i Include file shows

```
STRUCTURE TIMEREQUEST,IO_SIZE
   STRUCT  IOTV_TIME,TV_SIZE
   LABEL   IOTV_SIZE
```

The second argument of the STRUCTURE macro (as in exec/types.i) gives an initial offset. In this case, IO_SIZE is the size of the I/O structure from exec/io.i. The STRUCT after TIMEREQUEST defines an occurrence of TIMEVAL. So, you calculate the proper offset at assembly time like this:

```
move.l  #1,IOTV_TIME+TV_SECS(a0)
```

assuming that a0 points to your timer request. Ken

---

amiga/amiga68000 #91, from cheath, Mon Oct 13 01:39:05 1986. A comment to message 90.

Thanks to ya. Was that intuition, brute force, luck, or example?

amiga/amiga68000 #92, from ksalmon, Mon Oct 13 01:41:47 1986. A comment to message 91.

In my case, that was just having been there before, and spending some time staring at the Include files. So, I know from practical experience that it works. Ken

amiga/amiga68000 #93, from cheath, Mon Oct 13 01:47:36 1986. A comment to message 92.

I stared, too, and didn't see anything obvious. Guess I'm not familiar with the structure definitions in Metacomco format - are they documented anywhere? Also, is there any relationship between the structure names in the ".h" files and the offsets in ".i" files?

amiga/amiga68000 #94, from jdow, Mon Oct 13 01:51:39 1986. A comment to message 93.

Yes, indeedy. Count out the bytes offset from beginning of the structure. They SHOULD be the same. I remember trying it some longish time ago last year just after getting the assembler and C compiler and trying to fathom fonts. <^_^>

amiga/amiga68000 #95, from ksalmon, Mon Oct 13 01:56:14 1986. A comment to message 93.

I figured it out a while ago by just sitting down with the macro definitions in exec/types.i and seeing how they were used in other Include files. Those macros aren't commented, but they are pretty simple. Most of the field names with .i structures have the same names as the .h fields, with a 3-character prefix (structure initials and _). But there's a lot of inconsistency, and the cases don't always match. It generally means you have to study each one individually to get the right name. I usually use a hard-copy listing of the .h version side by side with the .i version in RKM 1 & 2 (boy, I sure wish they had left all the Include files together like in the old RKM, instead of splitting across volumes). Ken

amiga/amiga68000 #96, from ksalmon, Mon Oct 13 01:58:28 1986. A comment to message 94.

I started out counting byte offsets just to assure myself everything was in order. Then I realized it's a *lot* simpler just to compare the .h and .i versions side by side. Things fall into place much quicker that way. Ken

amiga/amiga68000 #98, from cheath, Mon Oct 13 02:03:39 1986. A comment to message 95.

I'd figured out the xx_ stuff, but not the substructure offsets; the names for substructures don't seem to have any relation to the ".h" equivalents. Am I missing something?

amiga/amiga68000 #99, from jdow, Mon Oct 13 02:08:39 1986. A comment to message 98.

They seemed to with the fonts stuff. It took some serious digging 'til I got the flavor of how the cumulative offsets worked in there. Then I seem to have clicked a translator in my head for the assembly STRUCTURE declarations comparing to C "struct" declarations. Once that worked, it was obvious. Now, the reason I am a wizardess and not a guruess is I can work the magic but not adequately explain it. <SIGH>

Remember to note exactly what size an object in a C language declaration really is. Many times, you find a structure included in full rather than as a pointer in a C declaration. Then, the offsets simply add. Otherwise, if only a pointer is included, the offset simply adds four bytes. I seem to remember that there was a different name for assembly pointers, sizes, and actual objects. Had to do with the prefix, I think. --- so long ago. I'm getting old and forgetting stuff only a year old already! <^_^>

amiga/amiga68000 #101, from ksalmon, Mon Oct 13 02:22:15 1986. A comment to message 99.

It really turns out to be quite simple:

A STRUCTURE macro defines a new structure, just like a struct in C; if the second parameter is non-zero, it defines the size of what would be the first embedded substructure. The symbol SOFFSET is used to keep a running offset for locations within the structure.

A STRUCT macro defines an occurrence of some other structure, as a substructure to the current STRUCTURE. The first argument is equated to the substructure name, then SOFFSET is advanced by the amount of the second argument (mostly, this will be xx_SIZEOF, but sometimes they fool you and use lowercase).

BYTE, UBYTE, WORD, UWORD, APTR, BPTR, and the rest simply equate the first argument (actually the only one) as a label, to the current SOFFSET, then advance it by the appropriate number of bytes.

LABEL is generally used at the end of a STRUCTURE list, to assign a label to the current value of SOFFSET. That label is the one used in other STRUCT occurrences, to "reserve space" for that many bytes in the SOFFSET counter.

It really isn't necessary to add up the offsets in your head. Just use those symbols and let the assembler worry about it. The key thing is to remember that a STRUCT is just like a subordinate struct in C. I understand the complaint that there is not always a one-to-one match with the actual names used in the C header files. That's why I recommend a side-by-side comparison. Works every time or your money cheerfully refunded. Ken

ATARI ST

The questions in the Atari section this month are all solved using the tools within C. In the first, the problem is C; or more specifically, the way C handles (or doesn't handle) data structures. In the second, the details of high-speed, low-level control of the MIDI port are discussed.

STRUCTURES IN C

atari.st/c.language #384, from cmarriott (Chris Marriott), Fri Oct 24 07:39:11 1986.

There seems to be a bug in code generation with the Megamax C compiler. Recently, I've written a routine to print disk directories, which uses the following structure for a disk transfer address block:

```
struct {
   char system[20];
   unsigned char attribute;
   unsigned int time;
   unsigned int date;
   long size;
   char name[13];
} dta;
```

The problem is that all the information is getting passed into the structure OK, *except* that references to the characters at the start of the structure are out by one, for example, to get at the attribute byte, I cannot use dta.attribute, I have to say dta.system[21], which *should* refer to the first byte of the time field. The time and all later fields are OK, though, so it seems like Megamax is referencing all the character offsets as one too great.

Can anybody see if I'm missing something here, because this looks like a bug to me. +++ Chris M +++

atari.st/c.language #385, from comeau (Greg Comeau), Fri Oct 24 08:30:16 1986. A comment to message 384.

continued

Try changing "unsigned char" to just plain "char". Of course, this may require that you change some of your logic also. Or are you saying that the system also starts at system[1] and not system[0]?

---

atari.st/c.language #386, from sprung (Ron Sprunger), Fri Oct 24 12:06:37 1986. A comment to message 384.

Your system variable is one too short - use bytes 0 through 20.

---

atari.st/c.language #387, from mmallett (Mark E. Mallett), Fri Oct 24 13:40:48 1986. A comment to message 386.

Right. Just to be more explicit, dta.system[21] accesses TWO past the end of the system element, since declaring system[20] defines the array from 0 to 19.
mm-

---

atari.st/c.language #388, from jim_kent (Jim Kent, Dancing Flame), Fri Oct 24 15:20:27 1986. A comment to message 387.

Also, many compilers will pad structure elements (especially ints) to be on even (WORD) addresses. This isn't a bug but in fact makes the 68000 go faster.

---

atari.st/c.language #389, from sprung, Fri Oct 24 15:31:43 1986. A comment to message 388.

It may not be a bug, but it sure could foul up some re-mapping that the less-disciplined of us (read sprung) do occasionally.

---

atari.st/c.language #390, from comeau, Fri Oct 24 22:33:09 1986. A comment to message 388.

Even further... some will align the beginning of the structure itself on a word (or some multiple thereof) boundary.

---

atari.st/c.language #391, from sprung, Sat Oct 25 02:24:39 1986. A comment to message 390.

That could be interesting if you allocate a bunch of them in sequence and try to access them absolutely as an array.

---

atari.st/c.language #392, from jim_kent, Sat Oct 25 03:50:20 1986. A comment to message 391.

Oh, but the same compilers will most likely pad the length of the array (the returned value of the sizeof() compile-time function) to be even as well.

---

atari.st/c.language #393, from heller (Robert Heller), Sat Oct 25 12:58:41 1986. A comment to message 388.

It is also REQUIRED in the 68000 - you can't fetch a word or long from an "odd" address - causes an alignment error trap (exception #3: Address Error). So... malloc and friends on a 68000 system should (had better!) return even addresses, and C compilers generally always give an even number for sizeof (some struct type) and will pad structure elements in structs to make ints and floats come out on even offsets. It is generally considered a compiler bug if the compiler will let you declare something like

```
struct x { char name[33]; int z;} ;
```

and really only reserve 33 bytes for field name. Most proper C compilers will actually pretend that you said

```
struct x { char name[34]; int z;} ;
```

(The same will (should?) happen for Pascal and Modula record types.) Note that this is a sticky portability problem, but only if you need to transfer data packed into binary files (i.e., ARC files - the MS-DOS version does fwrite/fread with an odd-sized struct - the headers in ARC files are 29 bytes! Of course, the (long) ints are byte-swapped, too (low byte first, the 68000 wants high byte first...). Robert

---

atari.st/c.language #394, from jim_kent, Sat Oct 25 13:33:12 1986. A comment to message 393.

Actually, I believe the Green Hills compiler will let you start an int on an odd address, and then fetch it a byte at a time. Maybe I'm wrong, I didn't look at the assembly, but there were things I thought would cause an exception #3 in some early Amiga IFF routines that didn't when compiled under Green Hills or Lattice, but certainly did under Aztec.

LOW-LEVEL READING OF SERIAL PORTS

atari.st/c.language #401, from hsoroka (Howard Soroka), Sun Oct 26 02:06:55 1986.

I need to read the MIDI-in port of the ST VERY QUICKLY! The BIOS/XBIOS calls to read and write these ports seem to work OK, but they're extremely slow, or so I think. I say this because my attempts to read and store data dumps from various Yamaha MIDI devices only work if the devices are sending very small dumps (< 255 chars). It seems that, with more information coming in, a buffer is being overrun in the ST, as the BIOS read calls don't empty it out fast enough. This poor little buffer is being blasted with 8K or 9K bytes at maximum speed (31.25 Kbaud is the MIDI rate; pretty snappy).

The solution (I suspect) is to read the ports in an assembly routine called from C (MWC, of course). Why then does the system politely BUS-ERROR every time I try to read from 0xfffc04 or 0xfffc06 (the MIDI ACIA ports)? Same thing with the other ACIA (at 0xfffc00 and 0xfffc02). I think it's a bus error anyway (2 cherry bombs, non-fatal). For now, I'd be happy to just read one byte, let alone the whole mess. I know some may think this question belongs in the MIDI department, but it's really a question about ST internals more than MIDI itself.

Here's the code I use (from MWC). I also tried setting the status register to 0x2700, but that made no difference. This code does work consistently with any address between 0x1000 and the top of RAM, but how on earth do you read a device port at a low level? The BIOS appears to do the same kind of thing as I'm trying (according to the Abacus books). Why does it work for the BIOS and not for me? HELP!

```
.shri
.globl atest_ atest_:
link    a6, $0x0
clr.l   d0
movea.l 0x8(a6), a0
move.b  0(a0), d0
unlk    a6
rts
```

The variable passed in on the stack is the address we want to read, of course, using a0 to do so. ARRGGGHH. MFFTTSSFFTT... BZZZZTT. BZTZTZTZ.
(Sound of programmer imploding, much gore, tears shed, etc.)
Beggingly,
howard

---

atari.st/c.language #407, from jim_kent, Sun Oct 26 15:01:09 1986. A comment to message 401.

Looks real simple to me, Howard; you just need to pass the address of your routine to the OS to execute in supervisor state with a Super call. It's in osbind.h somewhere...

---

atari.st/c.language #408, from jtittsler (Jim Tittsler), Sun Oct 26 16:31:51 1986. A comment to message 401.

The MIDI input is being received by an interrupt service routine and stored in a small circular buffer by the BIOS. If your program cannot take it out of the buffer fast enough to keep it from overflowing, I think

continued

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there are a couple of better solutions than directly reading the UART at task time. 1) Increase the size of the buffer. XBIOS call 14 (iorec) returns a pointer to a structure that contains a pointer to the buffer to be used, as well as the size of the buffer (and other things). 2) Write your own interrupt service routine to buffer the bytes at interrupt time. XBIOS call 34 (kbdvbase) gives you a pointer to a structure that includes a pointer to the MIDI input interrupt service routine that will be entered with the MIDI byte in D0.b.

---

atari.st/c.language #410, from tjeffries (Tom Jeffries), Tue Oct 28 04:33:42 1986. A comment to message 401.

If I remember correctly, you can change the size and/or location of the MIDI buffer without having to write your own routine with one of the XBIOS routines. If you do want to read the port directly, jim_kent is correct that you need to be in supervisor mode to read those memory locations. Supexec() in the XBIOS is another function to get you in that mode. I'm curious about details of the data loss you are experiencing. I've hit the MIDI-in pretty hard and have still been able to get everything out with Bconstat(). What are you reading, patch data? And do you miss chunks of bytes or a bit here and there?

---

atari.st/c.language #411, from hsoroka, Tue Oct 28 12:03:21 1986. A comment to message 410.

Jtittsler suggested a couple things, one of which was manipulating the size and location of the MIDI buffer with XBIOS function 14 (iorec). Jim_kent mentioned the Super() call for reading the port directly from assembly language. You're all correct. All of your (the three of you collectively) suggestions work!

The most robust approach, however, is definitely to change the size of the buffer (why go low-level when it's not necessary?). This worked the first time. I simply declare a large global array of chars in my program and, using iorec(2) to find the address of the MIDI buffer, I replace the contents of that iorec struct with the relevant information of my own. I flush out the "real" MIDI buffer before doing this, although I'm not sure that that's necessary. When I'm through, I replace the old buffer's iorec using a struct assignment, but this requires the Super() call, as the iorec lives in protected memory (I think. Am I right about this, guys?).

This works like a champ, and no assembler required. Many thanks to you folks for your kind help; you've improved the quality of life on Earth.

As for the actual MIDI data, I was trying to store data dumps from a DX-7, RX-11, and QX-7 sequencer. Since all MIDI system-exclusive messages end with EOX (0xf7), my code waits for that character to terminate its read loop. The RX-11, for example, blasts out about 8K bytes at maximum speed when told to dump. The MIDI buffer being circular, all that data just kept overwriting the buffer (which I think is only 128 bytes) so often that the 0xf7 just got lost along with loads of other stuff. In addition to not gathering the correct data, my program would usually hang, because it never found an 0xf7 anywhere. The f7 was probably somewhere in the buffer, but lost between the head and tail pointers, and therefore never recovered. I was losing whole chunks of many bytes, in answer to your question, not merely a bit or two here and there.

Ugh, what a mess. However, all is hunky-dory now. Have you had success using the BIOS/XBIOS calls for large data dumps without changing the buffer? If so, I'd love to know how. Thanks...
howard

---

atari.st/c.language #412, from dsmall (David Small), Tue Oct 28 16:47:54 1986. A comment to message 411.

I had to increase the buffer size in the MacCart as well to handle input blocks of 5120 bytes (decimal) coming in at 9600 baud, so I believe that MIDI might drop bytes at 31 Kbaud.

---

atari.st/c.language #413, from tjeffries, Wed Oct 29 03:44:48 1986. A comment to message 411.

Howard, I wrote a patch editor for the Casio CZ series (CZ PATCH, published by Dr. T's Music Software) that just grabs the sys ex data as it comes in and sticks in my own buffer area, so I didn't have to rely on the ST's buffer at all. Easier than changing the buffer, but then, I always know how many bytes are coming in. Actually, I've been quite pleased with what I've seen of the XBIOS MIDI calls. I'd sort of expected to have to write my own low-level stuff but Atari's stuff has been robust enough (as long as I didn't rely on the size of their buffer) that I haven't had to. I've had a lot more trouble with different Casios operating/responding at different speeds than I've had with the ST.

---

atari.st/c.language #418, from jtittsler, Wed Oct 29 22:53:44 1986. A comment to message 413.

The only word of warning about the MIDI OUTPUT routines provided in the standard TOS is that it's done by polling the UART rather than by interrupts. This has the advantage that you can know within a character time when that byte is being sent, and the disadvantage that if the UART is busy outputting the last character, you will wait for it (so, in some applications you might want to check the output status before calling the output function). Just a "user note."

---

atari.st/c.language #419, from dsmall, Thu Oct 30 02:49:30 1986. A comment to message 418.

Also, look out for the IPL=7 bug. If you kick up the IPL when data is coming in, you can get into a deadlock situation with the MFP and UART. Essentially, the UART gets 2 chars in the non-services time (while IPL=7). The IPL is then restored. MFP processes first interrupt. However, 2nd character is never "seen" by MFP because the UART holds the IRQ line low (asking for service) -- and the MFP is edge-triggered. This locks your keyboard/mouse, if done to that UART, and should hang the MIDI as well, because it's the same line. Moral: Watch the IPL critical code stuff during I/O.

-- Sadder and wiser, Dave

IBM PC and Compatibles

The threads in the IBM PC section serve to illustrate how discussions flow in BIX. In the first, a question on reentrant code is answered and is promptly followed by a longer discussion on DOS return codes. In the second, a question in the IBM PC conference is ultimately answered in the Telecomm.Tech conference, with pointers showing the connection between the two conferences.

REENTRANCY IN MS-DOS

ibm.pc/programming #546, from damoore (Dave Moore), Mon Oct 13 07:08:25 1986.

I have been trying to write a "HOT KEY" routine that would allow you to reenter a program when a key was struck (as opposed to when it is read by a program/MS-DOS - slightly different). To overcome the problems with MSDOS/BIOS not being reentrant, I captured all the relevant interrupts and set up a semaphore so that I only switch tasks when the BIOS/DOS is not being accessed (i.e., I treat it like a critical region). The trouble is, once I take the interrupts, my program goes wild. I am almost certain that my capture code contains *no obvious bugs*. I am simulating an INT by pushing the flags saved from the real INT and then doing a long call. When I get back, I update the real flags. The only other things I do are increment/decrement the semaphore and check if a "HOT KEY" request is pending. WHATS HAPPENING? WHY DON'T IT WORK?

By the way, I am plugging the interrupts direct, not asking DOS nicely for them. Also, I wondered if perhaps something in the BIOS 'backs up" over its interrupt for any reason. Otherwise, what's the difference between a real interrupt and PUSHF/CLI/CALL FAR?

---

ibm.pc/programming #549, from gperfect (George Perfect), Wed Oct 15 02:50:32 1986. A comment to message 546.

Be careful how and when you perform the inc/dec on return from the original int handler. Inc/dec affect the flags, so you MUST save the flags before decrementing your flag. The following code works:

```
pushf            ;Simulate an interrupt
call far ptr oldint
; Now decrement flag and return correct results
;
;Save flags to be returned
dec word ptr MYFLAG
popf             ;Restore flags after change by DEC
iret             ;Return to interrupted process
```

I assume you have already incremented your flag prior to above code (actually, I just forgot it!).

---

ibm.pc/programming #550, from skluger (Sigi Kluger, Definicon Systems), Wed Oct 15 13:25:44 1986.

I have a program that uses the DOS EXEC function (4Bh) to execute another program. After the call returns, I use function 4BDh to get the return code and I always get 0 back. Why?

---

ibm.pc/programming #551, from mws (Mark Shurtleff), Wed Oct 15 15:02:43 1986. A comment to message 550.

What program are you EXECing? If it is a standard DOS utility, only BACKUP and RESTORE ever return a valid code, all others give you a 0. If it's a program of your own, does it terminate using Fn 77 (4Ch) with the return code in AL? More info, please.

M S
W

---

ibm.pc/programming #555, from skluger, Thu Oct 16 01:06:19 1986. A comment to message 551.

Any program I EXEC, including a test program that only consists of a MOV AX,4C55h followed by INT 21h, returns 0. I do the exec, immediately followed by INT21/4D, and get zero. Every time. All the time.

---

ibm.pc/programming #556, from dmick (Dan Mick), Thu Oct 16 01:10:53 1986. A comment to message 555.

Um...bug? I've never tried it, but I will. It should be pretty easy to trace the 4Dh call, as it doesn't seem to do much.

---

ibm.pc/programming #560, from mws, Thu Oct 16 16:39:02 1986. A comment to message 555.

Every time. Can I ask a very dumb question? Are you testing *AL* for the return code? *AH* indicates the program termination using Fn 77 (4Ch), and will return the following codes:

```
        AH = 0 --> Normal Exit
           = 1 --> Exit by Ctrl/Break or Ctrl/C
           = 2 --> Exit by Critical Error
           = 3 --> Exit by TSR
```

Does this help, or do I reiterate something already known?

M S
W

---

ibm.pc/programming #561, from skluger, Thu Oct 16 17:10:41 1986. A comment to message 560.

Since I'm "really" interested in the return code I'm, of course, examining AX.

---

ibm.pc/programming #563, from geary (Michael Geary), Fri Oct 17 07:21:17 1986. A comment to message 561.

Here's a little test of EXECing a child process and checking its return code.

This is test1.com, it EXECs test2.com and then breaks at 0129 with the return code in AX, or at 012A if there were any errors. (Only run this under Debug, because of the INT 3s!)

```
-u 100 12a
2394:0100 BC0002        MOV    SP,0200
2394:0103 BB2000        MOV    BX,0020
2394:0106 B44A          MOV    AH,4A          ;"J"
2394:0108 CD21          INT    21
2394:010A 8C0E4401      MOV    [0144],CS
```

continued

```
2394:010E 8C0E4801        MOV    [0148],CS
2394:0112 8C0E4A01        MOV    [014A],CS
2394:0116 BB4001          MOV    BX,0140
2394:0119 BA5001          MOV    DX,0150
2394:011C B8004B          MOV    AX,4B00
2394:011F CD21            INT    21
2394:0121 7207            JB     012A
2394:0123 B44D            MOV    AH,4D          ;"M"
2394:0125 CD21            INT    21
2394:0127 7201            JB     012A
2394:0129 CC              INT    3
2394:012A CC              INT    3
-d 140 l e

2394:0140  00 00 60 01 00 00 5C 00-00 00 6C 00 00 00
..'...\...l...
-d 150 l a

2394:0150  74 65 73 74 32 2E 63 6F-6D 00
test2.com.
-d 160 l 2

2394:0160  00 0D                                 ..
```

And this is test2.com, which just exits with a return code of 77h:

```
-u 100 104

2394:0100 B077            MOV    AL,77          ;"w"
2394:0102 B44C            MOV    AH,4C          ;"L"
2394:0104 CD21            INT    21
```

ibm.pc/programming #564, from skluger, Fri Oct 17 09:44:19 1986. A comment to message 563.

Just like my code (which doesn't work). I don't use call 4A though since I've butchered my .EXE file so that it only takes up 12K.

SETTING A HIGH BAUD RATE

ibm.pc/hardware #1687, from tjeffries (Tom Jeffries), Thu Nov 20 23:40:45 1986.

Is it possible to set the serial port UART to a higher baud rate than 9600? My super-cheap multi I/O card uses an 8250 UART, which is supposed to be capable of rates up to 56 Kbaud, but I don't have a spec sheet and the "documentation" that came with my card doesn't tell me much. Is the 8250 the standard UART on serial cards? And how do I access it to set baud rate and send data?

ibm.pc/hardware #1688, from sparks (Dave Sparks), Fri Nov 21 00:42:17 1986. A comment to message 1687.

<flip> <flip> According to the documentation I have on the IBM async card, the baud rate generator in the 8250 is capable of only 3.1 MHz, which means the effective bit rate is 193.75 Kbaud. However, in the next sentence, it states that the data rate should be no greater than 9600 baud. I would tend to believe that the data rate is dependent on the chip designation (e.g., 8250A, versus 8250). If you want to experiment, the theoretical clock setting for 19.2 Kbaud is 0006h, 38.4 Kbaud is 0003h. Since the accuracy of the clock is purely dependent on the crystal, there should be no problems, other than that caused by the ability of the chip to operate at that rate. :-) dave

ibm.pc/hardware #1700, from barryn (Barry Nance), Fri Nov 21 08:11:34 1986. A comment to message 1687.

I think the answers to your questions are over in telecomm.tech/example.code, which contains a rather thorough discussion on communications programming.

ibm.pc/hardware #1693, from geary, Fri Nov 21 02:33:40 1986. A comment to message 1688.

The 8250 works fine at 19.2 Kbaud using the divisor of 6; I've run them that way with no problems. You do start to run out of compute horsepower in a 4.77-MHz PC around that rate, though. Haven't tried 38.4 Kbaud.

ibm.pc/hardware #1699, from proman (Peter Romanchuck), Fri Nov 21 05:12:59 1986. A comment to message 1688.

We have a program that uses the standard COM port at 115 Kbaud with no problem. Alas, I do not know HOW this is set, but it works.

ibm.pc/hardware #1696, from tjeffries, Fri Nov 21 03:31:38 1986. A comment to message 1693.

How do you set it to the higher rate? The only references I have found so far just explain how to set the baud with a BIOS function that only recognizes speeds up to 9600.

ibm.pc/hardware #1698, from geary, Fri Nov 21 03:37:21 1986. A comment to message 1696.

You have to program the chip yourself. I could give you some sample code but it's complex. (The routine I have handles interrupts, etc.) Or you could look at "async.drv" in listings (IBM area) for some sample code.

telecomm.tech/example.code #68, from cdanderson (C. David Anderson), Fri Nov 21 22:51:56 1986.

After some searching around in here, based on a pointer in ibm.pc/hardware re the possibility of setting my serial port to 19,200 rather than being limited to 9600, I confess that I am over my head. Does anyone know of a commercially available program that will give me 19,600 baud for a normal serial port, so that I can run my HP laser at 19,200 (which it has switch settings for, and which Lotus will support) so that I can also run my word processor at 19,200 (not just Lotus)? Thanks.

telecomm.tech/example.code #69, from barryn, Fri Nov 21 23:05:08 1986. A comment to message 68.

You're not looking for a way to program it, but a program that sets the baud rate for subsequent COM port usage? Sort of a souped-up MODE command?

telecomm.tech/example.code #70, from petewhite (Pete White), Sat Nov 22 00:22:33 1986. A comment to message 68.

I thought PC-Talk was capable of 19,200 transfers; we use it at that speed to transfer files to a typesetter (unless my memory has gone west). I'll take a look . . . .

telecomm.tech/example.code #71, from geary, Sat Nov 22 06:36:55 1986. A comment to message 68.

Here is a little program to set a comm port's baud rate to 19,200. To create the program, enter the program below and name the file 19200.DBG. Then, enter the command

```
C>debug <19200.dbg
```

This will create a program called 19,200.COM. This program sets the baud rate only; it does not affect the other communications parameters (parity, data bits, stop bits). So you should first use the MODE command to set the other parameters. Then give the command:

```
C>19200 {port#}
```

where {port#} is 1, 2, 3, or 4.

So, for example, to set up a serial printer on COM2 that uses 8 bits and no parity, you might say

```
C>mode com2:9600,n,8,1,p
C>mode lpt1:=com2
C>19,200 2
```

File 19,200.DBG follows...

```
a
CLD
MOV     SI,0081
LODSB
CMP     AL,0D
JZ      0140
CMP     AL,31
JB      0104
CMP     AL,34
JA      0104
SUB     AL,31
XOR     AH,AH
MOV     BX,AX
XOR     AX,AX
MOV     ES,AX
ES:
MOV     DX,[BX+0400]
TEST    DX,DX
JZ      0140
ADD     DX,03
IN      AL,DX
JMP     012A
MOV     BL,AL
OR      AL,80
OUT     DX,AL
JMP     0131
SUB     DX,03
MOV     AX,0006
OUT     DX,AX
JMP     013A
ADD     DX,03
MOV     AL,BL
OUT     DX,AL
INT     20

n 19,200.com
r cx
42
w
q
```

APPLE II/MACINTOSH

The Apple II section centers on a discussion of how to alter the system speed of the IIGS in order to maintain compatibility with existing speed-sensitive peripherals. The Macintosh thread discusses some of the pleasures and frustrations of working with MacApp (the "official" Macintosh software development tool).

SPEED CONTROL

apple/gs.other #334, from delton (Don Elton), Tue Nov 18 23:26:23 1986.

Is there a simple way, from software, to alter the speed of the IIGS long enough to standardize timing loops, etc., across the various Apple machines? For example, my terminal program turns off an Accelerator IIe or Transwarp card during all timing loops via a couple of byte stores, so the timing-sensitive parts of the program run correctly regardless of the machine. I'd be interested in being able to do the same on a IIGS, given the info on what to poke or read and where to do it.

apple/gs.other #335, from mdavis (Morgan Davis), Wed Nov 19 00:46:15 1986. A comment to message 334.

You can kludge it somewhat by accessing the slot that gets slowed down from inside your timing loop. Most of the speed-up cards will slow down for a few hundred milliseconds after they've been told to do so. You'd probably want to use a bit instruction to access any slot address, and so you'd have to take into account the cycles involved in your bit absolute (or indexed) instruction.

Of course, this is all dependent on your card being able to slow down (as per DIP switch settings) when a certain slot is accessed.

This would also be pretty generic between speed-up cards, since it doesn't involve any knowledge of slow-down/speed-up register locations.

apple/gs.other #337, from delton, Wed Nov 19 18:35:50 1986. A comment to message 335.

I wonder how many cards on a IIGS will need slowing down, and does the IIGS slow down for slot access? The problem isn't with accelerator cards; it's with running an emulation mode program on the IIGS, and being able to slow it down momentarily from time to time in case the IIGS is running at the 2.8 speed instead of the 1.0 speed.

apple/gs.other #338, from gs.softteam (Apple Computer Inc.), Wed Nov 19 19:29:46 1986. A comment to message 337.

Yes, the IIGS does slow down for slot access. Any access to $CnXX will slow to 1 MHz, but (and I mean BUT) any internal operations to the 65816 during execution of code residing in a slot in fast mode will not necessarily occur in slow speed. The fetching of Op-Codes, reading ,and writing from a slot will occur at 1 MHz while internal operations will accur at fast speed if the system is set to the fast speed. The result is that timing loops executed from a card that were written based on 1-MHz timing actually run faster when the IIGS is running fast. Slots 4, 5, 6, and 7 have the ability to force system speed to slow mode when a disk interface card is installed in the slot. The firmware configures a softswitch that enables motor on detection for these slots. If a motor on address is accessed (as in diskII), then the system will automatically slow down to 1 MHz. System speed will be restored when the motor-off switch is accessed.
Ray Montagne (IIGS Software Team)

apple/gs.other #340, from delton, Wed Nov 19 20:36:39 1986. A comment to message 338.

Nice to know that slots can slow down. So, how specifically does one, from a user program, change the system speed to 1-MHz operation, and then how does one change the system speed back to 2.8-MHz operation? The obvious solution for a timing-sensitive piece of code would be to get the machine running at a standard speed (across the IIe and IIGS, for example) for the duration of the execution of that code. Is there a softswitch or something you hit to get slow speed or fast speed? If so, what code is needed specifically to do the trick? Thanks.

apple/gs.other #347, from mdavis, Thu Nov 20 15:01:18 1986. A comment to message 338.

Ray, when a slot is accessed for a brief moment, how long is the slow window in effect? When you "hit" an Apple II speed-up card for slowing down, it will last for approximately 300 milliseconds *after* access to a slot has stopped. Does the GS do this, too?

apple/gs.other #349, from larryt (Larry Thompson, Apple Computer Inc.), Thu Nov 20 23:32:16 1986. A comment to message 347.

The GS does not have the 300-millisecond time lag after a slowed cycle. After a slow read or write cycle, the GS will speed up right away if the machine is configured to run fast.
Larry Thompson

apple/gs.other #353, from mafischer (Michael Fischer, Apple Computer Inc.), Sat Nov 22 02:53:31 1986.

In regard to the question about how to set system speed from an application, the following code example is taken from my book -- The Apple IIGS Technical Reference (due in early January from Osborne/McGraw-Hill). It sets speed to fast, saving the original setting. It could just as easily set speed to normal.

continued

Note that the code is written for the APW Assembler using the macros available on that system.

```
Pushword #$0000      ;Result space
Pushword #$0020      ;Want system speed
                     ;parameter
_ReadBParam          ;Get speed setting
PLA                  ;from top of stack
AND #$00FF           ;Mask off high byte
STA OldSpeed         ;and save it
BNE ItsFast          ;Skip rest if already fast
                     ;speed
Pushword #$0001      ;Set fast speed
Pushword #$0020      ;System speed parameter
_WriteBParam         ;and change it ItsFast
. . .
*Rest of program that needs this speed goes here
*At end of this part of program, reset speed as
*follows:

LDA OldSpeed         ;Find old speed
BNE Done             ;Old speed was fast, don't
                     ;reset
PHA                  ;Normal speed value
Pushword #$0020      ;System speed parameter
_WriteBParam         ;Reset to old value Done
. . .                ;Rest of program goes here
```

apple/gs.other #354, from delton, Sat Nov 22 22:52:04 1986. A comment to message 353.

It looks like this code changes battery RAM. Does it actually change the speed setting immediately or only after a reboot? I'll need to change the speed instantaneously, more or less. Thanks.

apple/gs.other #363, from gs.softteam, Wed Nov 26 16:54:43 1986. A comment to message 353.

This is not the proper way to set system speed. What you have done here is change the system default speed so that the next time the system is reset, the system speed will be set according to the parameter written in battery RAM. Writing to the battery RAM has no immediate effect on the system. You must also set the appropriate hardware register to get the system environment set as you wish. In order to set the system speed, the most significant bit of the speed register ($C036) must be set to a 1 for fast or 0 for slow. Remember that this must be done in 8-bit mode. The hardware register should probably be accessed in bank $E0, in case I/O shadowing has been turned off (this assures access to the register). Only the bit being modified should be accessed. Other bits in this register are set by the firmware on system initialization and could have disastrous results if set to the wrong state by an application. Here is an example of setting fast speed:

```
sep    #$20     ; 8 bit "m"
longa off
lda    #$80     ; bit 7 is fast speed
phb
pea    $E0E0    ; set data bank for switch access
plb
plb
tsb    $C036    ; set fast speed
plb
```

To set slow speed, replace the "tsb" with a "trb" instruction. Another method might be

```
lda    >$E0C036 ; read register
ora    #$80     ; and set fast speed
sta    >$E0C036
```

Either of these methods has an immediate effect on system speed while not destroying the state of other bits in the register. If your program needs to restore the system speed, then there are two methods available. First, your program can save the system speed by reading the register and pushing on the stack prior to setting the new speed. In this case, you just pull the saved speed off the stack and write it to the register. The second method is to read the battery RAM and set the hardware register based on the value read from the battery RAM. Your application should never write the battery RAM unless it intends to alter the system default. A control panel-type desk accessory is the only application likely to do this. We sure would like to have reviewed any material being published by anyone to assure that no technical problems arise.
Ray Montagne (IIGS Software Team)

CREATING DIALOG BOXES WITH MACAPP

macintosh/macapp #40, from chn (Carl Nelson), Wed Sep 17 04:02:59 1986.

In creating a dialog the other night, I wanted to add a single text item on the end of a dialog, and I was surprised to find that someone didn't put in what I would call an obvious (trivial) method in TDialogView called "DefineText". It seems almost too trivial to put in, but basic in that it would be a method someone would want to override for some exotic text field input. Anyone else miss this one or any other like it?

BTW, the Define Radio cluster is NICE! It only took 2 hours to get a new kind of TRadioCluster (TAdrsCluster) running. I use it to read part of my SCSI disk boot blocks, then show it to me in the other parts of the dialog. (Real EASY, the hard part was convincing my SCSI drive to give it to me.)
....Carl

macintosh/macapp #49, from scotty (Barry Wilson), Thu Nov 20 02:59:05 1986. A comment to message 40.

I am new to BIX but have been using MacApp now for about three months. I was as surprised as you are when it took more lines to create a Check Box than a radio cluster! After one or two dialog boxes done that way I finally added a new dialog unit to my library, inheriting all the features of UDialog and defining my own convenience functions DefineText, DefineCheckBox and DefineScrollList. I have a wish list of more features I would like to add, including using Icons and Picts as Buttons.

macintosh/macapp #50, from kschmucker (Kurt Schmucker), Thu Nov 20 22:44:33 1986. A comment to message 49.

How about sharing with us some more of the details (and the code) for your improvements to UDialog, and your wish list for other stuff?

macintosh/macapp #51, from demars (Dennis DeMars), Sun Nov 23 19:42:11 1986. A comment to message 49.

MacApp is obviously in a less developed state than other elements of MPW, and one of the most obviously uncompleted portions in UDialog. The documentation on this unit is so skimpy as to be almost useless, and the whole dialog implementation appears to me to be rather kludgey. I assume that the final product will contain more substantial documentation for UDialog (actually, the documentation for the entire MacApp package needs to be expanded), and I hope that UDialog will be honed up to contain support for check boxes, user items, and so forth.

macintosh/macapp #53, from kschmucker, Tue Nov 25 09:03:45 1986. A comment to message 51.

I agree that UDialog needs more documentation, but the sample programs demonstrate a lot of stuff that is not explicitly expressed in the documentation.

Historically, MacApp is in a MORE developed state than the rest of MPW. MPW's slow schedule and many postponements slowed down the release of MacApp.

macintosh/macapp #54, from dgoldsmith (Dennis Goldsmith, Apple Computer Inc.), Wed Nov 26 12:48:34 1986. A comment to message 51.

It's certainly true that UDialog doesn't have all the features it could, but we just haven't had time to put in some of the things that would have been nice. It's not at all hard to add these features yourself. It's also not necessary to use UDialog at all for dialogs; if you find that it's not doing what you need, you can either just use the dialog manager directly (for modal dialogs) or use an ordinary window with controls in it. UDialog is one of the areas in MacApp that we are planning to examine carefully for future releases. I wouldn't say that MacApp in general is less finished than MPW (or rather, was at the time of the 1.0 Beta2 releases). We've certainly tightened up the error handling since then, but the architecture hasn't changed. You also don't get to look at the source code for MPW. Working on MacApp is sort of like living in a glass house; everyone gets to see your dirty laundry. Part of the reason MPW 1.0 is finished but MacApp 1.0 isn't is that we are trying to be extremely careful. A bug in MPW can be worked around, but a bug in MacApp is a bug in every program built with MacApp. We are currently sweating out the last week or two of testing and we're hoping we'll be ready to go soon.

---

macintosh/macapp #59, from demars, Mon Dec 1 00:51:51 1986. A comment to message 54.

When I said MacApp appeared to be in a less developed state, I was thinking mainly about the documentation rather than the MacApp program itself (I haven't seen anything in the program I would call incomplete except for UDialog, which I've already commented on).

Of course, there is the problem that any new user is going to have using a complex new system, but even after immersing myself in the system for several weeks, I have found that the documentation, as extensive as it is, is still too terse in many areas (UDialog is one example; the info on implementing the Clipboard is perhaps a more important example).

Actually, documenting something like MacApp is pretty tough because it is impossible to provide enough information to accommodate every way that a programmer may want to customize various methods short of describing the entire MacApp program in detail from top to bottom...and the source code itself fulfills that function.

It is my feeling, though, that a programmer should only be forced to peruse the source code in extraordinary circumstances. Currently, you have to look at the MacApp source to figure out what it's doing even to do some fairly simple things. For instance, I needed to create a window with two subframes inside the window, both containing text edit regions, and one of them with a vertical scroll bar (the scroll bar belonging to the subframe, not the parent window). I had a heck of a time figuring out how to do this. How to switch the active target between the two frames was the main problem, and it is pretty simple to do, once you know how. But I couldn't figure it out from the MacApp manual alone.

Don't get me wrong; programming with MacApp is both easier AND less error-prone (once you get accustomed to the system) than without MacApp. I just think the documentation needs some work. And after all, isn't this what beta versions are for - to find weaknesses in the package? And this is, perhaps, a weakness that is hard to detect by the people who are close to the project, since they already know how things work and it may not be obvious to them what needs to be made explicit. Also, MacApp is pretty unique and presents some new problems (I tend to think that some parts of MacApp will look different in the future as people think of more flexible ways of doing things). -Dennis D.

---

macintosh/macapp #61, from scotty, Mon Dec 1 03:30:10 1986. A comment to message 59.

I certainly hope that MacApp will be a teensy bit more programmer-friendly in future releases. I started out by trying NOT to read the source but quickly learned the hard way.

The FilterEvent method of dialog items has been on my mind today. (DoFilterEvent? or something like that.) I tried to override it for a custom item I had in mind and spent a lot of time wondering what was going on until I looked at the Dialog View and found out that the method was only getting passed along to KeyHandlers. Now, I could make my custom item a descendant of KeyHandler, but I want to retain the currently selected KeyHandler while this item operates.

Another possible solution is a new dialog view with a different DoFilterEvent, but I am unsure if this will work. Mainly, I am trying to reimplement a Scrolling List using the List Manager package. (My first version was more along the lines of what Kurt Schmucker did in his book.) I want to call the LClick and LUpdate routines and DoFilterEvent seems like the right place. Anyone have any ideas? If I get it worked out I'll let everyone know how it works.

It seems to me that if you declare a FilterEvent, then that is what it should do, and referring back to the implementation shouldn't be needed. On the other hand, I can see that it would be a waste to do an EachChild(DoFilterEvent), or some such, when probably very few dialog items need to do this.

Another thing I realized when doing this was that if an item needs to filter events in a modal dialog, then it probably needs the same treatment in a modalless dialog, as well. Oh well.

This is not to say that I dislike MacApp. I think it's great, and it can do things that I only dreamed of on my Apple III (on which I'm writing this), but because I'm relatively new to MacApp and Mac programming in general, and haven't used the List Manager outside of the MacApp environment, I am a little surprised at how difficult it is to merge the two. (I know a simple view would be easier!)

On the other hand, I have been writing Pascal code since I got my first Apple II and would be glad to help anyone new to Pascal. But I am as green on objects as the next guy.

---

macintosh/macapp #63, from demars, Mon Dec 1 23:11:33 1986. A comment to message 61.

I experienced periodic frustrations while learning MacApp, and one of them was discovering that the List Manager (which I had planned to use) was none too compatible with the "view" concept. Of course, the MacApp mavens might say that nothing prevents you from using the List Manager (you don't HAVE to use views), but, of course, quite a bit in MacApp revolves around views, so you just about have to use them.

On the plus side, when I decided to forgo the List Manager and simply write a view to do what I wanted, it turned out to be very simple to do in the MacApp framework, and actually closer to what I visualized the interface to be than what the List Manager would have given me. Anyway, it's a trade-off, like most things, between flexibility and convenience. -Dennis D.

BASIC

New versions of BASIC generate considerable discussion in the BASIC conference. Why BASIC is best is another subject of interest.

MEMORY-RESIDENT PROGRAMS AND QUICKBASIC

---

basic/newbasics #351, from pwashburn (Peter Washburn), Tue Nov 25 00:42:32 1986.

continued

Does anyone have an easy way of making the QuickBASIC 2.0 editor and SideKick compatible with each other? I had already discovered that you couldn't paste from SideKick into the QuickBASIC editor, but I was really disappointed to find that when I use the Debug section of QuickBASIC, the computer locked up the first time the program encountered TRON. The only way to get out was to shut the machine off. My best guess is that the two programs are fighting for control of the keyboard.

I've become really dependent on having SideKick available while programming. I know that there is no love lost between Borland and Microsoft, but does anyone have a way to make these two programs work together? Or know of another resident editor that is compatible with QuickBASIC 2.0?

---

basic/newbasics #352, from btonkin (Bruce Tonkin), Tue Nov 25 22:24:27 1986. A comment to message 351.

QB takes the keyboard, and I doubt very much it will like *any* memory-resident editor. In fact, MS has told me several times that they don't guarantee QB will run with *any* TSR.

But why would you want to use the SideKick editor? Seems to me that QB has a better editor already. Different, surely, but better. I've never had any problems, but then I don't have any TSR programs and wouldn't use any if I had them. I need all the memory I can get and can't afford glitches caused by someone grabbing the KB vector and changing it. Think about it: Is that a bug in the compiler, a bug in the source code, a conflict between the TSR and the compiler, a conflict between the TSR and DOS, or a conflict between this TSR and one of the others? Or is it some combination? Without TSRs, life gets a lot easier while writing software. A lot of the possible problems are eliminated.

---

basic/newbasics #353, from dmick (Dan Mick), Tue Nov 25 23:45:28 1986. A comment to message 352.

Well, I don't like the QB editor better than SK's except for the limited file length. Oh, and the fact that the error indication and in-memory compile text go to and come from the editor (not SK's, no way). That's why I haven't bitched too much...it gains you that tied-in editing. I'd like it much better if it were like Turbo's editor, though (WS, in essence).

BUSINESS BASIC I/O

basic/newbasics #354, from mmr (Micro Matic), Wed Nov 26 12:23:02 1986.

This is coming from across the Atlantic (Belgium). We are trying to access a device driver using the OPEN, INPUT#, and OUTPUT# commands of BBASIC. The program runs successfully on the normal GW-BASIC, but BBASIC seems to require an input _before_ any INPUT# is done. At this point, no input is ready! Anyone know any fixes?

---

basic/newbasics #355, from btonkin, Wed Nov 26 18:29:34 1986. A comment to message 354.

Have you tried using LOC and LOF on the file to check the size? It may well be that BB is treating the input as an INKEY$; if so, using a WHILE/WEND loop would collect the input. Are the drivers attached to COM ports, or are they returning their input elsewhere? If to COM ports, then you may need to link the communications library when you link the .OBJ files. Please let us know more details.

---

basic/newbasics #367, from mmr, Tue Dec 2 12:03:48 1986. A comment to message 355.

Sorry at being a little slow in responding to your suggestions. I haven't tried linking the communications library. I assume you mean BASCOMB.LIB? (I have 2 libraries: basrunb.lib & bascomb.lib.) Checking LOC and LOF will only be possible if the resulting program is _completely_ compatible with GW-BASIC.

---

basic/newbasics #368, from btonkin, Tue Dec 2 20:22:53 1986. A comment to message 367.

No; the library used for communications is called something else, and it is an .OBJ file that must be linked with your programs. It has different names, depending on the version of the compiler you're using. Please look at the files on your original distribution disk for one with a name that looks like it might refer to communications. The manual will also usually have references in it to "communications software," too. For QuickBASIC, the library is called "GWCOM.OBJ," and it's mentioned in the manual on page 376 (among other places). Other versions usually have names that are variants of this. As far as *completely* compatible with GW-BASIC, I don't know. I suspect there is little chance that any communications software you write will be generically compatible with MS-DOS machines; even the IBM BASIC compiler version 1.0 would create programs that had problems on quite a few not-very-compatible machines, and QB is a lot more demanding. Communications programs usually need to know where the ports are if they're going to use anything more than 300 baud. With QB, the 1.0 IBM compiler, and most other versions, *you* don't have to know where the ports are; but the compiler run-time had better be able to find them where they ought to be. If not - you'll get errors like "device not available," "bad file mode," and "device fault."

---

basic/newbasics #369, from mmr, Thu Dec 4 11:49:47 1986. A comment to message 368.

After a little more experimenting, it becomes clear that the fault lies with the handling of device drivers by BBASIC. Try compiling and running the following program both with GW-BASIC and BBASIC (install ANSI.SYS first):

```
10 open "I",1,"CON"   ' the console
20 print "prompt:"
30 input #1, a$
40 print a$
```

With GW-BASIC, as is expected, the message "prompt:" is displayed, after which BASIC waits for input (processing the input #1 statement). BBASIC waits until you type a return, THEN displays the "prompt:" and THEN displays what you have typed in before the return! Imagine what happens when you try to access a peripheral which has to be started up by BASIC in some way or another (I need to do a print#) before it sends anything. The problem is not limited to the console (replacement) driver but occurs with any character device driver, even those that do not use the comm ports.

Next, I'll get a copy of QB and try with that. More news later.

WHY BASIC IS BEST

basic/misc #207, from cable (Robert Cable), Sun Nov 9 20:28:52 1986.

Wishing to restart an old argument many (Pascal, C, Ada, etc.) programmers seem to think long dead, I'd like to make my statement on the subject of computer languages. They don't know it, but BASIC is not only far from dead, far from out of use, and far from what the current market needs in a programming language, it offers power that not many programmers can handle. Think I am kidding? I can prove it.

Believe it or not, the fastest spreadsheet currently running on a micro was written on an IBM PC in Microsoft BASIC and compiled. Not C, not Pascal, not FORTH, just BASIC. How do I know this? I have seen it through my very own spectacles. Not advertising a product, but I'll happily prove it to the satisfaction of the worst skeptics.

The program, by the way, depends on new programming techniques and is just being released into the market. Why BASIC? According to the author, BASIC has the power without external libraries. Since the program depends on the actual compiler that created it much more than it does on the language itself, and since C lacks power in its kernel, as does Pascal, BASIC is the language of choice.

The same problem of depending heavily on the libraries rather than the language (or, as the author puts it, having a program that looks up at the language just as the user looks down at it) means that it cannot be portable the way C and Pascal programmers claim their code is. The program is married, as it were, not just to the language, but to the compiler that created it. The spreadsheet is built around a central math engine that compiles user input strings into native code subroutines which are linked to the main program so that (1) it can call them, and (2) they can call the routines in the main program's internal libraries. Running on an IBM PC with an 8087 at 4.77 MHz, this wondrous contraption processes 1500+ cells of exponentiation or 6400+ cells of square roots in ONE second. And that ain't C.

---

basic/misc #208, from btonkin, Sun Nov 9 20:39:02 1986.
A comment to message 207.

I agree wholeheartedly. I'd like to see some of the routines from this package myself. Does the author have a BIX account? Might he like to talk about the techniques he used (either specifically or generally)? (The "he" is meant generically; the author might well be "she.")

---

basic/misc #209, from cable, Mon Nov 10 20:15:06

The author of the Amy math engine, which is used by the Indy spreadsheet I mentioned, is George Harvey, who lives in New Hampshire but works in New York and New Jersey. He may or may not have a BIX account, though he does subscribe to BYTE and surely knows of BIX.

He is not particularly bashful about his work, and I am quite sure of this because he has given talks on the subject to both the Monadnock Users Group and the New York chapter of the Independent Computer Consultants Association. (You guessed right, I have known him for several years.) I am sure he would like to join the BASIC language discussions on BIX. I'll ask him.

---

basic/misc #212, from cable, Mon Nov 24 18:38:39 1986.

I got the following from George Harvey.

Thank you for your recent message. I think I can answer your question as to why Indy87 and Indy88 were written in BASIC without getting too technical. They are the first demonstrations of the Amy math engines. There are Amy engines to support three particular compilers as of now, the IBM BASIC compiler, version 1, the Microway 87BASIC compiler, and the Microway 87BASIC/Inline compiler. The Amy engines are designed to support BASIC compilers for one reason: I believe BASIC is the best language for this application.

In order to understand my reasoning behind this, you have to understand the functioning of the Amy engines. In brief, they compile user input strings into callable native code subroutines, linking them on the fly to the currently running program, of which the Amy engines are modules. In order to save memory, they access the internal library structures of the main program to do their heavy work. In this way, a subroutine to raise a variable to the power of another variable is typically less than 20 bytes. Compiled BASIC can run through a lot of such subroutines in a second, and, using some looping tricks, the Indy spreadsheet can process over 1500 cells of 8087 exponentiation in a second on your 4.77-MHz PC. This is why the Indy spreadsheets are so fast compared to any others on the market.

The Amy engines work by producing code that functionally copies that of the compiler for which it is designed. The code uses the same processor registers in the same ways to do the same things. This is one of the keys to how Amy engines operate. The differences that do exist are mainly due to the fact that special programming techniques are employed to find the library routines after they have been loaded.

You might say that Amy operates by looking up at the language with which it functions from underneath. Amy does not particularly care about the specifics of the commands, the language, or how modular the program is, or whether the language is structured or has recursion. Amy is quite concerned about how the language uses the registers in the processors and whether it accesses interrupts and how it stores results of calculations, because Amy has to act the same way as the host language.

Amy sits at a level below the language and has a good deal more room in which to work when the language was designed to operate at a high level. When a language is built to function at a low level, the programming techniques in Amy become more difficult and less useful.

Amy engines cannot be made portable with any of the current languages, and the issue of portability is irrelevant. Amy engines do not benefit from elimination of the GOTO or from the ability to pass parameters to subroutines. Amy engines do benefit from the kind of power associated with a language that is not afraid to be machine-specific and has a robust core library. The library of a good modern BASIC compiler has considerable power, far more than than the core libraries of Pascal or C. It is especially important that BASIC has such good string-handling functions, because the Amy routines must be, at least for part of their lives, data strings.

The truth is, if you want to get the most out of a machine, there is no getting around learning to use the insides of the operating system, ROM BIOS, and assembly language. Once you have done that, you can do anything the machine is capable of doing as long as the language you are working in has good hooks to system level. It is important to let the language do as much as it can, keeping the low-level programming to a minimum. BASIC has the hooks and the power.

You might tell people that if they want a free demo, AMY-DE.ARC (which requires a color graphics adapter but not an 8087) is in the CompuServe Access Area and on at least a few BBS systems.

And now you know as much as I do. ghh

---

basic/misc #213, from btonkin, Mon Nov 24 18:48:54 1986. A comment to message 212.

Sounds like an interesting technique. I hadn't thought of doing things that way myself, but it sure seems like it ought to work nicely. Has anyone else done anything like this? The closest I can think of as an equivalent in C or Pascal is the ability to pass a pointer to a function; as was mentioned, that method suffers somewhat in languages that don't have the core routines written in assembler already in the library. Neither C nor Pascal commonly have floating-point transcendentals written in assembler and available in their libraries, though such libraries can sometimes be purchased (depending on language, version, etc.).

continued

C

The C conference excerpts include discussions of how compilers handle certain cases and tips on optimization of programs.

IMPROPER STRUCTURE HANDLING

c.language/compilers #725, from erael (Ernie Rael), Fri Nov 7 05:02:12 1986.

I tried the following two programs. Only one got an error during the compilation phase.

```
struct a {int a,b,c;}*a;
m(){
    if(*a) a->a++;
}
```

The above passed the compiler.

```
struct a {int a,b,c;}a;
m(){
    if(a) a.a++;
}
```

It seems that neither is correct, and both should be equivalent.   -err-

c.language/compilers #726, from geary (Michael Geary), Fri Nov 7 05:15:13 1986. A comment to message 725.

They certainly are both illegal, and Microsoft C 4.0 complains about both with "struct/union comparison illegal." In both cases, you are trying to compare an entire structure with zero. Not kosher. But, maybe not surprisingly, the first one slips past some compilers. Would be *very* interesting to see what kind of code it generated for that!

OPTIMIZATION

c.language/tips #646, from geary, Sat Nov 8 01:52:52

Here's a trick for speeding up simple assembler functions called from Microsoft C. It works only for near functions (small model) and is easiest when there are only a few parameters. Basically, the trick is to pop the parameters (and return address) off the stack instead of setting up a frame pointer. As an example, here is a function to output a byte to a port:

```
; void near pascal Out( port, val )
;       int  port;
;       char val;

OUT     proc    near

        pop     bx                      ; return addr

        pop     ax                      ; val
        pop     dx                      ; port

        out     dx, al

        jmp     bx                      ; return

OUT     endp
```

This works best with the Pascal calling sequence, but can be used with the traditional C calling sequence as well. In the example above, you would reverse the "pop ax" and "pop dx" and insert a "sub sp, 4" right before the "jmp bx".

By way of contrast, here is the same function, coded with the conventional technique of setting up a frame pointer in BP:

```
OUT     proc    near

        push    bp
        mov     bp, sp

        mov     dx, [bp].6
        mov     ax, [bp].4

        out     dx, al

        pop     bp
        ret     4

OUT     endp
```

As you can see, the first method only saves a few instructions, but in a really time-critical situation it may be worth it.

PASCAL

The excerpt from the Pascal conference discusses the use of the communications port from Turbo Pascal.

pascal/turbo #2227, from bernie.g (Bernie Gallagher), Sun Nov 30 13:17:33 1986.

I just bought Borland's Turbo Pascal to write a communications program. My first Pascal program is a translation of a BASIC program, which came with my modem, that "talks" directly with the modem. However, the Pascal version locks up whenever I call EOF(AUX) or EOLN(AUX). It seems that BASIC's EOF function is designed to work on both true disk files as well as logical devices such as the COM ports, but Pascal's only works with true disk files.

I've tried tricking Pascal by opening the COM port as a file. but Pascal won't let me write to it when I open it using ASSIGN/RESET (as would be expected), and it won't let me read from it when I open it using ASSIGN/REWRITE (only this time EOF and EOLN don't hang, they just fall through even if the buffer's empty, causing the READ error). If anyone else has had this problem, please clue me in to what I'm doing wrong.

pascal/turbo #2228, from jimkeo (Jim Keohane), Sun Nov 30 13:51:50 1986. A comment to message 2227.

Bernie, try using 2 files, one for input and one for output, with both assigned to "COM1" or whatever. Also, do yourself a favor and check out the PC.BIX conference. That conference contains the full working source to a turbo communications program for BIX communications. There's a "BIXCOMM.INC" file that has *everything* you might want in the way of full comm support.   - Jim

PS - Another choice would be to install an async driver under DOS. You can then handle COM as if it were a file but still retain full interrupt handling. Look for ASYNC.DRV in the IBM area of Listings for full 8086 source.

pascal/turbo #2229, from jimkeo, Sun Nov 30 14:03:21 1986. A comment to message 2227.

Bernie, it's hard to imagine where BASIC (or any language) could correctly determine end of line or end of file on a comm port. These are usually things that a communications package lets you control. For example, is a CR end of line, or must it be CRLF, or LFCR, or just LF? It's even more true for EOF. Would EOF be a Ctrl-Z, or a NULL, or loss of carrier?

For a comm program you're writing, you're better off being in control fully and BarryN's PC.BIX turbo software is an excellent model to use. Aside from the fact that use of PC.BIX could save you money on BIX connect time.

Just do a "join pc.bix" and look for a "readme" topic or similar name.   - Jim ■

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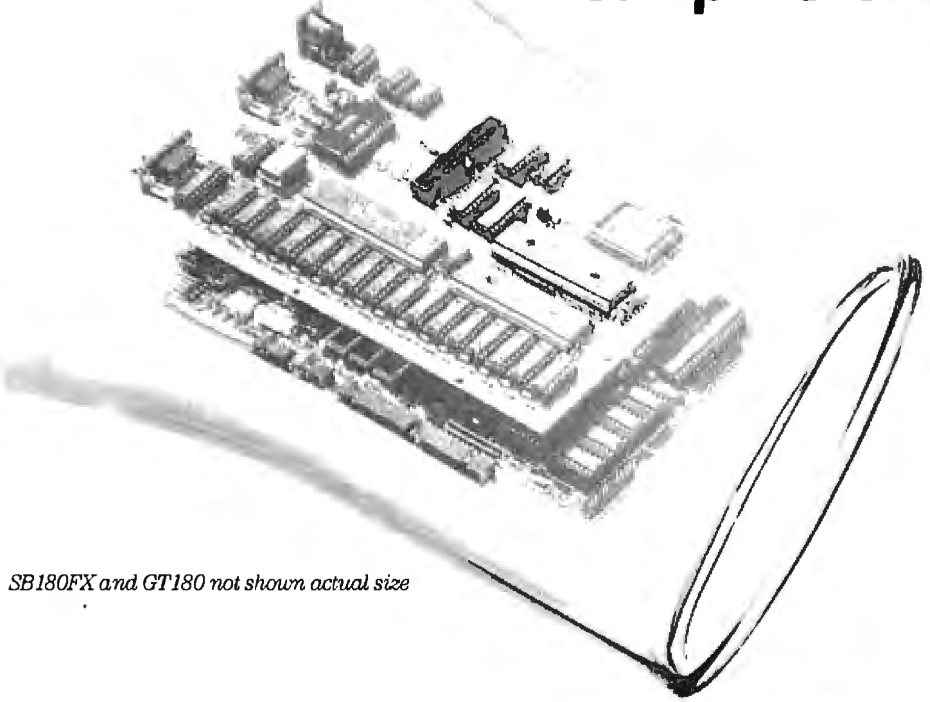

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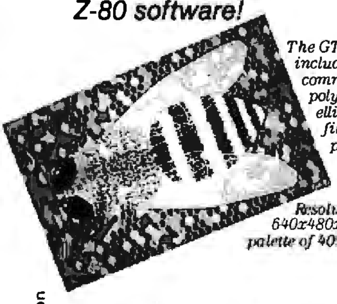

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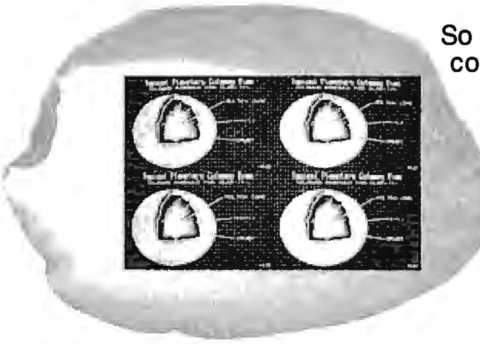

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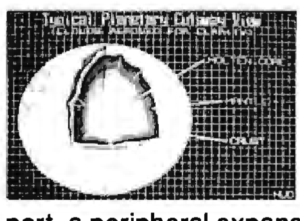

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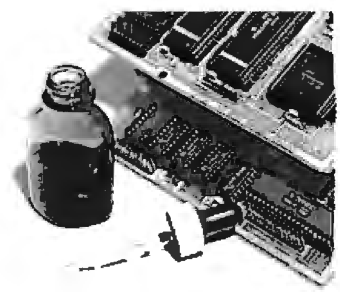

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Inquiry 85

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Inquiry 51

Inquiry 55

Inquiry 56

Inquiry 61

DiskMASTER®
The Ultimate Diskette Value ...

Discover The Difference ...

2 FOR 1 LIFETIME WARRANTY

- *Performance exceeds ANSI specifications by 62.5%*
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.49 5¼" - 48 TPI DS-DD — **1.19** DS-HD 96 TPI IBM-AT Compatible

Simply top Brand-Name Quality, made in the U.S.A. by a leading manufacturer. Factory polybagged in lots of 25 (min order 50)

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SS-DD	QTY. 10 BOXES OR 100 DISKETTES	DS-DD
.74	5¼" Color, BOXED, 48 TPI	.98
1.39	3.5" Color, BOXED	1.95
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	High Density, Color, 1.6mb, IBM AT Compatible	1.95

Includes Tyvek sleeves, w/p tabs, and ID labels. **FREE** Financial Calculator Software. Call for details.

America's No. 1 Name-Brand Diskettes

- *LIFETIME WARRANTY*
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SS-DD	QTY. 5 BOXES	DS-DD
.74	5.25, 48 TPI	.97
1.35	3.5, 135 TPI	1.90
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Call for best 3M prices on head cleaning and data cartridges.

Nashua™ *Affordable Quality Incredible Value Best Prices Ever!*

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1.12	3.5", 135 TPI	1.46
	High Density, IBM PC-AT Compatible	1.50

BULK SPECIAL OF THE MONTH
Made in U.S.A.

- *LIFETIME WARRANTY*
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- *Includes Tyvek sleeves and w/p tab*
- *Hub Rings*
- *100% tested and certified*
- *Made in USA*

BULK MULTIPLES OF 100

5¼ DS-DD **35¢**

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TERMS: Free use of VISA, Mastercard, and American Express. P.O. orders accepted from recognized corporations rated 3A2 or better, government and schools on net 30. **SHIPPING:** Add $3.00 per 100 diskettes or fraction thereof, add $5.00 for COD orders.
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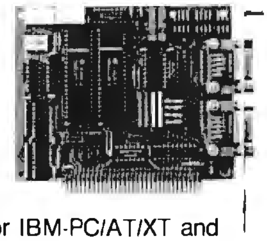
Computer Affairs, Inc. 199 Cottage Avenue, Salt Lake City, Utah 84070. Hours: 8am to 5pm (mtn. time)

RS-422
Communications Board



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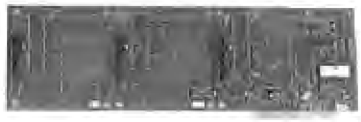
Inquiry 232

72 Digital I/O



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Parallel Expansion Board

- For IBM-PC & Compatibles
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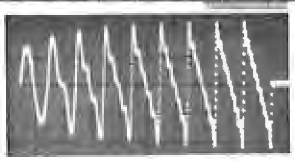
Inquiry 235

WAVEFORM SYNTHESIZER



- For IBM-PC/XT/AT and compatibles
- Generates user-definable signal
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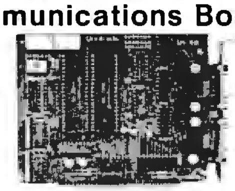
Inquiry 236

RS-232
Communications Board



- For **IBM-PC/XT/AT** & comp.
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640K, 1 Floppy, 20MB, AT Style KBD, One Year Warranty, FCC Approved **$895**

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MULTITECH 900 10/6 MHz $1500

Compatible Computer

- *10 or 6 MHz*
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- *Keyboard*
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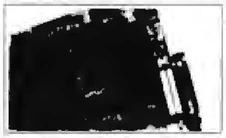
Multitech multifunction plus EMS, 0 to 1.5 MB	$219
Daughterboard to expand to 3 MB	$128

Modem

US Robotics Direct 1200	139
INCOMM 2400 Baud External	[illegible]
US Robotics 2400 PC INT	199
Everex Evercom 1200	129

Memory Expansion



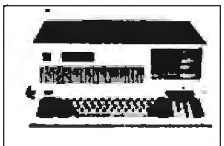
AST Premium 256K 2 MB SixPakPlus	234
Clone SixPack	89
AST Rampage PC	234
AST Rampage AT	445
TallTree J-Ram 3	184

Chips

256K 150 Nano	27
256K 120 Nano	29
64K 150 Nano	9
8087	119
8087-2	158
80287-3	199
80287-8	299

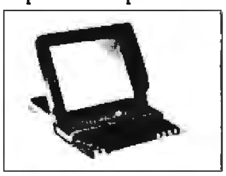
HARDWARE

Desktop Computer



IBM PC AT 512K	2495
Compaq Deskpro 386	4995
IBM PC XT 640K 1 Floppy	1689
IBM PC 256K	1089

Lap-Size Computer



NEC Multispeed (4.77/9.54 MHz)	1595
Toshiba T1100+	CALL
Toshiba T3100	CALL

Floppy Disk Drive

Fujitsu 360K	85
Teac 55BV 360K	99
Teac FG, 1.2MB	149
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Toshiba 3 1/2" 720K	139
Toshiba 1.2	149

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Seagate ST225, 20MB Kit	379
Seagate ST238, 30MB Kit	479
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Seagate ST4038, 30MB	629
Rodime 203E, 30 MB	498
Seagate ST4051, 40 MB	729
CDC 9415-86, 80MB	1295
Western Digital 1002	125
Western Digital WA2	239
Western Digital WAH	189
Disk Manager Software	99

Alternative Mass Storage

Everex Stream 60 ext	819
Archive 60 internal	695
Irwin 10MB internal	389

Diskettes and Tapes

3M DC-600A cartridge	26
3M DC-1000 cartridge	19
Bernoulli 20MB cartridge	72
Maxell MD2-DM 10 disks	19
Maxell MD2-HD 10 disks	35

Color Monitor

Princeton SR-14 770 × 400	495
Thompson color RGB	269
Taxon 630	450
Taxon 640	515

EGA Color Monitor

NEC Multisync	569
Princeton HX-12 E	539
Multitech EGA	419
Sony Multisync	599

Monochrome Monitor

Samsung amber/green/TTL	85
Amdex 310A TTL amber	159
Princeton MAX 12 amber	155
Multitech soft white TTL	119

Printer–Dot Matrix Near Letter Quality

Epson LQ-1000	830
IBM Proprinter	415
IBM Proprinter XL	629
Citizen 120D 120 CPS	190
Citizen MSP 10 160 CPS	307
Citizen MSP 15 160 CPS	414
Okidata 182 120 CPS	249
Panasonic KXP 1091 120	270
Panasonic KXP 1092 180	348
NEC P5 290 CPS	1053
NEC P5 XL 290 CPS	1192
NEC P6 216 CPS	475
NEC P7 216 CPS	865
Toshiba P-321 216 CPS	442
Toshiba P-341 216 CPS	699
Toshiba P-351 288 CPS	949
Toshiba P-351 288 CPS	1135

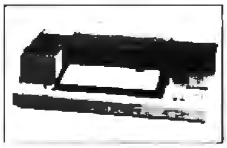
Printer–Letter Quality

Citizen Premier 35 CPS	517
IBM Quietwriter	1215
Brother M1509 180cps	399

Printer–Laser

H P Laserjet 500	3850
H P Laserjet Prot	2350
H P Laserjet Plus	3000
Toshiba Laser	call

Plotter

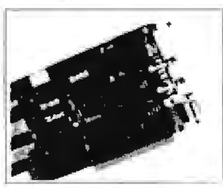


HP 7475 A Plotter	1744
Houston Ins. DPM 56	8169
Roland 880 8 pen	[illegible]

Input Device

Microsoft Mouse	119
Mouse System Mouse	139
logic Mouse	79
PC Optical Mouse w/Dr. Halo	135

Graphics Board, Monochrome



Hercules Graphics Plus *(New!)*	194
Everex Edge Mono/RGB/132col.	239
ATI...Mono/color/high/res	239
Clone monochrome graphic	95
Persyst Bob/MG mono/RGB	171

Graphics Board Color

Paradise Mod. Graphics	249
Hercules Color Graphics *(New!)*	149
Clone Color Graphics	85

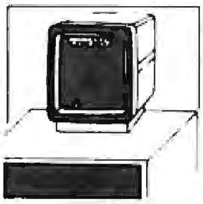
Graphics Board EGA

ATI Wonder	299
Paradise EGA/Auto Switch	359
Video 7 Deluxe/Auto	389
Multitech EGA	239
NEC EGA for Multisync	499

I/O Board

2 Floppies P/S/C/G/	89
AT I/O P/S	89

What You See Is What You Get!



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Micro Display

is a full page, ultra high res display that reduces the time and effort to produce top-notch results with desktop publishing software.

The Genius is a vertical 8 1/2" x 11" monitor. It includes its own video display adapter board which allows a special split-screen for simultaneously displaying both text and graphics.

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SOFTWARE

Accounting

Doc–Easy Accounting	45
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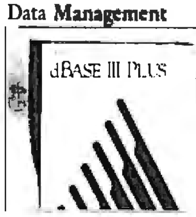
Data Management



dBASE III Plus, Ashton T	399
R Base 5000, Microrim	308
Reflex, Borland	66
Paradox Ansa Software	442

Desktop Management

Sidekick, Borland	49
The Desk Organizer, Warn	65

Education

Math Blaster	25
Early Learning Series	33
Newsroom, Springboard	30

Games

SceneryDisks Western US	72
Flight Simulator, Microsoft	32
Jet, SubLogic Communication	33
Sorgon III, Hayden Software	29
Zork I, II, and III, Inf.	29
F-15 Strike Eagle MicroPro	29
Temple Of Apshai Trilogy	29
World's Greatest Baseball	25

Graphics–Business

Charter-Master, Decision Re	220
Harvard Presentation Graphics	299

Graphics–CAD

ProDesign II, American	173
In-a-Vision, Microsoft	237
Generic CAD, Generic	99

Integrated

Framework II	399
Math Plan Word Perfect	112
Symphony, Lotus	425
1-2-3, Lotus	305
Lotus HAL	112

Investment

Andrew Tobias's MECA	115
Dow Jones Market Manager	147
Dollars and Sense	107
Market Analyzer, Dow Jones	219
Market Manager Plus, Dow Jones	158

Project Management

Harvard, Software Pub	299
Microsoft Project	238
Time Line, Breakthrough	235

Tax Planning or Preparation

Tax Preparer, HowardSoft	299
PC/TaxCut, Best Program	65

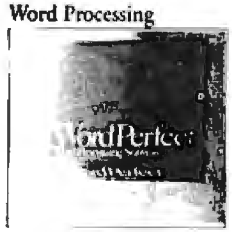
Training

Teach You self dBASE III	89
PFS FirstChoiceSP	95
Webster's New World Writer	82
Webster's New World Thesaurus	45
Print Shop, Boderbund	52
Typing Tutor III, Simon & Simon	42

Utilities

Norton Utilities, Norton	51
Carbon Copy, Meridian	130
PC Tool, Central Pnt	39
Copy II PC, Central Pnt	39
1 DIR+, Bourbaki	53
V Feature, Golden Bow	99
SQZ! Turner Hall	59
Fast Back, Fifth Generation	94
XTree, Executive Systems	29

Word Processing



WordPerfect 4.0	219
TheLibrary	91
Microsoft Word, Microsoft	285
Wordstar2000, MicroPro	217
Easy, MicroPro	75
Multimate Advantage AshtonT	317

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- 640K on Board RAM
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- Disk Controller Card
- 150W Power Supply
- FCC Type Slide Case
- 'AT' Style Keyboard
- 8 IBM I/O Slots
- 8088-2 Micro Processor
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- 4.77 MHZ/8MHZ Clock Selectable
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Fully Assembled and Tested $595.00
(Other Options and Configurations Available, Please Call.)

TURBO SYSTEM

- 640K RAM on Board 4-77/8MHz Motherboard
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- Mini 'AT' Style Case With Key Lock
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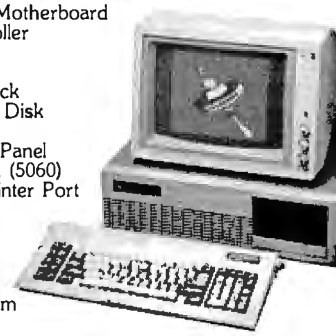
- NEC V-20-8 Processor Used (330% Faster than IBM PC)**



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PINECOM AT SYSTEM
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- 8/6 MHZ Clock Selectable
- 80286 CPU
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- Clock Calender w/Battery Backup
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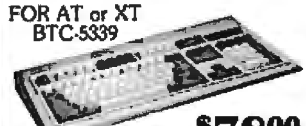
Other Options, See Below

BTC (5152)
5 ENHANCED KEYBOARD
IBM PC/AT

FOR AT or XT
BTC-5339



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- Positive Tactile Feedback
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- Separate Numeric Key Pad
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- 12 Function Keys Supports DOS 3-2

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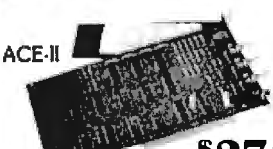
ACE-II



Captures video from video camera or TV, transfer to your PC computer, can display on your monitor, storage on disk, or transmits it out via modem to other user. Requires color graphic card. Install to any empty slot on your computer. Software and instruction included.

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PCI-286 SPEEDCARD
For IBM PC/XT Compatibles

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- 7.2MHz Clock Speed
- 8K Cache Memory
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- Math Co-Processor 80287 (5/8MHz) Optional
- Fully DMA Compatible
- Runs All AT/XT Software
- Easy To Install, No Soldering Required

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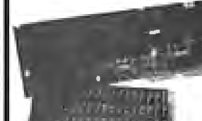
3 LTIFUNCTION CARD FOR 'AT



#MF-3000
$184.00

- User Expandable Up to 3 MGB with 128/512K Increments
- One RS-232 Serial Port (2nd Port Optional)
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RAM Set (Each 1MB) $108.00
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#RAM-310-AT

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20 MGB Hard Disk (Seagate ST-225) (79 MS)	$290.00
Western Digital Hard Disk Controller Card WX-2	$100.00
30 MGB Hard Disk For 'AT' (ST 4038) (39 MS)	$620.00
Half Size Modem Card 300/1200 BPS Hays Compatible (Logictech)	$125.00
3 Button Mouse System with Software (Serial)	$85.00
TTX 1411 RGB Monitor 14" 0.39 Dot 640 X 250	$330.00
Samsung 12" Monochrome TTL Monitor, Amber or Green ..	$89.00
Samsung 12" Monochrome Composit Monitor, Amber	$75.00
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0/576 K Max. RAM Expansion Card For PC/XT	$45.00
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Joystick with 2 Fire Buttons For IBM	$18.00
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8087-3 Co-Processor Chip For XT (4.77 MHZ)	$115.00
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80287-8 Co-Processor Chip For AT (8 MHZ)	$299.00
NEC V-20 Processor (Replace 8088) 40% Faster	$13.00
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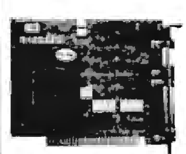
I SERIAL PORTS (RS-232) ADAPTER



MS-400-XT
$92.00
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- 4 Serial Ports COM-1, COM-2, COM-3, COM-4
- Custom Fully Molded Serial Cabling and Mountings
- Short Card Design, Available For 'AT' or 'XT'

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"Copies Virtually All Protected Software"

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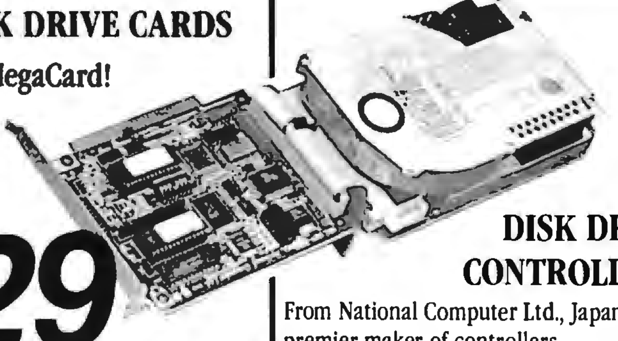
HARD DISK DRIVE CARDS

Logic Array MegaCard!

21-Megabyte



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- **two year guarantee**—parts and labor

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(Half height, boots from hard disk—includes controller, cables, manual)

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40-Megabyte $555
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(with Disk Manager software)

FLOPPY DISK DRIVES

360-K $89
1.2 Megabyte, AT-Compatible $129
1.2 Megabyte, PC-Compatible
(enables your PC or XT to read and write AT-formatted diskettes)
was $299—clearance price NOW $129

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From National Computer Ltd., Japan's premier maker of controllers

- These compact AT-compatible controller cards are among the smallest available.
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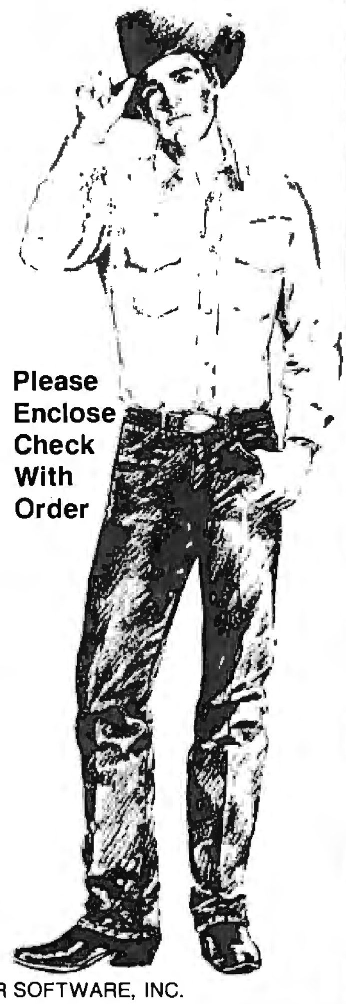
- ☐ **(2) NEW YORK WORD** (#528, 529) Powerful word processor that creates keystroke macros, split screen editing, mail merge and more. Watch out Micro-Soft.



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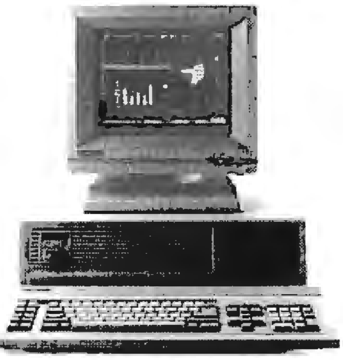

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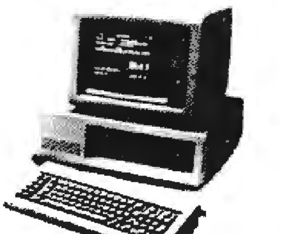

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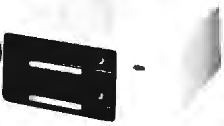

The Bernoulli Box by Iomega, features 10 and 20 megabyte removable cartridges, and delivers reliability, expandability, transportability, security and speed in one versatile subsystem. It lets you transfer megabytes of information safely and swiftly for primary or backup storage. Or combine several software programs onto a single cartridge for easy switching from one to another.

Reliable... the Box has incredible resistance to shock and vibration completely eliminating the possifity of head crash.

Expandable... grow at your own pace by adding inexpensive cartridges. When **security** is essential, don't lock up your system... just lock up the cartridges.

The Bernoulli Box delivers preformance that often exceeds the best of hard disk speed and the convenience of floppy disks. At these prices don't be caught wishing you had one after a loss of irreplacable data.

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10+10 Meg.	**A2210H**	**$3450**	**1595**
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Bootable Controller		**255**	**159**
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20 Meg. Cartridge		**99**	**65**

FOUR PEN COLOR PLOTTER **$159**

The manufacturer has asked us not to publish their name. But this four color plotter was produced by one of the Worlds largest makers of personal computers.

The 410 color plotter will connect to the serial port of virtually any micro-computer. Simple ASCII commands direct one of the four color pens to draw circles, arcs or ellipses on paper or transparency material up to 11 by 17 inches. The plotter is capable of producing the full upper and lower case alphabet along with seven international character sets. Text can be printed horizotal, vertical or diagonal in sizes from 1/16 to 6 inches, slanted forward or backward to 85 degrees.

Enlargements or reductions are achieved through elaborate firmware. Pen travel is four inches per second with .004" pen resolution. Standard pens are available in an assortment of 32 different colors and widths.

The ideal plotter for architecture, CAD engineering or graphic design. **At $595 it was a great buy, at $159 its a steal.** Support packages for specific computers available. Manual only $15 refundable upon purchase of plotter.

SONY 53W Floppy Disk Drive

3 1/2" New IBM portable compatible

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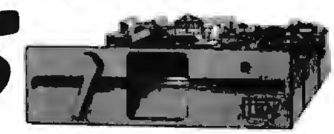
Quantity Two



	One	Two	Ten
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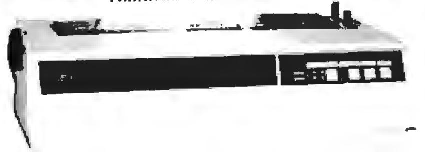
TEAC FD55BV half height	**109**	**99**	**89**
TEAC FD55FV 96 TPI, half ht.	**119**	**109**	**105**
TEAC FD55GF for IBM AT	**169**	**159**	**155**
PANASONIC 455 Half Height	**109**	**99**	**89**
PANASONIC 475 1.2 Meg./96	**119**	**115**	**109**
MITSUBISHI new 501 halfht.	**129**	**119**	**109**
MITSUBISHI 504A AT comp.	**169**	**159**	**155**
Switching power supply			**49**
Installation Kit with manual			**10**
Dual enclosure for 5¼" drives			**59**
34 pin edge connectors			**5**
Scotch head cleaning kit			**19**
Flip & File Storage tubs			**15**

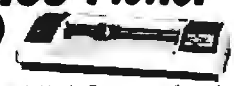
Adeus Daisy Wheel $159



The Adeus CP/2000, is a 22 character per second daisywheel printer which accepts 96 character Diablo wheels and ribbons. This printer was manufactured by the Olympia Typewritter Company for Cosmo World USA. This unit will print 10, 12 and 15 characters per inch proportionally spaced with increments of 1/120". Bi-directional printing, 2 K/Byte buffer (expandable to 6K) and both serial and Centronics parallel interfacing make the Adeus CP/2000 an exceptional buy at only $159. Original price $595.

Sweet P 100 Plotter

$159

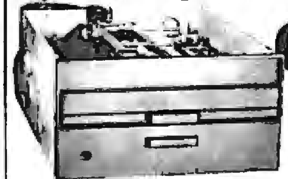


The Sweet "P" 100 was private labeled for the Epson corporation under the Comrex Brand. This plotter makes short work of translating financial and numeric data into a graphic presentation. Many ready to run programs such as Auto/CAD, Lotus 1-2-3, and Visi-on already support this plotter.

The Sweet "P" 100 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 Sweet "P" 100 immediate use with the printer port of most personal computers.

Also available is a support package which includes demonstration software, interface cable, a multicolor pen assortment and a variety of paper and transparency material.

QUME $119



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QUME 841 single side	**129**	**119**	**call**
SHUGART 801R	**359**	**359**	**354**
SIEMENS FDD 100-8	**119**	**115**	**109**

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SHUGART SA851R	**495**	**485**	**475**
OLIVETTI double sided	**159**	**155**	**149**
REMEX RFD-4000	**179**	**169**	**159**
MITSUBISHI M2896-63 ½ Ht.	**459**	**449**	**409**
Dual 8" enclosure with power and fan			**259**
Switching power supply			**89**
Installation kit with manual			**10**

PRINTERS

MATRIX PRINTERS

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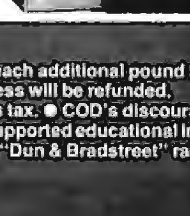

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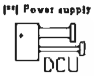

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TMS4416-12	16,384 x 4	(120ns)	4.25
8118	16,384 x 1	(120ns)	.69
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2102-2L	1024 x 1	(250ns) Low Power (91L02)	1.95
2114N	1024 x 4	(450ns)	.99
2114N-L	1024 x 4	(450ns) Low Power	1.09
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2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
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6264LP-12	8192 x 8	(120ns) Low Power CMOS	4.25
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6514	1024 x 4	(350ns) CMOS (UPD444C)	4.49
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2732	4096 x 8	(450ns)	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
2732A-45	4096 x 8	(450ns) 21V	3.75
27C32	4096 x 8	(450ns) 25V (CMOS)	6.49
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.75
2764A-25	8192 x 8	(250ns) 12.5V	4.25
2764-45	8192 x 8	(450ns) 21V	3.49
27C64	8192 x 8	(450ns) 21V (CMOS)	5.49
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27128A-25	16,384 x 8	(250ns) 12.5V	4.95
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	5.95
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27C256-25	32,768 x 8	(250ns) 256K (CMOS) (12.5V)	8.95
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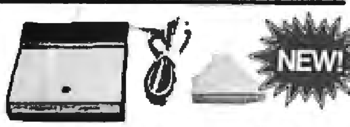

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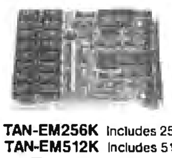

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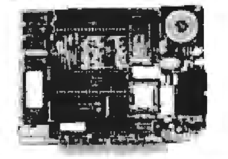

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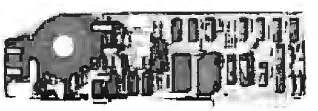

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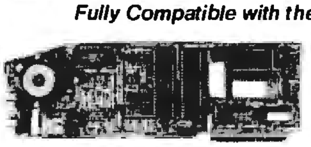

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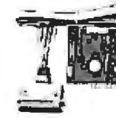

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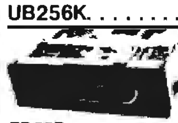

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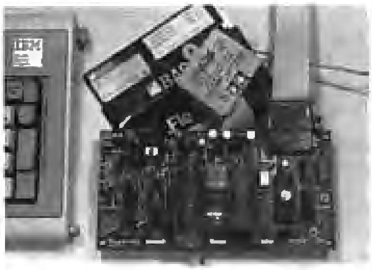

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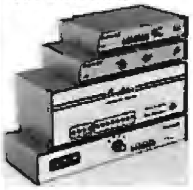

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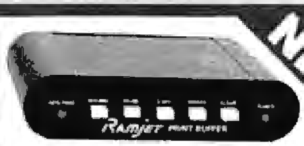

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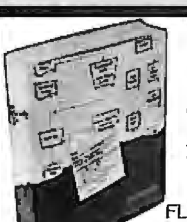

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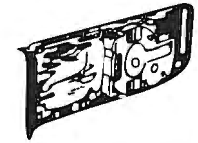

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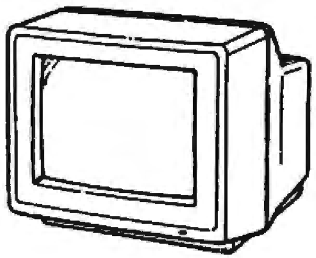

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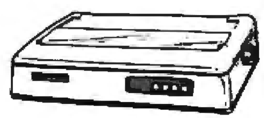

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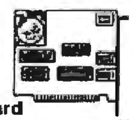

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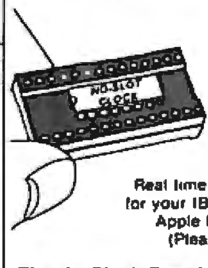

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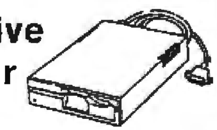

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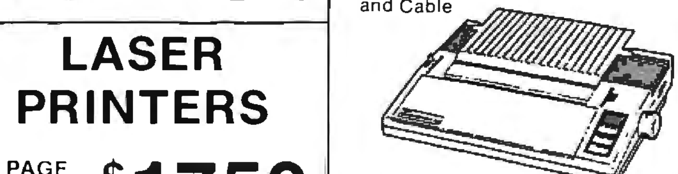

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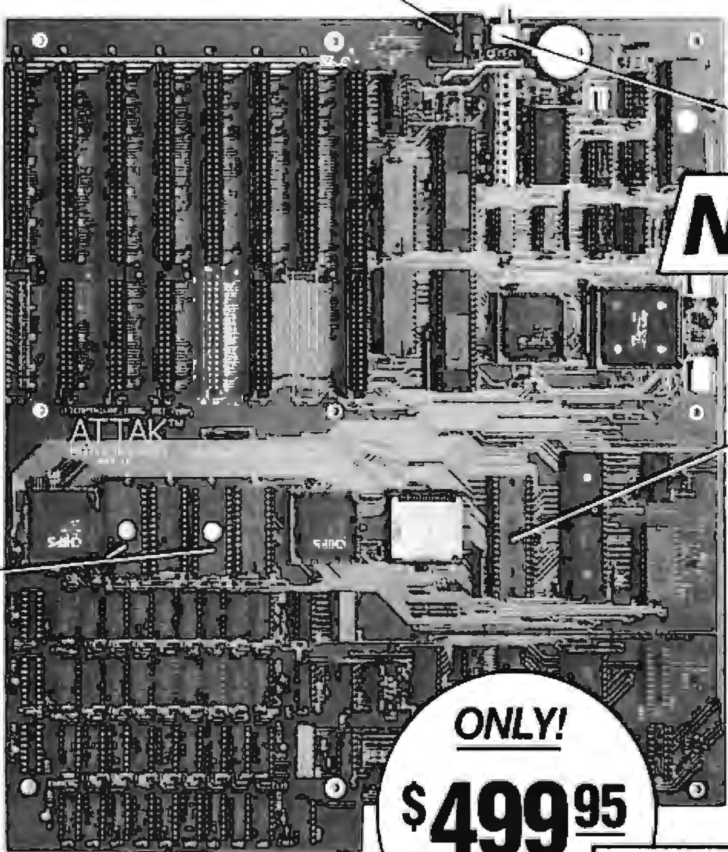

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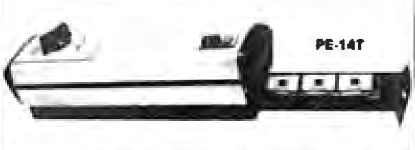

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74LS09	.18	74LS192	.69
74LS10	.16	74LS193	.69
74LS11	.22	74LS194	.69
74LS12	.22	74LS195	.69
74LS13	.26	74LS196	.59
74LS14	.39	74LS197	.59
74LS15	.26	74LS221	.59
74LS20	.17	74LS240	.69
74LS21	.22	74LS241	.69
74LS22	.22	74LS242	.69
74LS27	.23	74LS243	.69
74LS28	.26	74LS244	.69
74LS30	.17	74LS245	.79
74LS32	.18	74LS251	.49
74LS33	.28	74LS253	.49
74LS37	.26	74LS256	1.79
74LS38	.26	74LS257	.39
74LS42	.39	74LS258	.49
74LS47	.75	74LS259	1.29
74LS48	.85	74LS260	.49
74LS51	.17	74LS266	.39
74LS73	.29	74LS273	.79
74LS74	.24	74LS279	.39
74LS75	.29	74LS280	1.98
74LS76	.29	74LS283	.59
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7406	.29	74151	.55
7407	.29	74153	.55
7408	.24	74154	1.49
7410	.19	74155	.75
7411	.25	74157	.55
7414	.49	74159	1.65
7416	.25	74161	.69
7417	.25	74163	.69
7420	.19	74164	.85
7423	.29	74165	.85
7430	.19	74166	1.00
7432	.29	74175	.89
7438	.29	74177	.75
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7445	.69	74181	2.25
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7474	.33	74192	.79
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7485	.59	74199	1.35
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7489	2.15	74246	1.35
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ADC0817	9.95	8T97	.59
ADC0831	8.95	8T98	.89
DAC0800	4.49	DM8131	2.95
DAC0806	1.95	DP8304	2.29
DAC0808	2.95	DS8833	2.25
DAC1020	8.25	DS8835	1.99
DAC1022	5.95	DS8836	.99
MC1408L8	2.95	DS8837	1.65

VOLTAGE REGULATORS

TO-220 CASE

7805T	.49	7905T	.59
7808T	.49	7908T	.59
7812T	.49	7912T	.59
7815T	.49	7915T	.59

TO-3 CASE

7805K	1.59	7905K	1.69
7812K	1.39	7912K	1.49

TO-93 CASE

78L05	.49	79L05	.69
78L12	.49	79L12	1.49

OTHER VOLTAGE REGS

LM323K	5V	3A	TO-3	4.79
LM338K	Adj.	5A	TO-3	6.95
78H12K	12V	5A	TO-3	8.95

IC SOCKETS

	1-99	100+
8 PIN ST	.11	.10
14 PIN ST	.11	.09
16 PIN ST	.12	.10
18 PIN ST	.15	.13
20 PIN ST	.18	.15
22 PIN ST	.15	.12
24 PIN ST	.20	.15
28 PIN ST	.22	.16
40 PIN ST	.30	.22
64 PIN ST	1.95	1.49
ST=SOLDERTAIL		
8 PIN WW	.59	.69
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80
WW=WIREWRAP		
16 PIN ZIF	4.95	CALL
24 PIN ZIF	5.95	CALL
28 PIN ZIF	6.95	CALL
40 PIN ZIF	9.95	CALL
ZIF=TEXTOOL (ZERO INSERTION FORCE)		

LINEAR

TL066	.99	LM733	.98
TL071	.69	LM741	.29
TL072	1.09	LM747	.69
TL074	1.95	LM748	.59
TL081	.59	MC1330	1.69
TL082	.99	MC1350	1.19
TL084	1.49	MC1372	6.95
LM301	.34	LM1414	1.59
LM309K	1.25	LM1458	.49
LM311	.59	LM1488	.49
LM311H	.89	LM1489	.49
LM317K	3.49	LM1496	.85
LM317T	.95	LM1812	8.25
LM318	1.49	LM1889	1.95
LM319	1.25	ULN2003	.79
LM320	see 7900	XR2206	3.95
LM322	1.95	XR2211	2.95
LM323K	4.79	XR2240	1.95
LM324	.49	MPQ2907	1.95
LM331	3.95	LM2917	1.95
LM334	1.19	CA3046	.89
LM335	1.79	CA3081	.99
LM336	1.75	CA3082	.99
LM337K	3.95	CA3086	.80
LM338K	6.95	CA3089	1.95
LM339	.59	CA3130E	.99
LM340	see 7800	CA3146	1.29
LM350T	4.60	CA3160	1.19
LF353	.59	MC3470	1.95
LF356	.99	MC3480	8.95
LF357	.99	MC3487	2.95
LM358	.59	LM3900	.49
LM380	.89	LM3909	.98
LM383	1.95	LM3911	2.25
LM386	.89	LM3914	2.39
LM393	.45	MC4024	3.49
LM394H	5.95	MC4044	3.99
TL494	4.20	RC4136	1.25
TL497	3.25	RC4558	.69
NE555	.29	LM13600	1.49
NE556	.49	75107	1.49
NE558	1.29	75110	1.95
NE564	1.95	75150	1.95
LM565	.95	75154	1.95
LM566	1.49	75188	1.25
LM567	.79	75189	1.25
NE570	2.95	75451	.39
NE590	2.50	75452	.39
NE592	.98	75453	.39
LM710	.75	75477	1.29
LM723	.49	75492	.79

H=TO-5 CAN, K=TO-3, T=TO-220

EDGECARD CONNECTORS

100 PIN ST	S-100	.125	3.95
100 PIN WW	S-100	.125	4.95
62 PIN ST	IBM PC	.100	1.95
50 PIN ST	APPLE	.100	2.95
44 PIN ST	STD	.156	1.95
44 PIN WW	STD	.156	4.95

36 PIN CENTRONICS

MALE

IDCEN36	RIBBON CABLE	6.95
CEN36	SOLDER CUP	4.95

FEMALE

IDCEN36/F	RIBBON CABLE	7.95
CEN36PC	RT ANGLE PC MOUNT	4.95

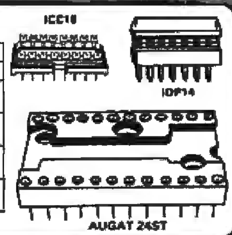
INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	4.95
ICM7207A	5.95
ICM7208	15.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	—	.95	.95	—	—	—	1.75	—	2.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE BELOW



DIODES/OPTO/TRANSISTORS

1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
1N5402	.25	4N37	1.19
KBP02	.55	MCT-2	.59
KBU8A	.95	MCT-6	1.29
MDA990-2	.35	TIL-111	.99
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

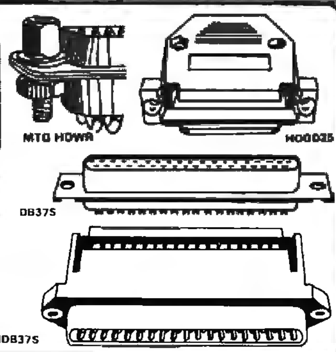
D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.82	.90	1.25	1.25	1.80	3.48
	FEMALE	DBxxS	.95	1.15	1.50	1.50	2.35	4.32
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.20	1.49	—	1.95	2.65	—
	FEMALE	DBxxSR	1.25	1.55	—	2.00	2.79	—
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	—	3.89	5.60	—
	FEMALE	DBxxSWW	2.76	4.27	—	6.84	9.95	—
IDC RIBBON CABLE	MALE	IDBxxP	2.70	2.95	—	3.98	5.70	—
	FEMALE	IDBxxS	2.92	3.20	—	4.33	6.76	—
HOODS	METAL	MHOODxx	1.25	1.25	1.30	1.30	—	—
	GREY	HOODxx	.65	.65	—	.65	.75	.95

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED.

EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE $1.00



LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM ANODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
MAN-8940	COM CATHODE	.8"	1.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/LOGIC	.270"	9.95
HP5082-7340	4x7 HEX W/LOGIC	.290"	7.95

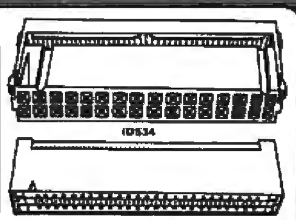
DIFFUSED LEDS

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	—	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE ABOVE



SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
SPST	TOGGLE ON-OFF	.49
BCD OUTPUT	10 POSITION 6 PIN DIP	1.95

DIP SWITCHES

4 POSITION	.85	7 POSITION	.95
5 POSITION	.90	8 POSITION	.95
6 POSITION	.90	10 POSITION	1.29

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.18	1.60	.30	2.75
16	.28	2.50	.48	4.40
20	.36	3.20	.60	5.50
25	.45	4.00	.75	6.85
26	.46	4.10	.78	7.15
34	.61	5.40	1.07	9.35
40	.72	6.40	1.20	11.00
50	.89	7.50	1.50	13.25

HARD TO FIND "SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE	1.49
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2x40	RIGHT ANGLE	2.99

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Inquiry 136

2400 BAUD MODEM FOR IBM WITH PC TALK III SOFTWARE $259!

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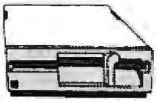
FOR APPLE COMPUTERS



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- ½ HT, DIRECT DRIVE
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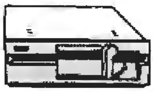
- SIX MONTH WARRANTY



BAL-500 $129.95
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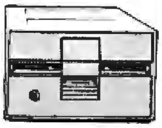
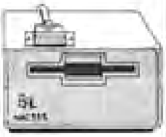
- FULL ONE YEAR WARRANTY



AP-135 $129.95
- FULL HT SHUGART MECHANISM
- DIRECT REPLACEMENT FOR APPLE DISK II
- SIX MONTH WARRANTY

DOUBLE SIDED!



MAC535 $249.95
- 3.5" ADD-ON DISK DRIVE
- 100% MACINTOSH COMPATABLE
- DOUBLE SIDED 800K BYTE STORAGE
- HIGH RELIABILITY DRIVE HAS AUTO-EJECT MECHANISM
- FULL ONE YEAR WARRANTY

AD-3C $139.95
- 100% APPLE IIc COMPATIBLE, READY TO PLUG IN, W/SHIELDED CABLE & MOLDED 19 PIN CONNECTOR
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- SIX MONTH WARRANTY

DISK DRIVE ACCESSORIES

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IIc ADAPTOR CABLE	$19.95

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CASE WITH KEYBOARD FOR APPLE TYPE MOTHERBOARD
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- CAPS LOCK
- AUTO-REPEAT

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- CAPS LOCK KEY, AUTO-REPEAT
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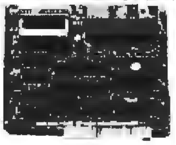
MODEL RP525



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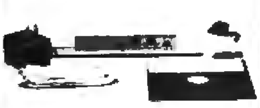
FOR APPLE OR IBM

INCLUDES ASCII PRO-EZ SOFTWARE



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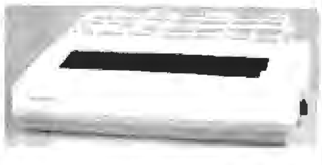

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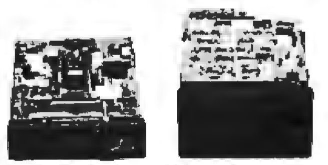

TEAC FD-55 TANDON TM100-2

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CAB-2SV5 CAB-1FH5

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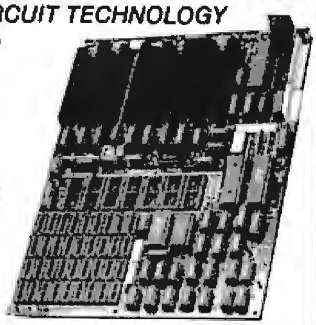

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JDR PART #: MCT-TURBO
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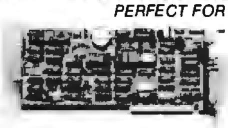

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- 1 RS232 SERIAL PORT; OPTIONAL 2nd SERIAL PORT
- PARALLEL PRINTER PORT
- GAME PORT
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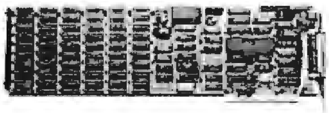

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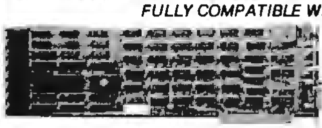

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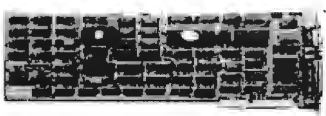

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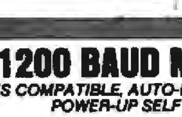

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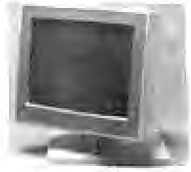
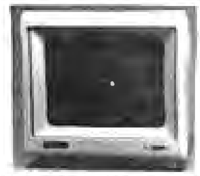

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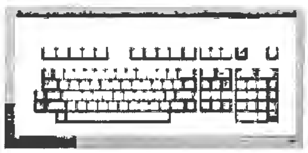

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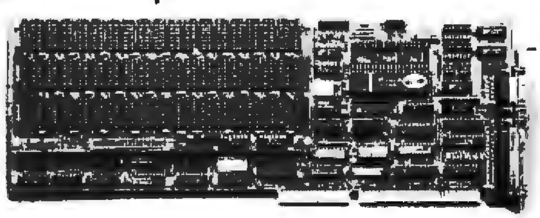

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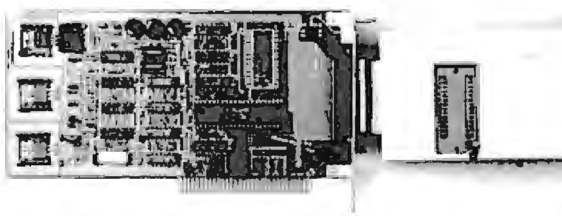

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BOMB RESULTS

November's Representation

Paul Walton wins $100 for his article on "The State of Soviet Microelectronics," which placed first in November. In second is "Memory Management Units for 68000 Architectures" by Gregg Zehr, who wins $50. Third place is awarded to John D. Unger for his review of "Three IBM Clones." The $50 prize for quality goes to Paul Walton for his treatise on the Soviet computer culture. Congratulations.

COMING UP IN BYTE

Theme:
So you thought image processing had to be either mainframe-oriented or amateurish? Take a look at some of this. The Mona Lisa is being restored through the use of a personal computer, and microcomputers are imaging stars that can't be seen with even the most powerful telescopes.

Features:
We have on hand a feature on Turbo BASIC, a piece on memory-resident C programs, and programming insights on teaching old screens new tricks and building a random-number generator.

Special 68000 Series:
Following this month's Amiga project, we have a hardware project for the Atari 520ST.

Reviews:
Reviews available include a trio of inexpensive IBM PC AT clones, four laser printers, four optical readers, languages for artificial intelligence program development, Concurrent PC-DOS, and an operating system toolbox. We've also got an in-depth look at a three-dimensional CAD package.

Circuit Cellar:
Have you seen those commercials lately where this terrific television set has a remote-control unit that will also take care of the VCR and the stereo—no matter who makes them? Steve Ciarcia is going to show you how to build one of those little hand-held controllers, so you won't have to go out and buy a new TV just to get one.

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Good	2	6	10	14	18	22	26	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98
Fair	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99
Poor	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100

Article No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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Good	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170	174	178	182	186	190	194	198
Fair	103	107	111	115	119	123	127	131	135	139	143	147	151	155	159	163	167	171	175	179	183	187	191	195	199
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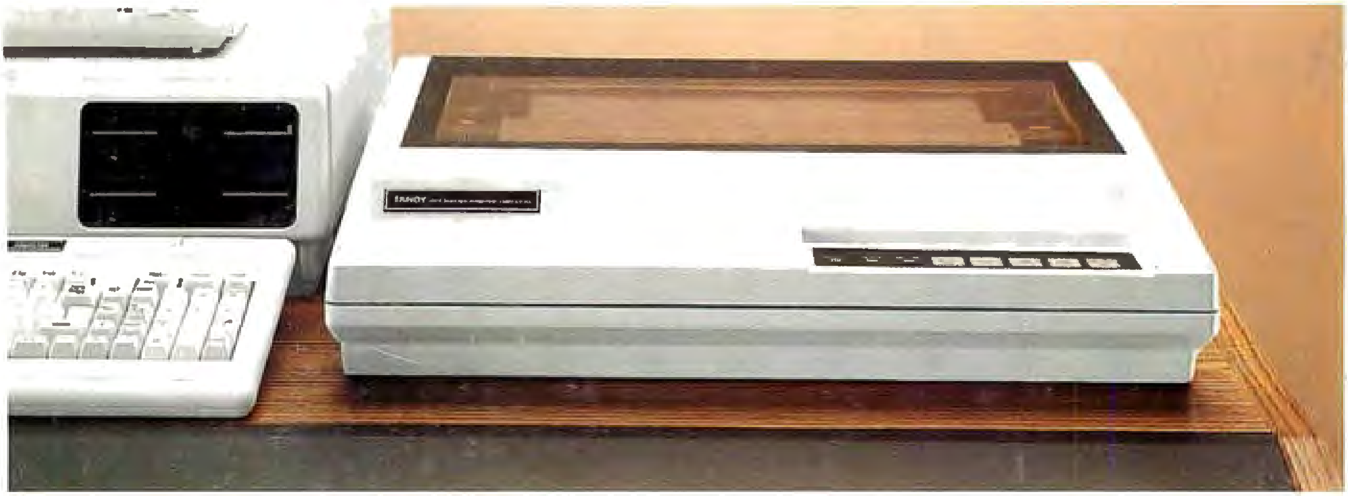

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