WORLD'S LARGEST COMPUTER MAGAZINE

Computers & ELECTRONICS

MARCH 1984 $1.75

FIRST REPORT

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THE DAY THE IBM® PERSONAL COMPUTER BECAME OBSOLETE.

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There are only two methods for acquiring real wealth

METHOD #1

Anyone who has made a fortune has probably done it in one of two ways. The first way—and until now practically the only way—has been to learn successful investing techniques in the "school of hard knocks". Many of the self-made millionaires you've read about actually spent years and a great deal of money learning the hard way how to make money work for them. Their success was the result of trial and error, of learning all the ins and outs of the financial world, of many failures before the big success, and years of struggle preceding the "overnight success".

Requires a lot of nerve

Making a fortune this way requires a lot of nerve, determination and the willingness to take chances—to start out with nothing more than guess-work and to try again if your financial guesswork turns sour.

But most people can't afford to take the chances necessary to gain that kind of practical, nuts and bolts financial knowledge. Very few are in a position to risk everything to acquire the skill that is essential to consistent financial success.

METHOD #2

But now there is another way to acquire the skills and knowledge necessary to be successful in making your investment decisions. Now you don't have to risk everything you have in order to learn how to acquire wealth nor take a trial and error approach to investing. Now you can build your fortune surely, secure that each step you take will produce results.

Because now you can enroll in *Successful Investing & Money Management (SIMM)*, a unique, self-study program, developed by some of North America's most successful and respected financial experts.

The program contains the input of such men as Dr. Morton Shulman, multi-millionaire investor and author of best-selling books on how to acquire wealth—and Andrew Sarlos, who built a multi-million dollar investment group.

And you will be able to take advantage of all this valuable knowledge because in Lesson 1 you will discover that you probably do have money you can afford to invest—without changing your standard of living.

Getting wealthy sooner rather than later

All right. So you've seen it is possible for you to amass a million dollars by the time you retire. But just as important is the fact that *SIMM* will enable you to act *now* to increase your wealth, and show you how to get the best possible standard of living out of the money you have today. By applying the techniques you learn from *SIMM*, you can reasonably expect to be on the road to financial security in 5 years. Ten years from now, you may no longer have to work for a living.

Positive proof that you can be a millionaire

Finding an extra $2,500—the first step

If you think you're too beleaguered by prevailing economic conditions to even think of investing, *SIMM* will show you how to find as much as an extra $2,500 a year to invest, depending on your income.

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Once you've found your $2,500 to invest, think of this: If you invest just $119 a month ($1,428 a year) at 13%, starting at age 30, you'll have over a million dollars by the time you're ready to call it a career. And with *SIMM* you can learn how to use leverage that could get you returns of up to 25%.

The safe way to learn to build a fortune

When you fill out and mail the enclosed no-risk enrollment form you can receive a total of 29 marvelously readable lessons that make up a complete, step-by-step education in the techniques necessary to acquire real wealth. You have to supply approximately 2 hours a week and the perseverance to build your fortune safely over a reasonable period of time.

The hidden barrier that stands between you and real wealth

Most people are used to the idea that they'll never be wealthy. They simply don't believe it's possible—and before *SIMM* was developed, they were probably right. But now, you can receive, in your own home, lessons that contain clear and practical explanations of techniques and principles of investing and money management that really do work.

You don't have to be a passive victim of prevailing economic conditions any longer. Real financial independence is a plausible, attainable goal for you. But, if you find it impossible to believe that you could ever be wealthy—if you think that millionaires are "special," then the hidden barrier between you and a fortune is yourself. And that's why we're offering you a can't-lose, no-risk opportunity to prove to yourself that you really do have the potential to become wealthy.

Accept Lessons 1 and 2 FREE

To help you get started on the road to wealth and financial independence, we'll send you Lessons 1 and 2 of the *SIMM* program free and with absolutely no risk or obligation on your part. They are yours to keep whether you continue with the program or not. When you enroll in the program you will be assigned a counselor who will always be available at no extra cost to answer any course-related questions you may have.

Statement of Principles

We are an independent educational service offering a unique, practical, successful method for learning the art of acquiring wealth. We are not a brokerage or insurance company nor do we make any financial offerings.

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Computers & ELECTRONICS

MARCH 1984 VOLUME 22, NUMBER 3

Features

42 MacIntosh: Big Step, Small Footprint

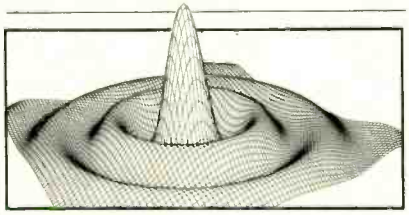
By Vanessa Schnatmeier
C&E gets a pre-release look at the newest Apple.

48 Breeding a New Variety of Apple

By Vanessa Schnatmeier
The technical challenge faced by the Macintosh team.

50 Quick On The Draw: Inexpensive Plotters

By Forrest M. Mims, III
These versatile peripherals provide useful, attractive printouts.



54 Windows: At Panes to Integrate Software

By Josef Bernard
The new integrating software helps programs work together.

58 From One Computer to Another

By Arthur Salsberg
Electronic mail provides an added feature for pc users.

62 AI Comes of Age

By Abraham Hirsch
Hardware and software tools permit development of practical AI applications.

COVER PHOTO BY LIONEL FREEDMAN

68 Electronic Ties That Bind

By T J Byers
Local area network designs and their implications.

72 Micros In The Recording Studio

By Martin Porter
Personal computers are reforming recording techniques and creating new sounds.

76 Three Printer Buffers

By John Smith-Richardson
Peripherals that increase the productivity of your personal computer.

79 Kaypro 4 Plus 88

By Charles P. Rubenstein
The Kaypro 4 gets an 8088 and MS-DOS.

83 Features of Eight Electronic Spreadsheets

By Barbara E. McMullen and John F. McMullen
Demystifying spreadsheet programs.

Columns

32 Bits & Bytes
By Sol Libes

34 Les Solomon on Computer Hardware

Those Were The Days.

36 The Computer Scientist

By Forrest M. Mims, III
Learning to use an X-Y Plotter.

Departments

6 Editorial
By Seth R. Alpert
Computer Literacy

12 Letters

16 New Products

113 Computer Mart/ Electronics Classified

120 Advertiser's Index

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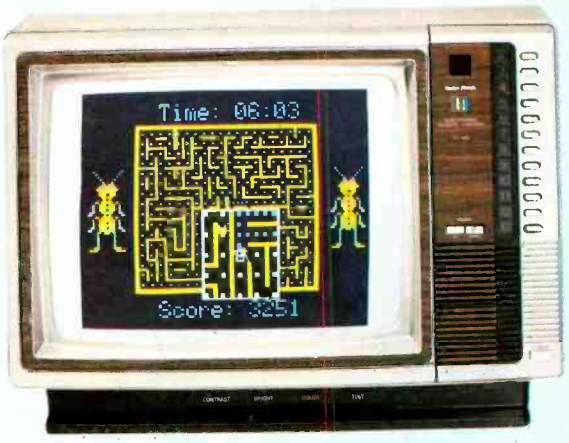

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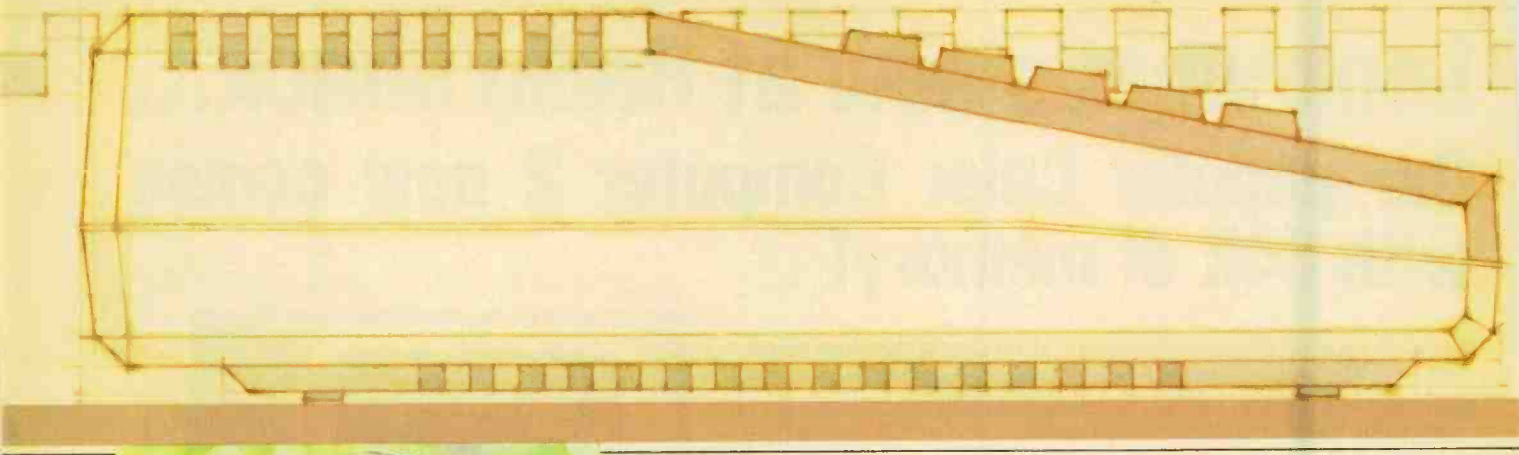

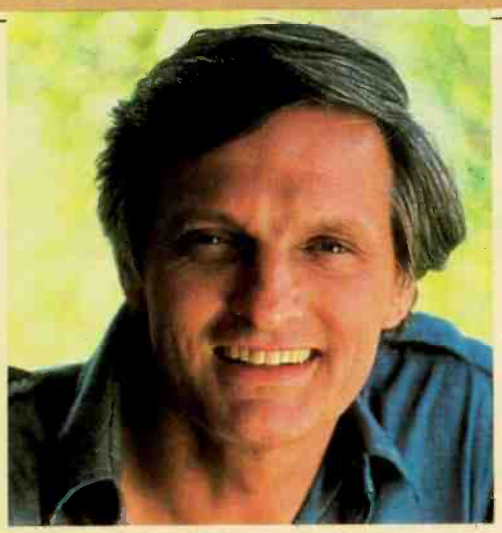

Computer enthusiast Alan Alda uses the ATARI 800XL Computer System. Alda reports: "It's going all the time!"

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SETH R. ALPERT

EDITORIAL

COMPUTER LITERACY

Some of you may remember the good old days. When men were men and micros were for the adventurous and technically proficient. Before inexpensive floppy-disk drives and self-booting systems and electronic spreadsheets.

Being "computer literate" in those days was no mean feat. You had to know a fair amount about how the hardware actually worked and a fair amount about programming as well. Yes, computer literacy wasn't for the masses then, and it certainly wasn't on everyone's mind, as it is today. If you understood computers in the good old days, you were among the select few; and, by God, you knew you were smart.

But, of course, all that has changed. The market is flooded with the present generation of easy-to-use hardware and software. Things are a lot friendlier now, and look at what it has done to demand. Personal computing is now a multi-billion dollar industry that fascinates and captivates an ever-growing audience.

Business people are anxious to become computer literate so that they can perform more effectively in their jobs—and get promoted. They are right to want to learn about and stay abreast of developments in this important and fast-changing field.

Parents are determined that their children should learn about computers so that they will not be at a disadvantage later in life. Dire predictions are being made of the advent of a new lower class in the 1990s, the poor folks who don't know how to use computers.

Let's examine those fears.

Just as today's micros (and mainframes) are more powerful and easier to use, tomorrow's will be a step forward from today's. Feature articles in this issue of C&E cover examples of such advances: Apple's Macintosh and the new windowing software represent quantum jumps in capability, integration, and ease of use. Being literate with these tools, and using your personal computer to get significant work done, will be a whole lot easier than programming in BASIC. Which, of course, is great.

Notice the trend, and think about how difficult it will be to be computer literate in the 1990s. If you have done any reading about artificial intelligence and the Fifth Generation, then you know that, by then, computers are likely to be extremely powerful, truly easy to use, and ubiquitous. Sort of like the telephone.

That wonderful little device we all use every day happens to control one of the most extensive, powerful, and complex computer networks in the world. When was the last time you heard someone worry about being telephone literate?

So all the worry about computer literacy in the 1990s seems to me to represent a bit of confusion on the public's part.

But, the public's concern is not without its beneficial side effects. Certainly the industry has capitalized upon and benefitted from the drive for computer literacy. And the increased interest and demand have pumped money into the field, which funds the next generation of advances in power and ease of use.

Along the way a huge number of people have learned about computing who otherwise might well have had nothing to do with it. They have learned that computers aren't frightening and mysterious. In fact, computers are helpful and—let us not forget—fun.

Yes, fun! They can entertain and fascinate and remove the drudgery from routine work. Writing is a lot more pleasurable with a word processor, and the electronic spreadsheet has it way over its manual counterpart. Graphs that appear instantly not only help you understand a set of numbers, but look beautiful to boot.

So the industry has been quite a success and will continue to grow. Those good old days are gone. As for me, I'm glad. Easy-to-use hardware and software have put more power at my fingertips than I had any right to expect ten years ago. Moreover, the technology itself has only grown more fascinating. And, best of all, it's only going to get better. ◇

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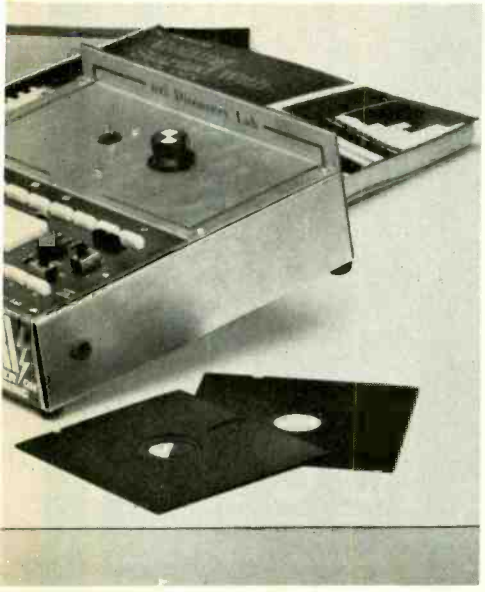

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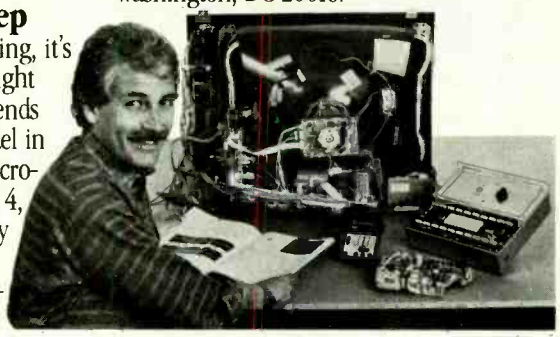

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LETTERS

CP/M-68

Mr. Bernard's interesting and informative article "What's New in the CP/M World" (January 1984) omitted one of the most promising new product lines to be supported by Digital Research, the 16/32-bit Motorola MC68000. This latest version of the CP/M system is called, not surprisingly, CP/M-68K. We have been shipping CP/M-68K for the Tandy Model 16 for some time. It supports the full directly addressed memory space of the MC68000 and comes complete with the usual CP/M utilities, an assembler, and a compiler for C language. Other languages available for CP/M-68K include BASIC-68K, CBASIC, and a full ANSI FORTRAN-77.

—James M. Knox
Trisoft, Austin, TX

DRAGON DOESN'T LIKE APPLES

In the "Bit & Bytes" column of your December issue, you mentioned that the Tano "Dragon" is Apple-compatible. In fact, the Dragon is a 64K, 6809E-based color computer that is completely incompatible with and wholly different from the Apple

—Guy Lyman, III
Tano Corp., New Orleans, LA

DENTAL SOFTWARE

Computers are my bag, and dentistry pays the bills. So I am interested in dental software programs. I am presently using PAS-3 from Artificial Intelligence and I am wondering if there is anything better. I would also be interested in knowing if there is a User's Group through which dentists exchange ideas and experience.

—J. D. Smith, Jr., DDS
2950 Maryland Pkway S,. Suite 6
Las Vegas, NV 89109

MICROWRITER BUFFERING

I have a small microprocessor (the Microwriter) which is RS-232C compatible. My problem is that its internal memory is only 5 pages, approximately, and I sometimes have to prepare articles and documents up to about 50 to 100 pages in length. So I need an additional memory or buffer that could hold the material—which sometimes takes several days to prepare—while it is all being assembled and reprocessed before it is sent, as one block, to the printer. A cassette tape can be used, but it is cumbersome.

—Danial Latifi
New Delhi, India

There are articles on the Microwriter and printer buffers in this issue. You may be able to use a buffer with the Microwriter, but bear in mind that you will have to keep the device powered up constantly to avoid losing your data, and that connecting and disconnecting your unit from the buffer while it is on may introduce "garbage" into what is stored there. Try one out before you buy.—Ed

(continued on page 120)

COMMODORE 64
(more power than Apple II at half the price)

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Tape	$69.00	$56.00	$37.00
Disk	$79.95	$63.00	$42.00
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Tape	$44.95	$39.00	$26.00
Disk	$49.00	$42.00	$29.00
Total Label 2.6			
Tape	$24.95	$18.00	$12.00
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Weather War II (Tape)	$19.95	$17.95	$12.00
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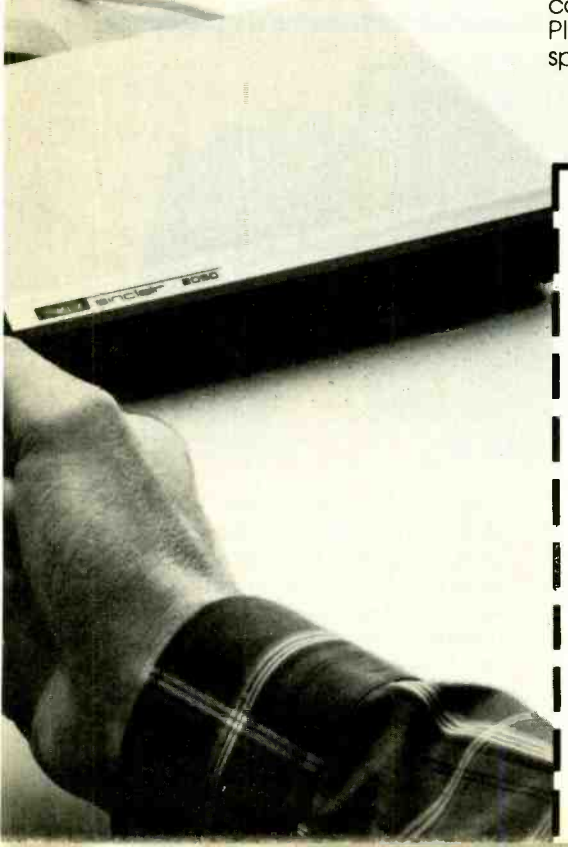

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NEW PRODUCTS

16-BIT DESKTOP COMPUTER

Monroe's System 2000 is a 16-bit desktop computer built around Intel's new 80186 microprocessor operating at 8 MHz. For 8-bit compatibility, the 2000 can be optionally equipped with a Z80A alternate processor. The computer is supplied with 128K or 256K of RAM, optionally expandable to 896K, exclusive of the 128K used for monochrome or 192K used for RGB color video display. The computer comes with one or two 5¼" floppy-disk drives, each with a capacity of 640K (CP/M-86)/720K (MS-DOS). Other features include: two RS-232C serial ports; IBM-compatible parallel printer port; calendar/clock; five expansion slots; detached keyboard with separate keypad clusters for numeric entry, cursor control, program control, and 10 user-definable function keys; 8 × 25-character text, 640 × 400-pixel graphics 12" amber video display monitor. Supplied at no extra cost are MS-DOS 2.0, CP/M-86 DPX, and GW BASIC. Options available for the System 2000 include word-processing, spreadsheeting, DBM, and graphics software; dot-matrix and formed-character printers; hard-disk systems; memory expansion plug-ins; etc.

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HIGH-CAPACITY HARD-DISK SYSTEMS

Quadram's "QuadDisk" systems are claimed to be the fastest, easiest-to-use hard-disk systems on the market for the IBM PC and work-alikes. They come in their own separate cabinets, complete with power supplies, and are available in capacities ranging from 6M to 72M, with a 6M removable-disk model in the line. Access time ranges from 30 to 50 ms, or about three to five times faster than comparable systems. QuadDisk features a menu-driven operating system that eliminates the need for users to know complicated DOS commands to use it. Up to nine users can run programs concurrently and up to eight "dumb" terminals can be connected into the system. $1995 for 6M fixed, $2195 for 6M removable, $2250 for 12M, $2495 for 20M, $2895 for 27M, $6700 for 72M versions.

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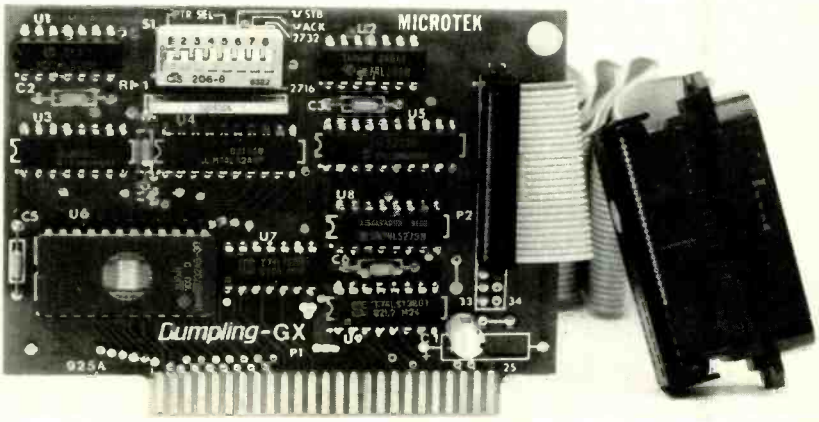

PRINTER INTERFACE CARD

Dumpling-GX is a high-resolution printer interface board from Microtek, Inc. for Apple and Franklin computers, and others with similar buses. Features include: dual-page screen dumps, side-by-side screen dumps, inversions, enlargements, rotation, enhanced printing fonts, chart recorder mode, and complete formatting for printing to any printer among the Dumpling-GX's more than 30 defined control codes. In addition, it has bypassing of all on-board firmware, lower-case screen dumps, partial line-selected screen dumps, and jumps to user routines.

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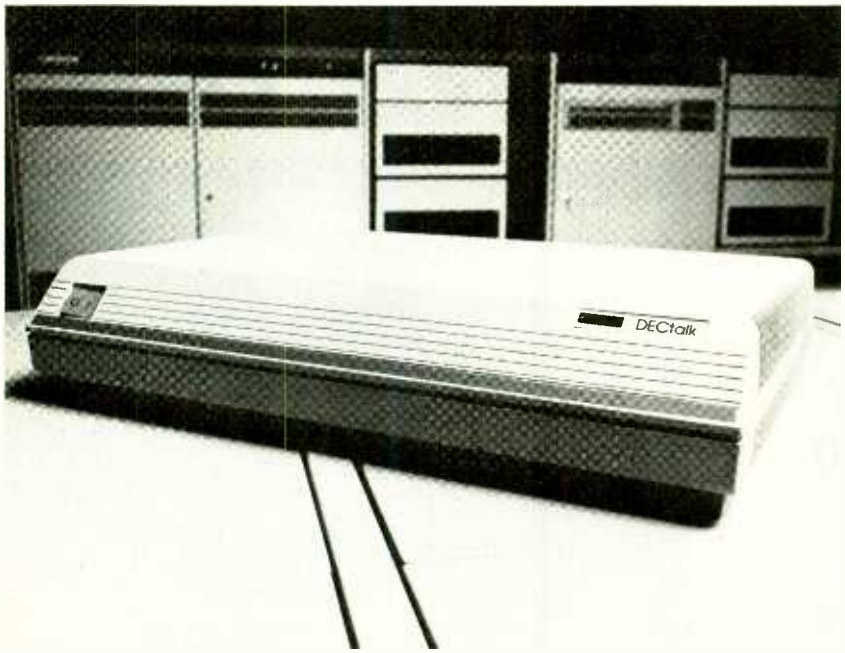

COMPUTER VOCALIZER

DECtalk from Digital Equipment Corp. is a text-to-speech system that allows computers to talk with human-quality speech. The self-contained unit is about the size of a modem and can vocalize through its own built-in speaker, an audio system, or from any Touch-Tone® telephone. DECtalk converts standard ASCII text into male, female, or child voice at a variable rate of 120 to 350 words per minute. Control is provided for pronounciation and intonation. Vocabulary is unlimited for pronounciation for most common English words. The user can specify an auxiliary dictionary of trade terms, acronyms, and other special words. Connection to most computers is via a standard RS-232C serial interface, and input is from a Touch-Tone keypad. Terminal and telephone line control for answer and dial-out are under computer control. $4000.

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COMPUTER SECURITY DEVICE

Transcryptor from Cryptext is a comprehensive computer security device that blocks unauthorized access to computers and terminals. It automatically encrypts messages upon transmission, decrypts upon receipt, and can be configured to provide control over employee access to computers and files. The Z80A-based device has two RS-232C ports and installs between a terminal or computer and modem or direct line. Encryption and decryption are automatic, requiring no special operator commands. The device generates its own encryption keys, a different one each time it is used. The encryption program provides roughly 2^{3000} times as many different types of cyphertexts as the

Data Encryption Standard. Transcryptor operates asynchronously and automatically adjusts to baud rates from 150 to 9600. An error-detection feature causes automatic resynchronization when line noises occur. $945. **Address:** Cryptext Corp., PO Box 425, Northgate Station, Seattle, WA 98125.

SOFTWARE SOURCES

IBM PC Tutorials. Cdex Corporation has released two comprehensive training tutorials for users of the IBM PC and PC-compatible computers. The two products, "How to Use Your IBM PC with PC-DOS" and "How to Use Your IBM PC with CP/M-86 and Concurrent CP/M", each include four diskettes of interactive instruction and a reference guide of important keystroke sequences and operating system commands. The programs are menu driven, and users can choose both the depth of instruction and the pace at which they learn. $69.96. **Address:** Cdex Corp., 5050 El Camino Real, Suite 200, Los Altos, CA 94022.

Personal Tax Planner. "Personal Tax Planner" from Aardvark/McGraw-Hill is a software package designed for the home computer user who wishes to calculate and reduce personal Federal income tax. It increases accuracy and reduces the need for tables, booklets, and forms. It can even be used to instantly display the tax impact of any financial decision. The package consists of a program disk, program manual, registration card, and update coupon. Current versions are available for Apple II, II+, and IIe and the IBM PC and XT computers. $99. **Address:** Aardvark/McGraw-Hill, 1020 N. Broadway, Milwaukee, WI 53202.

Non-Arcade Computer Game. Codebreaker from Sylvan Glen Software gives users a chance to prove that they are smarter than their computers. This non-arcade type game is based on the Mastermind concept in which logic is used to break a secret code. A unique feature is that players can test their ability against that of the computer on four skill levels, with three ways to play on each level. The ability of the computer to break the secret code increases with the level of difficulty so that inexperienced players can easily beat the computer at the lowest level. Codebreaker uses color and is written for the IBM PC with 64K of RAM, PC-DOS, color graphics, and one disk drive. $39.95. **Address:** Sylvan Glen Software, PO Box 31053, Des Perces, MI 63131.

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NTS offers three programs in computer electronics. You will receive training covering solid-state devices, digital logic circuitry, and the fundamentals of the computer itself. Instruction includes micro-control technology and detailed operation of microcomputers. These courses will prepare you for entry-level in many facets of the computer industry such as field service and customer engineering as well as programming. In addition to written texts your course includes the NTS/HEATH disc-drive computer which you assemble as part of the training process. The assembly and use of the computer will serve to reinforce practical application of principles.

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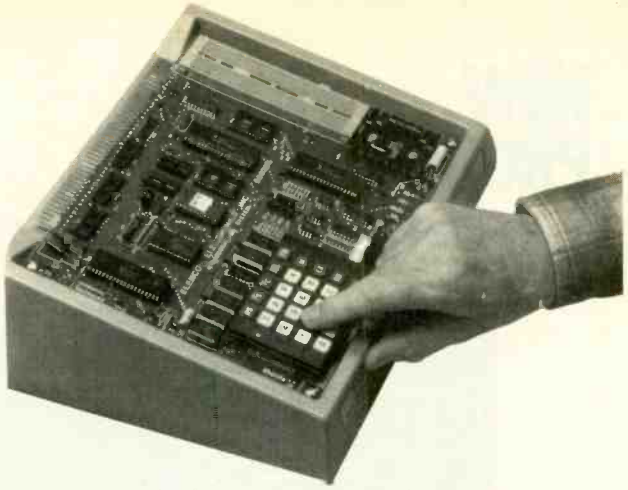
The field of industrial and microprocessor technology encompasses the application of electronic microprocessor control principles. Your course takes you from fundamentals of digital electronics and associated circuitry through the application of the microprocessor as a control device. You will learn how to move and manipulate instructions and information. The microprocessor trainer included in your course is a microcomputer system designed as a practical tool for learning the use of software and hardware techniques utilized in the linking of microprocessors to various systems.

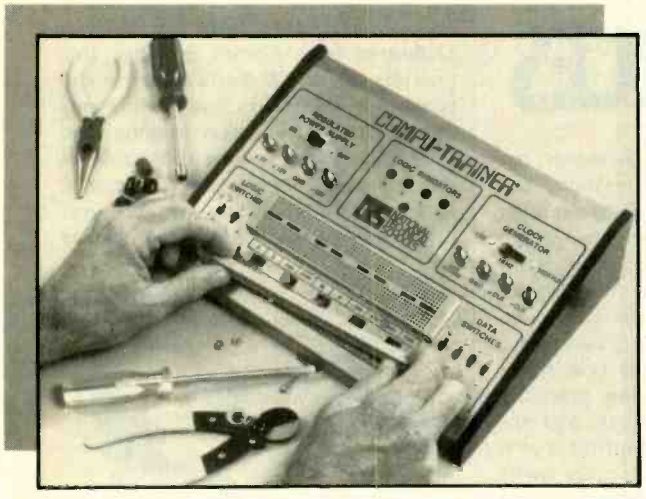


DIGITAL ELECTRONICS

The NTS Compu-Trainer is a fascinating solid-state device which you will build in order to perform over ninety logic circuit experiments. These experiments serve to emphasize an area of electronics which is essential to the understanding of state-of-the-art control equipment; they are also extremely important to those wanting to pursue a career in computer servicing. Separate courses involving the Compu-Trainer are also available in Microcomputer Servicing and Digital/Analog Electronics.

ROBOTICS & VIDEO TECHNOLOGY

Other NTS courses cover a wide range of specialization. In Robotics, the NTS/Heath Hero I is included to train you in robotic applications in manufacturing processes. In Video technology, a new course features the advanced NTS/Heath Z Chassis "Smart Set" color TV with computer space command remote control and space phone. This is an excellent program for those interested in a career in video servicing with microcomputer basics.



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NEW PRODUCTS

COMPUTER/RETAIL MANAGEMENT SYSTEM

NCR Corp. is offering a combination personal computer and advanced retail management system in a single package. It consists of an NCR personal computer with an electronically operated cash drawer and point-of-sale (POS) and inventory management software. POS software provides sales invoicing or ticketing and detailed sales reporting by salesperson and item. A helpful screen guides clerks through each transaction. The inventory management software can store 19 facts about each of 32,000 unique inventory items. Inventory levels are automatically displayed and adjusted during each sale. An ID number feature prevents unauthorized access. The system is available in two configurations, each of which includes a personal computer with cash drawer, 8/16-bit processors, 256K of RAM, and operating system. One configuration offers two floppy-disk drives and POS software for $4999; the other offers one floppy-disk drive and one 10M hard-disk system and POS Plus inventory management software for $7899.

Circle No. 87 on Free Information Card

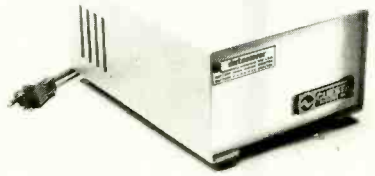
SOFTWARE SOURCES

Idea Processor. "Docupower!" from Computing! is an idea organizer that works with any word processor. The product asembles your random paragraphs, sections, pages, or any other word-processor texts into a master indexed resource file of usable ideas. There's no need to retype anything you've already typed; just pick the sections you want from the master index to automatically create new texts, reports, letters, proposals, school themes, articles, etc. After you mark any sections, paragraphs, or groups of pages of text you think you may use again, Docupower! adds the material selected to a master resource file and automatically makes an index, sorted by category. New text is made up by picking numbers from the indexed idea category file. The program is available in 20 disk formats for all **CP/M, CP/M-86** and **IBM PC**-compatible computers. $149. **Address:** Computing!, 2519 Greenwich, San Francisco, CA 94123.

Programming Kits. Timeworks has announced two new programming kits for the **Commodore 64.** Programming Kit II* is an intermediate game-design and sprite builder designed to allow intermediate-level users to delve deeper into the powers of their computers. In designing a slot-machine game, users are taught to use arrays, FOR/NEXT loops, subroutines, moving graphics, sound, special-function keys, and the RND function. The use of sprites is covered in detail, and a multi-color sprite builder is included with the kit. Programming Kit III* is an intermediate-level database system. **Commodore 64** users take part in the design of a fundamental database that can be used for anything from a mail list to a date reminder. Aspects covered include information entry and retrieval, tape storage, string arrays, and sorting techniques. Each kit, $24.95. **Address:** Timeworks, Inc., 405 Lake Cook Rd., Deerfield, IL 60015.

AC POWER BACKUP DEVICE

Datasaver from Cuesta Systems, Inc. provides up to 200 watts of ac backup power for computers and instruments during ac power interruptions and transients. When ac line voltage drops out or sags below 85% normal, Datasaver automatically switches over to its internal battery-powered inverter



to deliver uninterrupted power for up to five minutes, long enough to close files and safely power-down the computer. LEDs and a buzzer provide visual and audible indications of the device's operating status. Jacks are provided for connecting an external 12-volt battery to Datasaver for extended-period backup. Datasaver delivers one ampere of charging current to the external battery.

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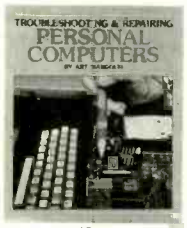

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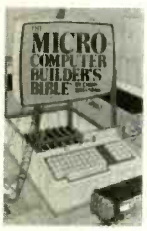

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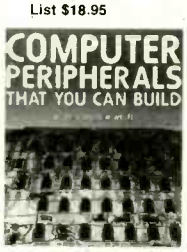

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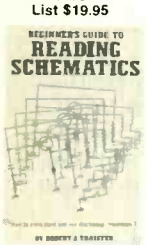

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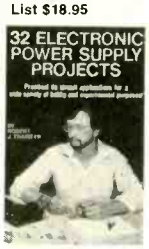

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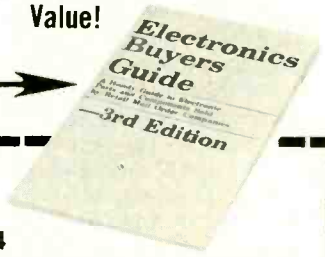

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NEW PRODUCTS

SOFTWARE SOURCES

Accounting Package. Certified Public Accountant from Sundex can be used to organize, analyze, and manage financial affairs. It pulls together cash flows, tax liabilities, and budgets for all checking, savings, and money market accounts, credit cards, stock portfolios, assets, and liabilities. It keeps an accurate record of past, present, and projected finances. The program features full-function budgeting; net-worth reports; income/expense, cash-flow and tax-impact statements; easily split transactions; editing from anywhere within the program; any type of check printing; menu selection; flagging of bills before they are due; and more. It has an on-screen tutorial, one-key help, and quick start-up. The package is available for IBM PCs (64K and 128K versions), Apple II and IIe, and TI Professional Computer. **Address:** Sundex Software Corp., 3000 Pearl St., Boulder, CO 80301.

Multiple-Functions Plotter. Plotpro is a set of three BASIC programs from BV Engineering that makes scientific graphs on any 80- or 132-column printer. It can be used to create linear, semilogarithmic, and full logarithmic plots and will plot multiple functions on the same graph. Forced scaling and autoscaling are supported, as well as optional grid lines to aid in graph interpretation. A Protemp module creates templates of the physical appearance of any graph and will work with user-specified imbedded control characters to utilize the features of more advanced dot-matrix printers. The package is available on 5¼" and 8" disks and can run under CP/M, TRSDOS, MS-DOS, and PC-DOS. $49.95. **Address:** BV Engineering, PO Box 3351, Riverside, CA 92519.

Software for IBM PC*jr*. Perfect Software has announced availability of Perfect packages for the IBM PC*jr*, including Perfect Writer word processor, Perfect Speller, Perfect Filer, and Perfect Calc electronic spreadsheet. To be able to fit into the PC*jr*'s environment, the software programs have been limited in size to 128K, system calls have been minimized, and code portability has been maximized to quickly run on new versions of operating systems.

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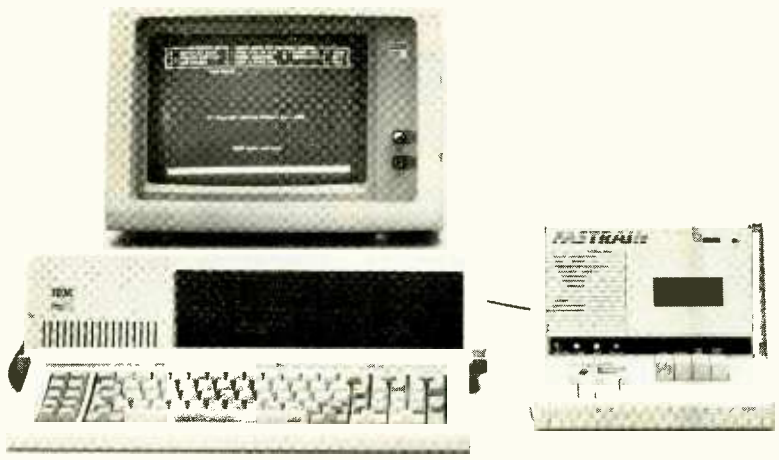

INTERACTIVE SOFTWARE TUTOR

"Fastrain" from Electronic Protection Devices is designed to help users learn about popular software packages without having to struggle through complex documentation or attending training sessions. With audio cassettes and software simulations, the device teaches use of popular software packages through a unique tri-sensory approach that combines sight, sound, and hands-on experience. The package includes both verbal lesson tapes and instructional software on disk. Played together during a training session, the tape triggers screen displays that match those of real software. The user types in responses, the screen displays both results and comments, and the tape adds guidance and narration and corrects the user's errors. The Fastrain console comes with a personalized pack that interfaces with the selected model of personal computer. Among the tutorial packages currently available are Multiplan, WordStar, and BASIC, with more planned. $498 for console, personalized pack, and learning program; $149 for each additional lesson package.

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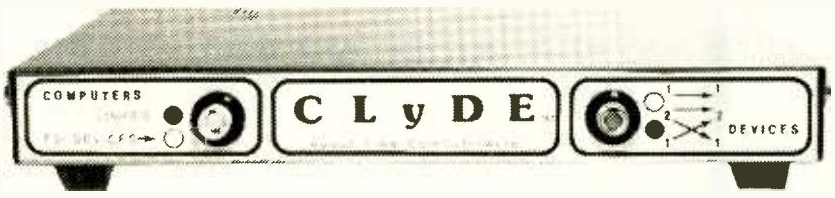
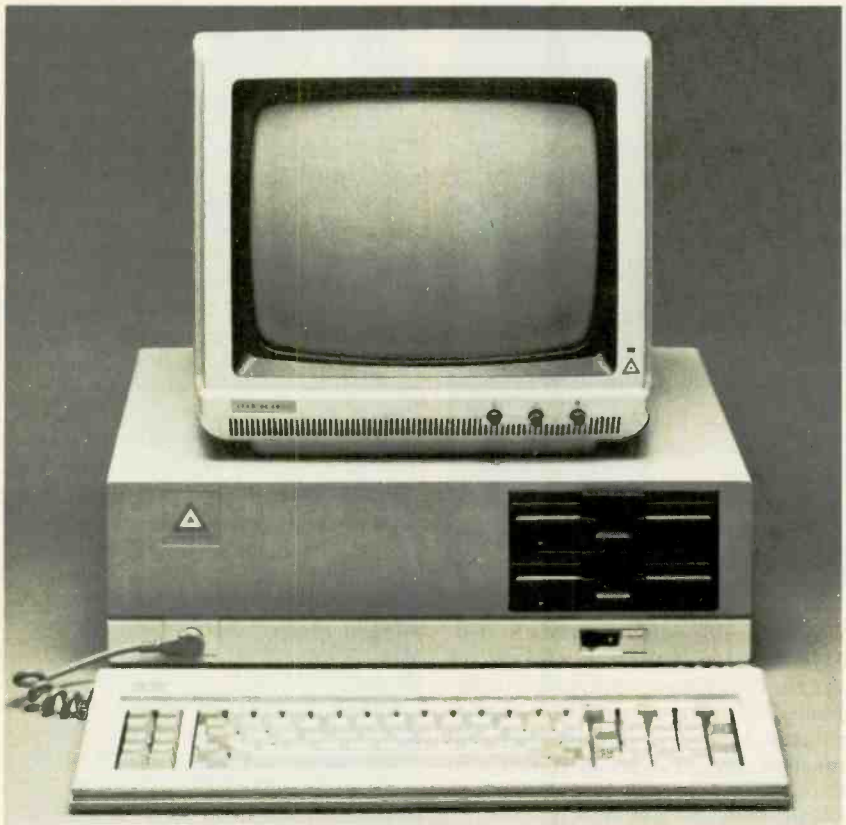


THE MISSING LINK

CLyDE from About Time Computerware provides facilities for two computers to communicate with and the ability for both computers to control two different devices simultaneously and the option to switch between them. One of CLyDE's two controls exchanges devices between two computers, while the other control establishes the proper computer link for data communications. The device is completely passive, requiring no power source to operate. It has four 25-pin subminiature D female connectors and uses standard RS-232 communications protocol. $149.50. **Address:** About Time Computerware, 2054 University Ave., Rm 209, Berkeley, CA 94704.

NEW PRODUCTS



DESKTOP PERSONAL COMPUTER

Leading Edge's new Personal Computer is built around the 8088, operating at a fast 7.16 MHz, and comes with 128K of RAM, an RS-232C serial port, and seven IBM PC-compatible expansion slots. Its features include a time-of-day clock with battery backup; IBM-format detached keyboard; 5¼" double-sided, double-density floppy disk drives with 320K capacity per drive; and TTL high-resolution 12" green video monitor capable of displaying up to 80 columns by 25 lines. Software bundled with the system at no extra cost consists of Microsoft DOS 1.25; Microsoft GW Basic; and Leading Edge Word Processing. $2895.

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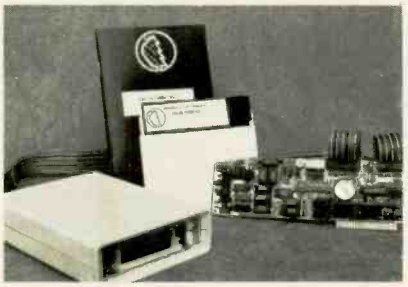
DATA ACQUISITION/ CONTROL SYSTEM

The Analog Connection II from Strawberry Tree is designed to simplify data acquisition and control at low cost. It is for laboratory and industrial use in data logging and process monitoring and controlling. It can be used to measure temperature, pressure, flow, and other voltage or current analog source, to turn on and off heaters, fans, pumps, etc. It can display maximum, minimum, average, or difference information or set alarm limits on any input. Measuring accuracy is rated at 0.04%, noise rejection is 110 dB common mode and 73 dB normal mode, and input protection is to



150 volts. Ten input ranges span from 25 mV to 10 V and from 2.5 mA to 50 mA. The device is designed for use in Apple II, II+, and IIe computers. **Address:** Strawberry Tree Computers, 949 Cascade Dr., Sunnyvale, CA 94087.

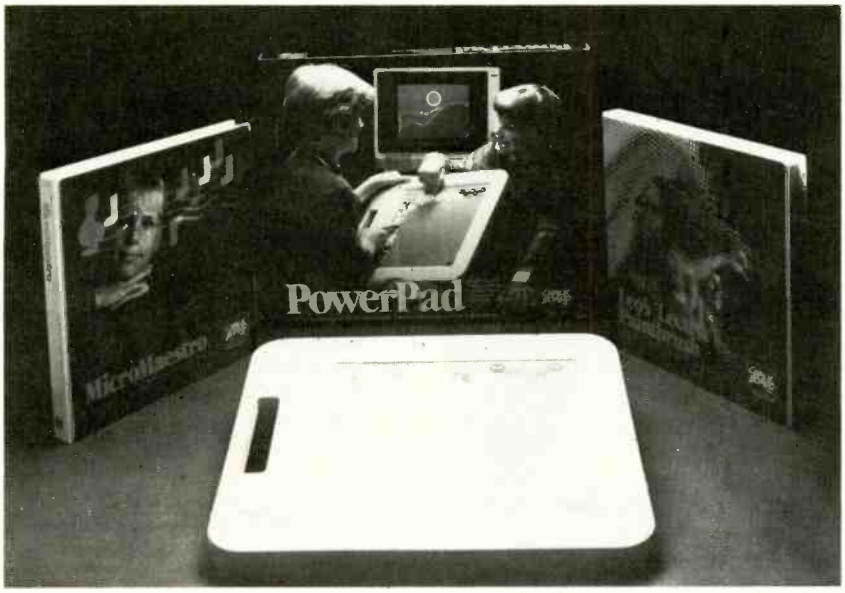
SOFTWARE SOURCES

Arcade-Style Games Board. Apple computer owners can enjoy the same fast action and visual and sound effects as big arcade machines with a new plug-in peripheral card from Synetix, Inc., reports the company. The SuperSprite board allows numerous animated objects to occupy the screen at the same time, each independent of the other and the background graphics. SuperSprite synchronizes Apple background graphics, animated sprite graphics, sound effects, and synthesized speech. The SuperSprite board plugs into slot 7 in the Apple computer. $395, includes board, software utilities, and demo diskettes. **Address:** Synetix Inc., 15050 N.E. 95th, Redmond, WA 98052.

Print Spooler. Tall Tree's JSPOOL is the DOS 2.00 sequel to the company's print spooler for DOS 1.10. JSPOOL is an installable device driver that is compatible with both parallel and serial ports and permits Xon/Xoff protocols. It offers nine special processing commands that can be inputted by the user directly or placed at the top of text files and automatically inputted as the spooler processes each file. With these commands, tabs, odd/even page boundaries, and baud rate can be set. The commands also control pausing or continuing print execution, flushing the spooler buffer, and directing output to one of seven printers. JSPOOL permits the user to change the size of the spooler buffer from the default of 2K all the way up to 2M. $40, includes source code. **Address:** Tall Tree Systems, 1032 Elwell Ct., #124, Palo Alto, CA 94303.

Electronic Mail. Members of **The Source** can now send E-COM electronic mail letters direct from their computers to any destination in the US. E-Com (Electronic Computer Originated First-Class Mail) letters from users of The Source are received in New York, batched, processed and sent on to the serving post offices. The messages are printed on paper, inserted into envelopes, and delivered as first-class mail by the US Postal Service. Cost of the service is $1.35 for the first page and $0.25 for the second. There is a two-page limit. **Address:** The Source, 1616 Anderson Road, McLean, VA 22102.

NEW PRODUCTS



TOUCH-SENSITIVE INPUT PAD

The PowerPad from Chalk Board, Inc. is a touch-sensitive input device for home computers that replaces the keyboard as a means of accessing a computer. Its 12" × 12" active surface contains 100 switches per square inch. With different software, PowerPad allows users to redefine the working surface at will. Mylar overlays (one comes with each of the firm's software packages) are imprinted with arrangements of color-coded areas that serve as both menu and function keys. PowerPad connects to the computer through a serial interface, usually the game port. $99.95.

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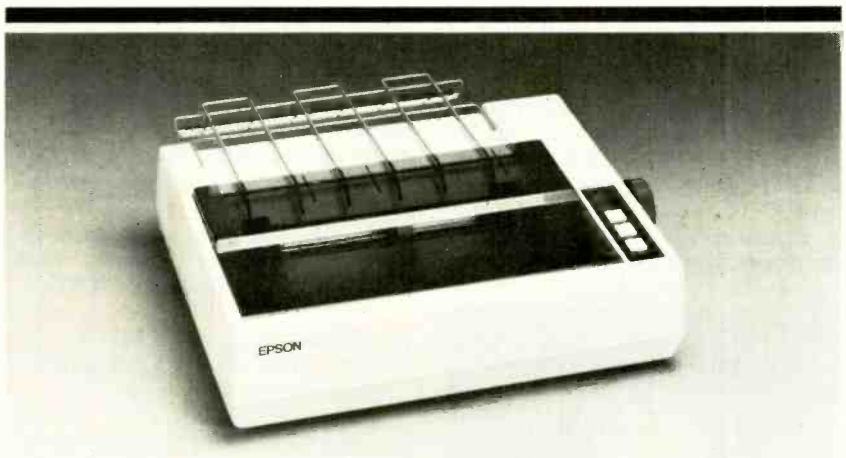

DOT-MATRIX IMPACT PRINTER

The new RX-80 F/T dot-matrix impact printer from Epson has all the features of the original RX-80 plus friction and tractor feed. It has a rated printing speed of 100 cps and offers a choice of two 96-character ASCII sets, nine international character sets, and 32 HX-20 graphics characters. Available with the printer are 128 type styles, including emphasized, double-strike, elite, and italics. Other standard features include: user-replaceable printhead; logic-seeking, bidirectional printing; underlining; and special Quiet Mode that reduces noise level during the printing operation. $599.

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SOFTWARE SOURCES

Introductory Science Software. Software Arts has introduced TK!SolverPack for Introductory Science, which includes 12 models that contain the necessary equations, values, and tables for solving problems in physics, chemistry, and biology. The models can be used in introductory courses in secondary schools and colleges. They are usable as is or can be easily modified by the user. Models included are: population growth, motion with constant acceleration, electrical circuit, and chemical. Programs are currently available for the IBM PC, Digital Professional 350 and Rainbow 100, and Wang Professional Computer. $100.

Circle No. 94 on Free Information Card

Computer Padlock. Code Keeper, a cassette-loaded program from Sherman Electronics for the **TRS-80 Model 100** portable computer, protects the entire computer from unauthorized use. It secures all files in the computer's memory from prying eyes, and prohibits anyone without the correct password from running any of the programs. If the owner of the computer should leave it behind somewhere, when the finder turns the unit on, it will inform him of the owner's name and phone number. The program requires 1K of memory. $25. **Address:** Sherman Electronics, PO Box 63-04, Miami, FL 33163.

Music Composition Teacher. Music Construction Set is an advanced software program that serves as a music composition and learning tool. The software from Electronic Arts lets experienced and inexperienced musicians compose and play their own music on **Apple** and **Commodore 64** computers. Users manipulate an on-screen "hand" with a joystick, keyboard, or touch pad to position notes, rests, sharps, flats, clef signs and other musical symbols on a formatted staff. They can then immediately hear the results. A cut-and-paste feature allows the mixing of rhythms and melodies at different volumes and speeds, and with different tone qualities. Compositions can be stored on disk. The software also includes a library of a wide range of musical selections. $40. **Address:** Electronic Arts, 2755 Campus Dr., San Mateo, CA 94403.

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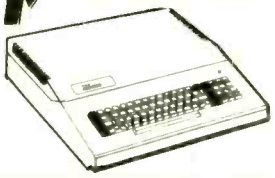

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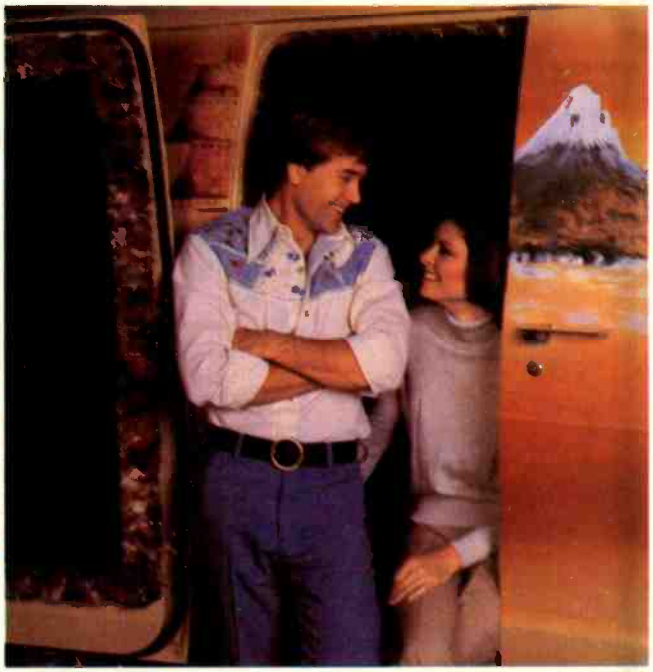

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BITS & BYTES

Rumors & Gossip

▶ They say Commodore is negotiating with Mark Williams Co., Chicago, IL, to use the latter's Unix-like Coherent operating system on Commodore's Z8000-based 16-bit microcomputer, now in development. The minimum system is expected to include 128K of RAM and a 320K disk drive and sell for under $1000. An 8088 plug-in card option is also expected. . . . In addition, Commodore is reported to be readying a portable computer employing a 16-line by 80-character liquid crystal display and wafer-tape drive. . . . Texas Instruments is rumored working on a 68000 processor card for its desktop IBM PC compatible system. It is expected to include a Unix-type operating system with the card . . . IBM may be readying an optional Selectric-type keyboard for its PC. . . . IBM will probably make 1.2-million PC*jr* home computers this year. It may also introduce an enhanced version of the PC*jr* shortly which it expects will be even more popular than the original. There are rumors that they are getting parts quotations to build 3 million of these units over a one-year period. . . . Gavilan Computer, which introduced a radically new portable computer last May is not expected to start shipping until March, fully 10 months after its introduction. The hang-up seems to be the software for its integrated operating system and the applications software which utilizes a mouse-like touch panel. . . . Coleco is possibly readying a new, high-end system that will be upward-compatible with its Adam system. This probably means that it will use a disk drive in place of its "stringy floppy". . . . There are also rumors that Apple will soon introduce a color version of the Lisa computer as well as windowing and mouse capabilities for the Apple II and III. . . . And expect Apple to shortly introduce a portable version of the Apple IIe with a $900 list price. . . . Apple may also be working on a wireless mouse using an infrared link. . . . A new version of the Apple IIe based on the new 16-bit version of the 6502 is also rumored to be in the works. It will be able to address 16M bytes of RAM and have a new high-resolution graphics display.

16-Bit Version of 6502 Announced

▶ When Commodore scrapped the 16-bit microprocessor it had been developing for several years in favor of the Zilog Z8000, it left the market wide open for an upward-compatible 16-bit version of the 6502. Sure enough a company has seized the opportunity. Western Design Center Inc., Mesa, AZ, has announced a 16-bit microprocessor that runs 6502 software in an emulation mode without revision. The CMOS chip can address 16M bytes of memory compared to the 6502's 64K. It has an 8-bit external bus and internal 16-bit bus. The most amazing feature is that it is pin-compatible with the 6502. You just remove the 6502 from its socket and replace it with the W65SC816. Then set the E-bit in the status register and it performs exactly like the 6502. If the bit is off, the device becomes a 16-bit device.

A Look At IBM'S PC*jr*

▶ The PC*jr* is far from the least expensive home computer system on the market and it is certainly not the best buy for the money. What it has going for it are those three magic letters on its front, IBM. And just as the PC and XT have become the de facto standard for office desktop systems, the PC*jr* is expected to introduce a standard into the home/educational computer market where no compatibility (even between systems from the same manufacturer) currently exists.

So companies that want to compete at the upper end of the home computer market are expected to provide PC*jr* compatibility. The successful ones will be those who offer a lower cost combined with some additional value over what is offered on the PC*jr*. Also, the success of PC*jr* alone will depend to a great extent on IBM's ability to meet the market demand.

IBM is currently limiting distribution to its existing marketing channels. There is little doubt that later this year it will increase its distribution channels to mass marketing channels. It will be at this point that companies such as Commodore, Atari and Coleco will begin to feel the competition.

It is also expected that this year will see the Japanese offering machines designed specifically for the home computer market in the U.S. They have previously tried entering the U.S. market with machines that have been very successful in Japan, but they have not met with success. The next wave of Japanese

home computers is expected to be based on standard operating systems offered by Microsoft and Digital Research. The MSX system from Microsoft has been adopted by several Japanese manufacturers and some of the systems are already on sale in Japan. They are expected to be introduced into this country shortly. CP/M, the popular disk operating system from Digital Research, is currently being moved into hardware by the Japanese, so that a single chip is being developed which includes the software and processor.

The home computer market is something brand new for IBM. It realizes that the consumer electronics business is treacherous and it is approaching the marketing of the PC*jr* very cautiously, especially after looking at what has happened to Texas Instruments, Atari and Mattel. This caution is evidenced by IBM's initially limiting the distribution of the PC*jr* to its traditional channels.

A second thing that indicates IBM's cautious approach to the PC*jr* is the fact that it has contracted out the entire production of the unit to Teledyne. Thus, if IBM finds that the sales of the PC*jr* are not up to expectation, it can easily pare back its commitment.

IBM will mount its most expensive and aggressive promotional effort for PC*jr*; probably spending well over $100 million on space and TV advertising in '84. This will probably be as much as all its competition put together.

The disk version of the PC*jr* will run essentially the same disk operating system and many of the programs designed for the PC XT. Thus programs such as EasyWriter and Multiplan will run on the PC*jr*. However, programs such as Lotus 1-2-3, which makes special calls to the IBM PC ROM and needs more than 128K of RAM, will not run on the PC*jr*. It is likely that Lotus will bring out a special PC*jr* version of 1-2-3.

IBM has taken special care in designing the PC*jr* to minimize any erosion on the sales of the PC. Thus, the PC*jr* is not easily expandable and lacks the keyboard of an office machine. Further, the way the machine is designed, suppliers of peripheral products such as keyboards, memory, and I/O functions cannot easily or economically upgrade the product the way they can with the PC and XT.

Computer Magazines Everywhere One Turns

▶ There are now more than 200 computer magazines published in the U.S. with a new one appearing almost every week. The five leading publications, in terms of circulation, are COMPUTERS and ELECTRONICS (600,000), *Personal Computing* (460.000), *Byte* (420,000), *Popular Computing* (306,000) and *Compute!* (270,000).

With most magazines depending on newstand sales for the majority of their circulation, limited shelf space has become a problem and several of the newer and smaller publications have already gone by the wayside. Recent entrants have come from the larger magazine publishers such as Ziff-Davis. Even *Time* is promising to get into the field. And many of the smaller and older pioneering magazine publishers are selling out to the larger ones.

Robots Attack!

▶ Odetics Inc., Anaheim, CA, has announced a "battlefield robot" called the Odex-I. It is claimed that the six-legged "functionoid" can move over rugged terrain, step over obstacles almost 3' high and lift up to 100 lb.

Random News Bits

▶ Apple has finally released its hardware/software package to allow its Lisa computer to access IBM, Digital Equipment and other computers. This fulfills a rumor which previously appeared here. . . . Tandy has begun shipping CP/M for its Model 4 computer, fully 9 months after it was first announced. . . . IT&T and Sperry have at last decided that they too have to jump into the already crowded IBM PC compatible computer market (Good Luck!). . . . Digital Research has replaced Microsoft on a project to develop a Unix operating system for Intel's iAPX286 microcomputer. . . . Apple is now offering a 30% discount to schools. IBM generally has a policy of offering a 20% discount to schools.

Quotation Of The Month

"When you're a little guy, you have to pay all your own bills. But when you get a little more successful, you get a line of credit, and the bank starts paying your bills. Then you get a little more successful, and the bank won't pay anymore, so you pay your bills slower . . . 30, 60, 120 days late . . . and now your vendors are paying your bills. Now you're even more successful. You get venture capitalists, and they're paying your bills. And it used to be when you reached the highest level of success, you could go public and have the public paying your bills. But nowadays, when you finally reach the true pinnacle of financial success, like Chrysler, the government starts paying your bills."

GEORGE MORROW
President, Morrow Design, Inc.

Apologies Due

▶ My apologies to Apple Computer. Back in November, I stated that Apple was rumored getting ready to drop the Apple III. I was wrong. Rather, Apple introduced the Apple III+, indicating its long-term committment to the III.

Also, in my November column, I commented that I had yet to see Commodore's version of CP/M for the C-64 on dealers' shelves despite Commodore's announcement of the product nearly a year previous. A large number of readers of this column wrote to me indicating that they had indeed purchased the product and that it was real. Unfortunately, the November column (the issue was actually in the mails to subscribers in early October) was written in late July and submitted in early August. Thus, at the time the column was written, as far as I can tell, my statement was true. But keep those letters coming. I appreciate the feedback. Incidentally, all those responding indicated that they

were delighted with the Commodore implementation of CP/M for the C-64.

Also, Glen Kirkland, sent me a copy of an ad which appeared in a Washington DC newspaper advertising the Timex 1000 computer for $19.97. He sent the ad in response to my statement in the November column where I said, "I could hardly believe my eyes, but there was the ad in my local paper—the Timex 1000/Sinclair ZX81 on sale for $29.97—how much lower can it go?" Thanks Glen for showing me how low it can go. Can anyone else beat it? ◇

LES SOLOMON ON

COMPUTER HARDWARE

THOSE WERE THE DAYS

A FEW days ago, during a coffee *klatch*, some of us got to talking about the amusing goings on in the microcomputer world at its birth (circa 1975). I thought those of you who weren't into computers back then might be interested in some of the stories from the beginnings of the industry.

1 **Story Number One.** Since the personal computer era really began with the Altair 8800 computer kit, let's start with MITS, the company that brought this kit to the consumer marketplace. The company's name was originally M.I.T.S., which stood for Micro Instrumentation and Telemetry Systems. Founded by Forrest M. Mims, II (the father of our popular columnist, Forrest M. Mims, III), this very small company had its headquarters in a small portion of a house trailer. Back then, M.I.T.S. made tiny electronic devices that went into model rockets and airplanes to locate downed models, deploy parachutes, turn on lights, etc.

M.I.T.S. was purchased by Ed Roberts, who planned to manufacture small electronic (at the time, noncomputer) devices. Ed changed the name to MITS (no periods) and shortly thereafter designed the Altair computer.

Historically, the first microcomputer conference was held in 1975 in the Airport/Marina Hotel in downtown Albuquerque, NM. We could understand the "Airport" part of the hotel's name, but "Marina" in the Arizona desert? Well, it turns out that the mighty Rio Grande, which starts way up north, passes by Albuquerque, where it's about 10 feet wide and 2 inches deep. So much for marina.

2 **Story Number Two.** Question: Does anyone out there know how the name Cromemco came about? (Will anyone associated with Cromemco please refrain from giving hints?) It seems that, when Roger Melen and Harry Garland designed the first Altair

plug-in board, the historic "Dazzler," the world's first microcomputer color graphics board and a very successful mail-order company were born. The business was named after Roger and Harry's residence at Stanford University—Crothers Memorial Hall. The name of the enterprise started out to be Crothers Memorial Company but was soon shortened to Cromemco.

The Dazzler conjures up some fond memories. The Dazzler and the Kaliedoscope program designed to run with it achieved early fame for the random color patterns generated. To this day, versions of this attention-getting color display are supplied with many modern color computers. In those days, there were very few computer stores, but they used the Dazzler as an attention-getting device for potential customers. One store in New York City, in fact, placed a color-TV receiver in its window and left the Dazzler program running throughout the night. The traffic jam caused by hundreds of passersby and dozens of motorists who stopped to watch the hypnotic display caused the New York Police Department to ask the owners of the store, politely but firmly, to shut down the system.

3 **Story Number Three.** In 1976, Joe Weisbecker of RCA developed the 1802 central processing unit that appeared in the pages of POPULAR ELECTRONICS (the former name of COMPUTERS & ELECTRONICS) as the "Elf" microprocessor trainer project. This project was the forerunner of the RCA VIP computer. Since the 1802 was a low-power CMOS device, it required only a tiny power supply. One day, just to see how little power it took to keep the Elf alive, we made a "battery" by wiring a couple of lemons (the fruit, not the surge protector) in series and used copper and zinc electrodes. The idea was to use the minuscule amount of power developed from this arrangement to maintain just the CMOS RAMs. And, by golly, it worked! So, way back in 1976, we had a solid-state disk, or was it the first portable computer?

4 **Story Number Four.** Also in 1976, the first East Coast Computer Show was held in the "world famous" Shelbourne Hotel/Motel located on Atlantic City's boardwalk. This historical "convention center" no longer exists. It was the first place to be demolished to make way for a new Altantic City gambling complex. However, during its very brief existence as a convention center, the Shelbourne achieved infamy for three things:

One, its dry man-made carpeting had the nasty habit of building up static charges on show attendees. Take a short walk across the carpet, reach out and touch a computer, and, *ZAP!*, some really strange things happened to the computer, some of them permanently.

Two, this was the birthplace of the name "S-100" for the most emulated bus format of the time. Several micro-

computer manufacturers had been using different versions of the original 100-contact Altair 8800 bus, and the prevalent name was the unwieldy "Altair/Imsai/Processor Technology bus." To simplify matters, a name change was in order. Among the several different names that were proposed was "Roberts Bus" in honor of Ed Roberts, designer of the Altair 8800 computer in which it was first used. The name that won out, of course, was Roger Melen's "S-100." (More recently, the S-100 "standard" went on to become the IEEE-696 Standard, the first personal-computer bus standard.)

Third, it was at this show that Steve Jobs—wearing jeans, T-shirt, and sneakers—had his first public showing of the computer that was soon to go on to fame and fortune. We all know this and later versions of it as the Apple.

Story Number Five. My last story poses a question: Where is the original prototype of the Altair 8800? Somewhere between Albuquerque and New York City, the computer just vanished. To this day, no one knows what ever happened to it. Ed Roberts had shipped to me the PE-8 (which stood for Popular Electronics 8-bitter, the original name of the Altair 8800) by Railway Express Agency, a now defunct carrier. After a couple of weeks waiting for the computer to arrive, we began inquiries with REA. Amusingly, REA told me not to worry, since its computer never lost anything. Trying to track down the computer from his end, Ed met with as much success as I had.

After about three weeks, Ed shipped another PE-8 to our New York offices, this time by a different carrier. The computer arrived and subsequently became the subject of the Altair 8800 project in our January 1975 issue.

Now the mystery. A week after Ed and I hinted to REA that the company had lost the prototype computer, REA suddenly went out of business. I wonder, could it be that REA's computer went berserk and lost REA? All records of Ed's shipment were lost. So somewhere out there in the great United States, perhaps in some dark and dusty warehouse, sits a cardboard box containing the original Altair. If you happen to stumble upon this historical treasure, the Smithsonian Institution would very much like to hear from you. ◇

FORREST M. MIMS,III

THE COMPUTER SCIENTIST

LEARNING TO USE AN X-Y PLOTTER

SCATTERED about my desk as I type this column are several neatly printed letters, a couple of snappy looking oscillograms, a stack of professionally drafted circuit diagrams, and a dozen or so flashy examples of computer-generated art. It seems to me incredible that a single appliance, which also resides on my desk, produced all of these publication-quality images.

The wonderful gadget to which I refer is an x-y pen plotter, one of the most versatile of computer peripherals. And I'm certain that an x-y plotter can greatly enhance the ways in which you use your own personal computer.

From time to time I plan to describe in this column, ways to use a personal computer and an x-y plotter as a drafting machine, chart recorder, curve tracer, oscilloscope and electronic artist. In the meantime, I urge you to find out more about x-y plotters and how they work.

Even if you know relatively little about computer programming, you can quickly grasp the fundamentals of how x-y plotters are programmed to create their remarkable drawings, plots, graphs and works of art. What follows is a mini-course in plotter interfacing and programming that will introduce enough of the basics to get you on your way.

Getting Started. Don't feel bad if you aren't a computer expert, or if your system doesn't have seventeen disk drives and a quadrillion gollybytes of storage. Most any computer with an RS-232C serial port can drive an x-y plotter having a similar interface.

Your biggest battle will likely be finding out how to get the two machines to "speak" to one another. Happily, plotter manufacturers have finally figured out that not all computers are on speaking terms with one another and have begun including, in their operating manuals, interfacing information for various (but not yet enough) computers.

Alas, if such information isn't provided, you may encounter major problems.

COLOR COMPUTER	HP7470A RS-232 SOCKET
CD	PIN 20
RD	PIN 4
GND	PIN 7
TD	PIN 3

RS-232 INTERCONNECTION GUIDE

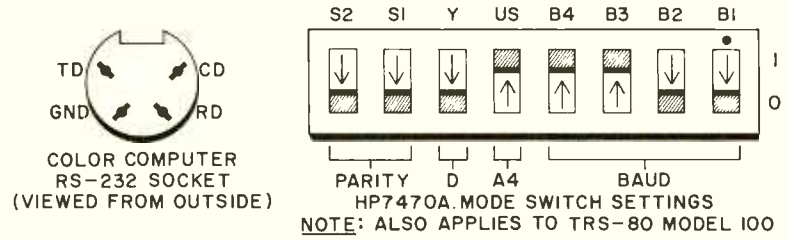


Fig. 1. Interfacing a CoCo and a HP 7470A plotter.

Misery loves company, so if you run into problems attempting to get a computer and plotter on speaking terms, remember you're *not* alone. I, for one, am all too familiar with the frustration and discouragement brought on by seemingly incompatible systems and incomplete operating manuals.

However, if you encounter a problem, before doing anything drastic, contact the plotter company. Hopefully it can advise you how to proceed. If it can't or won't, you're on your own.

Interfacing Problems. Probably the biggest interfacing problem is that many plotter and computer RS-232C serial interface sockets have *identical* connector orientations. While that may at first seem perfectly logical, it means that the *input* pin of the RS-232C port of one machine is connected to the *input* pin of the other. Likewise for the respective *output* pins.

However, an *output* must talk to an *input,* not another output. Therefore, when two such machines are interconnected, *no* communication can take place. First, it's necessary to reverse the input and output connections for one of the machines. This can be easily accomplished by using a special RS-232C cable with the unlikely name of *null modem adapter.* Or you can save your money and switch the input and output connections in your existing RS-232C cable.

Usually, this means reversing the connections to pins 2 and 3 at either the plotter or computer. While most computer serial port sockets adhere to the standard RS-232C pinout (using a 25-pin socket), others don't. If your plotter falls in the latter category, you'll need to carefully research the machine's operating manual to determine what goes where. Incidentally, don't expect the manual to warn you about the need to reverse some of the RS-232C cable connections. Even manuals that mention the matter often do so in some obscure, or hard-to-find, section.

I don't wish to discourage you further, but I would be remiss in failing to warn you that computer makers have taken many liberties with the traditional RS-232C interface. Some computers, for example, have a condensed RS-232C port that, while allowing the computer to send information to the plotter, fails to allow the plotter to send signals to the computer. This can cause several prob-

lems, not the least of which is *buffer overflow*.

Plotters, like printers, usually include some memory (the *buffer*) into which incoming bytes are dumped as they arrive from the computer. The plotter empties bytes from the buffer as it completes the execution of instructions in previous bytes.

Since plotters are slow, it's likely the buffer will be filled long before the machine has a chance to process its contents. When this occurs, the plotter sends a "busy" signal to the computer, upon receipt of which the computer temporarily ceases sending bytes until the plotter signals that the buffer has room. If the computer can't receive signals from the plotter, the buffer will overflow and the program will not be properly executed.

In such a case, buffer overflow can be precluded by inserting FOR-NEXT timer loops in the program. A typical loop might be:

```
100 FOR D=1 TO 1000:
    NEXT D
```

This loop is simply a do-nothing command that tells the computer to count to 1000 before proceeding to the next instruction. During the delay thus provided, the plotter has time to complete some of its work, thereby making available space in the buffer for new bytes.

While this method can eliminate buffer overflows, you'll have to spend time experimenting with the length of each delay. If the plotter stops drawing for a few seconds or more, break the program to see if the computer is stalled at a timer loop. If so, reduce the FOR-NEXT counter value and continue execution.

Incidentally, while you can use delay loops to overcome a one-way communications limitation, a plotter can't send error messages to a computer without a bidirectional transmission link. Nor can it be used as a digitizer.

Before a computer can talk to a plotter, any status or mode switches on the plotter must be properly set. These switches usually determine such matters as paper size and the communication protocol (e.g. baud rate, parity, etc.). All the plotter manuals I've seen clearly explain how these switches, which are usually located on the back of the machine, are set.

Once you've managed to interconnect a computer and plotter, it's necessary to determine if commands sent by the computer are received and properly acted upon by the plotter. This is best done by sending a simple pen command to the plotter and watching for a correct response.

While this seems simple enough, determining how to send commands to the plotter may require some experimentation if the plotter's manual doesn't cover your computer. Usually commands are sent to the plotter as *print* statements.

Verifying Computer-Plotter Operation. Some computers require no initialization statements before they send instructions to a plotter in the form of a print statement. To verify that the plotter can receive instructions from such a computer, simply write a one-line program that tells the plotter to move the pen down (or up). For instance, to verify communications from a Radio Shack Color Computer to an HP-7470A plotter, enter and run this line of BASIC:

The biggest problem is getting the two machines to talk

```
10 PRINT #-2, "PD;PU;"
```

When this line is run, the pen carriage should rapidly move down and then up again. This assumes, naturally, that the two machines are properly interfaced. Figure 1 shows how to interconnect a Color Computer and an HP-7470A. (Though I've tried every conceivable variation of the connections, I've only been able to establish one-way communications from the Color Computer to the plotter.)

Though most computers with an RS-232C port can drive an HP-7470A, I prefer to use a portable machine like the Radio Shack Model 100. This computer is so compact that both it and the plotter can be conveniently located directly in front of you.

As with the Color Computer, the status switches on the HP-7470 should be set as shown in Fig. 1. Also, lines 2 and 3 of the RS-232C port must be *reversed* when the Model-100 is connected to the HP-7470A.

When the status switches are set and the serial interface is properly wired, you can send a test instruction to the plotter. Sophisticated machines like the Model 100 require, in every plotter driver program, an initiation line to open a communications buffer and set the communication protocol. Here's the line we'll use for a test run:

```
10 OPEN "COM:48N2E" FOR
   OUTPUT AS 1
```

This line opens a communications file buffer (COM); specifies the baud rate (4=600); establishes the word length (8=8 bits); determines the parity (N=none); provides for stop bits (2=2 bits); and gives the XON/XOFF status (E=enable). The statement "FOR OUTPUT AS 1" allows subsequent commands to be sent to the plotter merely by preceding them with a "PRINT #1," command.

This communications protocol line probably looks more complicated than it really is. True, if your computer requires such a line, you'll have to spend time looking up the proper values. Fortunately, most computer manuals *do* provide the information. Once you determine the protocol values, you can use the same set-up line in *all* your plotter programs.

Preparing to Program a Plotter. There are many plotter languages, most of which are fairly easy to learn. Because of space limitations, this discussion will be limited to the Hewlett-Packard Graphic Language (HP-GL), which is used by the popular HP-7470A and HP-7475 as well as other HP plotters.

No matter which plotter you use, before you can begin writing programs for it you must become familiar with the machine's coordinate system, plotting limits and, if present, scaling points. Figure 2, for instance, shows the coordinate system for the HP-7470A as it is defined when the machine is first switched on. When this machine's paper-size mode switch is set for standard 8.5 x 11-inch paper (US), plotter units for the X axis range from 0 to 10,300 and those for the Y axis from 0 to 7,650. A single plotter unit corresponds to a

pen movement of 0.001 inch.

Incidentally, notice the points marked P1 and P2 in Fig. 2. These are *scaling* points that define the area in which plotting can take place, the so-called *hard clip* plotting limits. At power-on, P1 and P2 are located as shown in Fig. 2. Both P1 and P2 can be moved to new locations, either manually by means of the front panel switches or under program control. This allows a plot to be reduced in size and moved anywhere on the paper. It also allows multiple plots to be made on the same paper.

Drawing a Line. Now that we've been introduced to the HP-7470A's coordinate system, we can load a sheet of paper and start drawing. This line of code will draw a diagonal line across the paper: SP1;PA1000,1000,PD,10000,7000.

When this line is received by the plotter, the machine will first retrieve the pen from its left pen stall (SP1 means *Select Pen 1*). It will then move the pen to the first pair of x-y coordinates (PA1000,1000 means *Plot Absolute* to the following coordinate pair). The pen will then be placed down against the paper (PD means *Pen Down*). Finally, the pen will be moved to the second coordinate pair (10000,7000), leaving behind a diagonal line across the paper.

Incidentally, notice the placement of a semicolon after SP1. In HP-GL, semicolons are used as *terminators* that separate most instructions from one another.

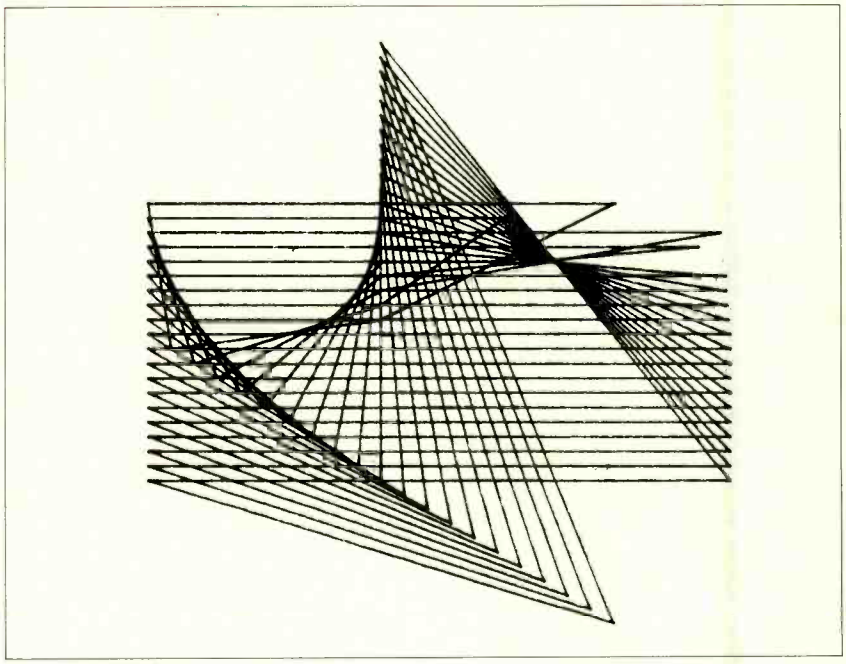
For these instructions to be sent from a computer to the plotter, they must first be incorporated into an appropriate driver program. Here's one that allows a Model 100 to send instructions to an HP-7470A:

```
10 'MODEL 100/HP7470A
   DEMO 1
20 OPEN "COM:48N2E" FOR
   OUTPUT AS 1
30 PRINT #1, "SP1,
   PA1000,5000,
   PD,4000,7000;"
```

Line 20 places the computer and plotter on speaking terms. Line 30 is a print statement that sends the HP-GL instructions to the plotter.

It's good plotter practice to lift the pen from the plotting medium during pauses and especially after a plot is complete. This keeps excess ink from bleeding onto the surface of the medium and is accomplished with a PU *(Pen Up)* command.

A nice feature of the HP-7470A is self-capping pen stalls that keep the pens from drying out. When a plot is completed, the final PU command can be replaced with SP0 *(Select Pen 0)*. This will lift the pen carriage and return the selected pen to its stall.



Some really attractive artwork can be created on a plotter.

Drawing Figures. Once you get a plotter to draw a line, you're only a few steps away from having it draw geometric figures. In the example above, for instance, all that's necessary is to add coordinate pairs to the PA instruction in the print statement. For best results, plan ahead by making a worksheet modeled after the plotter's coordinate system.

Here's a print statement that tells an HP-7470A to draw a triangle:

```
30 PRINT #1, "SP1;
   PA5000,5000,PD,
   7000,7000,9000,5000,
   5000,5000;SP0;"
```

The series of coordinates probably looks overly complex. But as you can see by the worksheet for the program in Fig. 3, the instruction sequence for making the triangle (and other figures) is actually very straightforward.

Incidentally, notice that the final coordinate pair is identical to the first. This is because the pen completes drawing the triangle at the point where it began.

Merging Graphics and Plotter Programs. Sometimes it's handy to have a plotter reproduce graphics displayed on a computer's display. For this to take place, you must first *embed*, or insert in the graphics program, additional steps that provide the necessary instructions for the plotter.

Here, for example, is a simple program that draws a triangle on the screen of a TRS-80 Model 100 portable computer:

```
50 CLS
100 LINE(120,32)-
    (200,0)
200 LINE-(200,63)
300 LINE-(120,32)
```

Line 50 clears the screen, and the remaining statements draw the three lines of the triangle. Any coordinates can be used so long as the x values fall within 0-239 and the y values fall within 0-63, the maximum range of the Model 100's liquid crystal display. The values given above form a large triangle centered at

(Continued on page 94)

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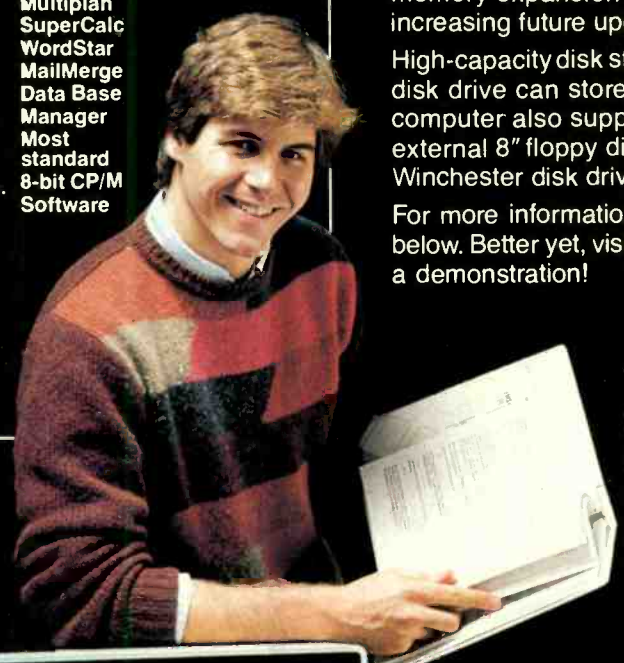
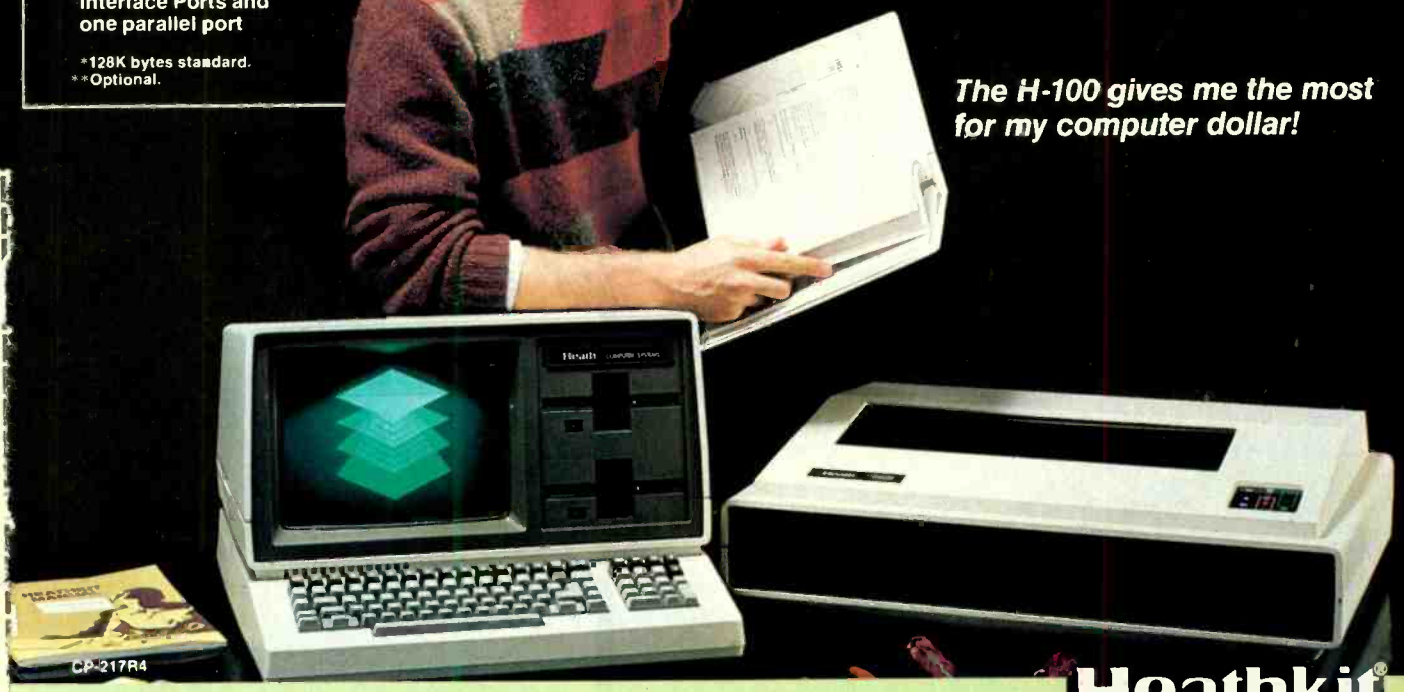


The H-100 gives me the most for my computer dollar!



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PHOTOGRAPH BY LIONEL FREEDMAN

MacIntosh

BIG STEP, SMALL FOOTPRINT

C&E gets a pre-release look at the newest Apple computer

By Vanessa Schnatmeier

APPLE Computer, possibly taking its cue from Robert Frost, has decided to take the road "less traveled" with its new microcomputer called Macintosh. It's no secret that most micro manufacturers are taking the path blazed by "Big Blue"—but not Apple. Its Macintosh is a low-cost 32-bit machine that runs under a proprietary operating system.

Aimed at what Apple terms "knowledge workers," Macintosh is a powerful, yet compact and easy-to-use microcomputer. It is similar to Apple's Lisa in that it has a sophisticated user interface that consists of pulldown menus, windows, and icons, with pointing, selection and other tasks handled with an electronic mouse.

Although by now Macintosh has already been released, we got to see it at a preview in Cupertino, CA. Here is what we found out.

Overview

At the heart of Macintosh is Motorola's MC68000 32-bit microprocessor. Some standard features of the machine are 128K RAM, 64K ROM, a 3.5" microfloppy disk drive, and a 9" black-and-white monitor.

At its rear, Macintosh has connectors for the mouse and an optional disk drive, two serial ports, and an audio output. Inside its beige case, Macintosh is streamlined to the point of bareness. Unlike the Apple II, there are no slots for expansion boards. Macintosh was designed for standardization and automated production, so "there just isn't any room" for add-ons, said a member of the design team.

Macintosh's 9.7" by 10.9" footprint (not counting the keyboard and electronic mouse) takes up less space on a desk than an ordinary in-box, and the unit weighs an eminently transportable 16 lb. Macintosh is upward-compatible with Apple's upgraded Lisa 2 (though not compatible with the Apple II or III), and is a member of what Apple calls its "System-32 Family." Suggested retail price of Macintosh, which includes the main computing unit (with built-in disk drive and monitor), detached keyboard, mouse, owner's manual, a guided tour of the machine on disk and tape (nicknamed MacLearn), a system disk, and a blank disk comes to a total of $2495.

A Tool for Knowledge Workers

The Macintosh is aimed at a segment of America's population that Steve Jobs, Apple's chairman of the board, calls "knowledge workers," people who compress information and ideas onto paper as a vocation or avocation. Apple estimates that army of workers to be about 25 million strong across the United States, and approximately 20 million in the international market.

As Mike Murray, marketing manager for the Macintosh division, explained it, the guiding philosophy behind Macintosh's (and Lisa's software) architecture is the creation of a "buffer zone"

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between the computer's operating system and its application programs. With most computers, users must accustom themselves to varying degrees of user friendliness, comprehensibility, and learning time from program to program.

With Macintosh, however, the consistent user interface imbedded in the ROM runs interference between the application program and the operating system. Users communicate with the Macintosh chiefly via the mouse and pulldown menus, in plain-language instructions rather than scores of cryptic code words.

The manual for the Macintosh is only about 100 pages thick, according to Murray, as opposed to the 3″-thick or multiple binders necessary for other systems. Murray indicated that beginning users require 20 to 30 hours of time to become familiar with some systems, while for the Macintosh the learning time is cut to 3 or 4 hours. Most applications will come with training cassettes as well as disks, according to Barbara Koalkin, product marketing manager.

The 16-lb Macintosh has a mere 9.7″ by 10.9″ footprint.

Macintosh Hardware

The CPU in Macintosh is Motorola's 32-bit MC68000 running at 7.8336 MHz. The 128K RAM that is standard with the machine cannot be expanded. However, when 256K or 512K RAM chips become available, Macintosh's memory could be expanded to 512K or 1026K, respectively. Macintosh's proprietary operating system and much of the application base is included in the 64K ROM. One Apple official, lauding the power and functionality of that ROM, called it "clearly the most magnificent technical achievement Apple has ever come up with."

The built-in 3.5″ disk drive is a modified Sony microfloppy. The disks, which are protected by a hard-plastic shell, can be formatted for 400K bytes of storage. Also built into the unit is a black-and-white, 9″ (diagonal) monitor that supports Macintosh's very-high-resolution (512 by 342 pixels) bit-mapped graphics capability.

There are two RS-232/RS-422 serial ports (1 megabyte/sec.) at the rear of the machine, as well as connectors for the mouse and an external disk. With appropriate software, the serial ports can be used to connect to other Macintosh computers (or other Apple models) in a networking arrangement called the Applebus.

Macintosh sound is produced by a 4-voice sound generator with 8-bit digital-to-analog conversion using a 22-kHz sample rate. The sound output jack is at the rear of the machine.

The detached keyboard looks similar to that of the Apple IIe, except that cursor keys are conspicuously absent. This is because the mouse handles cursor control. There are 58 keys on the keyboard, which is software mapped and has 2-key rollover. The mouse is a mechanical tracking device (similar to an upside-down trackball) with optical shaft encoding. It sends 3.54 pulses to the computer per millimeter of travel.

Analog board with power supply.

Last on the list of standard features is a CMOS clock/calendar with battery back-up. There are many optional hardware devices available, too. An external 3.5″ disk drive is slated to cost $495 ($49 for a 10-pack of disks); a separate numeric keypad, $129; an Apple 300-baud modem, $225; a 1200-baud version, $495; the Imagewriter printer, which can print Macintosh graphics, $495; and for those who want their Macintosh to talk to an IBM mainframe computer, there is Appleline, for under $1300.

To make sure no one takes off with your Macintosh, Apple sells a security kit for $49 that hooks into a security slot on the back. If someone defeats the security, he'll probably use the $99 fabric carrying case to whisk Macintosh away.

It is also notable that Apple is dealing with outside hardware manufacturers who will produce additional Macintosh peripherals. Perhaps the most significant maker of a wide range of computer peripherals to get on the Macintosh

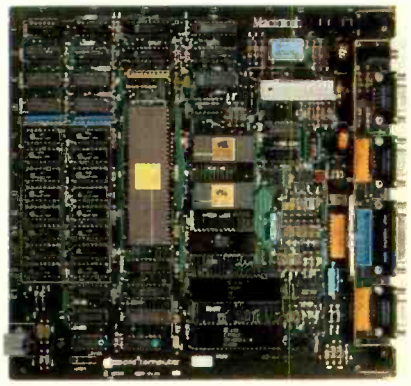
bandwagon is Tecmar, of Cleveland, OH. The company has already announced a series of add-ons to be available some time in the first quarter of 1984. The most important is a 5-Mb removable-cartridge Winchester that interfaces to Macintosh through Applebus. For those who want to use the Macintosh as a telephone adjunct, Tecmar has a telephone modem that is Bell 212A compatible and supports DTMF decoding and has pulse-tone automatic dialing and a full voice interface. A printer buffer and an IEEE-488 interface are also in the works.

Macintosh Software

Apple currently plans to release nine proprietary software applications over the first three quarters of 1984. Two of the basic applications, MacWrite and MacPaint, were released along with Macintosh. The two packages sell together for $195. (Other Apple software packages will retail around $100 each.)

MacWrite is a word-processing program that paves the way to a perfect document with features such as a "ruler" for tabs and margins; right, left, or center justification; easy modification of fonts and type size; and easy cut-and-paste operations.

The mouse, which must be used often during word processing, may be a small stumbling block for some people. Although users may not have any difficulty in manipulating the mouse to edit copy or mix and match paragraphs, some may have a spot of trouble switching back and forth between the mouse and the typewriter keyboard when editing a document. My opinion is that 15 or 20 minutes of experimentation with the mouse, to get used to maneuvering it on a surface and selecting options with the pushbutton, will stand the user in good stead when using MacWrite.



Digital board has CPU and RAM.

Macintosh is a powerful, yet compact and easy-to-use microcomputer

MacPaint is a sophisticated graphics program that provides a palette of shapes, fonts, lines, and sizes, enabling the user to draw or "paint" freehand with the mouse.

Other intriguing features of the MacPaint application are the *brush*, the *spray-can*, (which indeed produces a line and texture similar to that of the familiar aerosol), and a *lasso* that lets users knot freehand loops around an irregular figure they wish to copy.

Another of MacPaint's bells and whistles is an option that generates mirror-image graphics. Though probably not a high-usage feature, the images created with this feature are alluring in a Rorschach-like way.

Perhaps the most interesting aspect of MacPaint is it *fat-bits* option, which magnifies a selected area of the screen and permits the text or drawings to be modified on the pixel level. Drawings can be touched up or fonts can be modified or changed for the needs of a particular project.

On the Macintosh, information can be handled independently of the application under which it was entered, making it easy to paste a variety of drawings created on MacPaint into a company memo, or to interpolate captions from MacWrite into a slew of different drawings for any purpose.

Another application due in the first quarter of 1984 is the MacTerminal program, which allows Macintosh to emulate VT 100, VT 52, and TTY terminals. Also with Appleline (similar to IBM's Irmaline), it will be possible to emulate an IBM 3278 terminal.

Two more applications should be available in the second quarter: MacAssembler/Debugger and MacPascal. The MacPascal editor, demonstrated at the Macintosh preview, gives Pascal programmers a boost in several ways. For example, they can stop a program at the command currently executing. Also, they can split the screen to simultaneously view the code as it executes and the output of the program as the program progresses. A demonstration program that we were shown at the preview, a graphic display of boxes rotating in an inward spiral, illustrated the power of this feature for visualizing and refining the result of a program, especially in the graphics field.

Built-in monitor and 3.5″ disk drive.

The final four applications from Apple, MacProject, MacDraw, MacLogo and MacBasic, should hit the store shelves sometime during the third quarter.

Apple hasn't kept the goodies to itself for Macintosh software, however. Mike Boich, resident "software evangelist" for Apple, indicated that, as of November 1983, 75 developers had been "seeded" with the Macintosh technology and operating system, with approximately 100 software developers expected to be working on products by the release date in January.

Several major software publishers have thrown considerable backing behind Macintosh. Microsoft, for example, has developed nine software products and eight books for Macintosh. Microsoft officials expect 50% of 1984 revenues to be generated from the sale of Macintosh related products.

Some of the software and suggested retail prices from Microsoft are: MS-BASIC ($150), Multiplan ($195), Word ($195), Chart ($125), File ($195), Budget ($100), Financial Statement ($95), Cash Plan ($100), and Personal Finance ($95). Word is a word processor that includes a merge facility, Chart is a business graphics program, File is a database or list management program, and Budget, Financial Statement, Cash Plan, and Personal Finance are four "Expert System" products that work with Multiplan, Microsoft's spreadsheet package.

Software Publishing Co. will market PFS File and PFS Report for Macintosh for a suggested retail price of $100 each. Lotus Corp. is working on 1-2-3 for Macintosh. Apple also expects thousands of other packages for Macintosh to appear.

Lisa 2: A "Big" Macintosh

At the same time that Macintosh was introduced, Apple announced Lisa 2, which replaces the original Lisa. Lisa 2 will be marketed in three different configurations. The first, named Lisa 2, will come standard with 512K RAM, a 12" black-and-white monitor, and one 3.5" microfloppy for a suggested retail price of $3495. A second product, Lisa 2/5, will include a 5M-byte external hard disk and will sell for $4495. A third product, Lisa 2/10, will have a 10M-byte hard disk and sell for $5495.

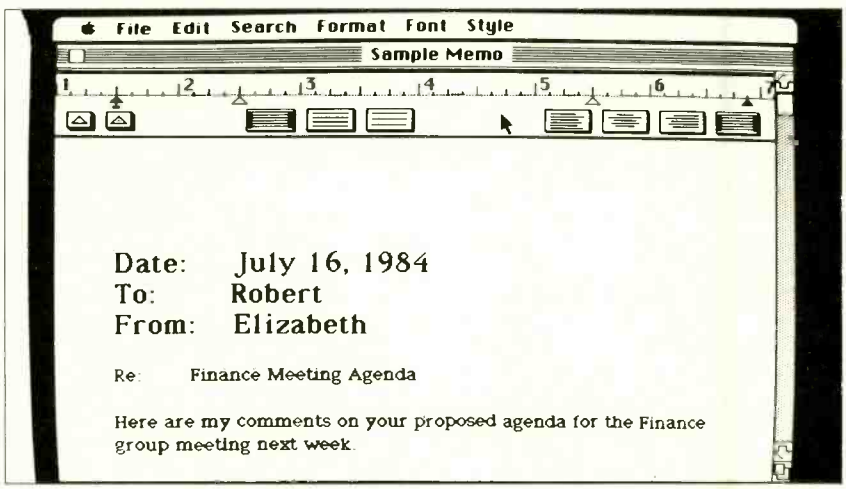
The applications software, which Lisa is so famous for, will sell for $200 to $400 each. To run the applications, a 512K add-on memory board is needed that costs $1350. The operating system for Lisa 2 is an additional $295.

One of the problems with the original Lisa was its slow performance in loading and saving documents. Lisa 2 reportedly works much faster, showing increases in speed of 100-200%.

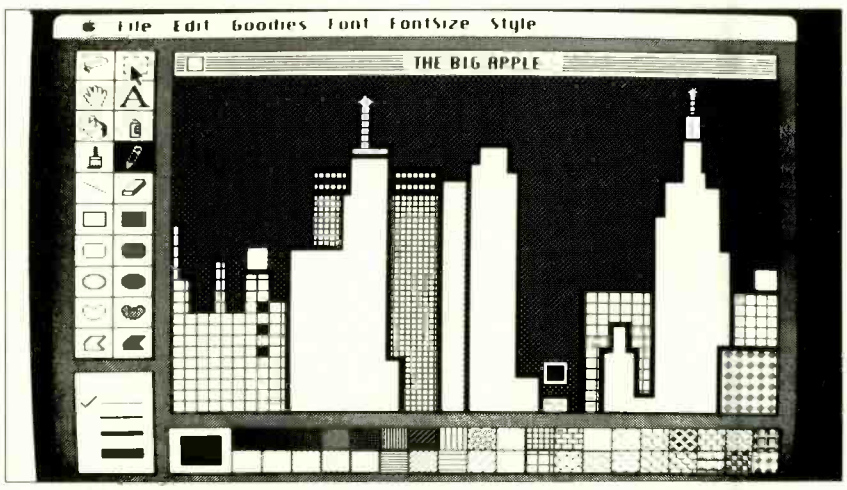
Lisa 2 will run all Macintosh software and, in fact, is an ideal configuration of a "big" Macintosh. A program called "MacAlike" allows Lisa 2 to emulate Macintosh. Some obvious pluses of Lisa 2 over Macintosh are the additional memory, larger screen display, and upgrade possibilities. Multitasking is another feature of Lisa 2. Although both machines have integrated software, Lisa 2 can juggle numerous different folders at once.

For those interested in using Lisa as a Unix workstation, two companies, Unisoft and Santa Cruz Operations, are marketing single and multi-user Unix systems that run on Lisa 2/5 and 2/10.

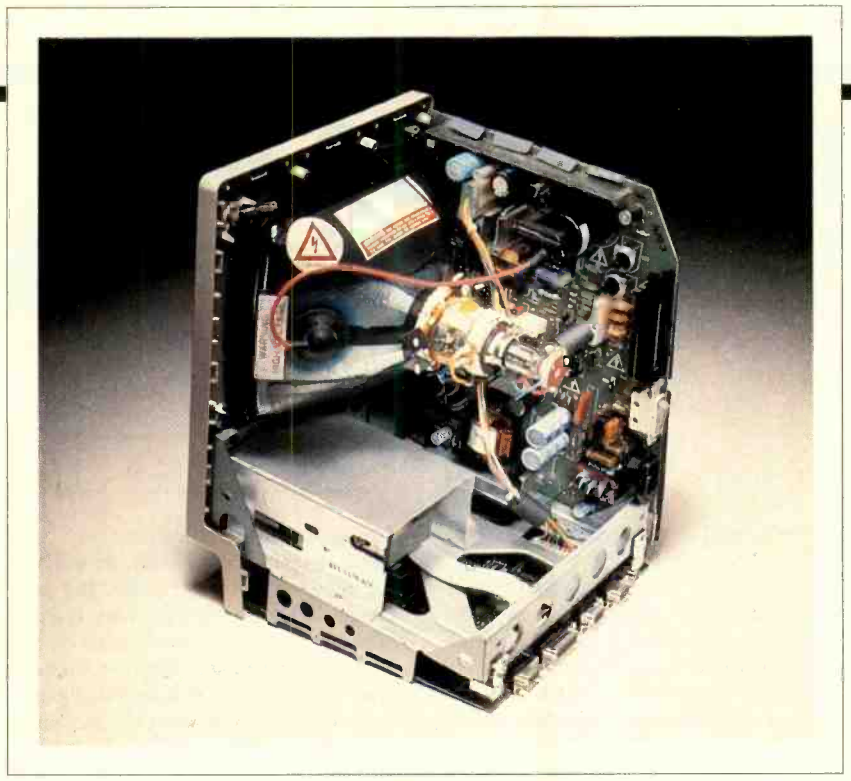
What happens to owners of the original Lisa? Wayne Rosing, general manager for the Lisa, said that Apple will offer retrofit kits free of charge to everyone who currently owns a "Lisa 1" so that the 3½" disk drive will be available to all. "We assure you we're taking care of our early customers," said Rosing. Users who want to upgrade fully to retain the ProFile as well as the 10M-byte hard disk can purchase a retrofit kit for that operation for "below $2000, with no profit to us," added Rosing. He noted that the expected volume of third-party software should entice Lisa owners to switch to the 3½" microfloppy.



MacWrite allows text in many sizes, fonts, and styles.



MacPaint makes it easy to achieve beautiful visual effects.



Macintosh, unlike Apple II, has no expansion slots.

Customers will have to lose their 5¼" drives to upgrade. The prospect of transferring megabytes worth of data from one storage medium to another may fill some users with trepidation, but for most, indicated Rosing, the data contained on their floppies is just back-up for the information stored on the hard disk. "In our survey there has not been anyone with so much data that they'd have to unbuild it and start again," he said "including the staff at Apple itself. Most people tend to keep their working data at about 5 megabytes."

Apple 32 SuperMicro Family

As well as making Macintosh and Lisa 2 upwardly software-compatible, Apple has developed a Lisa and Macintosh network via the Applebus system interconnect. Applebus, which is built into both computers, is a 230.4K baud, 32-node, 1000-foot interconnect that supports networking software.

Applebus will allow not only the Lisa and the Macintosh to electronically exchange documents, but also the Apple II and III family, at the text-transmission level. Graphics, a slightly more complex level of programming, won't always cross the fence between the architecture of the II/III and Lisa/Mac families.

Apple has also decided to drop its ill-starred Applenet, which Rosing called, "A great technical solution for a problem that no one wanted solved." Applenet capability would have cost $300 extra on the Macintosh and $500 extra on the Lisa.

In place of the Applenet, Apple has taken the surprising step of deciding to support IBM. "We really feel that there is one network of interest to the world—it's called the IBM local area network," said Rosing. Therefore, Apple will support the IBM LAN, while pushing its own Applebus. "We're also going to make full documentation available for Macintosh, and third parties, including IBM, can design all the goodies they want for it."

As companions to the Apple 32 SuperMicro System group of products, Apple plans to release two more products: an inexpensive laser printer, which will reportedly be able to print at high speed any document produced by the Macintosh or Lisa, and a file server of 74M bytes, with 20M-byte cartridge on an 8" Winchester disk. Apple plans to make the prices of these products "very aggressive," possibly at less than $10,000 for the file server and less that $5000 for the laser printer.

The market for all these products will be schools, universities, and the high end of small business.

International Macintosh

The Macintosh will be shipped to points outside the United States beginning in April. One major difference between the Macintosh and similar personal computers is that Apple has made tremendous efforts to localize the computer. Localized units have been designed for the United Kingdom, France, Germany and Italy. A bit further down the road are units for the Dutch and Swedish markets, perhaps even Hebrew and Arabic.

"We did this because it has been a very American and English industry," said Joanna K. Hoffman, international marketing manager for the Macintosh. "People who have used computers in any country have had to learn English, whether it has been mainframes, minis or micros; it has all been coming primarily from U.S. manufacturers. At the last Hanover Fair (a major European computer trade show), even Siemens was showing personal computers that spoke only English. And then they come back and say, 'The personal computer market in Europe hasn't taken off.' Clearly, if you (an English speaking person) had to use a machine that was in Japanese, it wouldn't have taken off in the States either."

Apple feels that a localized Macintosh will be extremely important for third-party software developers in Europe, because a machine that speaks their own language has a wealth of opportunities for them to increase their market size and market share. Hoffman said that Apple plans to set up third-party localizers for software, to whom they can refer software developers. That network should be in place by April.

"The reason that the Macintosh can be relatively easily localized," said Hoffman, "is the nature of the underlying firmware architecture, which separates the algorithms from the data. As a result, programmers don't have to worry about the language or format of the data as much."

She gave the example of a Macintosh program that one desired to translate into French. "To put in a French program, you ask the program to give you all the dialogue boxes; you get them on the screen, reshape them and resize them, and the program will use them automatically. The same is true of the menus, the keyboard types, and the lay-

outs. In hours, she said, one could localize software that previously would have taken months."

As another part of its efforts to make Macintosh international, Hoffman pointed out the icons used to direct the user within the programs and the labels on the external ports. As much as possible, Apple avoided using English and stressed the usage of internationally recognized symbols and pictures.

Apple has also been localizing programs for the IIe, the III and the Lisa. Hoffman predicted that the international market should equal the domestic market for the Apple family of computers in about 4 or 5 years.

A Bushel of Macintoshes

Macintosh's list price of $2495 is made possible in part because of the innovative assembly methods used in its production. A Fremont, CA, factory will churn out Macintoshes at the rate of one every 27 seconds when production is in full swing. The Macintosh was designed for automated production. The Fremont plant utilizes up-to-the-minute robotics technology to clap together Macintosh in six easy pieces.

What Won't Be Coming Soon

Close observers of this discourse may have noticed that despite the numerous possibilities of Macintosh's various applications, especially in graphics, one obvious option is not available: color.

"We can't do everything," said Steve Jobs. He indicated that a higher priority on Apple's list is a smaller, more portable computer, one which would be "book-sized."

No parallel port was included either, because it would have taken up too much "real estate" on the printed board. One rumor about the Macintosh before its release was that somehow it would support both the Apple proprietary operating system and MS-DOS. That, too, won't happen within Apple, though Apple will be completely open to someone endeavoring to write an application to accomplish that compatibility.

Despite these few omissions, Macintosh is an impressive product and worthy of taking the "less-travelled" road. Apparently, much of Apple's future depends on Macintosh, so its success or failure will truly make "all the difference." ◇

BREEDING A NEW VARIETY OF APPLE

The technical challenge faced by the Macintosh design team

By Vanessa Schnatmeier

THE soul of every new machine is different. Some computers evolve in an atmosphere of pure expediency and competitive frenzy; others begin as shy children pushed into the limelight; still others just grow.

The soul of the Macintosh, to look at the backgrounds of the members of its design team, should be half genius, half clown. How else to assess designers who list as their educational background, "BSEE, MSEE, Steven Wozniak University," or note as a major achievement having "welded a life-size razorback hog for the Mid-American Center Museum in Hot Springs, Arkansas"?

What set the Macintosh design team apart from many other corporate committees was the way its members were recruited to the project, largely on their enthusiasm for the unborn computer, rather than solely on the basis of their on-paper qualifications. "We looked for that twinkle in their eye," said Joanna Hoffman, international marketing manager for the Macintosh.

At the beginning of the project, in early 1980, the Macintosh team was very small, three or four people who were fascinated by the possibilities of the Macintosh. "It was a maverick product, out in the boonies," said Hoffman. "At first the corporation was very skeptical. It was hard to prove ourselves."

Many members of the core team had had previous experience working with the Apple II, through peripherals or software. The basic goal for the Macintosh was similar to that of the II, acording to Hoffman: a computer that could be used by all, even the "computer-naive."

Several concepts formed the backbone of design decisions for the Macintosh: small size, portability, no add-on slots, design for mass production, incorporation of the Lisa's user interface, and high-resolution graphics.

The original Macintosh prototype, back in what Hoffman calls "the pre-Mac period," was designed by Burrell Smith as an 8-bit computer based on the 6809 microprocessor. Soon it became apparent that the 6809 lacked the necessary power to accomplish the other aims for the computer, so the team quickly switched to the 32-bit 68000 from Motorola.

Once the microprocessor had been chosen, the team continually tried to push the technology just a little bit farther, particularly in the realm of software, while keeping the machine small, sturdy, and reliable. Wherever possible, the hardware for the Macintosh developed from off-the-shelf products instead of custom components.

The team continually tried to push the technology just a little bit farther.

Steve Wozniak's design for the Apple II and for the Disk II inspired the bare-bones layout of the Macintosh's logic board. Thanks to the wonders of PAL chips, the digital board packs in the custom graphics processor, a disk controller, hardware for sound and speech (in preparation for the coming wave of voice synthesis), the mouse connection, and the user interface, modeled on the "Lisa Technology." The analog board contains the computer's display electronics, and its power supply.

The corps of a new Apple (left to right): Andy Harzfeld, Chris Espinosa, Joanne Hoffman, George Crow, Bill Atkinson, Burrell Smith, and Jerry Manock.

And that's all she built—just two boards for a 32-bit, 128K RAM machine. This spare arrangement plays a crucial part in the mass-producibility of the Macintosh. "The Macintosh was designed to be built in the millions, with a minimal number of boards," said Barbara Koalkin, product marketing manager. The chief production plant for the Macintosh is capable of assembling one computer every 27 seconds, according to Apple figures.

Because of the decision to keep the number of boards low, the team decided to keep it a closed machine, and eliminated extra room for add-on memory boards or peripheral controllers. The Macintosh wasn't aimed at the computer hobbyist, according to Koalkin. It's for the general user, who would probably be happiest if he or she never had to touch the back of the machine at all and could instead treat it as just another tool, like a blender or a telephone.

Incorporating the Lisa's user-interface technology, while making the Macintosh more accessible to the international market was a triumph of the 64K ROM, indicated Hoffman. The Macintosh made only a few small changes in the basic Lisa programs, but compressed those same programs to bring them within the reach of a 128K RAM machine.

Two major decisions about the Macintosh came along relatively late in its development. High-resolution graphics had always been a primary goal for the computer, but until 1982 the Macintosh was slated to have only a 384-by-256 pixel display, certainly acceptable for business graphics, but not "at the leading edge of technology," Hoffman said. The efforts of George Crow, analog manager, pushed the resolution of the display to 80 dots per inch.

The leap to the 3.5" hard-jacket microfloppy also came late in the game. "We decided to go with the Sony disks because they were able to almost double our capacity," said Koalkin. "They're also much easier to handle than the fragile 5¼" floppies," she added. "People just leave them scattered around on their desks or lying in their pockets. I carry them in my purse, where they get knocked around and nothing happens."

Much of the team's unity of purpose came from Steven Jobs, both Hoffman and Koalkin concurred. While the design team didn't accept a new member unless the entire group approved of him or her, much of the recruitment for the team came from Jobs, who lured people away from other companies, pulled them off other projects, or otherwise cajoled them into joining the group if he felt they would be good for the project.

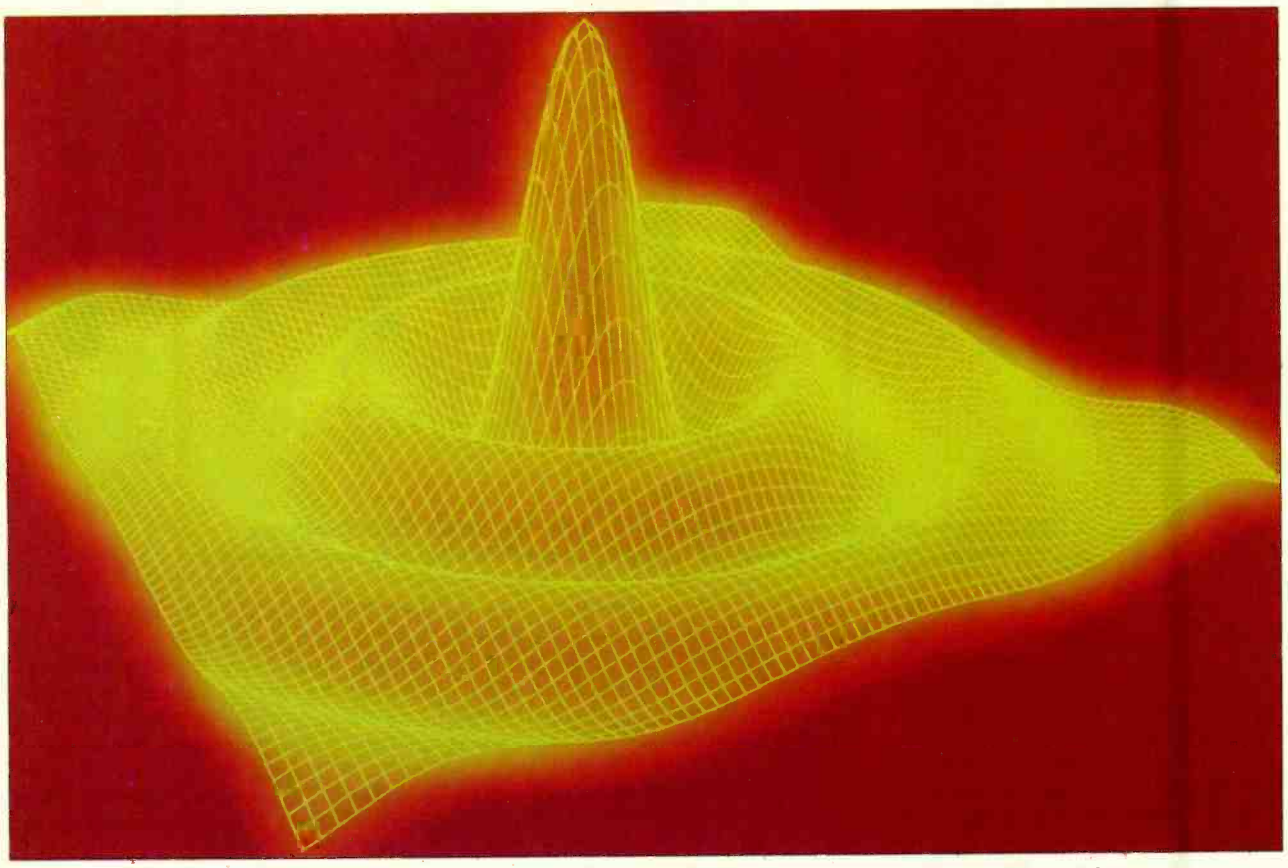
"Steve was always very involved on every level," said Hoffman. "He's a real technophile, and also a very esthetics conscious person. The design people sometimes felt very frustrated, because he'd notice every detail and say, 'Could you change this another degree and a half?' Even the styrofoam in the box had to give the sense of immediate gratification. He's a vey motivational kind of guy, like a Roman legion commander. He really knows how to motivate small groups of people to produce." ◇

Quick on the Draw:

INEXPENSIVE PLOTTERS

Consider an x-y plotter as your next hardware acquisition

By Forrest M. Mims, III



Beautiful effects can be achieved with three-dimensional contour plots such as this.

THE x-y plotter is among the most versatile of computer peripherals. A sophisticated electromechanical drawing machine, the plotter is like a computer-driven robot whose sole purpose is to draw, on paper or plastic film, *any* design, shape or pattern whose parameters have been incorporated into an appropriate driver program.

When personal computers first became available, x-y plotters cost as much as luxury sedans and were *very* difficult to program. Only well-financed laboratories and universities could afford them. So relatively few computer users were familiar with their operation and fewer still could program them.

Happily, the cost of plotters has recently followed the precedent set by the plunging prices of personal computers. Now you can buy a high-quality, multipen plotter for under $1000. If you can settle for plots on paper 4½" wide, you can purchase a 4-color plotter for as little as $200!

Early plotter "languages" resembled machine language codes and were therefore very primitive and exceedingly difficult to implement. Fortunately, at the same time plotter prices were falling, their manufacturers were making important advances in plotter programming languages.

Today's plotters are supplied with high-level, mnemonic-structured instruction sets which, when compared with the earlier languages, are very easy to use and remember. *PU,* for instance, means *Pen Up* in HP-GL, the powerful graphics language used by Hewlett-

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Packard plotters. Similarly, *PD* means *Pen Down* and *PAx,y* means *Plot Absolute* (i.e. move the pen) to the point specified by the x-y coordinates.

Having long been impressed by the capabilities and the potential of x-y plotters, I purchased one long before buying a printer. It was my sole computer output device for nearly a year.

Since some of my friends failed to share my enthusiasm for plotters, I was delighted when David A. Ahl, editor of *Creative Computing* magazine, expressed his zeal for plotters in the October 1983 issue of the magazine he edits. "I feel," Ahl wrote, "that plotters represent a vast, untapped resource for artistic expression, and should be the computer peripheral of choice after a disk drive."

Ahl is certainly correct about the artistic potential of the plotter. On a recent tour of Houston Instruments, a major manufacturer of plotters, I saw some truly spectacular examples of plotter-generated art created by a gifted programmer in his spare time.

Of course, being very versatile machines, plotters can also perform tasks far more mundane than creating artwork. For example, they are becoming increasingly popular for producing business graphics. Indeed, some companies use plotters solely as the hard-copy output device for a computer that does nothing but make publication-quality posters, signs, name cards, business forms, pie charts and assorted kinds of bar and line graphs. While these applications are important, plotters are superbly suited for much tougher assignments like drafting. They can draw such things as maps, surveys, house plans, and circuit diagrams.

Since the plotter must be programmed for a specific task, an entire job may not be accomplished any faster than a human being equipped with pencil and paper. The advantage of the plotter is that frequently used symbols and the data for a specific drawing are stored in a computer's memory. Completed drawings can therefore be conveniently edited, and revised drawings can be turned out efficiently and rapidly, even long after everyone has gone home.

My plotter is used for many of these purposes and more. For example, I've programmed it to make custom graph paper, stationery letterheads, manuscript forms and Christmas cards. I even use it as a printer. Indeed, the appearance of some of the correspondence printed by my plotter has so impressed the recipients that they have *telephoned* their responses!

When my plotter's not performing printing tasks, it draws circuit diagrams and produces hard-copy versions of the image on the display of a computer I've programmed to function as a storage oscilloscope. And when it's not working at these tasks, I enjoy playing with it. What other computer peripheral behaves much like a pen-wielding robot that draws on paper anything you tell it to? Certainly no other peripheral is as much fun to watch!

Kinds of Plotters

Ink-jet, thermal and carbon-ribbon dot-matrix printers build images from thousands of closely spaced dots. An x-y plotter draws continuous lines with a fiber, ballpoint, or drafting pen. Colored inks are often used.

Though plotters can draw on most kinds of paper, publication-quality plots are best made on specially coated paper. Projection transparencies can be easily made by substituting transparent film, in which case special pens must be used.

There are three principle kinds of plotters: *flat-bed, drum* and *roller-bed.* It's important to be aware of their differences.

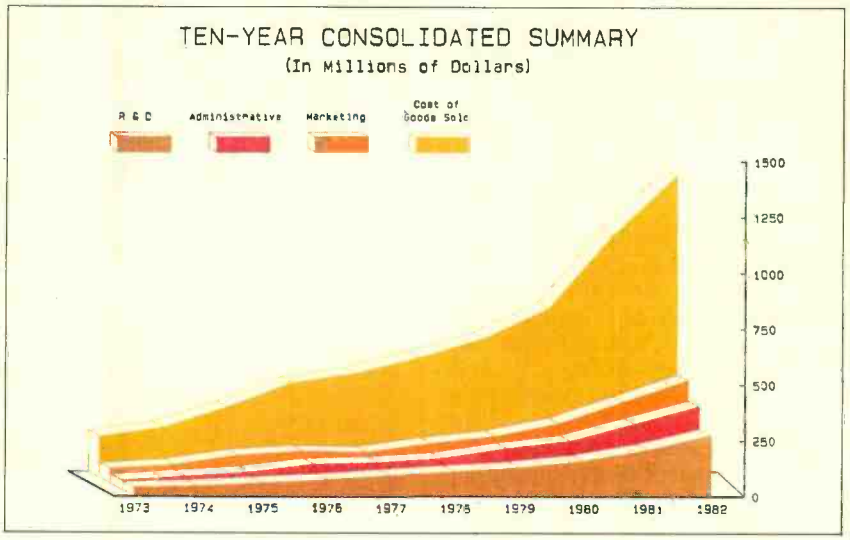
Most flat-bed plotters occupy considerable desk space since the medium upon which they draw is laid flat on the machine's upper surface. As shown in Fig. 1, the pen moves back and forth across the surface of the medium via a carriage assembly while the pen holder itself moves up and down the media while moving with the carriage assembly. The two directions of movement are controlled by a pair of stepping motors. A solenoid at one end of the carriage assembly raises and lowers the pen.

The typical flat-bed plotter includes as many as eight pens in stalls along one side of the bed. Under program control, the pen currently in use can be returned to its stall and a new pen selected. This permits easy multi-color plotting.

The typical drum plotter is much more compact than a flat-bed unit. As shown in Fig. 2, the drawing medium is wrapped around a drum which can be rotated to provide movement along the x (or y) axis. The pen carriage assembly is much simpler since the pen is required to move only back and forth as the drum rotates beneath it.

The roller-bed plotter is an elegant adaptation of drum plotter technology. As shown in Fig. 3, this kind of plotter is equipped with a pair of motor-driven, grit-coated wheels on either side of a relatively narrow, flat bed. A sheet of paper or plastic film with a removable paper backing is placed on the bed, and a pair of free-wheeling rubber wheels is clamped snugly over the medium and the grit wheels. The paper can now be moved back and forth across the surface of the bed while the pen carriage assembly moves back and forth above it. Since the grit-coated wheels impress a distinct (but virtually invisible) track along either edge of the paper, the repeatability of this method can be surprisingly good.

Several companies make roller-bed plotters capable of drawing on large



A three-dimensional time-series plot of four financial items.

sheets of engineering paper. These plotters are mounted on a stand over each side of which the paper is hung. Large plotters such as this put on quite a show as their paper is whisked up and down while various pens are selected and pushed back and forth across the fast moving medium.

Each type of plotter has advantages and disadvantages. Flat-bed units generally have more pen stalls, tend to be quieter than drum and roller-bed plotters, and are unquestionably the most fun to watch. But they tend to be bigger and heavier and have more moving parts than their drum and roller-bed counterparts.

Drum plotters require the least amount of desk space but are generally designed to draw on media having a fixed size. It's more difficult to load the medium into such a plotter since it must be wrapped around the drum and mechanically secured.

Both drum and roller-bed plotters have far fewer moving parts than flat-bed units and are therefore less expensive and easier to maintain. An additional advantage of roller-bed plotters is that drawing media of various lengths (but, usually, constant width) can be used. Since only the pen carriage and the virtually weightless drawing medium are moved, roller-bed plotters can be very fast. However, this requires very quick up and down movements of the pen carriage for the pen to keep up. The result can be considerable, staccato-like noise.

As with any electromechanical device, it's essential to protect the moving parts of plotters, especially large ones, from obstructions like instruction manuals and probing fingers. Should a collision occur, chances are high that both the plotter and the obstruction will be damaged.

Roller-bed plotters require an additional caveat about the rapidly moving paper. Though the roller-bed plotter requires less desk space than its flat-bed cousin, space *must* be provided for the moving paper.

The apparently "flimsy" paper in my roller-bed plotter has occasionally knocked cassette tapes, pencils and other objects clear off my desk. More substantial obstacles crumple the paper or cause the grit wheels to spin under the paper. Should the paper become misaligned in this manner, it will be sent flying from the back side of the plotter the next time the instruction for a long y-axis movement is executed.

Plotter Specifications

The foremost plotter specification is *resolution*, the smallest distance of which the machine's pen is capable of moving. Some plotters have a resolution as fine as 0.001" and can draw flawless curves, arcs and circles. Indeed, their resolution permits plotters to provide finer detail than most video monitors.

While resolution is a vital plotter parameter, it's of little use when viewed alone. A realistic plotter evaluation must include a look at *repeatability*, the accuracy with which a plotter's pen can return to a previously plotted point. Virtually all plots include many instances where lines begin, end, or intersect at previously plotted points. For instance, every drawing of an enclosed geometric figure requires that the pen complete the figure at the point where it began.

Most plotters, even low-cost units, have surprisingly good repeatability. Typical repeatability figures for plotters whose pen has not been changed range from ±0.003" to ±0.01". The repeatability accuracy is degraded by as much as a factor of two when the pen is changed. This is because the physical location of the point of the new pen might not exactly match that of the first pen.

How does one assess the relative importance of resolution and repeatability? Generally, a plotter with a resolution of only a few hundredths of an inch, but with a repeatability of, say, 0.003", is superior to a unit having finer resolution but poorer repeatability.

Pen velocity is another significant plotter parameter. Plotters are slow pokes compared to dot-matrix printers. If a plotter application requires high throughput, it's essential to select a model with a fast pen velocity.

Maximum pen velocities range from a low of about 3 inches per second (ips) to a high in excess of 22 ips. Keep in mind that maximum pen velocity figures apply only when both the x- and y-axis motors are operating at their maximum speeds. Therefore the *average* pen velocity of a plotter will always be less than the unit's *maximum* velocity.

Also keep in mind the fact that a plotter's noise level is often directly proportional to its pen velocity. This can be an important consideration if the machine is to be used in a crowded office or in a home or apartment.

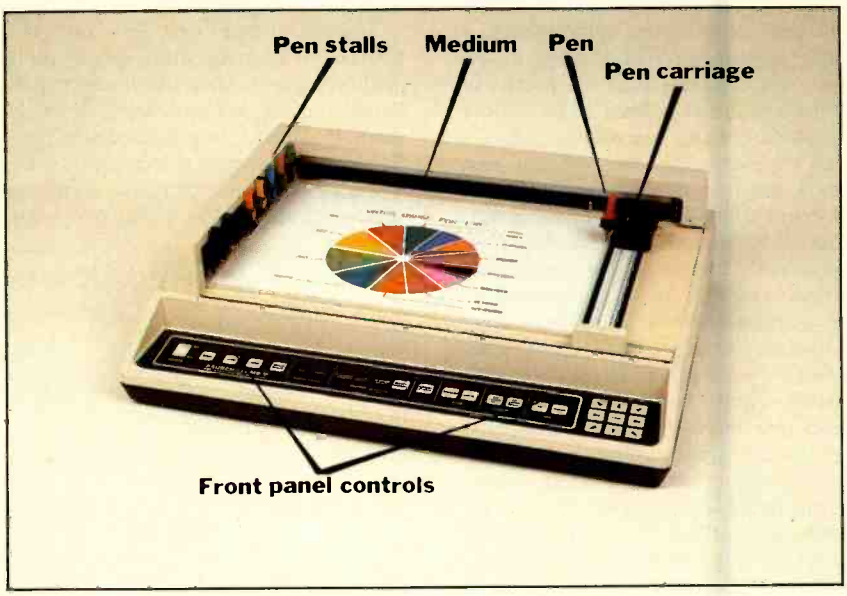


Fig. 1. A typical flat-bed plotter.

Plotter Languages and Instruction Sets

If you plan to use commercial software to drive your plotter, you need not be overly concerned about plotter languages. Just make sure the plotter you select is well supported with ample software.

On the other hand, if you plan to write some of your own software, it's a good idea to review the instruction sets of competing plotters before making a

purchase decision.

Experienced BASIC programmers should have little difficulty learning to use a particular plotter's language *if* the instruction manual is well-written and has numerous programming examples. Incidentally, Hewlett-Packard publishes the best plotter manuals I've seen thus far. Other manuals are generally adequate, but none matches HP's organization, thoroughness, and clarity.

If you're an experienced programmer but are unfamiliar with plotter languages, you should be aware that the graphics commands of BASIC and other computer languages are *not* directly compatible with plotter languages. In other words, that BASIC program you've written to display color bargraphs on your computer monitor will *not* work with a plotter.

Instead, you must write a special program that informs the plotter how to draw a bargraph. If you want to see a video version of the bargraph also, you

Each type of plotter has its advantages and disadvantages

can embed the plotter instructions between the lines of your original BASIC program. That's easily done since instructions can be sent to a plotter in standard BASIC print statements.

If your plotter has a *scale* instruction, you can easily set the machine's minimum and maximum coordinate values equal to those on your computer's monitor. This further simplifies modifying an existing graphics program to accommodate a plotter.

Plotter Features and Capabilities

The features and capabilities of today's plotters are impressive by any standard. While no single plotter is equipped with all the various features now available, most include a wide range of sophisticated labelling and line-drawing options.

Typical line-drawing instructions include commands for various kinds of broken and dashed lines, curve fitting, and automatic insertion of tick marks on graphs. Also available are commands for drawing circles, ellipses, and arcs.

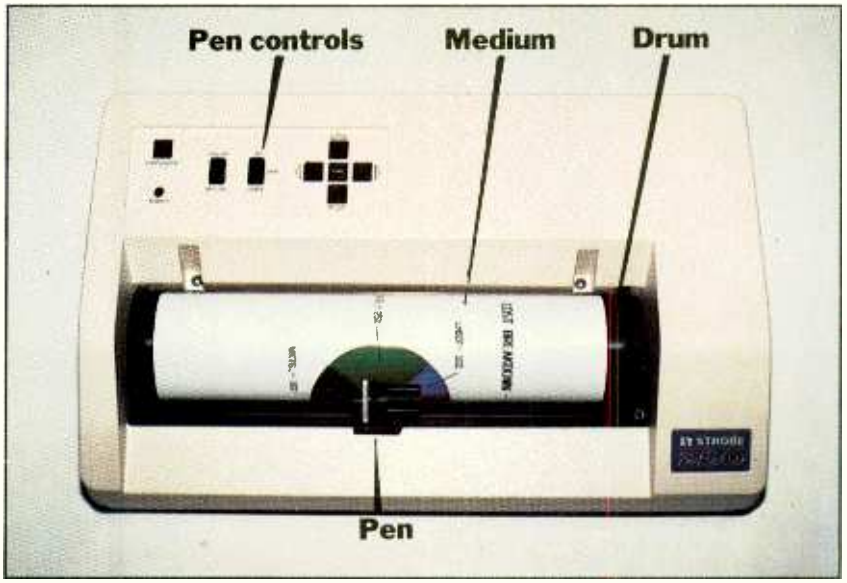


Fig. 2. A compact drum plotter.

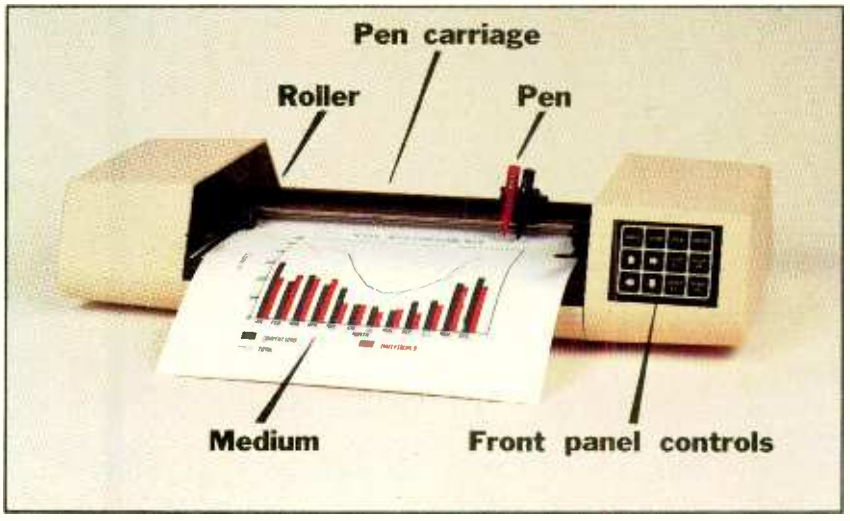


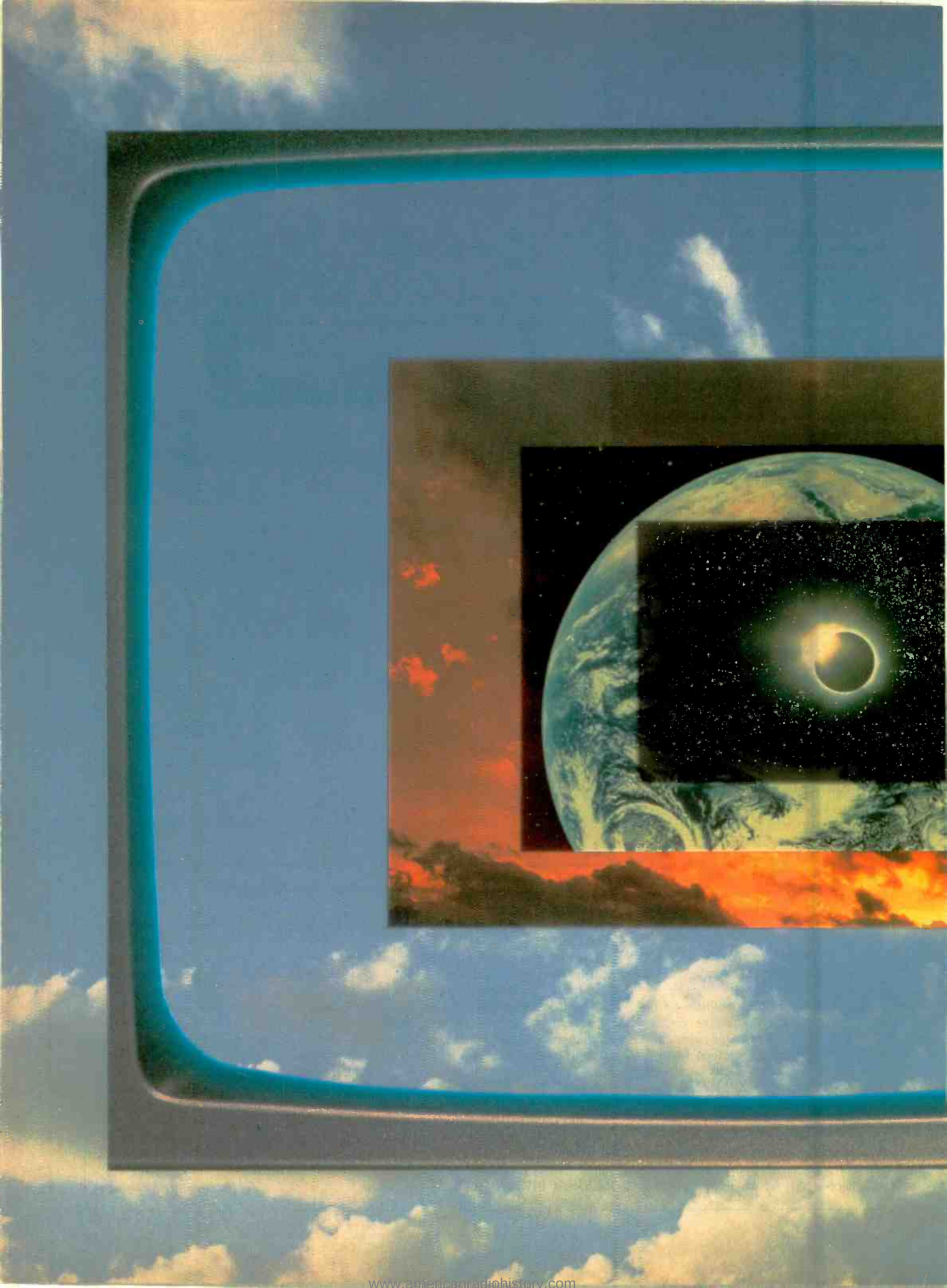
Fig. 3. A typical desktop roller-bed plotter.

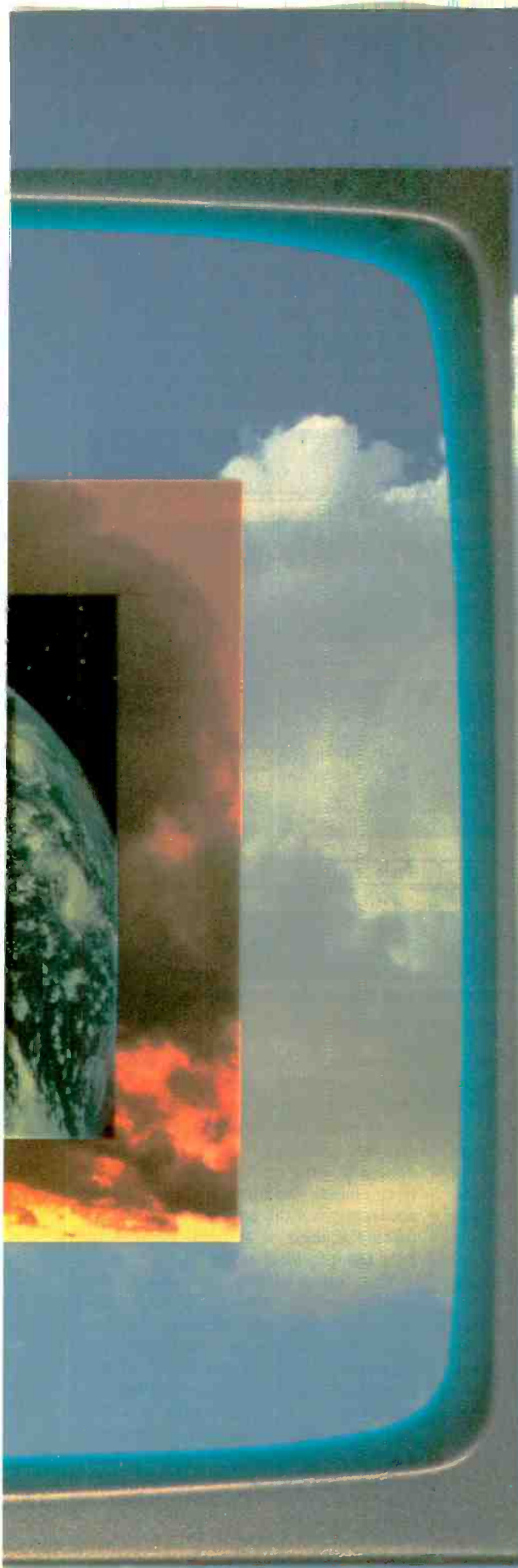
Labelling features include commands that set the size, height-width ratio, and orientation of labels and text. Some plotters include multiple character sets with various symbols and non-English characters. A few even allow the creation of custom symbols and character sets.

Most plotters include means to change the size and aspect ratio of a plot, either manually or under program control. For example, economically priced roller-bed plotters like Houston Instrument's DMP-40 and Hewlett-Packard's HP7470 include functions that allow a user to change the size and aspect of a plot and then reproduce the modified plot anywhere on the same or a new sheet of paper. Manual selection of a plot's size, aspect and location is easily accomplished by means of front-panel keys that control pen location and set scaling points.

While most plotters are used solely in an output role, many can also function as input digitizers. In this mode, the pen is usually replaced by an optical sight. A drawing, map, photograph, or other image is placed on the plotter's bed and the sight is moved to any desired point by means of the machine's front-panel con-

(Continued on page 104)





PHOTOGRAPH BY BARRY BLACKMAN

WINDOWS

AT PANES TO INTEGRATE SOFTWARE

The new wave of integrating software helps programs work together

By Josef Bernard

THE year 1984 may well go down in history as "The Year of Fenestration." The year computers got windows. Windows that allow you to look from one program into another.

The capability of a piece of software or an operating system to provide windows through which you can examine data elsewhere in the system is really secondary to its main function, which is to make separate programs work together in an integrated environment. That is, to allow information produced by running one program to be used in another.

(This *integrating* software, which coordinates discrete programs, should not be confused with *integrated* software—like Lotus 1-2-3—which is a single package capable of performing several different functions.)

For example, you may be writing a letter or report using a word processor and want to include in it a graph created by another program, a spreadsheet. With integrating software you can do just that. As you're creating your document in one window on your display screen, you can pause and go to another window where the spreadsheet operation is running. There, you can instruct that program to produce a graph illustrating its results.

Then, using a pointing device like a mouse, you can instruct the windowing software to mark the graph for extraction, and transfer it from the spreadsheet window to the word-processing window. It then becomes a part of your document.

Does the world really need integrating windowing software? For some of us, the answer is: Yes, this is just what we've been waiting for!

Certainly, in many applications—writing or editing, for

Josef Bernard is a C&E Technical Editor.

example—this feature is less important than the particulars of the program being used. Most programs are written to perform one specific function well. And many people who have computers use them for only one or two purposes . . . one at a time.

On the other hand, there are times when the ability to have instant access to several programs at once is a definite advantage.

The case given earlier concerning the graph that was integrated into the word-processed report is one good example. Another might be a mailing list (created by a mailing-list program or just a word processor) that is subjected to statistical analysis by another program. Another might involve scanning several documents simultaneously for information on related topics. A paragraph found in one could be easily transferred to one or more of the others.

Why haven't we had windowing software sooner? It is only recently that microcomputers have become powerful enough, and memory for them cheap enough, for windowing systems for micros to become practical. Apple's Lisa, an entire computer system designed specifically to run integrated packages, was introduced only last year.

Integrating software requires a lot of computing power if it is to be truly useful. Certainly an 8-bit system *can* run several programs at once, but when the programs become more than rudimentary, the demands they make on a microprocessor can slow a system down to the point where waiting times become interminable.

The advent of 16-bit systems, with their more powerful and efficient microprocessors, makes it feasible for a computer to have several complex programs running simultaneously. Even though there may be some restraints on efficiency caused by the 8-bit data bus structure still used by most so-called 16-bit computers, their internal architecture and extended memory addressing capabilities allow microprocessors like the 8088 (used in most current 16-bit machines) to handle complex tasks with more ease than can their 8-bit predecessors.

The availability of inexpensive memory is an even more important factor in making integrating software a reality. Complex programs, the data they must manipulate, and the results they generate require considerable memory.

While it is technically possible to use a small amount of memory and shuttle data back and forth between it and disk, that is a very inefficient method. It's much better to have as much as possible of what you're working with resident in memory all at once. High-capacity memory boards make this possible at a reasonable cost. Even so, frequent disk accesses—and the slowdowns in processing that result from them—are a part of the overhead of integrating programs, and even of some of the standalone integrated programs that offer a plethora of features. Still, the disk bottleneck is reduced as memory size increases.

Today it is possible to have several hundred K of memory in your computer for the price of just eight or sixteen K only a few years ago. Just the fact that so much memory is available so readily has made integrating software almost inevitable.

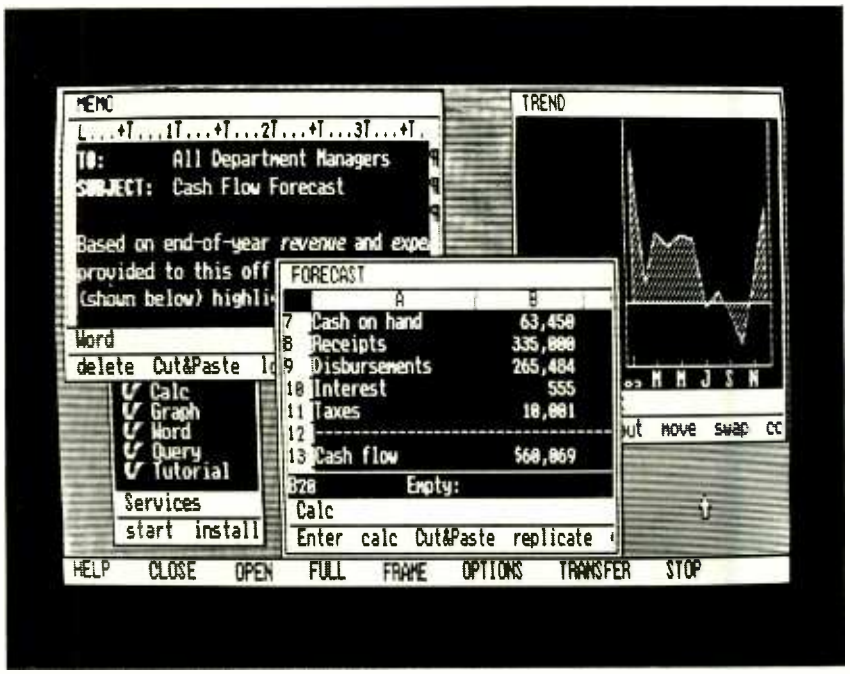
What makes the sophisticated visual capabilities of the new windowing software work is again a result, to a large extent, of the low cost of memory. High-resolution *bit mapped* display techniques are typically used. A bit-mapped display is one where every picture element created and displayed by the computer has a corresponding location in memory. And, with memory cheap, high-resolution displays are feasible. It is the ability to put high-resolution images on the screen and manipulate them that makes it possible to present the displays needed by windowing software.

Consider. As you move the mouse beneath your hand on your desktop, a small arrow or other marker moves correspondingly about the screen. Without a bit-mapped display containing a large number of picture elements, it would not be possible to do even that. When it comes to changing the size of a window, or scrolling material within it, the ability to change the display smoothly and accurately is vital, and can only be performed if there is enough memory to hold the information for display.

The other factor necessary for windowing is a powerful microprocessor. Every time the display changes, enormous amounts of data have to be manipulated. To do this while, at the same time, maintaining a certain level of computation, requires a type of CPU and instruction set that simply were not available until recently.

Given these things, though, the stage is set and windowing software is here.

Only recently have computers become powerful enough for windows



Visi On overlaps windows like papers on a desk.

Visi On

Probably the most heralded windowing package has been Visi On

from VisiCorp, the company that sells VisiCalc and the other VisiSeries programs.

Intended for business professionals and managers, the Visi On system is a completely integrated applications environment that allows a personal computer screen to take on the function of a desktop. Windows that allow users to work on several tasks simultaneously appear on the computer screen in the same way as sheets of paper on a desk. Like papers, the windows can be stacked or piled on top of each other, with the window representing the current job being topmost and occupying most of the screen.

A mouse permits users to manipulate information within each window and to transfer information between windows and applications. The Visi On mouse differs somewhat from other mouses on the market. (No plural form of the word has yet been agreed upon. Some say "mouses." Others say "mice.") Most mouses use strictly mechanical means to sense movement. They work somewhat like an upside down arcade-game trackball. The device offered by VisiCorp uses an infrared sensor to determine its position. It is, presumably, more accurate. Certainly it has fewer moving parts, and could prove more reliable. Even this mouse, though, is connected to its computer by its tail. The infrared device is used only to sense movement, not to transmit information to the computer.

Some windowing systems use pictures, or *icons*, on the screen to represent functions to be carried out. By using the mouse to point to an icon of a sheet of paper, for instance, a word-processing program might be invoked. Pointing to a picture of a floppy disk could bring forth a menu of disk functions from which a particular operation (like COPY or ERASE) could be called up. Visi On, though, prefers to use words, feeling that they are more descriptive and easily understood.

A menu at the bottom of the screen lists eight commands that are constantly available to the Visi On user. They are:

- HELP: Provides an explanation of anything visible on the screen. Describes and cross references each part of the Visi On system. Consists of more than 100 pages.
- OPEN and CLOSE: Allows user to set aside and retrieve windows.
- FULL: Enlarges a window to fill the entire screen.

Some systems use icons, others keywords for menu selections

Rather than overlapping, Microsoft's windows abut one another.

- FRAME: Repositions and resizes and window.
- OPTIONS: Displays and permits changing of parameters that affect the way individual activities act.
- TRANSFER: Moves information between windows and applications.
- STOP: Terminates the current functions.

Visi On is referred to by its originators as an "applications manager." It is a shell that becomes integrated with MS-DOS to permit that operating system to run software interactively. Programs will have to be tailored to run under Visi On; and, to that end, VisiCorp makes available to independent software vendors a development package for the C language that runs under the Unix operating system on computers from micros to mainframes.

Similarly, the Visi On shell itself has to be specially configured for different systems. At about the time you read this, it should be becoming available for a number of computers, including the IBM PC and XT. As a matter of fact, IBM and VisiCorp have signed an agreement whereby IBM will distribute and sell Visi On and the software from VisiCorp that runs under that system through its own channels.

As can be seen from Fig. 1, Visi On is designed to isolate itself and the software it runs from any operating system or hardware peculiarities. Once the host interface has been developed (by a computer manufacturer) and overlaid onto the host operating system, it should be possible to use any Visi On compatible package on any Visi On system.

A large number of software and hardware suppliers have hopped on the Visi On bandwagon, including VisiCorp itself. Among the interactive programs it is offering are: Visi On Calc (spreadsheet), Visi On Word (word processing), Visi On Graph (graphics), and Visi On Query (relational database management system).

Visi On requires an MS-DOS based computer with 512K of RAM and a hard disk. A mouse, too, is a necessity.

Windows

Visi On's chief competitor is Microsoft's Windows. It, too, is an extension to MS-DOS, providing a universal integrating operating environment for soft-

(Continued on page 101)

FROM ONE COMPUTER TO ANOTHER

Electronic mail provides a big plus for personal computer owners

By Arthur P. Salsberg

ONE of the most tantalizing applications for a personal computer is electronic mail. It comes in two flavors: electronic messaging and computer-generated mail. Anyone with a computer, modem, communications software, and telephone can use this business- and personal-information delivery tool. In some instances, a portable terminal and access to a telephone are all you need to achieve your goal. However, there are many options that will improve your appreciation of this fast-growing communications area.

Electronic Messaging

It's often more efficient and less costly to transmit messages and documents by computer than other means, such as conventional mail or voice telephone communications. Mail delivery often takes days; while if you phone someone, the chances are that he or she is not available for one reason or another or that the information is too complex to relay person-to-person.

Arthur Salsberg is C&E's Editorial Director.

You can send data directly to a person's computer for immediate reading or, if the computer is unattended, for storage and later reading. Another variation of electronic mail utilizes electronic mailboxes. Here, a message is stored by a service for electronic "pick-up" by the addressee at a convenient time. Local area networks can also be used to send and receive mail as described in another article in this issue of C&E.

A handful of major vendors supplies electronic mailboxes (said now to number nearly 100,000) for business-oriented purposes. These suppliers include General Electric with its Quickcomm, ITT's Dialcom, Tymnet's Ontyme II, and GTE Telenet's Telemail, among others. Information utilities such as CompuServe, The Source, BRS After Dark, and Delphi also offer electronic mailboxes, and there are many local computer-club and private bulletin-board systems (CBBS or BBS, for short). Unlike the others, the latter are often free systems manned by a hard-working systems operator (SYSOP) as a labor of love. The first computer bulletin board system is said to have been started by Ward Christensen and Randy Seuss around 1978 in the Chicago area so that club members would have a good way to contact each other by computer.

A personal computer can be used to communicate with Telex (telegraph exchange) and TWX (Teletypewriter exchange) machines, too, reaching virtually any country in the world by accessing one of about $1^1/_2$-million such machines now in use. To do this, though, you might like to subscribe to a special service to do the "translating" for your computer for electronic mailbox and store and forward work. One concern that offers such a service is Graphnet, Inc., Teaneck, NJ 07666.

Electronic messaging has one major shortcoming: The only people you can reach are those having computers or terminals. Moreover, these people would have to employ the particular service you use.

Computer-Generated Mail

Unlike electronic messaging, where the addressee has to personally bring up an electronic message (or else it will simply lie in the electronic mailbox unread by anyone), computer-generated mail systems translate data into hard copy that's then mailed or delivered by private carrier to the addressee. The advantage here is the elimination of stuffing the mailing piece in an envelope, determining how much postage is needed, and mailing the material. Additionally, some systems melt away the miles by relaying data to an area near the addressee.

Hoping to cash in on the new technology, the Postal Service initiated a computer-generated mail system in January 1982, called E-COM. In a typical use of the system, a letter that's composed on a computer is sent over the phone lines to one of the 25 post offices equipped to handle it. The Postal Service then prints it, puts it in an envelope, and delivers it the same way that First-Class mail is

handled. One big obstacle to the efficiency of the system is that there are only 25 locations nationwide that can accommodate E-COM transmissions, none of which can transmit data electronically to a post office closer to the intended destination. Further, the sender must pay for a minimum of 200 messages at a time, at a cost of 26 cents for each one-pager and 32 cents for each two-page message. And there's a $50 charge to establish an E-COM account.

Of course you can bypass the 200-minimum requirement of the Postal Service by using other services that bundle individual E-COM messages until 200 are gathered. You also avoid the $50 annual fee this way, too. One such service is Compuserve's EMAIL. MCI recently introduced a competitive service to E-COM that's unusually flexible and includes an electronic message option. (See accompanying sidebar for a full description.)

You can communicate with Telex and TWX machines around the world

If you have provisions for communicating with Telex and TWX machines, then you can also use Western Union's hard-copy mail delivery, the Mailgram. (You can also wire home for money or send flowers.) The Source, among others, also provides such services.

Equipment Requirements

To use electronic mail facilities, whether for messaging or for hard-copy delivery, one can make do with a dumb communications terminal that has a built-in modem and connects to a standard TV receiver. Using this, you could subscribe to an information service such

as The Source or CompuServe to communicate with subscribers. However, this is an extremely limited facility. Not having memory, you cannot download—capture information shown on the screen in some local storage medium. Similarly, you cannot efficiently upload—send local files or data by the electronic mail service—since you must use the keyboard in real time to input data. Therefore, if you're seriously interested in electronic mail, you'll have to have a computer system.

With a full-blown computer system, you can use a word-processing package to compose a letter or other document, making all the corrections or changes you wish before sending it into the communications stream. After doing this, you can then send out data at lightning speed, saving enormous transmit time when compared to typing on-line. And time on a telephone line means money!

You'll have to use a MODulator-DEModulator (modem) to convert computer signals to telephone signals and vice-versa. Some portable computers contain modems. In other cases, a modem board can be added to an existing computer or an outboard modem can be utilized by connecting it to the computer's serial port (RS-232C).

There's a variety of different types of modems, distinguished primarily by the speed at which they operate. Slow-speed modems transmit and receive data at the rate of 300 baud (bits per second). (The terms are used interchangeably, though they're not precisely the same.) These are the least expensive types. Next up the ladder is the 1200-baud machine, which reduces telephone costs, but, naturally, costs more itself.

If you can afford it, a dual-speed modem that can operate at either rate, using the Bell 212A standard, is the best to get. If not, the 300-baud machine will suffice.

A full-duplex machine is most desirable, since a half-duplex design will limit you to one computer communicating at a time. Thus, the other computer operator could not interrupt. Moreover, half-duplex will not enable a receiving computer to echo a transmission on screen. There are direct-connect and acoustic-coupled types, too. The former provides better audio quality, while the latter can be used anywhere without worry about having the right telephone interconnect jack. Beyond the foregoing, you'll have to decide how "smart" you want your modem to be. Will it contain a buffer memory? Do you want automatic answering so your computer will accept data even though you're not at home? How about automatic dialing so you can save time when phoning someone?

Equally important, and cause for a more frustrating buying experience, is communications software. You have to consider those communications protocols or parameters that must be set in order to communicate with other modems. Also, how versatile is the software? And how easy is it to use?

Software

Here is where the fun begins. More and more people are buying "personal computers," and this has caused a flurry of activity among manufacturers to produce communications software.

The computer already has its own terminal—the monitor and keyboard—and the two communicate with each other. However, some programming is needed to tell the computer to talk to a *modem*, which can then talk to another computer.

First, the good news. Some of this software is essentially yours for the asking. For example, some dealers might provide you with a public-domain program called "MODEM7." If your computer is CP/M-based, there's a chance that a version of it has been configured for your system and is available simply for the price of a single floppy plus copying charges. Don't worry, you aren't stealing anything, since the program was donated to CPMUG (the CP/M User's Group) by Ward Christensen. The problem is that this package is unlikely to have all the features you may need for your applications. Moreover, it's not particularly user-friendly.

Don't despair, though. There is a huge amount of excellent and highly sophisticated commercial communications software available. It is designed specifically for almost all popular computers on the market today and all the popular operating systems from Apple DOS to CP/M to MS-DOS.

Since most computer owners today have little desire to be programmers, the communications software purchased would likely be simple to use and also provide maximum flexibility. Modern software contains a lot of "menus" to make it easy to pick and choose parameters.

As an example, "Mite" from Mycroft Labs, written by Larry Hughes for CP/M and for the IBM PC and similar computers, has eight menu screens that pivot around a main menu. They consist

MCI's NEW ELECTRONIC MAIL SERVICE

A NEW national electronic mail and message service was launched recently by MCI Communications to compete with other systems such as Western Union, the U.S. Postal System, Tymnet, Telenet, et al. MCI Mail, however, has a flamboyance that the others lack. It combines some of the best features of each and adds fillips that others don't have. For instance:

*No registration or monthly customer charge.

*Messages can be sent to any registrant for electronic mailbox pickup for $1 (up to 7500 characters or two to three pages of copy).

*A letter for one- or two-day U.S. Mail delivery for $2.

*Overnight letter "hand delivery" for $6.

*Within four-hour "hand delivery" in major cities for $25.

*Letterhead logo printing and signature options.

What MCI created, therefore, is a service for time-sensitive mail/messages to meet a variety of delivery-speed and dollar needs. The parent company, an important long-distance-communications competitor to AT&T, is reportedly ready to spend $100-million to establish MCI Mail.

The new system can be used with virtually any digital communicatons device—personal computer, Telex machine, data terminal, or dedicated word processor. The system accommodates Bell-compatible asynchonous modems with speeds from 110 to 1200 bits per second. Also, 2400-bit per second transmissions can be sent (though this speed does not include interactive use.)

Personal computers and dedicated word processors require terminal communications software, of course. This will also allow users to send files created off-line direct to another computer as well as writing messages received to disk. Further, MCI Mail enables users to transfer documents between different word-processor systems, such as a Wang to a Xerox. In this "batch" mode, the interactive menu-driven stage is bypassed. Here, the system converts any special format symbols to a standard transmisssion form, reconverting

of a parameter menu, text file upload, text file download, option, binary transfer, macro string definition, character filter, and system command processor. This last menu gives the user the choice of checking disk information such as space remaining, directory, etc., without returning to the operating system's command level. Of particular interest in the option menu is the choice of whether or not the system is to be used in a TWX mode. Connected as a dedicated TWX line, a computer becomes, in effect, a TWX machine.

Then there's Microcom's Apple II menu-driven program, Micro-Telegram, that accesses Telex and TWX facilities, while including convenience features such as an auto-dial directory, a basic text editor, and clock/calendar transmit schedule.

Another among the myriad of promising communications software packages is "Transend" from Transend Corporation. With versions for Apple computers and the IBM PC, it includes a complete electronic mail package, right down to screen icons with simulated in and out baskets that information is shifted to and from. (There's also a waste basket.) It even has electronic bulletin-board communications that

Finding versatile and easy-to-use communications software can be a very frustrating and difficult buying experience

can send confidential information through a locked file on the recipient's data disk.

A new software product called "Postman," for use with an IBM PC, is a user-friendly electronic mail package with a simple built-in word processor. It's designed to allow a computer user to access the Western Union Priority Mail services, automatically sending up to two pages of material for Mailgram or E-COM letter. After typing the message, you just direct "send." You must open a Western Union account, of course. (A credit card number will do the trick.) The $50 package, which handles up to 30 addressess, is from Sydney Dataproducts, San Diego, CA 92101.

MAIL-COM is a more sophisticated computer-generated-mail package from Digisoft Computers, New York City. Versions are available for a variety of computer formats. It is specifically designed for speedy transmission to the Postal Service's E-COM, enabling one to send out data for up to 2000 letters per hour. It's said to be compatible with Wordstar and dBase II software and also incorporates a letter editor and address maintenance program.

To use the electronic-message facilities of a bulletin board, you should know that many of them are machine-specific and may require special communications software. These packages are usually modestly priced, though.

There are many more communications packages for you to investigate, naturally. Those mentioned here will give you an idea of what's available on the market.

Summing Up. Electronic mail has, without doubt, come of age. Of course, choosing which facility to use for this purpose is challenging since it depends on your intended application(s). But armed with any computer and a modem, you can quickly enter the world of telecommunications. ◇

data into compatible character sets for the receiving computer.

Calls are handled by a Packet Assembler-Disassembler and sent to packet switches for microwave transmission to one of MCI's central computers. Digital Equipment Corp.'s VAX 11/780 computers are used to implement the system's software, which includes holding letters in electronic mailboxes until retrieved by addressees. What to do with "dead" letters has not been officially solved yet owing to the newness of the system. But an official said that if mail isn't picked up for, say, 30 days, MCI would make a strong effort to contact the addressee, even if it means phoning him.

Computer-generated mail is printed on bond paper by Hewlett-Packard 2680 laser printers, a speedy technology that the Postal System's E-COM does not use. These printers are also used to print letterheads and signatures.

For security purposes, a user's name and a password are used. The password consists of eight randomly generated letters that are encrypted in the system. If the user forgets his password, a new one must be issued. MCI uses another security tier to prevent computer hackers from breaking into the system. A constantly scanning high-speed system flags MCI security when from 3 to 10 unsuccessful attempts are made to match the correct password with the name of a registrant.

Overnight or four-hour delivery of documents is handled by Purolator Courier, while another delivery agreement with DHL, an international package carrier, gives MCI Mail access to destinations in 110 countries.

In another arrangement, anyone registered for MCI Mail automatically gets access to the Dow Jones News/Retrieval Service (stock quotations, news, on-line encyclopedia, etc.), being billed by MCI at regular DJ rates only when the service is used.

MCI estimates it would need 200,000 subscribers to break even. After only a few months, it has 70,000 (including 50,000 Dow Jones subscribers who automatically became MCI Mail subscribers). Three-thousand companies are said to be represented here, among which 500 requested a registered letterhead for automatic laser printing. Perhaps 30,000 subscribers use a computer from their homes.

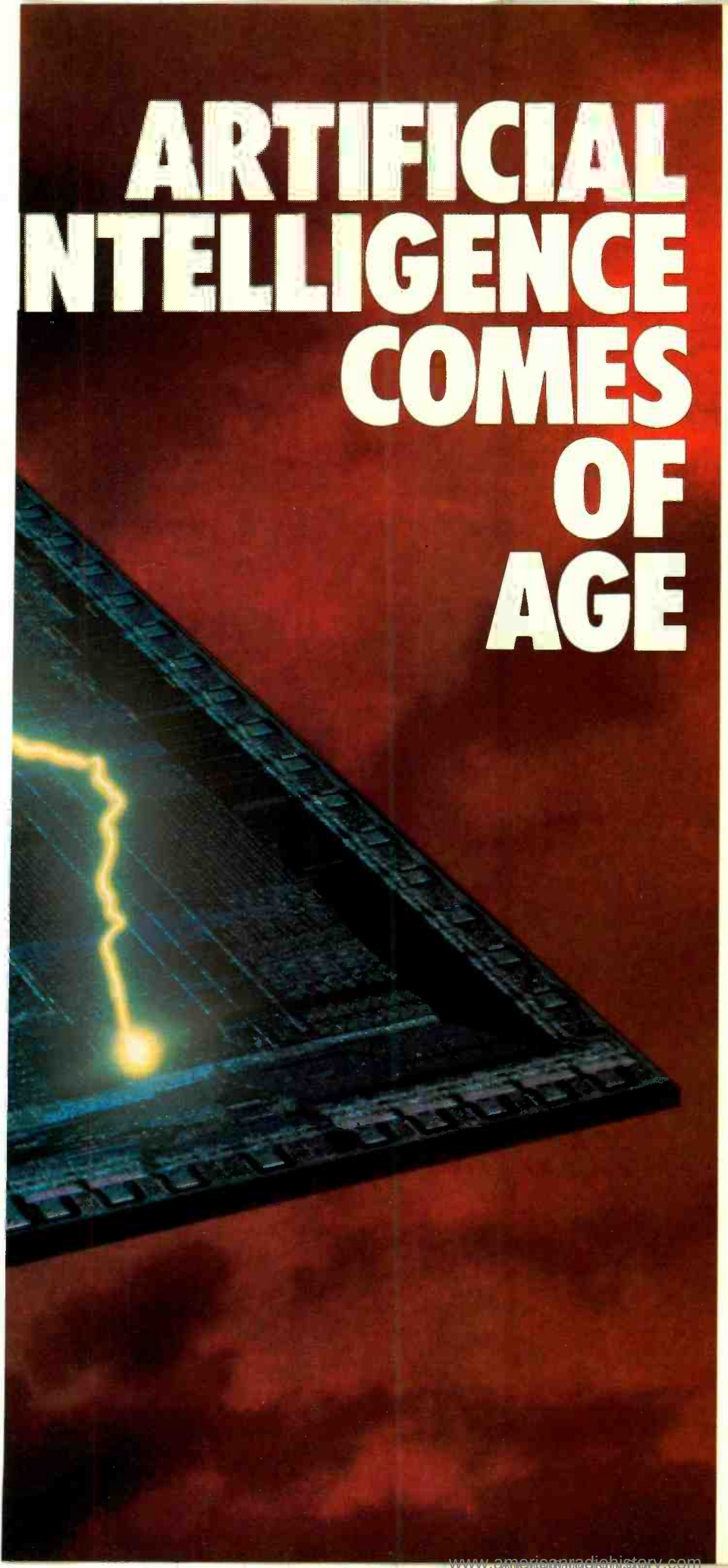
In a private demonstration of MCI Mail, it was apparent that the menu-driven system was especially easy to use. One can scan the screen to see if another party has the MCI Mail service, for example, simply by typing the person's name. Sending a four-hour message to test the system, it took less than two hours to receive it in the middle of New York City, a feat that taxicabs would do well to emulate.

Beginning sometime this year, MCI plans to permit subscribers who are unable to access their messages electronically to call up and have their mail read to them! This incredible service is made possible by a new device from Digital Equipment Corporation called DECtalk. The unit is able to handle any ASCII output that would normally be directed to a printer. Instead of printing output, DECtalk speaks it in any one of eight voices and at a user-selectable speed. MCI Mail clients will be able to access spoken messages from any touch-tone phone by dialing an 800 number and keying in account information

MCI Mail is not without its shortcomings. Fast document delivery is not flawless. To use this service to the fullest, data must be sent between the hours of 6 a.m. and 6 p.m., Monday to Friday. Otherwise delivery is made on the next business day. Further, four-hour delivery is limited to 15 major cities and their suburbs (up to 25 miles away). For overnight delivery, the same restrictions hold except that it covers the 48 contiguous states. MCI Mail's access telephone numbers are limited too, there being only 23.

Keys to MCI Mail's potential success will be its low cost made possible by the long-distance communications facilities owned by MCI, its capability of reaching even non-subscribers, and its lack of any charge to new subscribers. If it is as successful as it hopes to be, we may all begin thinking of an ounce the way MCI does—7500 characters. ◇

ARTIFICIAL INTELLIGENCE COMES OF AGE



Commercially available hardware and software tools permit the development of practical artificial intelligence applications

By Abraham Hirsch

ARTIFICIAL intelligence is the attempt to create computer hardware and software capable of emulating human reasoning. Its basic theory and technical capabilities have been around for a long time in university computer research labs and the heads of a few academic zealots. In fact, computer programs to perform rudimentary imitations of human deductive and inferential logical processes were written at least as long ago as engineering programs to handle coordinate geometry for state highway departments and payroll systems for insurance companies.

The reason AI has suddenly become a hot topic in corporate boardrooms and the popular press is not its newness. Research centers like MIT, Carnegie Mellon, Stanford and others have been successfully building a foundation of theory, techniques and tools since the late 50s. What's new is the commercial availability of hardware and software tools that make it possible to develop economically justifiable AI applications for a wide range of end user organizations previously served only by more traditional data processing methods.

The pivotal software tool for AI is LISP (List Processing Programming Language), the original version of which was developed by John McCarthy in 1957. Unlike the programming languages with which we are most familiar—BASIC, FORTRAN, COBOL, Pascal, APL, and so on—LISP deals with complex objects, not just numbers. Therefore it lends itself to the development of flexible systems that can accommodate ambiguities, infer relationships between data, and even perhaps learn.

The pivotal hardware tool is the "LISP-machine" or symbolic processor—a computer system whose logical architecture is specifically designed to support economical AI program development.

Interest in AI is expanding rapidly in companies eager to enter a marketplace

Abraham Hirsch is Product Marketing Manager at Symbolics, Inc.

PHOTOGRAPH BY BARRY BLACKMAN

that computer industry analysts predict may account for 50% of all EDP by the end of the 1990s. The Japanese have captured the public imagination with the aggressive AI research program in their Fifth Generation Computer project. As a result of AI's increased press, attendence is high at executive education seminars like those offered through Worchester Polytechnic Institute by Richard Morley and William Taylor of the Office of Advanced Systems and Software Technologies, Gould, Inc. In their forthcoming book, *Demystifying Artificial Intelligence* (Graeme Publishing), Morley and Taylor attribute the emergence of AI as a viable commercial technology to the recent development of tagged memory architectures and to VLSI, the same phenomenon that is allowing microchips to be put into virtually every manufactured gadget from self-diagnostic home appliances to six-cylinder sedans. Electronic circuits photographed, reduced and etched into silicon wafers have made the computer smaller, more powerful, and magnitudes of cost cheaper.

According to Bill Taylor, "Twenty years ago computer iron was expensive and people were cheap. Today it's just the opposite. AI eats up a lot of memory, but memory is cheap today. Numerical processing techniques and software that could make the most efficient use of computer hardware became the dominant technology for economic reasons. The ideal systems design goal behind numerical processing is to make the computer more productive. New computer designs were necessary to provide economical processing of data structures more complex than numbers. The ideal behind AI—or *logical* processing—is to make people more productive. We've got the tools to do that now."

Symbolic Processing.

Conventional computer programming assigns numerical equivalents to stringently defined pieces of data and then assigns those numerical equivalents to stringently defined files. Data definitions and the allowable relationships between data elements and files are narrow, literal and unforgiving. Computers understand only two states—on and off, the zero and one of the binary coding system. As thinkers, even the most powerful computer systems and complex data bases are infinitely less sophisticated than the first popeyed protosimian. Computers can go on crunching numbers indefinitely without getting bored or tired, but without getting any smarter.

People, on the other hand, think in terms of complex symbols. Symbolic logic is tremendously economical. It enables us to pack a myriad of abstract and empirical meanings into a single penstroke, object, sensation, word or feeling. It enables us to shuffle and rearrange all of that in our heads at random and at immeasurably fast speeds. It makes us capable of invention, intuition, leaps of faith, terrible puns, scholarship and common sense. We learn more than we consciously remember. As Morley and Taylor summarize, "Computers have infinite memory and limited processing power. People have infinite processing power and limited memory."

Symbolic processing seeks to emulate that human richness, however crudely, by enabling computers to manipulate arbitrarily defined "objects" or symbols made up of lists of associated properties. Each symbol may be assigned an unlimited list of attributes which define it. Symbols and their properties are maintained in a relational database in which the interrelationships possible among them are expanded under the operation of general rules rather than limited by predetermined data structures. Symbolic processing therefore has two advantages over numerical processing—flexibility and the ability to accommodate uncertainty and extreme complexity.

Conventional data processing is not going to go away, however. It will continue to be applied to nice, neatly defined problem solving and data management tasks. Inventory management, theatre ticket sales and general ledger accounting, for example, can all be reduced to consistent formulas that produce finite and predictable results.

Many computer applications, though, simply have not been attempted because the sheer volume and complexity of coding and/or computation they would require are prohibitively expensive. Industry researchers estimate that only about 10% of the computer applications that could be written have actually been done. It is precisely those complex tasks that have defied the rigidly laid-out formulas of numerical programming methods that are candidates for symbolic processing and AI treatment.

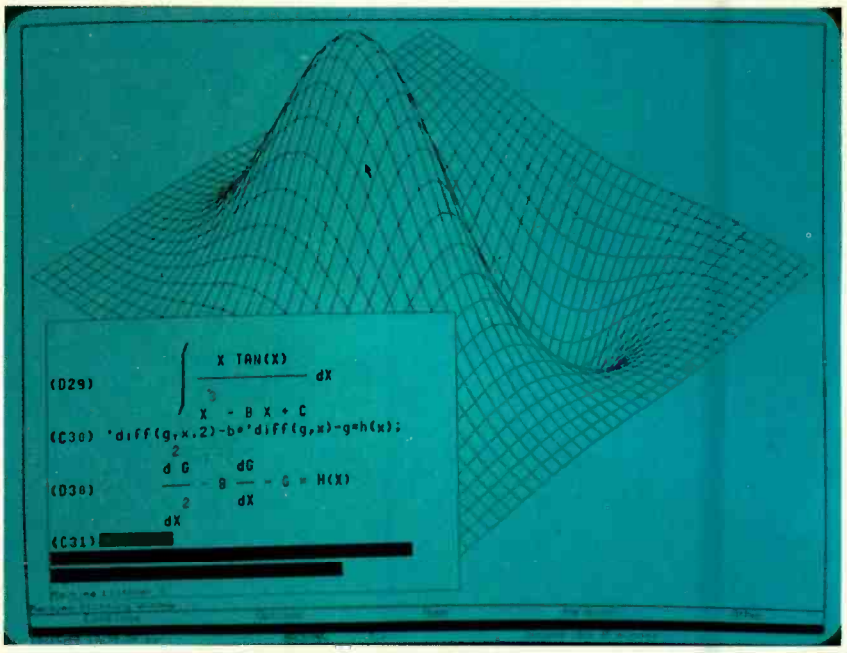


Fig. 1. MACSYMA graphic output and equivalent mathematical representation.

Symbolic processing allows us to compress both data and computational operations. Symbolic processors measure their speed in LIPS (Logical Inferences Per Second) rather than in arithmetic operations per second.

In numeric processing, data and logic are inextricably wedded in programs. Data are stored in fixed formats—so many characters for a name, so much space allotted in a file. Properties or attributes may not be added to define a data element without reprogramming or restructuring the information in the

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LISP FOR YOUR PERSONAL COMPUTER

By D. T. McClellan

Owners of 16-bit microcomputers such as the IBM PC can now experiment with and develop software using the artificial intelligence (AI) techniques described in this article. MuLISP-83, developed by the Soft Warehouse, and IQLISP, from Integral Quality, take advantage of the large address space and powerful instruction set of the IBM PC; and support development of AI programs previously possible only on mainframes. Like BASIC, both LISPs are interpreters, allowing interactive program entry and debugging. Unlike BASIC, both make top-down modular development easy, as LISP programs are composed of separately modifiable and storable functions and data structures.

IQLISP and muLISP will run on IBM PCs with at least one disk drive, a display, and at least 64K of memory. Both will take advantage of more drives and more memory if available—up to 256K for muLISP and 640K for IQLISP. MuLISP will run on other microcomputers that run MS-DOS; whereas IQLISP is tied more closely to the IBM PC's internal architecture. Consequently, IQLISP applications are not as portable, but IQLISP offers extras which help make up for this: 8087 math support, function key capturing, display windowing, and more MS-DOS interfaces.

IQLISP and muLISP offer all the basic data types needed to build any complex LISP data structure. Both support infinite-precision integers, thousands of digits long, with 16-bit integers as an efficient subcase. IQLISP also has floating point numbers in single and double precision. Both LISPs have the full range of arithmetic, recognition, and comparison functions for numeric data. With these tools, a mathematically inclined programmer can implement a good symbolic math system for solving problems in calculus, matrix manipulation, and polynomial evaluation.

Character strings and names in muLISP and IQLISP may be from 0 to over 32000 characters long; strings may be searched, substringed, and (in IQLISP) concatenated. IQLISP and muLISP both manage these large data items efficiently by storing each unique name once, in a garbage-collectable area, and use typed pointers to them for assignment, type recognition, and comparison.

Property lists are good for attaching user-defined information to atoms, and both LISPs have functions to store, fetch, and remove property flags and name-value pairs. This makes attachment of extra information to literal atoms easy, for applications such as natural language understanding and expert systems.

IQLISP provides sequential file and display window I/O functions, and allows an arbitrary number of files and windows to be used. MuLISP reads from and writes to only one source and one destination at a time, but it can toggle between the open files and the console, and supports simple random file I/O. Both LISPs allow the programmer to read or write anything from single characters to full LISP expressions easily.

IQLISP and muLISP provide generous sets of list management functions. Data structures such as arrays, records, stacks, queues, trees, and even LISP functions can be built under program control with lists, using the provided construction, selection, and modification functions. IQLISP also has true arrays and array functions for efficient table implementation.

Programs require control structures as well as data structures. LISP control structures are function calls, using choice-making, looping, recursing, and error trapping functions, and providing assembly language and hardware interfaces. IQLISP and muLISP use the familiar multi-branch COND function as an if-then-else and case statement.

MuLISP provides an iterative LOOP function for repetitive code execution. IQLISP uses the PROG function with its local labels and GOTOS for iteration, and adds as LISP macros a LOOP with WHILE and REPEAT-UNTIL forms, and a FOR macro. Users of IQLISP can write their own macros, which will expand into LISP code at execution. MuLISP does not support standard macros directly, but like IQLISP it has *read* and *splice* macros, to flag certain characters for special input processing.

User functions are recursive, and can be defined to receive either a fixed or variable number of arguments, with arguments evaluated before being passed in or received untouched, as needed. Lastly, both LISPs allow calls to user-written assembly language functions when fast code or special processing is needed.

To aid development, muLISP has a debugging and tracing package, and CATCH and THROW functions for escaping deeply nested calls, useful when a heuristic search discovers it has picked a wrong path. MuLISP also has a full screen editor, interfaces to its garbage collection and management functions, and to the host hardware and display. IQLISP has error trapping and stack manipulation functions, various system management and garbage collector calls, and interfaces to MS-DOS and DEBUG for assembly language routines. It provides a simple list-oriented editor.

The two LISPs are well documented in informative, indexed manuals. MuLISP also comes with a one-year newsletter subscription. This is a nice added value as it publishes good public-domain LISP code. IQLISP and muLISP also come with some sample applications on diskette, including (in muLISP) a useful tutorial, based on Winston and Horn's *LISP*.

Since the new muLISP-83 was introduced in the fall of 1983, the two LISPs have become fairly close in power. IQLISP has true macros, better I/O support, a larger workspace, and a lower price than muLISP; but muLISP has a full screen editor, easier exception handling functions, and is more portable. Both will continue to improve; and so picking one will depend mainly on what special features you prefer. The accompanying table may help. The groupings are based on the sometimes differing classifications in the manuals. ◇

SPECIAL FEATURES OF IQLISP AND muLISP

Function Type	Number in IQLISP	Number in muLISP
Selector (e.g. CAR)	18	17
Constructor (e.g. CONS)	4	5
Modifier (e.g. RPLACA)	3	5
Assignment & Definition (SETQ)	5	7
Recognizer (e.g., NUMBERP)	16	9
Comparator	9	6
Property List (e.g. PUTPROP)	6	6
Mapping (e.g. MAPCAR)	8	none
Evaluation Control (COND)	12	9
Numeric (e.g. +, ADD)	22	8
String	6	6
I/O (file/window/console)	41	17
Environment Control	20	16
DOS & Machine Interface	10	7
Arrays	5+assignment	none
Function Types (LAMBDA)	2 by 2	2 by 2
Macros	Normal, Read, Splice	Read, Splice

For both LISPS, numerous extra functions (and IQLISP macros) are available on the diskettes as non-built-in code.

computer's memory. Numeric programming reduces all data to the commonest denominators. Little room can be made for exceptions or rare instances.

Symbolic programming, on the other hand, separates data and logic so that there are no limitations on data types and structures. Names don't have to be abbreviated and uncommon properties may be added easily to individual symbols—height and weight to a name and address file, for example. Symbolic processing allows the flexibility to define and compare three-propertied apples with 300-propertied oranges and infer new information from their possible relationships. Symbolic processing even allows us to define and compare apples and oranges and infer new information on the basis of something less than absolute certainty.

Intelligent systems can be designed that operate on what AI researchers affectionately call the "DWIM" or "Do what I mean" principle. For example, in INTELLECT, an intelligent management query system developed by Artificial Intelligence Corporation of Waltham, MA, *New York* is New York City if it is placed in the context of a user query like, "Compare January sales figures for Chicago, New York and Los Angeles." In a symbolic system one of the properties of the symbol New York is *city*. Another is *state*. The symbols Chicago and Los Angeles also own the property *city*. The system automatically compares the three symbols, sees that they share the *city* relationship, infers that New York City is what the user means and performs the requested database query operation on the basis of that inference.

One of the earliest and still most impressive AI based software packages is MACSYMA, developed at the MIT Artificial Intelligence Laboratory and marketed by Symbolics, Inc. of Cambridge, MA. It is an intelligent system that uses the flexibility and power of symbolic processing to solve equations of algebra and calculus so complex that they are generally beyond the skill and patience of human mathematicians. MACSYMA produces important analytical solutions that could otherwise only be approximated by numerical methods. Moreover, computation results can be printed out as more easily comprehended, and often as beautiful, graphic presentations (Fig. 1). Indicative of the system's power is the fact that a single line of MACSYMA code is typically equivalent to eleven lines of conventional FORTRAN.

MACSYMA's ability to compress entire mathematical entities like variables, symbols and operations into symbolic objects points out one of the major commercial advantages symbolic processing has over numeric processing. Applications software can be created faster and less expensively using symbolic programming methods. Because data and commands are separate, programs can be developed, prototyped, tested and edited in more efficient increments. In fact, one of the most widespread applications for symbolic processors today is as fast software development systems. Programmers use symbolic processing techniques to speed the prototyping of engineering and scientific applications software that will eventually run on conventional DP systems. Different

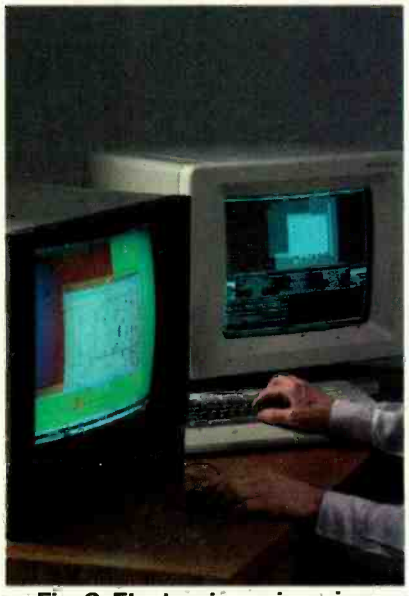


Fig. 2. Electronic engineering system for VLSI design.

data and control structures can be experimented with at high levels before settling on the "best," resulting in higher productivity and reliability.

Expert Systems

MACSYMA is an "expert system." It provides logical rules which use facts in the data base to infer other facts about how to solve an equation. As in all expert systems, the secret of MACSYMA's power and effectiveness is in its data base. In expert systems, as Ricahrd Morley points out, "The power lies in the knowledge, not the program."

Expert systems, probably the most widely implemented and well-known applications of AI technology, are simply huge data bases of information and a collection of the best rules of thumb that can be applied to that data to make it yield the solutions to problems. Expert systems are a way of capturing, codifying and making available to others specialized human expertise and of magnifying it with the memory capacity and tirelessness of the computer.

There are three types of expert systems in use today—*rule-based, model-based* and *knowledge-based*. While it is characteristic of symbolic processing to accommodate ambiguity in defining data and its relationships, because of their sheer size and complexity, expert systems still have to be designed around very circumscribed worlds usually accompanied by their own highly specific jargons. Mycin, developed by the National Institutes of Health, for example, diagnoses bacterial infections by subjecting gram stains, morphology, aerobicity and lots of other technical medical information to the operation of a set of rules culled from medical microbiology. Stanford's AI lab is currently at work with IBM developing a model-based expert system that will simulate computer circuits to enable users in the field to troubleshoot equipment. Unlike Mycin which collects data on a sick patient and subjects it to the operation of rules, the model-based system collects data on a sick machine and compares it to a model of a well machine. Knowledge-based systems know a lot more about the real world than the narrow confines of one problem-solving environment. Expert military systems that combine information from many scientific fields like physics, ballistics and electronics, for example, are probably as close as we've gotten to implementing true knowledge-based systems.

Usually expert systems have a *natural*—that is, English, French or Hebrew as opposed to FORTRAN, Assembler or BASIC—language interface with which to feed facts into the data base and query it. Natural language systems are also in and of themselves an important commercial application of symbolic processing technology. "Intellect" is a natural language "front end" to a conventionally structured data base.

Natural language is perhaps the stickiest and most difficult area of AI system development. Any eighth-grade foreign-language student struggling with irregular verbs and idiomatic expressions, or any poet, will attest that just programming in the rules of grammar and a massive vocabulary will not come even close to reproducing the conceptu-

(Continued on page 93)

ELECTRONIC TIES THAT BIND

Local area networks provide facilities for linking personal computers in an office complex or building

By TJ Byers

LIKE their human counterparts, personal computers, peripherals, and terminals often need to exchange a few words among themselves in order to get the job done. Data communications between adjacent offices or buildings may also be necessary.

These conversations are usually carried on through a system called a *Local Area Network*, or LAN for short. LANs come in many sizes and shapes to satisfy the user's requirements.

What is a LAN?

A local area network is any system by which a computer can talk with another computer station. These stations can be printers, terminals, or another computer. LANs range in size from two terminals to entire college campuses.

The best way to describe a LAN is to compare it to a small telephone system. The purpose of a telephone network is to put the subscriber, namely you, in touch with any other subscriber on the line. If you want to talk to your aunt in Peoria, the phone company has the equipment and knowledge to put you in touch.

This is basically how a local area network serves the computer community. When the central computer wishes to discuss matters with one of its terminals, or vice versa, the LAN has the facilities to connect the two.

Unlike a telephone exchange, though, the computer network is normally confined to a rather small area—usually a room or a building. In most cases, the network subscribers are no more than a few thousand feet apart. Hence, the

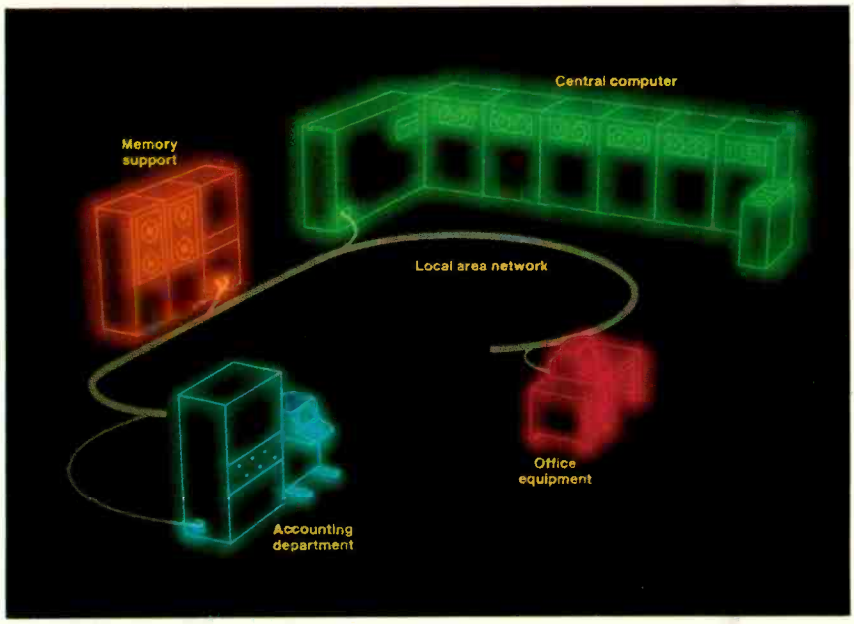


Fig. 1. How a modern office is linked together by a LAN.

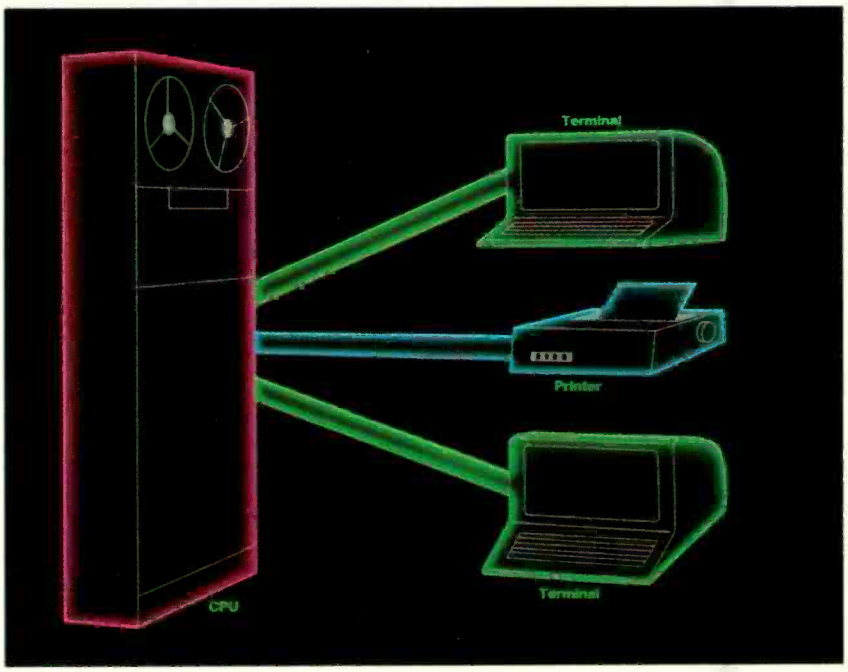


Fig. 2. A simple LAN allows the CPU to connect three units.

term *local area* has been attached.

LANs are found in a wide variety of everyday applications. They are commonly used to tie together a CPU and a remote printer or mass-storage memory. By sharing limited resources, like memory, the cost of operating a computer system is greatly reduced.

Factories also employ LANs to integrate their assembly lines. All stages of operations are fed into a central computer and quality control center. One operator can now oversee the work previously supervised by several people.

LANs in the Office

Probably the biggest impact by LANs has been within the modern office. A portion of a typical one is illustrated in Fig. 1. Secretaries now type on word processors and use computer based data sources on a daily basis. Since it would be a duplication of effort to provide each individual with a complete computer work-station, the secretarial pool is often tied together with a local area network. The output of the pool can be fed to a central computer, and perhaps a single printer. (This printer may be located in the mail room, where the letters can be posted immediately.)

The sales department is connected directly to the accounting department. Such details as credit ratings and previous orders are but a finger's touch away. And sales may be tied into shipping and receiving, which can expedite the order within minutes after it is confirmed.

What's more, shipping and receiving is in constant touch with the inventory computer, which is linked to the manufacturing plant, and so on. As you can see, there is no end to the possibilities. The modern office has become one huge communications network.

Network Topology

Linking all these stations together is no easy chore. It would be nice to be able to say there is a single standardized method for laying out a network. Unfortunately, though, network topology is dependent upon the type of equipment used, and the distances and costs involved.

A simple network consists of running a cable from one site, called a *node*, to the next. This approach, which is shown in Fig. 2, allows the user to connect the CPU to a printer, a mass memory device, or a terminal—or all three of them. The only restriction here is that a separate communications line must be established between each and every node and the CPU.

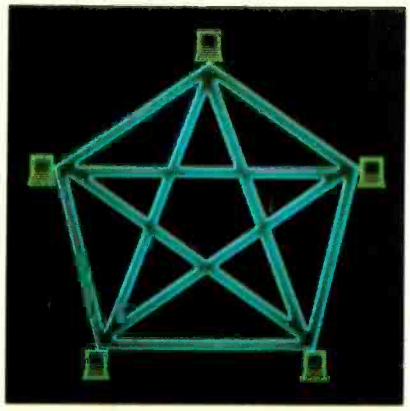


Fig. 3. A distributed network.

This may be all right for a small, centralized system, but problems appear when one of the peripherals must communicate with another peripheral. For instance, if a terminal wants access to the memory, a link must be established between the two—this *in addition to* the already existing lines. Each station must have a separate and dedicated link to every other station it must communicate with. The end result looks something like Fig. 3.

Not only is this approach awkward, it is downright clumsy. Every time a piece of equipment is added to or subtracted from the network, the system must be reworked. Can you imagine the work involved in adding support memory to a LAN with 30 nodes?

Star Networks

As a network grows in size, it is better to centralize communications operations by putting a single station in charge of traffic control. Basically, this idea is the equivalent of using a telephone operator. Now instead of everyone being tied to everyone else, the only connection needed to complete the system is to the central controller.

As you may imagine, this topology (as seen in Fig. 4) is commonly called a *star network*. Any station can contact any other station by simply ringing the "operator" and giving the address of the intended receiver. The central controller makes the necessary connections and when that has been accomplished the link is established.

Here again, though, we run into problems. The star configuration has the disadvantage of limited capacity. Many times the central controller is also the master CPU, and while it is busy playing "operator," it can perform no other useful duty.

The network is also solely dependent upon the reliability of one station. Should the central controller fail, the entire system will also fail.

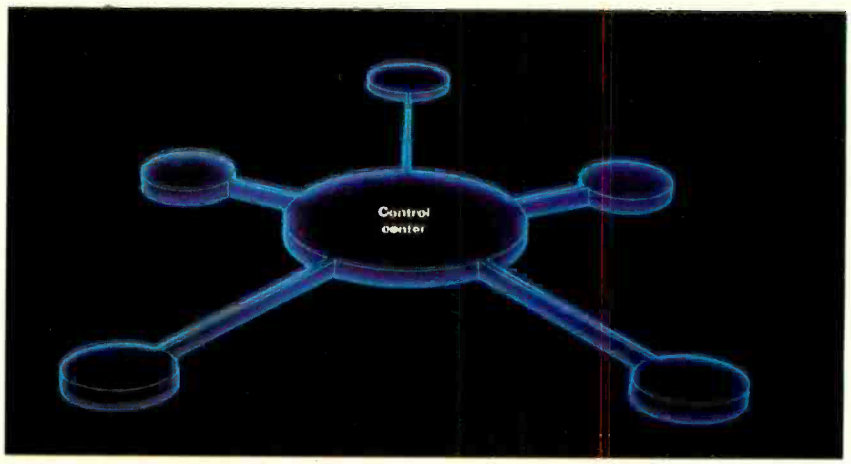


Fig. 4. In a star network, stations connect to central node.

Rings

Another way to untangle the wiring mess suggested in Fig. 3 is to interconnect the nodes in one big circle. This topology takes on the look of a ring (Fig. 5). Appropriately enough, this concept is called a *ring network*.

Rings behave differently than stars, though. Let's examine the ring by putting a message on it. We'll call ourselves Station A.

First, we initiate a message and pass it on to Station B. Station B, in turn, reads

the message (or sometimes just checks it for its destination) and forwards it to Station C. Likewise, Station C passes it on to Station D, which returns it to us via Station E. Each station reads the message and acts on it accordingly. If the memorandum doesn't apply to that particular node, it is ignored.

Of course, we know that the intended recipient got the message because it was returned to us intact. If we hadn't received it in exactly the same form in which it was sent, we could send it again. Some networks have the intended recipient attach an acknowledgement of receipt to the end of the message.

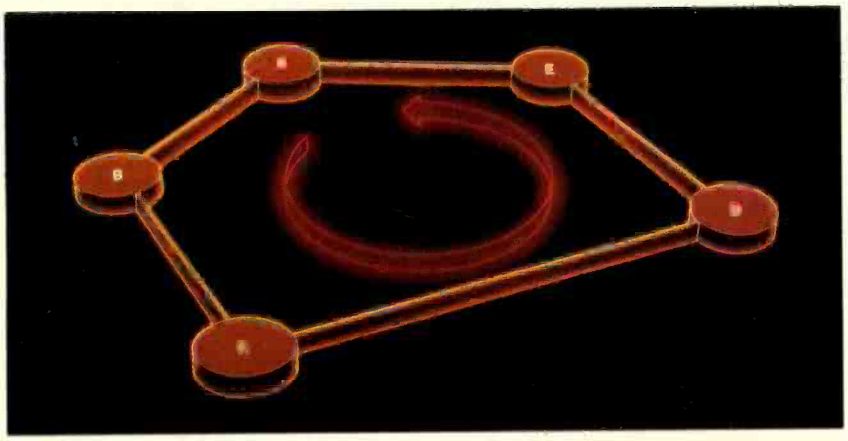


Fig. 5. Ring network reduces the number of connections.

Sometimes the ring will have a master controller in its loop. It is the responsibility of the controller to maintain the integrity of the network. It does this by reviewing all transmissions and directing traffic. Other times the master controller is eliminated. In such instances, each station is responsible for monitoring its own communiques.

Ring networks, however, have an obvious shortcoming. Upon reflection, we know that the only way to disable a star network is for the central controller to fail. Failure of a node is of little consequence.

A ring network, on the other hand, must take the reliability of every node into account. If even one node in the chain fails, the network is out of service, like a chain of old-fashion Christmas tree lights. Network failure can be something as simple as the failure of a node to recognize a message.

The chances of a station failing in a ring network are multiplied by the number of nodes in the ring. As a fail-safe precaution, redundant bypass systems are commonly engineered into the nodes. Should a node fail, the defective station is bypassed and the ring remains unbroken.

Star-Shaped Rings

A special configuration of the ring topology bridges the gap between star networks and ring networks. It is the *star-shaped ring*. Outlined in Fig. 6, the star-shaped ring routes all links through a central hub. The hub can be either active or passive.

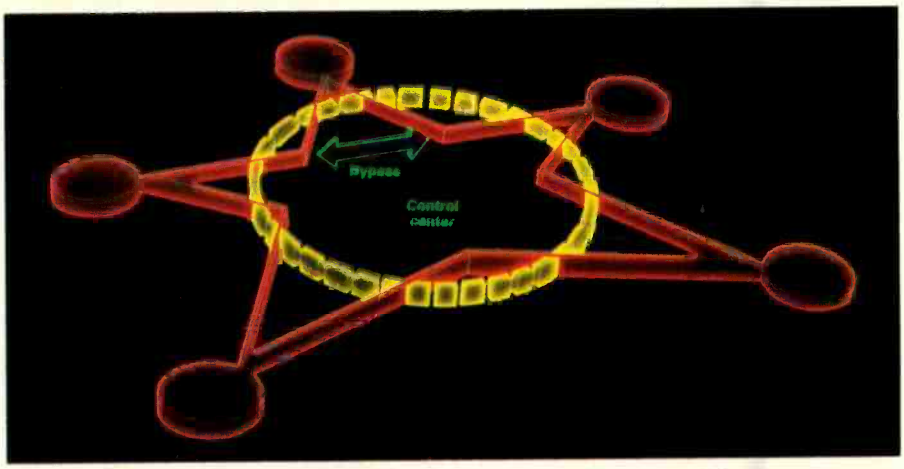


Fig. 6. The star and ring configurations can be combined.

Normally, the hub is not involved with the communication process. However, a malfunctioning link or node can be detected at the hub and bypassed, thus maintaining normal ring operations. The central hub can also contain a central controller that can be used to direct network functions.

Bus Networks

A specialized case of the star configuration is the *bus network*. It may be convenient to visualize it as a star network with no central hub. The bus concept is unique in that it is a passive network, unlike the active designs of the typical star or ring. In other words, the network isn't required to make routing or addressing decisions. The burden of network management falls squarely on the shoulders of the individual nodes.

Bus networks are typically composed of a single length of cable that snakes throughout the LAN area. A node can be attached to the network cable at any point along its length with a simple parallel tap (see Fig. 7).

The advantages are obvious. First, it permits the greatest flexibility of any network scheme for the physical placement of a node. Furthermore, a station can be added or deleted at any time with absolutely no modification to the network itself.

Bus networks also have the advantage of not requiring central controllers. The network is passive and can stand on its own through most any crisis. On the negative side, the increased responsibilities put on the node increase its complexity and cost.

In a bus network, a node has access to every other node at all times. This allows any station on the network to contact any other (or all) station without going through an intermediary.

Network Access

One of the major problems facing a network user is the allocation of network time. Who has access to the network and for how long? Can two stations use the network at the same time, while avoiding a mess of overlapping pulses? These problems apply to all networks.

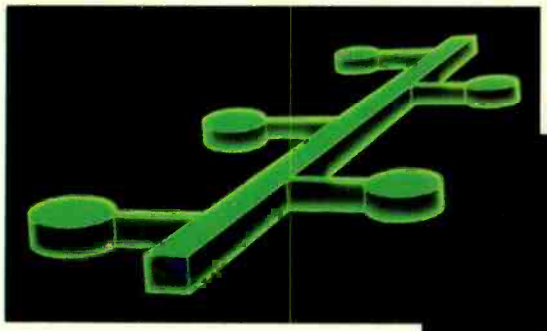


Fig. 7. A bus network can be tapped at any point.

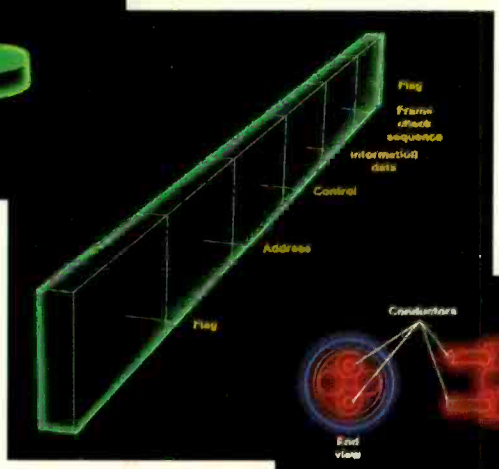


Fig. 8. A bit-oriented protocol with flags at either end.

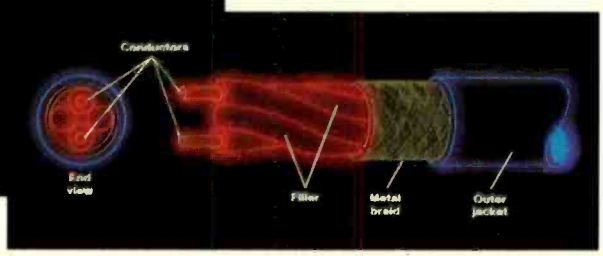


Fig. 9. Shielding is achieved as shown below in the Twinax cable used by IBM.

Several schemes have been proposed and used for network contention. One method is to allocate a time slot for each node on the network. Each node is assigned a *queue number*. It's like taking a number and waiting in line. When your number comes up, you have use of the network for a prescribed period of time.

This is a convenient method for network use because your turn comes around over and over at precisely defined intervals. This gives you time to organize your message, or work on other problems, without worrying about when your number is due.

Unfortunately, it also wastes time—network time. If you have no message to transmit, the network remains idle during your entire time frame. Multiply this by all the nodes that have nothing to say at the moment, and you find the scheme isn't really very efficient.

Token Passing

A more sophisticated approach is *token passing*. As before, each node is assigned a station number, or address. Next, a "token" is given to the first node. This token allows that station—and that station alone—access to the network for transmitting purposes.

After the first station has sent its message, the token is passed along to the next node in line, like the baton in a relay race. Now if the second station has a message to send, it takes advantage of the token and the network. If, however, it doesn't need the network at the time, it immediately relinquishes that token to the next station. In other words, the network isn't tied up waiting for a station's time to expire.

The token continues around the network from node to node, in a circular fashion, giving everyone access to the network. The last station to receive the token must return it to the first node, thus beginning the process anew.

To prevent loss of the token, the receiving station must acknowledge its receipt. If an acknowledgement is not received, the token is retained by the forwarding node and a search is made for a station capable of accepting it. In this way, a station can be pulled off line without disrupting the network.

Although token passing appears to favor ring networks, it works equally well for all network configurations. Depending upon the protocol procedure involved, the token doesn't have to be forwarded to the next node in line. It can be given to any node. Let's say station 19 had possession of the token. It may pass that token to station 53, if so programmed.

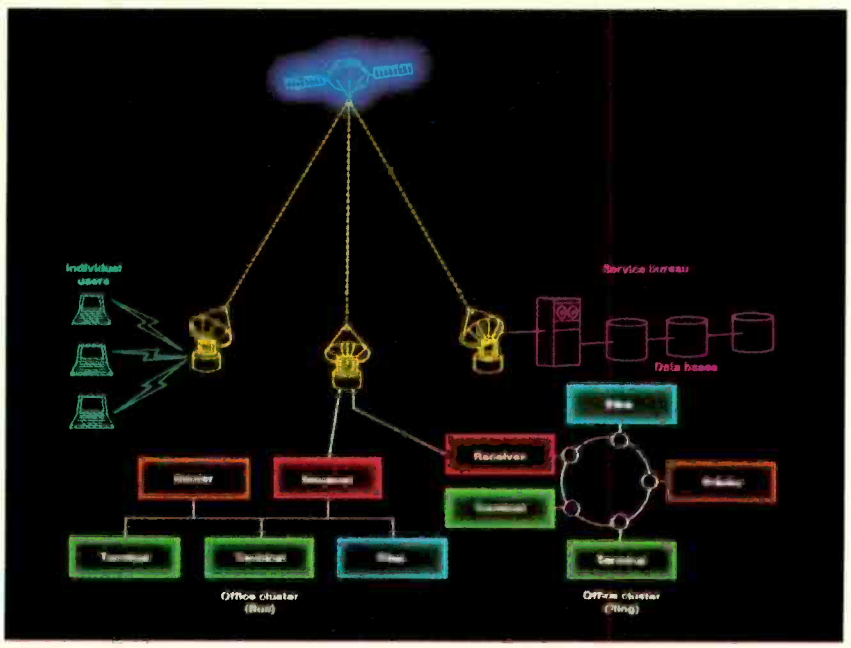
This protocol freedom can give certain nodes priority over others. It's even possible to have a node receive the token more than once during its course by software-programming its return to a different destination each time the privileged node receives it.

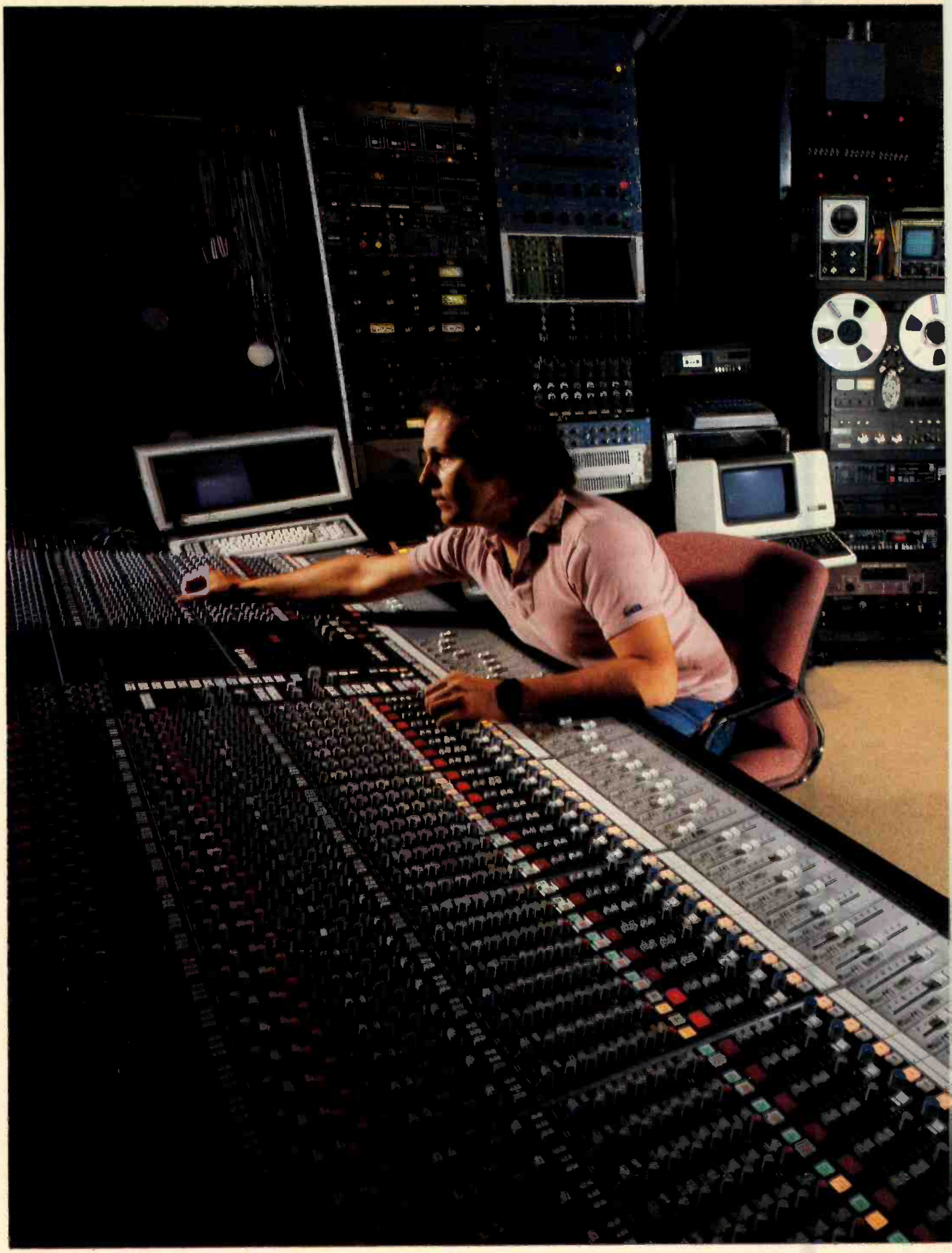
Contention Schemes

Another way to look at the access problem is to let all nodes have access to the network at all times. When a station has something it wants to say, it simply starts transmitting. This is fine . . . if the network happens to be idle at the time.

Unfortunately, you can't always expect that to be the case. It is certainly true that most communiques are just a short burst of data, and have a good chance of catching the line clear. How-

Networks of the future will combine LANs globally.





PHOTOGRAPH BY LIONEL FREEDMAN

MICRO COMPUTERS IN THE RECORDING STUDIO

Personal computers are reforming recording techniques and, in the process, creating new sounds

By Martin Porter

BACK in the sixties when everything, in terms of consumer electronics, was audio, the recording studio was the place to be. Not only were these wired cubicles the hotbeds of rock and roll, but with regard to engineering they were the laboratories of hi-fidelity.

Today, recording is taking its lessons from the research parks of Silicon Valley—and though these other lab technicians most likely listen to canned orchestras or AM Top 40, they are generating micro chips that are transforming the contemporary recording scene and, thus, the sounds of popular music.

Roger Nichols has been the chief recording engineer for pop recording artists Steely Dan since the band's formation. He has reaped three Grammy Awards and five nominations for his engineering efforts and, as a result of the band's hits and attention to audio quality, has the budget to try virtually any new pro audio gadget available.

Unfortunately, everything he needed wasn't always available—especially when it came to computers. The band was one of the first to work on a multitrack digital recorder, a 32-channel, 16-bit machine with a 50-kHz sampling rate from 3M owned by Soundworks, a New York studio downstairs from the famed westside disco Studio 54. However, even before Nichols got his hands on this $150,000 hardware beauty he had been fiddling around with ways to apply the personal computer to the recording studio setting.

New Percussion

Nichols and the band had a need for drum sounds that no human drummer could produce; and, though there were already a number of drum machines available, Steely Dan's ear drums demanded better fidelity than any were able to produce. Nichols created a computer synthesizer with a sampling rate that would match that of the 3M tape machine with a sizable bandwidth of 20 kHz, as compared to the 8-10 kHz available from the other drum machine makers. He accomplished this using a CompuPro 16-bit CPU with an 8086 microprocessor and one megabyte of memory, plus a DEC terminal and a Micropolis hard disk.

"We would create the drum sounds on the computer and then transfer them directly onto the digital tape machine. Then we would process them any way we wanted in the computer and again dump them onto the tape, without ever leaving the digital domain," Nichols explains.

He adds that, by manipulating the

Roger Nichols, a leader in the use of micros in audio recording.

screen graphics on the DEC VT 100, he has created waveforms for drums and also altered the quality of vocals. Theoretically (and with the appropriate software), he feels that a personal computer could easily replace the multiple racks of signal-processing devices that line the walls of most control rooms and shape the sound on today's pop recordings.

"I didn't think it was necessary to try and reinvent the wheel. There are already plenty of processors available. I just needed a tool that then didn't exist," Nichols says.

Sound Meets Digital Technology

The first computers to enter the recording studio were signal processors that date back to 1971 when the Massachusetts-based manufacturer Lexicon developed a commercially viable digital audio delay, a product that is used to "thicken" recorded sound.

According to Lexicon president Ron Noonan, "You could say that signal processors were the first computers in the recording studios. Clearly the first digital products developed for commercial audio, they could digitize sound, record a delay in a random access memory, and then bring it out."

Today's signal processors generally use two microprocessors: high-speed, specialized chips that are able to make audio changes and execute elaborate algorithms in microseconds, and standard chips like the 8080 that serve as the intelligent interface between the user and the control panel. The end result is devices that can send audio signals through hula hoops to change pitch, create harmonics or develop an extensive array of musically distorted effects.

Digital technology, in general, has made quantum leaps since the early 1970s and audio recording has felt the effect with the development of digital tape machines that can translate analog data into binary codes. The resultant audio specs dazzle the ears with no distortion and impeccable hi-fidelity. Prior to the introduction of the Compact Disc came the first digital studio tape machines, high-ticket reel-to-reels that hit the studio marketplace at a bad time (1979) because artists and record companies were slashing recording budgets due to the recession. Moreover, the earliest units had their fair share of reliability problems and some engineers still complain about their error correction, the lack of standardization between the available models (3M, Mitsubishi and Sony), and the quality of chips that make the conversions from analog to digital and back to analog again.

Martin Porter is a contributing editor for PC magazine and writes about audio for the NY Post and electronics for GQ.

Enter the Disk

Bob Liftin, owner of Regent Sound in New York, has been recording pop music since the 1950s when he generated 45s at one-a-day clips for artists ranging from Smokey Robinson to Aretha Franklin. Today he is noted for his pioneering efforts in audio for video post-production and produces the sound for a range of TV programs including the Emmy's, "Saturday Night Live" and MTV. Seven Apple IIs, which are used for everything from studio scheduling to synchronizing audio and video machines, sit on desktops throughout his recently refurbished Broadway studios. He and his staff have even experimented with recording directly onto floppy disk though, admittedly, with poor results.

"I clearly see digital taking over from analog. However, the way I see it coming about is recorded on hard and floppy disks in the magnetic medium. It will lower costs. You will be able to access tapes much faster. It will allow the operator to determine how many tracks he needs, whether it be eight or 100 because it is synchronous. You will thus come out with a machine that virtually has an unlimited amount of tracks."

A move in that direction was made at the fall meeting of the Audio Engineering Society where Gotham Audio displayed the industry's first digital recorder to use a hard-disk storage medium. The Systex system featured Winchester hard disks and Fujitsu M-2294, CDC and Ampex disk drives, controlled by a Motorola 68000 processor. The standard machine is a 16-bit unit with a 48-kHz sampling rate that can be controlled by any multitasking computer.

According to Gotham sales manager Russ Hamm, "The unit could have studio applications in multitrack configurations but in mono or stereo it will prove useful to broadcasters who will be able to program a day or maybe a week's worth of slots, tie them into billing and, in general, fit the studio into the entire automation of radio broadcast."

Analog Fights Back

Analog tape machine manufacturers haven't taken the digital revolution sitting down. In fact, it is generally acknowledged that the next generation of

professional tape machines will be hybrid units that record magnetically onto analog tape but have the guts of microprocessor monsters. Studer of Switzerland introduced the first such unit last year with its A810 stereo reel-to-reel. Computer control of all tape recorder functions is possible via a serial interface, which, in recent demonstrations, was a Falco TS-1 terminal. The unit is thus able to program virtually all its operation modes (i.e. PLY for play, REC for record, LOC for locate) while the terminal operator can quickly program an entire sequence of events: The computer can shuttle the tape, put the machine into record or play, locate address points on the tape, and switch electronics into any mode. Because of its microprocessors, the unit can also be tweaked via a system recently introduced by test equipment manufacturer Sound Technology which interfaces the recorder with a Hewlett-Packard HP86B computer and printer. All A810 parameters (bias, level, EQ) are set through digital attenuator networks with memory storage. The computer and printer are used to document all these settings in chart form in all modes, at four tape speeds, for different EQ curves and for two different tape formulations. The Sound Technology set-up can also run a test sequence on the machine to determine basic performance specifications such as S/N, distortion, azimuth and frequency response.

PHOTOGRAPH BY STEVE BORNS

Using an Apple to control a range of audio equipment.

"I clearly see digital taking over from analog"

Says Tom Mintner, director of Studer Products, "All the necessary hardware (for automated set-up of audio parameters) is in there. It's simply a matter of developing the interfaces and the software to do the job."

Control by Personal Computer

The move by Studer is but one in a general trend within the audio and video industries to develop equipment that can be controlled via a personal computer. At Liftin's Regent Sound, the Apple computers control a range of equipment by EECO, BTX, Convergence and Ampex that feature either RS-232 or RS-422 ports to facilitate computer sequencing and operation.

"The general idea is to make the editing and recording process transparent to the engineer and give him centralized control," Liftin explains.

The idea of making an audio engineer's life easier is certainly nothing new; though automation in the recording studio in the past has largely centered around the mixing console—that desk-like contraption with faders, switches and dials that route and shape every sound that makes its way from the microphones onto tape. Because of the layered complexity of today's multitrack sessions, console automation took a tape-based form that would store the mixing movements (i.e. fader levels and mute status) onto a free track on the multitrack master tape.

However, tape-based systems have their limitations and it was this that brought more personal computers into the recording studio environment.

Diskmix from console manufacturer Sound Workshop, based on Long Island, NY, is an automation storage and editing system that can interface with many standard recording consoles. Utilizing an IBM PC terminal, a main computer using two 6502 microprocessors, and two eight-inch floppy-disk drives, Diskmix is attached via four cables into the console's patchbay and requires no console modification.

Sound Workshop president and Diskmix developer Michael Tapes explains the rest: "Since most audio engineers resist having to sit at a computer keyboard or having a computer run his or her mix, Diskmix was conceived to have minimal keyboard input from the engineer. In general, while mixing, no keystrokes need to be entered and all levels and mutes will be stored on disk. Only when a bad mix pass is made is the delete key operated. Mixing continues until such time as a mix is valid enough that it can be named, for later recall, in part or full, for review or merge with another mix."

From Across the Sea

Automation of all mixing functions is currently the aim of the high-end console marketplace. In the United Kingdom, Rupert Neve Inc. has introduced the world's first all-digital console, which was built in conjunction with the BBC. Meanwhile, fellow UK manufacturer Solid State Logic is rapidly becoming the state-of-the-art studio standard via its high-tech mixing boards with internal computers.

A new software package from SSL illustrates how this computer-oriented product works. In the realm of tape machine control, a menu contains complete profiles of up to 16 audio and video transports and provides machine changeover at the touch of a button. A master transport selector automatically switches tach pulse, time-code, direction sense and transport controls for the master machine. Adds U.S. sales manager Piers Plaskitt: "The data bussing looks at every pot, switch, and fader; and the computer mainframe is wired for a great deal of further development."

In fact, a new SSL board was recently installed at Soundworks where Roger Nichols does much of his work for Steely Dan and, though he is clearly tempted by its automation, for the time being his excitement about computers in the recording studio is fixed more on the musical instrument side of the control room glass. These include synthesizers, and other digital instruments that are able to replicate virtually any sound imaginable and are being used increasingly in studios by producers and musicians to create the currently fashionable electronic sounds and, mean-

(Continued on page 98)

HARDWARE REVIEWS

Products representative of the types of buffers available.

Three Printer Buffers

Peripherals that increase your personal computer's productivity

By J. Smith-Richardson

As personal computers and the software they run become more sophisticated, a conflict can arise between the amount of time a computer actually works and the time it has to wait for external devices to catch up with it.

Today's sophisticated software chews up both RAM and external storage by the bucketful. Much of the power of today's super-graphics software, do-everything word processors, and financial modeling progams arises from the fact that computer memory is cheap, and program size is no longer restricted by an arbitrary boundary of 64K bytes of RAM.

A programmer is free to use as much memory as he needs for optimum performance, be it 128K, 256K, or even more. By the same token, the amount of data capable of being stored by a computer has also increased, and data files are frequently larger than 64K in size.

When your computer tries to transfer all this information to an outside-world device like a printer, it encounters a bottleneck. Some letter-quality printers operate as slowly as 120 words per minute. Printing out a 10,000-word document—which nominally consists of 60K bytes—on such a printer can tie up a computer for about an hour and a half. That's time during which the computer is useless for any other purpose.

Similarly, a simple 5"-high monochrome bar graph consisting of six three-tier bars can take as long as 20 minutes to be printed out on an 80 cps (characters-per-second) printer.

In short, a few major printing jobs a day can take a personal computer out of service for several hours.

How can you get back that lost time? The solution is a device commonly known as a *printer buffer.* A printer buffer is a self-contained bank of RAM controlled by its own microprocessor and connected between the computer and the printer. When the computer is instructed to print, it dumps the material to be printed into the printer buffer's RAM thus freeing up its own. Within seconds the computer is ready to resume high-speed data processing—the printer buffer has taken over the task of producing hard copy.

The microprocessor within the buffer device, in addition to handling routine data input and output, can also support special printing functions. Among them are *pause* (stop printing temporarily), *multi-copy* (after the document is printed, print it again a certain number of times), and *character translation* (change a particular character to another every time it's encountered). The list of special printing functions available from some printer buffers is almost endless with cost—or so it would seem—being the limiting factor.

Printer buffers seem to fall into three categories: simple (or "plain vanilla"), advanced, and do-it-all. We'll look at one device from each category to see what makes them different. (One thing they all have in common, you should note, is that none of them is supplied with cables. You will have to purchase one, or possibly two, cables representing an additional cost of $20 to $80. Be sure to add the cable cost to the price of the buffer.)

PHOTOS BY BOB LORENZ

Radio Shack PTC-64

This printer buffer ($249.95, Radio Shack, One Tandy Center, Fort Worth, TX 76102) has 64K of RAM of which 62K is available for data storage. Incidentally, Radio Shack refers to it as a "printer controller." Though designed to work with Centronics-type parallel printers, only the input connector is the common Centronics-type. The output connector is a somewhat unusual DIP header and it's unlikely that you will be able to use any standard cables you may have lying around.

The unit is housed in a low-profile gray plastic cabinet measuring $6\frac{7}{16}$" × $7\frac{3}{8}$" × $2\frac{5}{16}$". It is powered by a wall-plug-type ac adaptor with a cable that plugs into a jack on the buffer. A membrane keyboard on the top provides three operating keys labelled CLEAR, COPY, and PAUSE. Three LEDs serve as indicators for POWER, STATUS, and FAULT.

The CLEAR key "flushes" the memory to eliminate any residual "garbage" prior to commencing a print operation. It can also be used during printing to abort the operation while leaving the information in memory intact. The COPY key allows you to determine how many

Radio Shack TRS-80 PTC-64

copies will be printed. Each press of the key will generate another copy. Up to 100 copies can be requested. The PAUSE key temporarily stops, and then restarts, printing.

Combinations of the keys provide special functions. Simultaneously pressing CLEAR and PAUSE causes the buffer to run a self-test. CLEAR and COPY enables features like an internal beeper, character redefintion, and the translation of single bytes into strings (multi-byte sequences); pressing the CLEAR and PAUSE keys disables those features.

Basically, the PTC-64 serves as RAM storage: the data that flows into it from the computer flows out to the printer for a single print or for multiple copies. Also, late-model Radio Shack printers permit some characters to be translated to any of 16 pre-programmed Greek symbols. Alternatively, you can create your own special characters, such as copyright and trademark symbols, within a 7 × 5 matrix.

The device appears to have been designed specifically for Radio Shack's own application programs that permit special printing functions. For example, Model II Scripsit can be programmed to *automatically* utilize the buffer's translation characters, user-created characters, and even the buffer's own control codes such as PAUSE.

One important thing *every* printer buffer must be able to do is "busy-out" the computer. That is, when it is full, it must send a BUSY signal to the computer to indicate that it cannot accept any

A simple bar graph can often take 20 minutes to print

more data and that the computer should not send anything more for the time being. Without that capability, data may be lost, or may be overwritten in the buffer.

According to the manual supplied with the PTC-64, the unit cannot reliably busy-out a system when the data to be printed exceeds its 62K capacity. To get around this problem, Radio Shack advises starting printing immediately—a flying start—when the size of the document to be printed exceeds 62K.

It works this way. Assume that the document to be printed occupies 75K of the computer's RAM, and that only one copy is required. The computer dumps to the printer on the command PRINT and the printer starts almost instantly—even while the computer is still filling the buffer's RAM. Within seconds that RAM is full (because it fills many times faster than the printer can print) but there is still approximately 13K of data in the computer's RAM because the buffer is full and there's no place for it to go. However, as each character is printed a byte of RAM in the buffer is freed up. And, as buffer RAM becomes available, the computer fills it with data that gets tacked onto what's already in the buffer.

Eventually all the data gets dumped from the computer to the buffer and the computer is again free for use while the buffer empties its 62K of RAM.

If the data or document does not completely fill the buffer's memory, you can feed in additional material to be printed behind the first. Depending on whether the data originates from a word processor or not, the buffer will either print each document separately by issuing a form feed at the end of each one, or will chain one dump to the next. In this manner you can be working on a second, third, or fourth document while the printer is printing the first one. Similarly, disk files whose total size is well beyond the capacity of the computer's RAM can be appended or merged into a single document.

If the buffer is programmed to make more than one copy, all the data must fit into its RAM, otherwise the later dump(s) will overwrite the start of the document. If the data or document is completely within the buffer's RAM, then the buffer can be programmed to print up to 100 copies. It may take all day to print those 100 copies, but the computer will be free for other purposes within seconds.

The Angel

Next up the ladder in complexity is The Angel ($295. LIGO Research, Inc., 396 East 159th St., Harvey, IL 60426). Billed as "The Intelligent Printer," The Angel is essentially a "plain vanilla" buffer with enhancements that permit it to be used easily with virtually any computer and printer combination. Containing 64K of RAM, it has both RS-232C Centronics-type parallel ports which can be combined serial to serial, serial to parallel, parallel to parallel, or parallel to serial.

Programming the operating mode and the serial-communications characteristics (baud rates, number of data bits, parity, etc.) is done through three 8-position DIP switches accessible through a cutout in the front panel. The setup instructions in the manual are

LIGO Research's Angel

clear enough so it should be difficult to set those switches incorrectly.

The serial connectors are the standard DB-25 type usually used for RS-232 I/O. The parallel I/O connectors, however, are a rather strange sort that is neither commonly used nor available. LIGO will provide a set of matching I/O cables terminated in standard Centronics-type connectors if needed. An order form is provided in the manual. Additional cables are $39.

The Angel buffer has two major enhancements in addition to the intermixed I/O. The first is *space compression* that permits a single byte to represent many contiguous spaces. Depending on the data being printed, the 64K Angel can store the equivalent of 128K bytes. The second enhancement is a *page definition* mode that provides detection and control of page information.

The Printer Optimizer probably has every printing feature you want

The page definition mode allows the user to select any one of sixteen page definitions, which allows alteration of the number of lines per page, the formfeed character, and the response to that character (i.e., 66 lines/page, 66 lines/page + auto linefeed after carriage return, 88 lines + formfeed, etc.). The Angel can even be programmed to suspend transmission of data (PAGE-PAUSE) at the end of each page.

The unit is housed in a low-profile plastic cabinet whose dimensions are $7\frac{5}{8}$" × $5\frac{1}{4}$" × $1\frac{7}{8}$". The power supply arrangement is similar to that of the Radio Shack buffer. A membrane keyboard on the top of the enclosure has eight keys labelled: HOLD, PAUSE, FUNC(tion), 2ND FUNC(tion), CLEAR, COPY, PAGE SKIP, and RE-PRINT. Six LEDs are used as POWER, DATA and STATUS indicators.

The HOLD key controls the flow of data from the computer to the buffer. The PAUSE key controls the flow of data from the buffer to the printer, and does double duty in enabling multi-key commands. The FUNC and 2ND FUNC keys are used in conjunction with other keys to provide additional commands. No change in data flow is effected when these keys are pressed.

The CLEAR key flushes the memory to eliminate "garbage" prior to commencing a print. The COPY key copies (prints) the contents of the entire buffer; it is cancelled with the 2ND FUNC key.

The key labelled PAGE SKIP stops printing of the current page, generates a formfeed, and begins printing from the top of the next page. The one marked RE-PRINT reprints the current page, or, if at the beginning of a page, reprints the previous page.

Pressing FUNC and CLEAR together enables or disables the PAGE mode. This allows you to make use of the 16 stored page formats. Pressing FUNC and COPY together allows you to select multiple copies in units of 1, 10, or 100 depending on the key sequence used.

Other keys used in conjunction with the FUNC key control space compression, multiple-page reprints, data skips, page-pause (pause after every page), and even allow you to determine the current number of lines per page. As with other buffers, you can stack data into the buffer for continuous printing.

Essentially, The Angel enhancements are oriented toward providing the user with extra facility to determine how individual pages or copies will print.

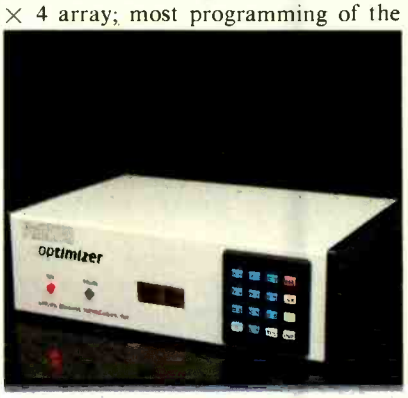
As one might expect from this kind of page orientation, The Angel can busy-out a computer under any operating conditions. For example, even if the device starts out in the PAUSE mode (no output to the printer) the computer will dump into the the buffer until its RAM is full and it sends a BUSY signal back to the computer to stop the dump. When the unit is taken out of the PAUSE mode to start data flowing to the printer, the computer resumes filling the buffer as its RAM is emptied. Similarly, if the buffer is put on HOLD it busies-out the computer until removed from that mode. There is no instability in the generation of a BUSY signal, as there seems to be with the Radio Shack device.

Printer Optimizer

The Printer Optimizer ($499. Applied Creative Technology, Inc., 2723 Ave. E East, Arlington, TX 76011) is the *ne plus ultra* of printer buffers. Any printing feature you desire is probably possible with it, because it is essentially a complete computer specifically programmed for printing functions.

The basic unit uses Centronics I/O and comes with Centronics-type connectors. Several user-installable plug-in options are available: Opticom ($99) adds an RS-232 serial port to the existing parallel one, Opticom + ($149) adds two serial ports, and Opti3po ($79) adds two parallel ports (for a total of three). The amount of RAM—64K in the basic package—is also expandable, to 256K.

The device is housed in a metal cabinet measuring $10\frac{7}{16}$" × $7\frac{1}{2}$" × $3\frac{7}{16}$". The power supply is a wall plug device; but, unlike those used with the other buffers, it is permanently connected to the unit. The front panel contains a 16-key pushbutton keypad arranged in a 4 × 4 array; most programming of the buffer is done through it. There is also a pushbutton PAUSE switch used to start and stop data transmission from the buffer to the printer, and an LED power indicator. A three-digit alphanumeric LED display shows the amount of free RAM, indicates when the unit is in PAUSE mode, and serves as a readout for all operating modes and user programming.



ACT Printer Optimizer

On the back of the unit are the I/O connectors, the ON/OFF switch, and a RESET button that erases all the data in the buffer.

One feature that sets the Printer Optimizer apart from the other printer buffers discussed here is a set of 99 memory "slots," each of which can store up to 127 bytes. These slots, which make up what is called "housekeeping memory," can be used to hold ASCII codes representing text or graphics characters or control sequences to make your printer do things like change fonts. The slots can also contain character-conversion information (see below). The housekeeping memory is kept alive by a lithium battery when the printer buffer is not plugged in. To prevent accidental erasure of the information contained in the slots, the Printer Optimizer will query you when you attempt to change

(Continued on page 106)

Kaypro 4 Plus 88

The Kaypro 4 gets an 8088 and MS-DOS

By C. P. Rubenstein

Two of the hot tickets in microcomputing today are transportable machines and IBM PC compatibles. The Kaypro Corporation (formerly Non-Linear Systems, Inc.) has been cashing in on the demand for transportables with its Kaypro II, 4, and 10 line. Now, it is aiming at both markets with an IBM PC compatible transportable called the Kaypro 4 Plus 88.

To backtrack a bit, the Kaypro 4 is an updated, and upgraded, version of the single-board, Z80-based Kaypro II (reviewed in C&E in June 1983). The Kaypro 4 Plus 88, which is reviewed here, is a Kaypro 4 with factory-installed 16-bit Intel 8088 co-processor and an additional 256K bytes of dynamic RAM. Suggested retail price of the 4 Plus 88 with bundled software is $2195. (An 8088 upgrade kit is also available for the Kaypro II and 4 from SWP Microcomputer Products, Dallas, TX.)

Inside the 4 Plus 88

The main board of the 4 Plus 88 contains a Z80 microprocessor, 64K RAM, 2K video RAM, a 2K ROM for the "boot" software, and a 4K character generator. Actually, the Z80 is on a separate small board that plugs into the socket that houses the Z80 on other Kaypro models.

Two Zilog Z80 PIO chips and a Z80 SIO chip are used to implement the 36-pin Centronics-type parallel port and the DB25 serial RS-232C port. The PIOs have a spare 8-bit parallel port as yet unused. Thus, future expansion busses, add-ons, or even an IEEE-488 port could be added with a connector and a few lines of system software.

The 4 Plus 88 has upgraded its disk drive capabilities by using a Western Digital FD1793 floppy-disk controller chip (the II had an FD1791) and including the "UniForm" formatting program, which reconfigures the disk parameters for Xerox 820, Osborne I, and TRS-80 Model I disks. (This controller chip can handle single/double density as well as 5¼" and 8" drives, so watch for 8" add-ons).

The main computing board is well designed with one-third of the 70 ICs socketed for later repairability and ROM upgrades. However, there are no specific sockets available for add-on boards, modems, etc.

The new feature of the Kaypro 4 Plus 88 system is an Intel 8088 co-processor (5.33 MHz) and 256K bytes of RAM. A 16-pin ribbon cable connects the Z80 board to a 6" × 7" board that has the 8088 co-processor and 65 other ICs supplying 256K RAM and 4K ROM. This board is attached to the rear of the disk drive cage and to the 5-V power bus. On this board, only the RAM, the ROM, and the 8088 have sockets, with the other 30 ICs soldered in place.

The board does double-duty as an 8088 co-processor MS-DOS or CP/M-86 system, and as a 256K-byte RAM disk under the CP/M-80 operating system. This RAM disk feature allows programs to have rapid I/O without the expense of a hard disk. It is only implemented when requested, and, since it is dynamic RAM, it is reset when warm/cold booted.

The only drawbacks to this upgrade are those related to IBM PC compatibles in general (see below), the unavailability in the original Kaypro 4 design to support an "open" bus with spare card slots, and the 8088 board's current lack of any place to put additional RAM or the Intel 8087 floating-point mathematics chip that gives the 8088 so much more power.

Physical Characteristics. The Kaypro 4 Plus 88 is in a rugged, grey metal case measuring 8½" × 18¾" × 14⅜" and weighing 28 lb. The carrying handle is on the back of the case.

Also on the back panel are a removable line cord that wraps around the case, a reset button, a brightness control, *exposed* vent slots, and keyboard, serial, and parallel connector sockets. In spite of its rugged appearance the entire unit would require environmental seals and covers to avoid the "raindrops keep falling on my RAM" syndrome. Of course, you can always get a separate carrying case.

The Kaypro 4 Plus 88 features an Intel 8088 and an added 256K.

No doubt listening to its customers' complaints, the 4 Plus 88 now has a foldup wire support brace on the bottom that permits angling the display and drives at a comfortable 15° viewing angle. This allows complete freedom of movement for the keyboard without the II's need for a book, ledge, or shelf add-on to reduce neck strain.

The Keyboard

The keyboard is attached to the console through a standard (unshielded) 4-pin

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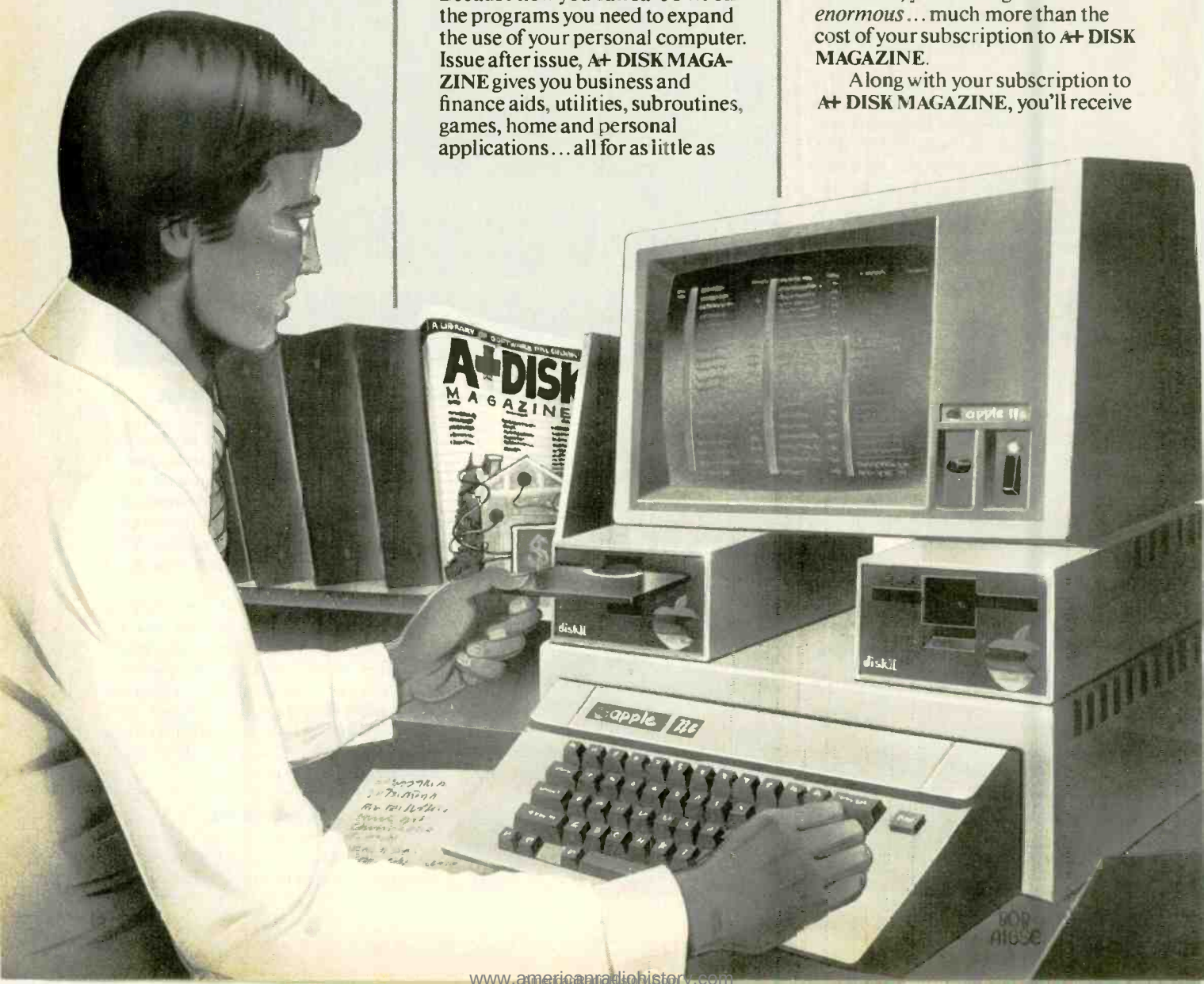

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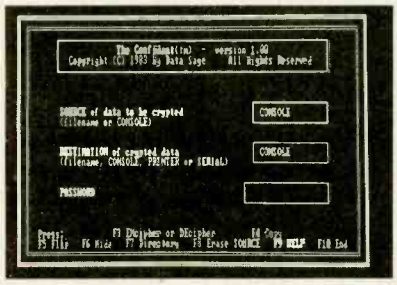

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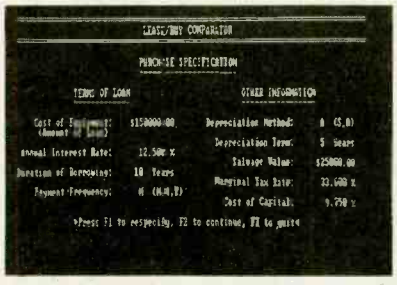

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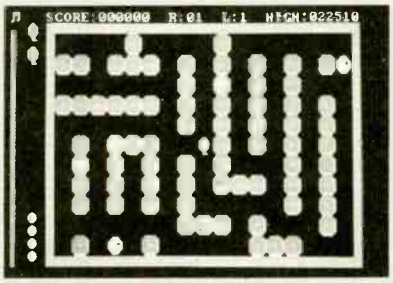

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modular telephone plug. The 12″ coil cord can extend to about 4′, but unhappily half of that extension is lost going *under* the console to plug into the rear panel.

The keyboard chirps through its built-in piezoelectric speaker when you press the keys down. Although this can be annoying, it is under software control and thus can be turned off either from within the various BASICs supplied, or as a machine language command by outputting "8" to port 5. I do like the feel of the keys with this feature, and must admit that the chirp simulation of tactile feedback is more pleasing as you get used to the keyboard. The keys are a bit light, though, and have a plastic-tinny feel.

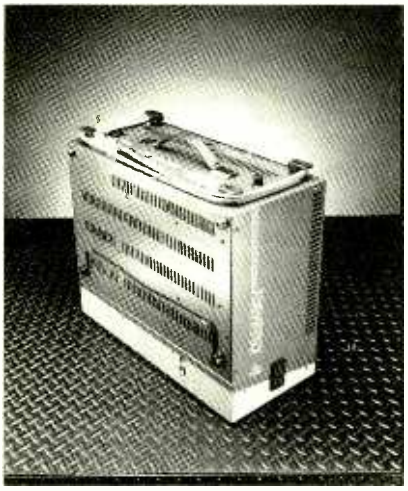
The full-featured QWERTY keyboard with 14-key numeric keypad, standard-control keys, and up-down-left-right cursor-control keys is manufactured by Maxi-Switch Co., and uses an 8049 dedicated microcomputer chip (with 2K of on-chip ROM) for key encoding and 8-bit serial communication with the main processing board.

Using the menu-driven CP/M-80 "Config" program, you can redefine the 18 cursor and numerical keypad keys to any hexadecimal value. The program accomplishes its task by rewriting the key code tables in CP/M's BIOS. Located just after the CP/M jump table (which begins at $FA00), the cursor keys are defined at $FA35H-FA38H, and the numerical keypad at $FA39H-FA46H. Your customized definitions are written onto the disk's CP/M and remain in the memory's CP/M image until a *cold start* (reboot or reset) is done. Each disk can therefore have its own specific keyset to enable rapid use of Perfect Writer or WordStar control-key codes. The keyboard's circuit board has 15 currently unused locations where Kaypro could place user-definable or special-function keys in future upgrades. (See white squares in photo.)

I loaded the CP/M to MS-DOS program on a disk whose cursor key codes were redefined and found that they had been reset to their original values in the booting process. The current MS-DOS disk does not have a "Config" program and thus more information about the MSDOS.SYS and IO.SYS files must be made available. (Their directory attribute of "2" makes them invisible to the directory, and thus cannot be examined by "Debug," etc. unless an MS-DOS equivalent of the IBM PC Norton's Utilities, or a disk editor, becomes available.) It's not clear if Kaypro intends to support key definition tables in CP/M-86 or MS-DOS.

The Display Monitor

I prepared a few WordStar documents with the system and found little problem reading the 9″-diagonal (about 5″ × 7″) green-phosphor screen (even from a distance of over 5′). Also I had no trouble interpreting the rather well-proportioned, 5-dot wide and 7-dot high (8 dots are used to create lower-case descenders) characters on the Elston Electronics, Corp. display that the Kaypro 4 Plus 88 uses for its CRT. The screen displays 25 lines of 80-character blocks



A luggable 28-lb package.

(6×9 dots) or about 480 × 225 pixels if full graphics could be implemented.

The characters are generated, along with an auxiliary Greek alphabet (ESC-G toggles lower case to Greek translation, ESC-A turns off the toggle), using a socketed, 4-kilobyte ROM, thus allowing for future upgrades.

I did notice that there still is some power-surge "screen-pulling" on the left margin whenever the disk drives are accessed.

The Disk Drives

The dual drives on the 4 Plus 88 are double-sided and double-density, thus allowing for twice the Kaypro II's storage capacity (800K). Something that is troublesome, but no great problem, is the constantly "on" LED indicating the last active drive. In many other systems, the drive LEDs are only on during the times that the disks are actually spinning. (When in MS-DOS, the LEDs *are* off when the disks are not running.) Instead of looking at the drive LED, you have to *listen* for the drives to stop if you want to remove the disks. Another interesting thing is that *both* drives spin at any drive request.

The Software Bundle and Documentation

The Kaypro 4 Plus 88 is bundled up nice and warm with a plastic library case containing about a dozen 5¼″ diskettes of enough software to get the new owner off to a good start (see Table I). Also added for your evening's readings are an equal number of manuals weighing in at close to 10 lb, and containing over 2400 pages of excellent user information. (Gee, buy the computer and they throw in a library at "no-extra-cost.") Most of the manuals are high-quality photocopies of the original manufacturer's manuals, some of which are noted for their lack of comprehensibility.

The new user might really feel intimidated without a large dose of dealer support after opening these classics. Some, like the CP/M manual, have confused many people for many years, others like the WordStar Training Manual are designed so that the new user doesn't have to read the WordStar Reference Manual (which has been much streamlined from the last time I saw the WordStar 2 manual).

(Continued on page 103)

TABLE I—KAYPRO 4+88 SOFTWARE

Operating System:	Digital Research CP/M-80 2.2 Microsoft MS-DOS 1.25 (version 2.1 also available)
Word Processor with Spelling Checker:	WordStar 3.30 with the WordPlus 1.4 Perfect Writer 1.2 with Perfect Speller 1.1
Spreadsheet:	Microplan 4.04 Perfect Calc 1.1
BASIC:	S-BASIC C-BASIC 2.08 with CRUN 2.08 and 2.38 Microsoft BASIC-80 4.51 and 5.21
Database:	Perfect Filer
Other:	UniForm (disk format changer)

SOFTWARE REVIEWS

Features of Eight Electronic Spreadsheets

Demystifying spreadsheet programs and comparing the attributes of eight popular programs

By Barbara E. McMullen and John F. McMullen

AMONG the most popular of applications programs for personal computers is the so-called "electronic spreadsheet." Unfortunately, as with most other professionally oriented applications programs, what an electronic spreadsheet is and what it can do can be very confusing to someone who has never used one.

The electronic spreadsheet is basically a simple but very powerful tool for the computer user. It has a number of advantages over the ordinary pencil-and-paper worksheet equivalent. Among these is that it is a tremendous time saver. It has the ability to automatically perform tedious mathematical calculations without error (given the formulas on which calculations are to be made, of course) and it saves paper.

Because any and all calculations can be referenced to each other, a change made in one location on the spreadsheet will automatically be reflected in every other location in the spreadsheet that references the changed data. This very powerful "what-if" feature is used very effectively for making instantaneous projections and forecasts that might otherwise require considerable time to perform. A multitude of such operations can be performed in only a fraction of the time it would take to make a single what-if projection by mechanical means.

In this review, we will demystify what an electronic spreadsheet program is and compare it to the traditional paper-and-pencil worksheet. We will also detail the various functions and features of eight popular electronic spreadsheet programs to help you evaluate your needs if you are in the market for such an applications program.

Spreadsheet Defined

If you have never used an electronic spreadsheet program or seen one being demonstrated, a description of it in a magazine can be inadequate. Nevertheless, we will attempt to relate to you what this powerful computer tool is and roughly how it is used.

The best way to understand an electronic spreadsheet program, is to go through a simple problem, using a pencil-and-paper example and comparing it to the electronic version of the spreadsheet. Start by drawing a set of rows and columns on two sheets of blank paper. Mark each column with a letter and each row with a number as shown in Fig. 1. The point at which a column and a row intersect is called a *cell* or matrix entry.

Electronic spreadsheets have it way over their manual counterparts

The first of the two sheets you prepared will be your scratch paper, on

(Continued on page 88)

ABOUT THE COMPARISON CHART

(On pages 84 to 87, 90 and 91)

There are many electronic spreadsheet programs on the market. We have chosen eight of them to compare, detail by detail. Some are very popular; others are not as well known. However, they all share the basic identity as spreadsheet tools. All of the electronic spreadsheets we have chosen for review here consist of stand-alone packages. None is the type commonly found in integrated software packages that consist of word processor, database manager, etc.

We have also compiled a list of spreadsheet characteristics and indicated which of the spreadsheets exhibit which traits. So that you are better able to judge which program best suits your particular needs, we have briefly noted the significance of some of the differences we found.

MAGICALC
ARTSCI
5547 Satsuma Ave.
North Hollywood, CA 91601
(213-985-2922)
Price: $149.95

MICROPLAN
Chang Labs
5300 Stevens Creek Blvd., Suite 200
San Jose, CA 95129
(408-246-8020)
Price: $495.00

MULTIPLAN
Microsoft Corp.
10700 Northup Way
Bellevue, WA 98004
(206-828-8000)
Price: $250.00

PERFECT CALC
Perfect Software, Inc.
701 Harrison St.
Berkeley, CA 94701
(415-527-2626)
Price: $295.00

PRO CALC
Software Products Int'l., Inc.
10343 Roselle St., Suite A
San Diego, CA 92121
(619-450-1526)
Price: $350.00

SUPERCALC
Sorcim
405 Aldo Ave.
Santa Clara, CA 95050
(408-942-1727)
Price: $295.00

TARGET: FINANCIAL MODELING
Comshare Target Software, Inc.
1935 Cliff Valley Way, Suite 200
Atlanta, GA 30329
(404-634-9535)
Price: $325.00

VISICALC: ADVANCED VERSION
Visicorp
2895 Zanker Rd.
San Jose, CA 95134
(408-946-9000)
Price: $400.00

Spreadsheets

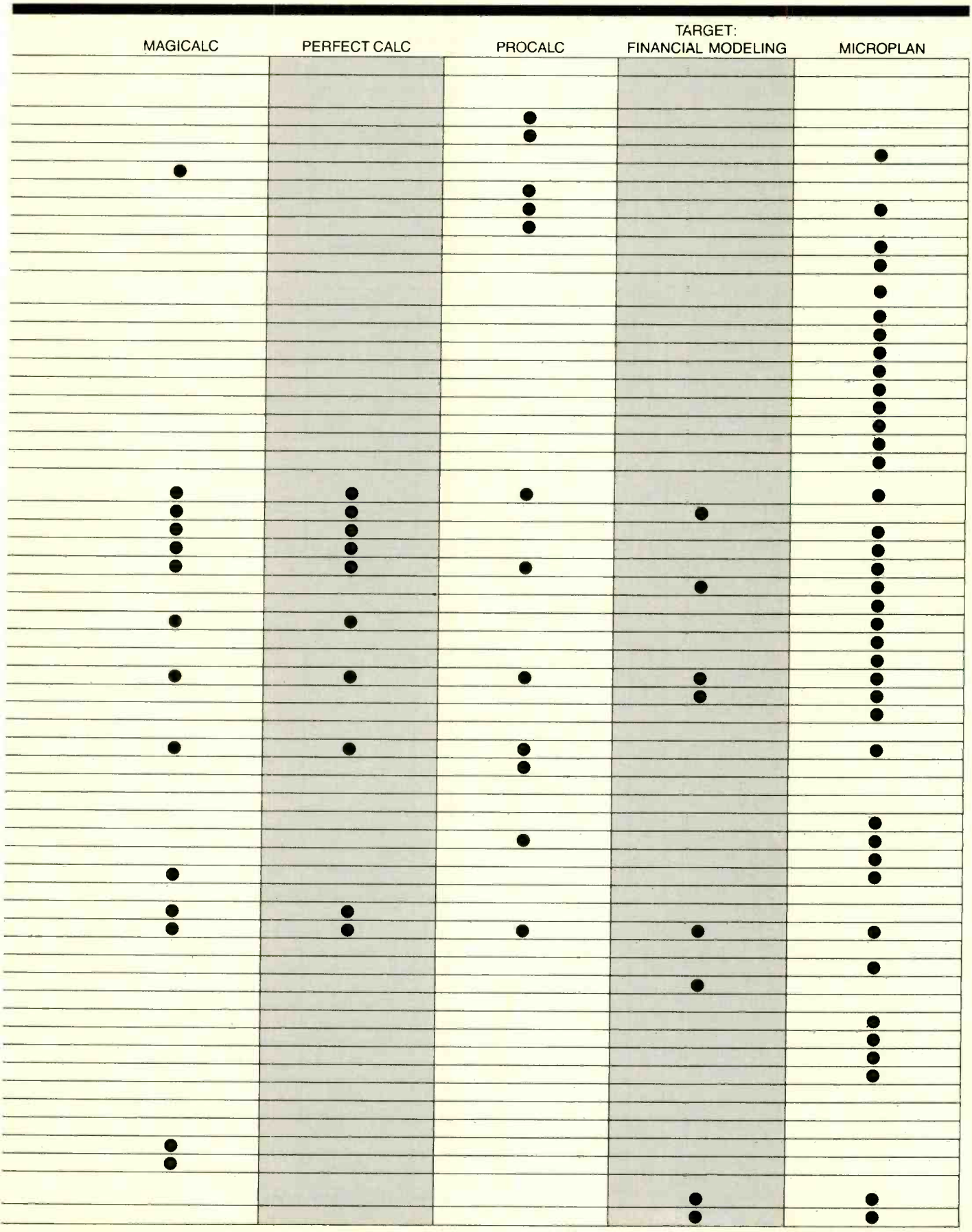
	VISCALC ADVANCED VERSION	SUPERCALC[2]	MULTIPLAN
Columns/rows	63/254	63/254	63/255
Minimum memory required	128K	64K	64K
Maximum usable memory	unlimited		64K(CP/M); 544K (non-CP/M)
Computers supported*	2, 3, 7	1, 2, 7, 9	1, 2, 3, 6, 7, 9
CELL ATTRIBUTES: Formulas in cells	●	●	●
Make cell contents invisible	●	●	
Protect cell contents	●	●	●
Only text in cell	●		
Only numerical data in cell	●		
Set tabs in cell	●		
Align data in cell (L = left, R = right)	L, R	L, R	L, R
Set gutter (L = left, R = right)	L, R		
Repeat character to fill cell			
Center text in column	●		●
Align text in columns (L = left, R = right)	L, R	L, R	L, R
Precede positive numbers with +, negative numbers with −	●		
Precede negative numbers with −, leave positive numbers unsigned	●	●	●
Display negative numbers with parentheses ( )	●	●	
Display negative numbers with credit (CR), positive numbers with debit (DR)	●		
Display commas in long numbers	●		●
Display decimal point in numbers with 0s	●		
Suppress trailing 0s	●	●	
Do percentages	●	●	●
Display $ with full decimal precision (e.g. $12.3456)	●	●	
Display $ with two decimal precision	●	●	●
Display values with specified number of decimal places	●	●	●
Display values as integers	●	●	●
Display values in scientific notation	●	●	●
Display values in graphic format	●	●	●
Display text wider than preset column			●
Lock only cells with text or formulas			●
Assign name to cell(s) for use in commands and formulas			●
Scale display values by powers of 10		●	
Fill empty space on either side of text with characters			
Interface for transferring information from/to spreadsheet program	Data Interchange Format (DIF)	Super Data Interchange (SDI)	Symbolic Link File Format (SYLK)
Consolidation capabilities	Only with DIF—no true feature	Information in like models can be +, −, ×, ÷	Full linking shares info. between 8 data sheets
CONDITIONALS: IF-THEN	●	●	●
AND, OR, NOT	●	●	●
ISERROR and ERROR	●	●	●
ISNA and NA	●	●	●
TRUE, FALSE	●		●
CHOOSE	●		
LOOKUP	●	●	●
INDEXED TABLE			●
VECTOR LOOKUP			
Statistical functions	none	none	standard deviation
Graphics	only rudimentary bar graphs using *s	only rudimentary bar graphs using *s	only rudimentary bar graphs using *s
Sorting capability	●	both rows and columns	rows only
Windows	up to 2	up to 2	up to 8

*1 = Apple II+; 2 = Apple IIe; 3 = Apple III; 4 = Chameleon; 5 = Columbia; 6 = Commodore C64; 7 = IBM PC; 8 = Kaypro; 9 = CP/M-80/85; 10 = CP/M-86; 11 = MP/M; 12 = UCSD Pascal

MAGICALC	PERFECT CALC	PROCALC	TARGET: FINANCIAL MODELING	MICROPLAN
63/254	52/255	32/192	999/5000	20/50
48K	56K	56K	64K	64K
unlimited	64K	limited only by disk	64K (CP/M); unlim (other)	64K (CP/M)
1, 2	2, 4, 5, 7, 9	7, 12	7, 10	1, 7, 10, 11
	●		●	●
●		●		
●	●	●		
●				
			●	
L, R	L, R	L, R		
			L	
			L, R	
	●	●		
L, R	L, R	L, R	R (heacs, foots only)	R
●	●	●	●	
	●	●	●	
		● (C and D)		
	●	●	●	●
			●	●
				●
		●	●	
		●	●	
		●	●	
2 places	●	●	●	● (0-3)
●	●	●	●	●
	●			
●	●	●		
			N/A	
			●	
		●	●	
		●		
Data Interchange Format (DIF)	none	interfaces to Logi-Quest DBMS	none	link module
none—except through DIF	through sophisticated file linking	through file linking and referencing	●	consolidation module
●	●	●	●	
●	●	●		
●				
●				
●				
●				
●	●	●		
		●		
none	none	linear estimation	none	delta; % growth; moving average; smooth; mean; sigma; variance
only rudimentary bar graphs using ⋆s	only rudimentary bar graphs using ⋆s	only rudimentary bar graphs using ⋆s	none	none
none	none	columns only	none	none
up to 2	up to 2	up to 6	up to 4	none

Spreadsheets

	VISCALC ADVANCED VERSION	SUPERCALC²	MULTIPLAN
FINANCIAL FUNCTIONS:			
Interest on discount rate	●		
Payment amount and Current value	●		
Future value	●		
Internal rate of return	●		
Net current value		●	●
Declining balance depreciation			
Sum of year's depreciation			
Annuity current value			
Straight line depreciation			
Double declining value depreciation			
Double declining balance with automatic switchover to straight line schedules			
Period by period depreciation			
Discount cash flows			
Loan schedule (annual, quarterly, monthly)			
Interest schedule on loan			
Select tax computation schedule			
Taxes using tax table and pretax earnings			
Savings balances and Percentage ratios			
Percent of total value			
Percentages based on rates			
MATHEMATICAL FUNCTIONS:			
Absolute value	●	●	●
Average	●	●	●
Base-10 logarithms	●	●	●
Base-e logarithms	●	●	●
Count	●	●	●
Cumulative total			
Ceiling			
Delta			●
Exponent	●	●	●
Floor			
Grow by			
Integer portion	●	●	●
Inverse			
Increment			
Length			●
Maximum and minimum value	●	●	●
Mean			
Midpoint			●
Modulo	●	●	●
Negate			
Power			
Plug			
Round	●	●	●
Sign			●
Square root	●	●	●
Sum	●	●	●
Sum of products	●		
Total			
Weight			
Add constant			
Subtract constant			
Multiply constant			
Divide constant			
Acos and Asin	●	●	
Atan	●	●	
Cos and Sin	●	●	●
Tan	●	●	●
Pi	●	●	●
REPORT FORMATTING:			
Line spacing and Page breaks	●	●	●
Column/row titles on each page	●		



(Chart continued on page 90)

Spreadsheets

(Continued from page 83)

which you will enter raw data and calculation formulas. The other sheet of paper will be your finished report, containing calculated values.

Electronic spreadsheets are like your two sheets of paper. The scratch paper equivalent in the electronic spreadsheet program is stored in your computer's memory; the results of your work, contained in the finished report, are displayed on your computer's monitor.

Getting back to your scratch paper, suppose you wanted to record the sales at a fruit stand you own. You would want to know how much fruit you sold, at what prices, and the amount of money you took in from the sale of the fruit. You would write these titles on your scratch paper as shown in Fig. 1: in cell A1, write ITEM; in cell B1, write QUANTITY; in cell C1, write PRICE; and in cell D1, write AMOUNT. Repeat these entries on your finished report sheet. Now, assuming you sold oranges, apples, and peaches, write these on your scratch paper and finished report.

When using an electronic spreadsheet, you would key all titles into the computer in the same cell-by-cell fashion as you did on your scratch sheet. A portion of the computer's screen is usually set aside as your scratch area. The titles, however, would automatically appear on your finished report without requiring you to repeat your entries.

Having set up your titles, you are ready to fill in your worksheet matrix. On both your scratch paper and your finished report sheet, write in the number of oranges, apples, and peaches sold and the prices of each in the QUANTITY and PRICE columns. Once again, if you had done this in the scratch area of your electronic spreadsheet, the numbers would automatically appear on your finished report without transcription.

Your next step is to calculate the amount of money you took in on the sale of the fruit, category by category. On your scratch paper, in cell D2, write down the formula that will be used to calculate the amount of money you took in on the sale of oranges. This formula would be the number of oranges sold times the price per orange, which would be the contents in cell B2 multiplied by the contents in cell C2. The actual formula would be written B2×C2.

Now do the same thing for the apples and peaches you sold. Write down the formulas on the scratch sheet. Calculate the results and write them on your final report as shown in Fig. 2. If you were using an electronic spreadsheet, you

(Continued on page 96)

	A	B	C	D	E
1	Item	Quantity	Price	Amount	
2	Oranges				
3	Apples				
4	Peaches				
5					
6					
7					

Scratch paper

	A	B	C	D	E
1	Item	Quantity	Price	Amount	
2	Oranges				
3	Apples				
4	Peaches				
5					
6					
7					

Finished report

Fig. 1.

	A	B	C	D	E
1	Item	Quantity	Price	Amount	
2	Oranges	25	.30	B2xC2	
3	Apples	75	.25	B3xC3	
4	Peaches	30	.45	B4xC4	
5					
6					
7			Total amount	D2+D3+D4	

Scratch paper—Raw data and calculation formulas

	A	B	C	D	E
1	Item	Quantity	Price	Amount	
2	Oranges	25	.30	7.50	
3	Apples	75	.25	18.75	
4	Peaches	30	.45	13.50	
5					
6					
7			Total amount	39.75	

Finished report—Calculated values

Fig. 2

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Spreadsheets

(Chart continued from page 87)

	VISCALC ADVANCED VERSION	SUPERCALC²	MULTIPLAN
Page numbering	●		
Set page dimensions (L = length, W = width)	L, W	L, W	L, W
Set margins (L = left, R = right)	L, R		L, R
Set margins (T = top, B = bottom)			T, B
Print with or without border		●	●
Activate special printer features	●	●	●
Remembers selected print options and uses them automatically	With keyboard macros		●
Automatically splits spreadsheet to fitprint paper			
Single-sheet feed		●	
Specify automatic top of form			
Specify no-print for models with nonpositive values in cells			
Specify report titles for printing			
Omit zero rows			
Suppress zero values			
Express zero values as dashes			
Express −0 value as −n, n−, or (n)			
COLUMN WIDTH: Adjustable and Individually adjustable	●	●	●
Minimum width	1	0 (removes column from view)	3
Maximum width	125	127	32
Default	9	9	10
Keystroke memory and expandability	Assign single-letter name to series of up to 7 attributes; captures up to 125 keystrokes	User-defined table; assign any of 7 attributes to any of 8 user keys; execute commands from disk files	Name cells; use full names in formulas and functions; concatenate 2 text values or text value and number
Calendar functions	Convert calendar date to absolute date; returns day or year portion of calendar date corresponding to absolute date; converts hrs/min/sec to fractions of day	Reads current date into cell; enter specified date; display year of specified date; display number of day of week; display modified Julian date; display date value from a numerical value	none
Partial save/load to disk		●	Not directly—with file linking, external copies
Save to text file	●	●	●
Limitations	Most commands work at global level or at individual cell level; not able to format columns with format command	Needs more built-in functions, especially in financial area	Requires two-character ID for each row and column that requires more work on the part of the user
Documentation	Excellent; contains tutorial and true reference and quick reference guides, plus good command chart	Good	Very good; includes both keyboard and quick reference guides
Ease of use	Great number of commands and subcommands are difficult to remember; has useful on-screen "help" facility; simple in concept and execution	Has excellent "help" facility that is specific and relates to what is being done when called; 12 tutorial lessons are supplied on-disk	Makes very good use of special function keys; uses English-language menus that reduce learning time; expanded on-screen "help" facility; tutorial disk is included
Other distinctions	Unsurpassed cell attributes and good report formatting	Sorting capabilities for both rows and columns; easy to consolidate like worksheets; handles partial worksheets nicely	Color is beautifully supported; text can be used to a limited degree in formulas and functions; excellent table lookup feature; range names can be used in all formulas and functions; relative references to rows and columns are supported

MAGICALC	PERFECT CALC	PROCALC	TARGET: FINANCIAL MODELING	MICROPLAN
				●
L,W	W	L,W	L,W	L,W
L,R			L,R	L,R
T,B			T,B	T,B
				●
●		●	●	●
●		●	●	●
●	●			
●		●	●	
			●	
			●	
				●
				●
				●
				●
				●
●	●	●	●	●
0	0	0	2	4
36	76	Computer width array	50	20
7	9	12	9	9
none	none	"Forms" mode permits automatic jump to any entries for data input	In addition to relative references, whole basis of system is programmability	Permits writing programs that automatically control modeling process from start to finish
none	none	System date or entered date function; system time or entered time lookup	"Date is" function for current date	none
			●	
●	●	●	●	●
Not for sophisticated spreadsheet user; using menus is slower than command language; system purposely limited for ease of use	Uses unfamiliar conventions to no advantage; uses unfamiliar column headings to no advantage	No interface with graphics system or file manager	Requires more initial planning to set up than with other spreadsheets	Not as flexible as most spreadsheets; system is row oriented
Includes tutorial section; reference guide; quick reference card	Consists primarily of hard-covered book meant to be read cover to cover; includes keyboard template and quick reference guide	Organization of user manual is unclear; no quick reference aids supplied	Not good, though actual instructions and wording in command reviews are concise and very readable	Good—print is easy to read but type style is difficult to adjust to; excellent tutorial examples
Very easy to get into and use, especially when using "Magic Window" with spreadsheet program; menu-driven system	Comparatively difficult to use owing to limited capabilities; 8-lesson tutorial diskette and prewritten templates are supplied	Tutorial is quite good; on-screen "help" function gives assistance by subject; comparatively easy to use	Good on-screen "help" capability; 106 keywords are provided to access help screens	Very easy to use; provides fully designed worksheet format that lets user simply fill in the blanks
Menus are different from those used in other systems that consist of a series of subsystems; no need to learn commands for difficult activities like file handling and printing	Time to learn system use is reduced if user is familiar with other Perfect software packages	System incorporates a text processor (UCSD Pascal editor)	Modeling can be done rapidly if user is familiar with other similar modeling systems	Interesting system with fixed format; has great many built-in functions

(Continued from page 38)

the right side of the Model 100's display.

It's relatively simple to add instructions that command a plotter to draw on paper the same triangle displayed on the Model 100's screen. The HP-7470A's *scale* (SC) instruction even allows this machine to draw a *scaled* replica of the displayed triangle.

The Model 100's display comprises an array of 64 x 240 pixels. This scale can be assigned to the HP-7470A by means of the following line of code:

```
70 PRINT #1, "SC0,239,
   0,63;"
```

When this line is run, the HP-7470A's default coordinates (0,10250,0,7479) will be replaced by *new* coordinates identical to those of the Model 100's display. Then program coordinates that specify points on the Model 100's display will apply equally well to the plotter.

Next, the expanded program must instruct the plotter to select one of its two pens. The following line causes it to select the *left* pen:

```
80 PRINT #1, "SP1;"
```

We can now insert a PRINT statement that commands the plotter to draw the first side of the triangle:

```
150 PRINT #1, "PA120,
    32,PD,200,0;"
```

When this line is run, "PA" *(Plot Absolute)* moves the pen to the first coordinate pair (120,32) and "PD" *(Pen Down)* lowers the pen to the paper. The pen then moves to the next coordinate pair (200,0), leaving behind a perfectly straight line.

These lines complete the remaining two sides of the triangle:

```
250 PRINT #1, "PA200,
    63;"
350 PRINT #1, "PA120,
    32;"
```

Notice that the coordinate pair in line 350 is identical to the first pair given in line 150.

The plotter sequence should be concluded with an instruction that lifts the pen or returns it to its stall (if present). As you'll recall, in the case of the HP-7470A, an appropriate concluding line is:

```
360 PRINT #1, "SP0;"
```

It might at first appear that interleaving the computer and plotter drawing commands will cause their respective triangles to be formed simultaneously. This, however, does not happen since the plotter is much slower than the computer.

The computer draws its triangle before the plotter's pen carriage has retrieved pen 1 from its stall!

Simplifying the Embedded Plotter Program

We can easily simplify the embedded plotter program by merging the coordinates in the PA instructions into a continuous sequence of coordinates. Here, for instance, is a single line that merges lines 80, 150, 250, 350 and 360 given above into a single line:

```
400 PRINT #1,
    "SP1;PA120,
    32,PD,200,0,200,
    63,120,32;SP0;"
```

Normally I prefer to write brief, concise BASIC statements. They're easy to edit and they make more sense when I'm trying to determine what they mean a week later.

Plotter languages, however, are an exception. It's actually easier to understand an unbroken sequence of coordinates than one spread over several print statements. Furthermore, it's much faster and uses less memory to condense a series of coordinates to be plotted into a single print statement. (Remember the worksheet example in Fig. 3.) Here's the final merged program:

```
10 'MODEL 100/HP7470A
   DEMO 2
50 CLS
60 OPEN "COM:48N2E" FOR
   OUTPUT AS 1
70 PRINT #1, "SC0,239,
   0,63;"
100 LINE (120,32)-
    (200,0)
200 LINE-(200,63)
300 LINE-(120,32)
400 PRINT #1, "SP1;
    PA120,32, PD,200,
    0,200,63,
    120,32;SP0;"
```

Going Further

A particularly important aspect of plotter operation is how to instruct a machine to label what it has drawn. Most plotters can print numbers, characters and symbols in many different sizes, aspect ratios and orientations. While several of the instruction manuals I've seen are deficient in some areas, they *all* provide good explanations of labelling.

Another important feature of most plotters with which I'm familiar is *relative* mode plotting. In this mode, the point defined by a set of coordinates following a plot command is positioned *relative* to the point defined by the previous coordinates. The power of relative plotting is that you can create your own shapes, sprites, logos, phrases, symbols and characters and then have them drawn anywhere on a sheet of paper.

Plan now to visit some computer stores in order to see actual plotters in operation. Once you've seen in person what these remarkable little devices can do, you'll undoubtedly want to acquire one of your own. ◇

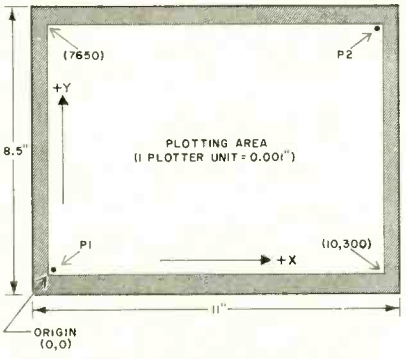

Fig. 2. HP-7470A coordinate system for ANSIA (8.5" by 11") paper

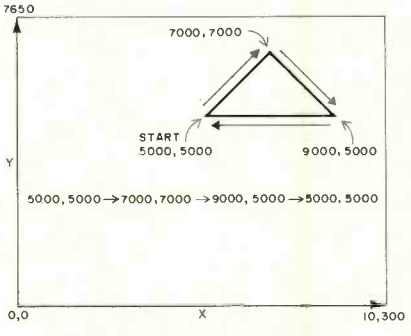

Fig. 3. Typical example of a plotter worksheet for drawing a triangle.

(Continued from page 67)

al and contextual expressiveness and syntactical flexibility of human language. Hence the importance of limiting the domains of natural language query systems—like expert systems—to specific types of information and unambiguous terminology. For example, in an architectural system *scale* has to mean the ratio between a set of measurements and not a plant parasite.

A third important commercial application of symbolic processing technology is in the area of picture and image processing. The goal is to emulate human sensory organs as data input devices. The familiar optical character readers that capture numerical data from bank checks and cereal boxes are precursors of this promising applications area. Raymond Kurzweil, a pioneer in the use of character recognition and voice synthesis in computerized readers for the blind, also developed the Omni-Font Scanner, a device that typographers use to "read" text, translate it into numerical code and enter it into computerized typesetting systems. What's interesting about the scanner is that it "learns." If it encounters a character it does not know—i.e. contain in its data base—it queries the operator who in turn identifies the character by inputting it on a computer keyboard. After a few pages of text, the scanner has learned enough to continue indefinitely without operator assistance.

The integration of expert systems with sophisticated sensory and image processing devices is just beginning to attract the attention of commercial AI developers. Such systems promise to be useful tools in computer-aided design and manufacturing, satellite and medical image analysis, environmental monitoring, process control and in all the tedious inspection jobs that human workers despise.

Related to image processing in its industrial promise and in its technical requirements is a fourth major area of commercial symbolic processing application—robotics. Bill Taylor refers to industrial robots as "numerical machine tools with elbows." It is an apt description. Programmable controllers and the mechanical devices they drive perform the same rigidly choreographed motions over and over. But truly intelligent robots are still in the experimental stages of development—notably at Stanford and Carnegie Mellon. Intelligent industrial robots have the advantage over numerically programmed machine tools of being adaptable to a wider range of tasks and of determining on the fly which tasks are appropriate to a given set of conditions presented in the form of, for example, a visual scan of a subassembly on a production line or a spectrophotometric analysis of the amount of pigment in a batch of wall paint.

Taylor sees the advent of industrial expert systems and intelligent robotic devices as the source of an industrial revolution on a par with Henry Ford's introduction of the assembly line. "Flexibility and speed are the big payoffs in applying AI in the industrial environment," he says. "Look, for example, at the auto industry. GM builds factories at about $300 million each. Major model changes mean gutting a factory and completely rebuilding. A $10 million expert AI system could do a better, faster job of designing an automated line and probably save $60 million worth of factory. Add the ability to retain most of the factory's existing robotic equipment which can be used on the new line without extensive reprogramming and retooling and you can save maybe $100 million. It's easy to see why the auto industry is particularly hungry for this technology."

The Japanese have taken over markets in the past by changing the rules

System Development A Factor

Because of their size and complexity, AI systems take many man-years to develop and can use up a lot of memory on very expensive machines. The development of MACSYMA, for example, lasted for 12 years and totaled over 100 man-years of effort. Morley and Taylor suggest "eight-to-ten man-years of development for difficult expert systems and three-to-five for easy ones." But the cost may be worth it. Taylor says, "LANSAT sends us more information than people can look at. Oil companies have warehouses full of magnetic tape with geological data. They'd love to be able to match those tapes with LANSAT data using up-to-date analysis techniques. An expert oil finder doesn't have to find oil to be useful. All it has to do in this case is cull data. If the computer could eliminate 99 percent of all that data and call a human expert's attention to interesting cases, that would be enough. You don't have to find much oil to pay for that."

The availability of more elegant versions of the LISP symbolic processing language and of less expensive and more efficient symbolic computers has taken some of the enormous cost out of AI development but it's still a significant undertaking. Current expert systems, for example, with extremely limited knowledge bases have thousands of rules and thousands of symbols. Each symbol—or object—needs the equivalent of about a thousand characters of storage space. In order to get really significant payback from expert systems, one must support thousands of inference rules and a hundred million objects.

LISP is the most widely used development tool for AI applications. LISP language development began in the 50s at Stanford University but was hampered by the memory limitations of the computers then available. Researchers had the language for AI in the 50s. They didn't have the iron. The introduction of virtual memory machines in the 60s reinvigorated development work. Since then LISP has spawned a number of offspring—even the capriciously named Franz LISP and Stiff Upper LISP. Today most of the major computer manufacturers support some version of LISP and the American National Standards Institute is about to issue a set of standards known as Common LISP for the language.

The Breakthrough Is Hardware

More powerful, lower-cost hardware was the real breakthrough in AI. Large scale integration (LSI) technology and virtual memory architectural schemes on minicomputers and 32-bit superminicomputers were a beginning. Most of the early development work was done on these machines because they are fast, powerful and—more important—because they could be funded under university research grants and dedicated exclusively to the work of AI development.

Symbolic processors grew out of work done by the Massachusetts Institute of Technology and Xerox in the 70s. Today there are three companies producing LISP machines—Xerox and two companies founded by former MIT AI Lab. computer scientists, Symbolics,

Inc. of Cambridge, MA, and Lisp Machine, Inc., of Culver City, CA. Symbolics is the leader in installed systems, some 300 according to company figures, and in continued development for the commercial marketplace. Last year the company introduced the 3600 Symbol Processing System which features a completely redesigned tagged memory hardware architecture to optimize throughput. Development of a custom VLSI version of the system is in the works.

Symbolic processors are engineered for logical as opposed to numerical processing (although they are capable of supporting both). Architectural advantages like flexible memory management and powerful processing mechanisms are engineered into the hardware rather than coded into the LISP compiler and operating systems software that uses up large chunks of memory in numerical processors. The Symbolics 3600, for example, is a 36-bit demand paged virtual memory machine. Data paths occupy 32 bits and four to six bits are allotted to tagging data by the type of information it represents. A front-end microprocessor unloads housekeeping tasks like managing the electronic interfaces between components from the main CPU. Unoccupied memory space is reclaimed for use immediately by hardware assisted "garbage collection."

One AI program written in LISP can tie up an entire mainframe computer. Because of their ability to compress, represent and manipulate higher orders of data and relationships, dedicated single-user symbolic processors can be used to produce the same program at about a third of the cost of producing it on a time-shared mainframe. These stand-alone development workstations can also be networked with each other and with larger computers for access to shared and/or larger data bases. They are currently being used in the development of everything from video games to film animation, VLSI circuit design, and training and simulation applications.

LISP and symbolic processors also speed development by providing a number of helpful software tools. Windows, as in Fig. 1, allow the user to look at his program, data, and the results of his work at the same time. Unlike the linear progression of traditional programming methods with several lengthy iterations of compiling and debugging. The developer can move very quickly from changing code to testing it.

Interactive high-resolution graphics further speed symbolic programming by allowing the developer to create and manipulate graphic images as he would any other objects in a program. For example, Steamer is an expert tutoring system developed by Bolt, Beranek and Newman for the U.S. Navy to train personnel in the operation and construction of complex steam propulsion plants. Steamer's knowledge base contains data on over 100 valves, 100 pumps, turbines, switches, gauges, alarms, indicator lamps and other complex physical devices and expert rules about how they all work together. Each device is represented graphically on a bit-mapped color display screen. The images that appear represent symbols—complete entities that have

AI may account for 50% of all EDP by the late 1990s

all the properties and typical behaviors of their physical counterparts. By touching a light pen to the screen, an instructor designing a simulation or a student performing risk-free experiments can connect a valve to a pipe, connect the pipe to a tank, and then open the valve. When the valve opens, the tank "fills" automatically. When you move a pressure gauge on the screen, you take with it all its properties, and its needle will accurately indicate the conditions it encounters.

In Steamer the objects themselves possess intelligence. What's important about the system is the ease and speed with which it may be modified by the instructor without programming, for example, to satisfy new or nonstandard training requirements. AI-based training applications like Steamer lend themselves readily to other environments in which allowing students to experiment with actual physical systems is precluded. Nuclear power plant operators for example, could be trained more thoroughly using intelligent simulation systems.

Because data and programming logic are independent of each other in symbolic processing, intelligent systems designed originally for one application are being successfully applied as software tools to structure other applications. For example, KEE (Knowledge Engineering Environment) is a system developed by Intelligenetics, Inc. of Palo Alto, CA, originally designed to help genetic engineers with the complex computational work of recombinant DNA technology. KEE's basic logical structure has also been used to develop systems that perform expert decision-making functions in other fields.

Japanese Strategy

The Japanese have settled on PROLOG, a symbolic programming language developed in Europe, rather than on LISP as the basis for their much publicized Fifth Generation Computer Project. According to Bill Taylor, who grew up in Japan, PROLOG is a much less useful medium for AI development than LISP because it does not track or document for the programmer the means by which it reaches its conclusions. "The Japanese have taken over markets in the past by changing the rules," Taylor says. "The classic example is when they bypassed the biker market for motorcycles and appealed to middle-class Americans. They painted their bikes white, ran ad slogans like 'You meet the nicest people on a Honda' and cleaned Harley Davidson's clock. They have no intention of competing with us head-to-head. The Fifth Generation Computer project and the selection of a different development language are part of an attempt to leapfrog the West. They have correctly identified what they call the 'knowledge industry' as presenting the lowest industrial pollution and the greatest commercial opportunity. If they do a lot of successful development in PROLOG and we don't, they figure they're that much ahead. The importance of PROLOG vs. LISP has been exaggerated. History has shown that the tools that work best become standards. LISP gives the programmer a lot more control and presents information in a much more usable form." The important thing is that these new languages are a serious threat to the U.S. computer industry if it fails to recognize that they will become as important as today's popular languages.

In the United States the biggst sponsor of research leading to the development of new computer architectures and symbolic processing techniques has been the federal government, particularly DARPA (the Pentagon's Defense Advanced Research Projects Agency) and the National Institutes of Health.

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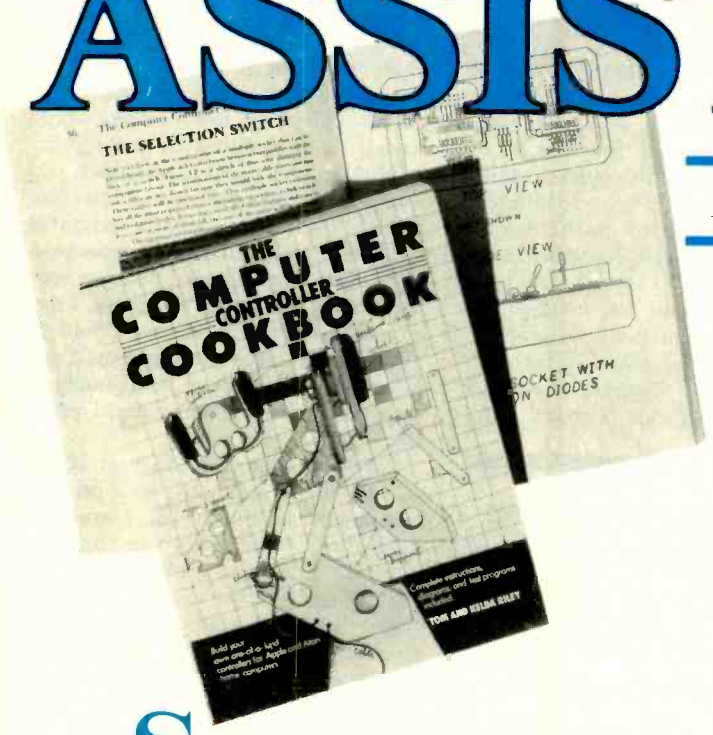

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Artificial Intelligence

(Continued from page 94)

Largely in response to the Japanese challenge, these agencies have recently been joined by the Microelectronics and Computer Technology Corporation, a nonprofit joint-venture research organization formed by a dozen leading American computer and electronics companies.

Symbolic Processing "Ready for Commercialization."

Morley and Taylor are telling their seminar audiences of executives and research and development vice presidents that the time is ripe to start building intelligence into their new products and internal processes. "AI is ready for commercialization" Morley says. "There is no pure market for artificial intelligence any more than there is one for MIS or Office Automation." Morley believes that for some time we are more likely to see intelligence embedded in specific products used for specific functions than we are to see the superhuman and annoyingly vocal general-purpose computers of science fiction.

We won't see AI development capabilities on personal computers any time soon either. The minimum capacity for serious symbolic programming is two megabytes of RAM and lots of virtual memory which requires lots of disk capacity. Some truncated LISP compilers are available (see sidebar for examples). There is a software product that claims to enable PC users to build expert systems, but it is not really a symbolic system. It sorts a matrix to get an answer to a problem in a minimum number of questions. Microsoft is offering a new extension of Multiplan that has a few rules programmed into it. There have been recent startups, however, of software companies planning to apply AI techniques to tax preparation packages and personal computer software.

Even these small signs are indications that artificial intelligence, a thirty-year-old set of theories, techniques and intriguing possibilities, has finally escaped from its confinement in the research lab. We have the tools to make AI practical today—symbolic language and symbolic processors. These tools will be used to design not only expert systems and intelligent devices but the next generation of their descendants as well. Expert electronic engineering systems (Fig. 2) are being used today to design the chips that will go into symbolic supercomputers capable of running even bigger and better expert systems tomorrow. ◇

Spreadsheets

(Continued from page 88)

would copy the formula you used for oranges in cell D2, rather than rekeying all of the formulas in column D. When you copy the formula from cell D2 to the other cells in column D, you would want to modify the copies somewhat. For example, in cell D3, you want the formula to be B3×C3. In other words, you will modify the formula to refer to the cells relative to each new location of the copied formula. A similar modification would be needed for cell D4 and so on down the column.

Let us also assume that you will be adding new fruits to the list. In fact, we will assume that you would like your computer/spreadsheet program to be able to calculate this same formula (quantity × price) for up to 20 different fruits. You would then copy the formula from cell D2 to the cells contained in the range from cells D3 though cell D21. The formula would be modified, of course, to use the proper cells to obtain the correct amount taken in for each fruit listed. Then whenever you add a fruit to the list and enter a quantity and

These stand-alone packages cover the gamut of prices and features

a price, the computer would automatically calculate the amount of money taken in from the sale of that fruit. On the manual spreadsheet, you would have to recalculate the formula yourself for each fruit on the list.

If you wish to include on the bottom line of your spreadsheet the total amount taken in for all fruits sold, write in the formula you would use to total up the column in cell D7 on your scratch sheet. This formula would sum the contents in cells D2, D3, and D4, expressed as D2+D3+D4. Write TOTAL AMOUNT in cell C7 on both your scratch sheet and finished report.

On your sheets of paper, you now have both the formulas you used and the results of the calculations. These are stored on paper. You would have the same information stored in your computer if you were using an electronic spreadsheet program.

Spreadsheet Advantages

Suppose after completing your paper report you discovered that you had actually sold 26 oranges instead of the 25 entered into cell B2. On your manual spreadsheet, you would have to write the new quantity at cell B2 and recalculate the formula B2×C2 to obtain the corrected amount ($7.80) in cell D2. Then you would have to erase and enter the old figure and replace it with the new one on your finished report to reflect the recalculated amount. If at the bottom of your spreadsheet you had calculated the total amount of money taken in for all the fruit sold, that number would also have to be erased and recalculated. Then the new number would have to be entered into the final report.

With an electronic spreadsheet, you would simply key the new quantity into cell B2. At this point, the new amount at D2 would automatically be generated, since the formula to generate it has been stored in the computer's memory. Likewise, the new total amount would be automatically generated, as would any other cell's information that contains a formula referencing the changed cell at B2.

On your manual spreadsheet, if you had to change a quantity or a price or add another fruit to the list, it would be necessary to recalculate the new AMOUNT and the new TOTAL AMOUNT each time. With the electronic spreadsheet, however, once the formula is stored in memory, it will always reflect the current status of the spreadsheet. Having left space for 20 different fruits in your electronic spreadsheet, you would put your total in cell D23. Your formula in cell D23 would sum any numbers found in cells D2 through D21. Thus, when you add a new fruit to the list in row 5, the total amount would immediately change to reflect the new amount in cell D5.

Summing Up

The example presented here demonstrates both the similarities and the differences between manual and electronic spreadsheets. The two are similar in that you design them yourself. You decide what will be in each column, row, and cell, and you determine the relationships between columns, rows, and cells. You can produce balance sheets, budgets, projections, and an unending variety of analytical models for an infinite number of applications for business and the home.

In fact, any work you do using rows and columns is probably better done with an electronic spreadsheet. ◇

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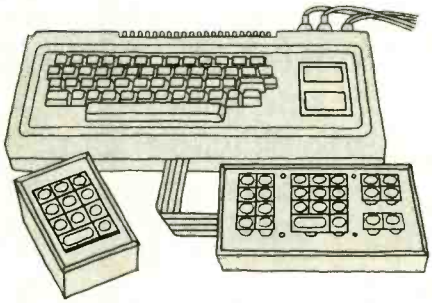

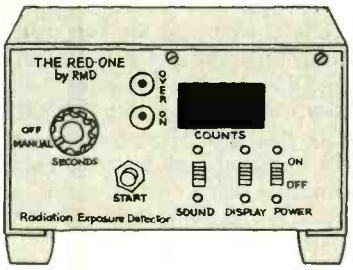

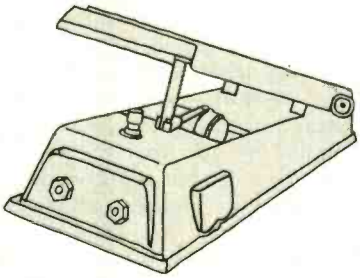

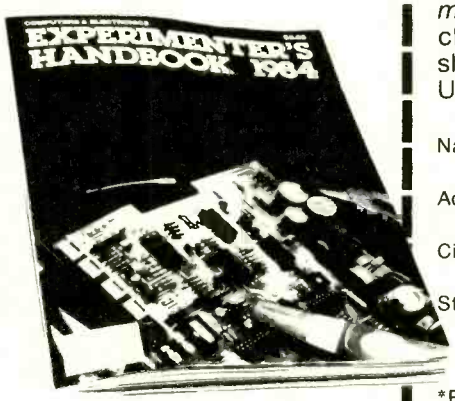

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(Continued from page 75)

while, to cut down on production time and musician union costs.

"Computers are going to make musicians extinct in the recording studio," Nichols says with more than a bit of tongue-in-cheek. "The real future of computers in the studio is with synthesizers."

A Musical Standard

The synthesizer movement in the recording studio was given a significant boost earlier this year when five of the major musical electronics manufacturers adopted a common protocol through which their different products can communicate with each other and personal computers. This so-called Musical Instrument Digital Interface (MIDI) will allow the integration of synthesizers, other electronic keyboards, and drum machines into one programmable system, with the computer controlling as many as 16 different instruments, each playing a different musical part. Roland Corp., a manufacturer of electronic keyboards as well as personal computer peripherals, has introduced the first MIDI interface, a peripheral the size of a phone modem, and foresees the development of a range of application software that could include musical education and stock music programming. Ultimately the unit will allow an engineer to create multitrack master tapes directly onto the tape recorder without even going through the console, with entire sequences programmed onto floppy disk.

Even before MIDI, sophisticated musical computers were finding their way past the "in session" lights outside studio control room doors. Their impact has been felt on the vinyl efforts of artists ranging from the avant garde performances of Laurie Anderson to the jazz funk of Herbie Hancock.

The Fairlight CMI, for example, a $28,000 electronic keyboard from Sydney, Australia, is now standard operating gear in over 250 studios throughout the world. The instrument comes with both alphanumeric and ebony and ivory keyboard, lightpen, CPU using two 6800 microprocessors running out of phase, two eight-inch floppy-disk drives, and monitor. Its musical control comes from eight 16K RAM voice card channels which make each of the voices on the system an independent synthesizer.

According to New York office manager Clive Smith, "The Fairlight is a full production instrument that can create as many as 16 tracks of music digitally before it is put onto tape." He adds that the newest version sports a frequency response better than 20 kHz and a signal-to-noise ratio better than 85 dB. Meanwhile, it has become the pet recording/composing tool of such leading artists as Pink Floyd, Pete Townshend, Devo, and Peter Gabriel.

Available products convert the Apple and IBM PC into third-octave, real-time spectrum analyzers

It was former Genesis bandleader Peter Gabriel who used the Fairlight extensively on his latest LP by wandering around Europe gathering industrial and "real world" sounds which he later fed into the Fairlight. There they were converted to digital form and manipulated graphically using the monitor and lightpen and the finished product was dumped back onto tape.

Jonathan Jaczalik, a Fairlight operator at London's Sarm West Studio has worked with the instrument with a variety of leading UK acts including ABC, Malcolm McLaren and Paul McCartney. He recently explained: "The Fairlight is an exciting musical instrument because you can imagine any kind of sound—say a combination of a snare drum and someone sneezing—and provided you can obtain that sound from the real world, you then can put it into the computer and use it creatively."

The Technical Digital World

For any audio environment to sound good it has to be equalized and appropriately designed; here again the personal computer has come into play. Two different programs and hardware adaptations for the Apple and IBM PC convert these common personal computers into third-octave, real-time spectrum analyzers that chart the sound characteristics of studios or any environment so they can later be adjusted to the preferable flat-line configuration. The hardware and software for the Apple (APX252) is produced by Eventide Clockworks and displays any audio signal in various third-octave bands on the monitor while additional software also offers the audio engineer a look at the reverb decay of the environment. The conversion for the IBM PC from Ariel (RTA 331) touts similar powers. By dividing the audio spectrum into 31 bands (20 Hz to 20 kHz) it displays the amplitudes of each frequency. In addition, it includes an on-board pink noise generator, while more than 20 seconds of audio can be stored in its 512K of memory.

Taking the use of computers for audio analysis one step further is the TEF System 10 from Tecron of Elkhart, Indiana (division of Crown International), which has packed one of the most sophisticated studio sound analysis devices into a portable computer strongly resembling units by Kaypro or Osborne.

Developed by the Jet Propulsion Lab of the California Institute of Technology in Pasadena, California, the device utilizes a so-called sweep signal to gain a three-dimensional and reflective picture of the sound in a given room, whether it be a studio or auditorium. The unit was recently used on an acoustical tour of the great halls of Europe by a team of leading acousticians who, for the first time, are analyzing data in the hope of finding the elusive formula for quality concert hall sound. In addition, the TEF System can act as a general purpose 96K RAM computer, with two RS-232 ports for peripherals or printer and supplied CP/M software.

Computer applications in the recording studio continue to grow. Though audio engineers aren't the leaders they once were, the fact that there are technical brain cells buried between the headphones indicates at least a predilection for new technology that will clearly change the course of modern music. Still, changes will have to be made.

"Eventually all audio will be in the digital domain and everything in the studio will in some way be a computer," says Michael Tapes. "The console won't be replaced because it has become the traditional human interface. But there will need to be a central computer to control everything, not a group of different keyboards. Ultimately, windows will have to be the answer."

Adds Chris Stone, owner of the Record Plant in Los Angeles, "Computers are totally changing the way we record. . . . There are still important engineers who refuse to use computers in the same way an artist won't do a picture by numbers. But that's like asking someone to push back the clock." ◇

Local Area Networks

(Continued from page 71)

ever, it is inevitable that sometimes someone will step on somebody else's toes and walk across his conversation.

When that happens, the receiving station can't make heads or tails of the garbled mess that results. Since it can't recognize the message, it doesn't acknowledge it. (In some cases, only part of a transmission is scrambled, and a negative acknowledgment is returned.)

Not having received the proper acknowledgment, the originating node sends its message again. And again, it waits for an acknowledgment. Through persistence, the message eventually gets through. This *contention scheme*, although easily implemented, results in a very low utilization of the network's bandwidth. The network will spend most of its time either idle or carrying garbled information, and the efficiency of this type of system runs less than 20% (18.4%, to be exact).

Contention Rules

To improve network performance, some basic rules were established. As you know, it is more polite and productive to wait for a conversation to end before you begin to talk. This rule of courtesy has been extended to local area networks.

Before a node can transmit on the network, it must first listen, and wait until the network is clear. If a conversation is in progress, it must patiently await its completion. This simple courtesy greatly reduces the number of collisions and increases network throughput.

However, collisions can still occur if two listening nodes attempt to sieze control of the network at the same time. In fact, the heaviest concentration of collisions occurs immediately following a successful transmission. When a collision occurs, the competing nodes back off and wait a period of time before attempting retransmission.

Unless both nodes wait different amounts of time, though, another collision is unavoidable. If both nodes wait the same amount of time during the backoff period, they will always collide, and the network become deadlocked. A deadlock can be avoided by giving each station its own unique waiting period, either permanently programmed or using a random-number generator.

In the basic contention scheme, a message is transmitted to completion. This means a collision won't be detected until the transmitter starts looking for an acknowledgment, and is a waste of time. If the transmitting node were to monitor the network while it was talking, it could immediately identify a collision as it happened and halt transmission. By keeping the network as free as possible of useless data generated by collisions, its utilization is increased.

Ethernet, developed by Xerox, is a classic example of a carrier-sense, multiple-access network with collision detection (CSMA/CD) that takes full advantage of all contention rules. It has efficiencies exceeding 80%.

Network Protocol

To prevent filibustering, each node's access time to the network is limited. Therefore, when a node has a message

that is longer than can be transmitted in the time allowed, it must be broken into smaller segments and sent out in pieces.

The receiver, then, must be able to identify the various segments and reconstruct the message. A good way to do this is to contain the message—or its part—within a framework called a *packet*. The packet is a precisely defined structure that contains all the information necessary to transmit a message segment. It has a starting code and an ending code, so that its boundaries will be recognized.

The packet also contains information about the contents of the frame. Ideally, it should identify the total number of frames needed for the entire message, the number of the frame presently being transmitted, and addressing information. The frames are numbered in consecutive order so the receiver will know if a packet is missing. A representative data packet is shown in Fig. 8.

Several protocols have been devised for the framing of a data packet. Obviously, some protocols are more sophisticated than others.

Some are designed to deliver only one byte at a time, like the HDLC and the internationally popular X.25. Others, like Ethernet, allow for a number of bytes to be transmitted within a packet. Sometimes the number of bytes is fixed, but more often than not, it is variable, within limits.

High-order protocols generally provide greater flexibility, but at the expense of substantially higher software overhead.

Network Media

There are several different media that can be used for carrying the digital information through the network. They range from the commonplace to the exotic. In some cases, the network medium is precisely defined, while other networks lend themselves to a choice of conveyances.

A very effective way to transport information from one place to another at a low cost is through a pair of twisted wires. (The wires are twisted together to reduce the effects of external interference.) Twisted pairs can move information at a fairly high data rate. Furthermore, it is easy to make connections to the exposed wires, making network modification quite simple.

Unfortunately, present-day communications and data systems are continually flooded with natural and man-made external electrical noises. Twisted pairs reject these unwanted signals by using differential receivers, which cancel common-mode signals. Even though twisted pairs can ignore a large percentage of the hash they pick up along the way, sometimes it's just too much to cope with.

An effective solution to the problem is to shield the wires from the outside world by wrapping them in a metal shroud. The metal screen intercepts the unwanted signals and bypasses them to ground before they have a chance to reach the inner core. This type of covered twin-wire cable is commonly referred to as Twinax (see Fig. 9). Twinax is used by IBM in its System/1 network.

Satellites will link LANs in the future

A cousin to the Twinax shielded cable, and one that has been around for much longer, is coaxial cable. Coax contails a *single* conductor within a braided protective shield. The braid acts as the signal return. The technology for coaxial cable has existed for over 50 years. Not only is the cable itself cheap and readily available, but standard connectors make its installation relatively simple and straightforward. Coax is used extensively in LAN systems, including Xerox's Ethernet network.

Emerging Network Media

Beyond the established twisted pairs and shielded cables emerges a host of new technologies that hold great promise for LANs. Undoubtedly the most heralded is fiber optics.

Fiber optics, since they use light as the transmission medium, have the inherent advantage of being totally immune to all forms of electrical interference, including EMI and RFI. Therefore, they require no elaborate shielding.

Furthermore, shielded cables—coax, for instance—affect the signals passing through them. Sometimes the waveform is distorted. Their biggest problem though, is their attenuation of high-frequency signals. As the signal frequency increases, more of the signal is absorbed by the cable. Eventually, a point is reached where not enough signal remains to distinguish it from normal background noise. This significantly limits the usable bandwidth of the cable medium.

Fiber optics are free from this problem. The frequency response of a fiber-optic link is virtually flat. This allows the network designer access to higher data rates (data rates are a function of bandwidth) than previously available. The challenge today is to design a fiber-optic network that meets the demands of LAN requirements.

Radio transmission is also used for local area networks. While radio links have been with us for quite some time, their use for the handling of high-speed digital data is relatively new. Much still remains to be done.

Radio networks are often used to establish communications between widely separated local-area networks—spaced miles apart. The ultimate example here is satellite networks.

Infrared communications is a relatively new approach to LANs. Basically, it is a broadcast technique very similar to radio transmission, but based on infrared light. Infrared communications are finding wide acceptance within the office environment.

Within the confines of a single room, an invisible beam of infrared light is bounced off a reflective ceiling. The light beam is modulated with digital information.

The light is scattered about the room, filling it entirely, and can be received by any network node using a simple solid-state detector. The node, in turn, can broadcast its own message using a solid-state infrared emitter.

In essence, an entire office is tied together by a beam of light. This greatly facilitates the placement of equipment within the room because there are no awkward cables to contend with.

Future Networks

The networks of the future will undoubtedly retain many of the same characteristics we see in networks today. However, changes will occur in the software required to interface the nodes to the network. Dedicated chips will contain network protocols in firmware (ROM) and the network functions will not be apparent to the user. Network access will be as simple as dialing a phone is today.

The biggest change, though, will come in the interconnection of small LANs. Using satellite technology, the world will grow smaller. Eventually, global networks will be commonplace. The networks of tomorrow will provide all the services of networks today—and more. ◇

Windows

(Continued from page 57)

ware. Microsoft Windows will allow independent software vendors to develop sophisticated graphically-based integrated software packages that run without modification on any 16-bit microcomputer system.

Like Visi On, Windows relies heavily on bit-mapped graphics and uses a mouse for pointing. When MS-DOS was originally developed in 1980, no allowances were made in the operating system to manage interactive software or graphics, and packages that included either of these features had to address the computer hardware directly. That made them extremely machine specific and meant that each computer had to run a version tailored specifically to it. Because of the time and work involved in such customization, many good programs never got the exposure they should have.

Windows eliminates the necessity to write application software that directly addresses hardware by extending the functions of MS-DOS to include the management of bit-mapped screen graphics and mouse hardware. Consequently, a program that is written for Windows will work on *any* system that is using that environment. Again, Microsoft Windows has to be configured for a specific computer system but once that has been done, any software that is compatible with Windows will operate under it.

Microsoft's answer to the integrating windowing problem differs significantly from VisiCorp's in two major areas. First is the use of icons instead of words to represent functions. Each function available is represented by a pictograph on the screen and, by using the mouse to point to the appropriate picture, that function can be invoked. Some initial users of Windows have had difficulty in deciphering the meaning of some of the icons but a little practice should overcome that stumbling block.

The other big difference between the two systems is the way in which the windows are presented. Microsoft Windows, unlike most other integrating interfaces, does not overlap the windows it displays on screen. Instead, a technique called *tiling* is used. All the windows lie in the same apparent plane, and abut one another. In normal use, a given window is expanded to fill the entire screen, with the other application programs available reduced to the status of icons. Microsoft believes that this technique leads to more effective use of the display screen.

Several tiles can be present on the same screen at once, though, and their sizes adjusted to taste. A feature called "zooming" allows a user to display an application at any size on the screen. In addition, it is possible to move a window or tile through an application (or the application through the window, whichever you prefer), much as you would use a scrolling feature in a non-windowing environment. The number of windows that can appear on a display is unlimited, but practical use restricts that number to four. If more windows are used, not enough information is shown in each to be meaningful.

Microsoft Windows can deal with programs written in any language, on any computer using MS-DOS. It is claimed to be able to run all existing

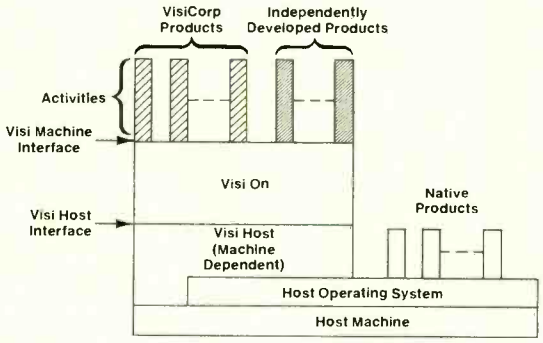

Fig. 1. Host interface makes Visi On machine independent.

WINDOWING SOFTWARE

Source	Package	Price
Microsoft Corp. 10700 Northup Way Bellevue, WA 98004	Microsoft Windows	<$100.00
VisiCorp 2895 Zanker Rd. San Jose, CA 95134	Visi On	$495.00
Digital Research PO Box 579 Pacific Grove, CA 93950	Concurrent CP/M with Windows	$150.00
Arktronics Corp. 113 S. Fourth Ave. Ann Arbor, MI 48104	Jane	$295.00
Quarterdeck Software 1918 Main St. Suite 240 Santa Monica, CA 90405	DesQ	$399.00

MS-DOS Version 2.0 based application programs, although those programs written without Windows in mind will not be able to take advantage of the Windows user interface or the data-exchange capabilities of the operating system. The system can recognize that a program is not Windows-compatible, and, after saving the state of a window's environment, will release control of the screen and hardware to the application program being started. Once a user has finished working with a non-Windows program, Windows will restore its environment and resume operation.

Microsoft Windows is less greedy in its hardware requirements than is Visi On. It can run on an MS-DOS computer with 192K of RAM and two floppy disk drives; and, of course, a mouse.

CP/M

Digital Research, the originator of the CP/M family of operating systems, also has its entries in the interactive windowing sphere. Although it missed the boat when MS-DOS became the "official" 16-bit operating system instead of its CP/M-86, it is still putting up a good fight.

In addition to its Concurrent CP/M, which allows several programs to be run simultaneously, it will now be offering Concurrent CP/M with Windows.

Concurrent CP/M has always permitted several programs to be run at once, through what it calls a "virtual console." It does this by partitioning the computer's memory into separate areas. Each program runs in its own area of memory, and is isolated by the operating system from the others to prevent data from one program inadvertently finding its way into another. Now, with windows, the user of Concurrent CP/M will be able to see what is happening in the various programs.

Unlike other windowing systems, where only one window at a time is active, all the CP/M windows are "live"—what you view in a window is the result of a program that is running *now*, and is instantly available to you. You are not simply looking at the contents of a disk file. You are viewing a program in progress. And, of course, you are able to transfer data from one program to another.

Up to four windows can be "open" at the same time. Windows with separate background and foreground colors can be positioned anywhere on the screen, scrolled, or sized to display the most important parts of each application. Information from one file can be transferred from one program to another simply by placing a window over the the appropriate data and issuing a command.

While there are "hooks" built into the operating system that allow it to be used with a mouse, the windowing functions are also directly available from the keyboard. A menu line at the bottom of the screen displays the functions that are available. They are selected by moving the cursor until it highlights the appropriate function.

In addition to windowing, this most recent addition to the CP/M family offers support for data communications. That is, one task (window) can be devoted to communications between the computer it is running on and another computer elsewhere. Thus it is possible, for example, to receive data from a source like the Dow Jones database, or simply to watch for incoming messages in a networking system, while at the same time doing something else.

For those who already use CP/M, and who have a large investment in CP/M software and files created under it, the concurrent windowing version provides an alternative to switching over to MS-DOS. There is no need to learn a new operating system, or to have to go through the time-consuming effort of rebuilding files for a new one.

DesQ

Meanwhile other companies, perhaps not as well known, have also brought out windowing software. Quarterdeck Software's DesQ (pronounced "desk") is one such package.

DesQ, as one might infer from its name, also emulates a desktop work situation. A user has the ability to spontaneously put aside a file, and then access it instantaneously, just as he would do with information on a desk. Files or documents are overlaid rather than tiled. Menus are presented in plain English—no icons.

Probably its chief virtue is DesQ's "openness" to use off-the-shelf applications, allowing its users to personalize their systems to best fit their particular needs. "Incompatible" applications from different sources can be integrated under DesQ without the need for any program rewriting.

A person using DesQ can be working on one file, and simultaneously reference one or more other documents visible in other windows. He can also take information from one program and put it in another in a different window.

Quarterdeck's program also has the ability to learn how to perform routine, repetitive tasks. Once a user knows how to perform a certain task, he can program DesQ to do it for him, invoking the operation with a few keystrokes or a mouse.

DesQ is designed to run on MS-DOS computers with 512K of RAM and a 5-megabyte hard-disk drive. The use of a mouse is optional.

Jane

MS-DOS computers are not the only ones getting windows. A small company called Arktronics has a program called Jane that runs on the Apple II family of computers.

Jane is not really a software integrator. It is, rather, a completely self-contained set of application programs that run in Jane's own window environment. Included in the package are a word processor, spreadsheet program, and file manager. Windows and functions are selected by means of a mouse and icons.

It should be pointed out that the applications included in the Jane package are not as complex as many of the stand-alone word processors, calcs, and databases that are already available to run n the Apple. They are integrated, though, and are probably more than adequate for personal use. If you require a program with all the bells and whistles you are probably not using an Apple anyhow.

Jane is currently available for the Apple II series of computers and the Commodore 64 (in a ROM cartridge). A version for the IBM PC is expected shortly. The program supports color. The Apple version requires 64K of RAM, at least one disk drive, and a mouse.

Which One?

With all these windowing packages appearing at virtually the same time, which one—if any—should you choose?

The first question to ask is obvious. Do you need the ability to leap from one program to another without even breathing hard? Certainly it's a nice capability to have. But, for most, it may be a luxury that they can get by without.

If you spend most of your computer time on just one application—word processing, for example—then you probably don't need windowing.

However, if you use your computer heavily and for a variety of tasks—which you may need to perform at any given time—then a system with win-

Kaypro

(Continued from page 82)

dows will probably benefit you. More so if the data you work with is required by several of the programs you use, or is generated by one program but required by another.

How do you decide which system is best for you? Obviously you can rule out some for hardware reasons, and others because you don't feel comfortable with the features they offer. That still isn't going to help you make your final decision.

Probably the best thing you can do, after weeding out the ones that are clearly not for you, is to see what software runs under those that are left. In the end, it's the application, and not the operating system, that will be the basis for your decision. ◇

Kaypro

(Continued from page 82)

The "IBM PC-Compatibility" Myth

The recent trend in portable computers is to either produce or retrofit a product so that it is IBM PC-compatible. But this is like a utopia that can never be reached because IBM cleverly merged the Microsoft MS-DOS into its hardware-dependent 40K ROM operating system. In doing so, and copyrighting same, IBM closed the doors (which Digital Research's CP/M had opened for 8-bit machines) for software swapping and compatibility on 16-bit microcomputers. Anyway, we now have to define what PC-compatible is.

By definition, any 16-bit microcomputer operating under MS-DOS that can read and write to a particular (IBM) disk format, and that can run an assembly level or language level program that does not directly access the *forbidden* IBM ROM BIOS, or use a bit-mapped video display, *might* run programs from any other system that claims the same. This means that BASIC, etc. programs that run through a machine-customized interpreter or compiler without using the special bells and whistles of the hardware, *might be compatible!* Thus unless you use "plain vanilla" or generic programs (on single-density IBM disks), that do not make extensive or creative use of the display, you will find that the Kaypro hangs up when you try to run the program.

Unfortunately, right now all of the applications software bundled with the Kaypro is for CP/M-80. Thus, all you can do when you get the machine is fool around with the MS-DOS operating system, and format MS-DOS disks. You will have to purchase MS-DOS software at additional cost. (A list of compatible software is available from Kaypro.)

I couldn't wait to see a 16-bit machine that would blow my mind and have me wondering why I hadn't changed to an IBM derivative until now. The first program I tried to run on the 4 Plus 88 was Supercalc3 (not on Kaypro's list), which was configured for the IBM PC and PC XT, the Compaq, Hyperion, and Columbia Eagle PC and 1600. I could read the disk's directory and any ASCII files. (The MS-DOS TYPE command dumps the entire file into memory and then to the screen rather than buffering the sectors as CP/M-80 does; keep your finger on CTRL-S.) I got anxious. I typed SC3 and pressed RETURN. Noise from the drive told me that the program was loading, chung, chung, chug, hiccup, hiccup, chug-chug, chu-u-u-ggg, ti-pocket-a, ti-pocket-a. Then there was silence. The cursor was in the middle of the last line on the screen. *Hangup time at the ol' corral.* There was no joy in my office, mighty Kaypro had struck out.

As could be predicted, the Kaypro 4 Plus 88 hung up whenever I attempted to run IBM standard software. However, I was later successful running software recommended by Kaypro as compatible with the 4 Plus 88.

Conclusion

The Kaypro 4 Plus 88, although an IBM PC compatible machine is limited in many ways. Much of the software written for the IBM PC cannot run on this machine. It remains to be seen whether software companies will tailor their MS-DOS programs to run on the 4 Plus 88. Besides the software problem, there are difficulties with the hardware. Memory size is limited to 256K and there are no expansion slots. The finer things of computing such as graphics and color won't be available on the 4 Plus 88. However, for those people who want to run the 16-bit software that is available, the machine is an exceptional buy. At a cost of just $400 more than the basic price of the machine, you gain access to the 16-bit world and also get a RAM disk for your CP/M-80 system as a bonus.

The Kaypro 4 Plus 88 is a well-designed and complete (including software) system at a great price. If your particular needs can be satisfied by the add-on 8088 board, I certainly recommend the system. ◇

Plotters

(Continued from page 53)

trols. When the desired point of the image falls under the crosshairs of the sight, its coordinates can be sent to a computer.

While not as convenient as a graphics tablet, the digitizing mode of a plotter is adequate for occasional tasks. And it's surprisingly accurate and more precise than joysticks, trackballs, light pens, and mice.

Do-It-Yourself Plotter Software

It is not difficult to learn enough about a plotter's language to write working programs. Most plotter novices will spend far more time learning to connect a plotter to their computer and setting its status switches than in deciphering the basic commands for moving the pen.

True, mastering a plotter language requires reading (and, perhaps, rereading) the user's manual as well as practical experience. Nevertheless, most first-time users will find plotter languages like Houston Instruments' DM/PL+ and, especially, Hewlett-Packard's HP-GL easier than BASIC. Serious plotter devotees can soon learn to write surprisingly complex programs for their machines.

Are you still not convinced that high-level plotter languages are easy to learn and use? Then consider that many of the plotter instructions and the context in which they are used closely resemble those of LOGO, a graphics language developed originally for use by young children. In LOGO, the user employs plotter-like commands to move a sprite (or "turtle") about the computer's display. A pen is to a plotter what a turtle is to LOGO.

Commercial Plotter Software

A few years ago plotter software was limited to very sophisticated and costly packages such as Tektronix's PLOT-10 series. If you were fortunate enough to afford or have access to a plotter, chances are you would have to write your own software.

Today the software picture has dramatically improved. If you haven't the time or inclination to develop your own plotter software or if you don't want to spend time writing software that already exists, you can choose from dozens of reasonably priced plotter software packages for business, drafting, and engineering.

While there are plotter packages for most popular personal computers, the emphasis is on the Apple II, IBM PC, and units made by Hewlett-Packard. Most popular plotters are also covered, with machines made by Houston Instruments and Hewlett-Packard being particularly well supported.

Many of the business software packages for plotters generate multi-colored, fully annotated, and titled graphs and charts of every conceivable kind. Others are designed to print signs, posters and placards in any of several available lettering styles and sizes.

The most comprehensive plotter software machine is that designed for engineering drafting. Some packages will convert a relatively economical computer-plotter combination into a computer-aided drafting (CAD) system equivalent to those selling for tens of thousands of dollars.

One particularly impressive CAD package is Robographics CAD-1. This package, which sells for $1095, converts an Apple II+ or IIe into a powerful, interactive drafting system capable of drawing precisely dimensioned lines, arcs, curves and circles. Custom symbols and even entire images can be stored on disk and retrieved for later reproduction. During retrieval operations, the

PLOTTER SOFTWARE COMPANIES

The number of companies that sell plotter software is growing rapidly and the list given here is merely representative. Some plotter manufacturers provide helpful descriptive brochures about third-party software compatible with their machines. In addition, major firms like Hewlett-Packard and Tektronix publish extensive applications libraries of user-contributed programs.

This list of software vendors is provided as an informational service only. Please be aware that software offered by the listed firms has *not* been evaluated and is not necessarily endorsed by the author or COMPUTERS & ELECTRONICS. Avoid disappointment by arranging for a personal demonstration or by discussing a particular offering with a previous user.

Business Applications

Analytical Software, Inc.
10939 McCree Rd.
Dallas, TX 75238
214-340-2564

Business & Professional Software, Inc.
143 Binney St.
Cambridge, MA 02142
617-491-3377

Chang Laboratories, Inc.
5300 Stebens Creek Blvd.
San Jose, CA 95129
408-246-8020

Data Display
171 West 4th St.
New York, NY 10014
212-924-8167

Decision Resources
25 Sylvan Rd. S.
Westport, CT 06880
203-222-1974

Ferox Microsystems Inc.
1701 North Ft. Myer Dr.
Arlington, VA 22209
703-841-0800

Graphic Communications, Inc.
200 Fifth Ave.
Waltham, MA 02254
617-890-8778

Lifeboat Associates
1651 Third Ave.
New York, NY 10028
212-960-1300

Peachtree Software Inc.
3445 Peachtree Road, NE
Atlanta, GA 30326
404-239-3000

Redding Group Inc.
609 Main St.
Ridgefield, CT 06877
203-431-4661

Software Publishing Corp.
1901 Landings Dr.
Mountain View, CA 94043
415-962-8910

Computer Aided Drafting (CAD)

Graphics Software Systems, Inc.
PO Box 673
Wilsonville, OR 97070
503-682-1606

MicroPlot Systems Co.
1897 Red Fern Dr.
Columbus, OH 43229
614-882-4786

Stoneware
50 Belvedere St.
San Rafael, CA 94901
415-454-6500

T&W Systems
18437 Mt. Langley St., Suite B
Fountain Valley, CA 92708
714-963-3913

Robographics
125 Pheasant Run
Newtown, PA 18940
215-968-4422

Comprehensive (Business, CAD, etc.)

Hewlett-Packard Co.
16399 W. Bernardo Dr.
San Diego, CA 92127
619-487-4100

Tektronix, Inc.
PO Box 500
Beaverton, OR 97077
503-682-341

stored images are reproduced in miniature on the computer's display to assist the user in recognizing the desired image. The Robographics package is menu driven and, as I found during a test session, very powerful and surprisingly easy to use.

Selecting a Plotter

Since there are more than fifteen manufacturers of x-y plotters, selecting an affordable machine that will fulfill your requirements is no simple task. Indeed, many of the decision processes that apply to the purchase of a computer apply equally well to the acquisition of a plotter. In both cases there's no substitute for a personal demonstration so that you know just what you're getting.

Some computer stores can provide excellent demonstration of plotters. Most cannot.

With the notable exception of a Radio Shack Computer Center, a Computerland store and several Hewlett-Packard dealers, few of the personnel at computer stores I've visited to date know enough about the plotters they sell to run more than a demonstration program. The situation is reminiscent of the poor level of computer proficiency exhibited by computer store sales people a few years ago.

If you plan to use commercial plotter software, be sure the machine you select is well supported. If, on the other hand, you plan to write some, or all, of your own software, be sure to compare the instruction sets of competing plotters before making a purchase decision to be sure you know how to use them.

Above all, arrange for personal demonstrations of several competing plotters before making a final choice. Is the machine built well? Is its noise level acceptable? Is it fast enough? Are the printed characters legible? Does it have obvious problems with repeatability? Will it accept the kinds of pens you want to use? How many pen stalls are provided? All these questions and more can be quickly answered during a firsthand demonstration. ◇

REPRESENTATIVE PLOTTER MANUFACTURERS

Alps Electric (USA), Inc.
100 N. Centre Ave.
Rockville Centre, NY 11570
516-766-3636

AlphaMerics Corporation
20931 Nordhoff St.
Chatsworth, CA 91311
213-709-1155

Amdek Corporation
2201 Lively Blvd.
Elk Grove Village, IL 60007
312-364-1180

Bausch & Lomb, Houston Instrument Div.
8500 Cameron Rd.
Austin, TX 78761
512-835-0900

California Computer Products, Inc.
2411 W. La Palma Ave.
Anaheim, CA 92801
800-556-1234, Ext 156

Enter Computer, Inc.
6867 Nancy Ridge Dr.
San Diego, CA 92121
619-450-0601

Hewlett-Packard Company
16399 W. Bernardo Dr.
San Diego, CA 92127
619-487-4100

IBM Instruments, Inc.
PO Box 332
Danbury, CT 06810
800-243-7054

Mannesmann Tally Corp.
8301 S. 180th St.
Kent, WA 98031
206-251-5500

Nicolet Zeta Corporation
2300 Stanwell Dr.
Concord, CA 94520
415-671-0600

Numonics Corporation
418 Pierce St.
Lansdale, PA 19446
215-362-2766

Panasonic Industrial Co.
One Panasonic Way
Secaucus, NJ 07094
201-348-5337

Radio Shack
1500 One Tandy Center
Fort Worth, TX 76102
817-390-3011

Soltec Corporation
11684 Pendleton St.
Sun Valley, CA 91352
213-767-0044

Strobe, Inc.
897-5A Independence Ave.
Mountain View, CA 94043
415-969-5130

Tektronix, Inc.
PO Box 500
Beaverton, OR 97077
503-682-3411

Western Graphtec
12 Chrysler St.
Irvine, CA 92714
800-854-8385; CA: 714-770-6010

Yokogawa Corp. of America
2 Dart Rd.
Shenandoah, GA 30265
404-253-7000

Printer Buffers

(Continued from page 78)

the contents of one. Only if you give it the go-ahead will it change or delete the contents of an occupied slot.

There are six operating modes, entered on the keypad as "000" through "500." Mode 000 is for normal printing. It provides for manual use of the PAUSE switch as well as a "stored pause," where the device treats an ASCII character as a command to go into the PAUSE mode. The EXE command immediately sends to the printer a string stored in one the 99 housekeeping memory slots, and the STO command adds the contents of any slot to the end of the data currently in the buffer.

Mode 100 allows you to enter data into housekeeping memory. For example, the entire heading for a letter could be stored in a slot and called up with a couple of keystrokes. There is a catch, though. Since the data has to be entered from the unit's keypad, which has numbers and functions but no letters, it must be entered numerically—the ASCII values in decimal form of the characters desired. If you wanted to store the sequence "ABC" you would have to store it as 65, 66, 67. Fortunately, a conversion table is provided in the instruction manual.

Mode 200 is used for character conversions: *from* anything *to* anything, as long as both can be represented by ASCII codes. For example, assume that a word processor sends only carriage returns (because it is intended for use with a printer that provides an automatic linefeed after a carriage return), but the printer being used doesn't provide an automatic linefeed. You can simply use mode 200 to program the Printer Optimizer so that an ASCII 13 (representing a carriage return) is automatically converted to ASCII 13 *plus* ASCII 10 (a linefeed).

Or consider this situation. You have an entire document on disk in which the "$" symbol was used as shorthand for the word "dollar." There's no time to run the document through the word processor to make the change. Instead, you use mode 200:

```
36($) = 100(d), 111(o),
        108(l), 108(l),
        97(a), 114(r)
```

From then on, each "$" received by the printer buffer is converted to the string "dollar."

Mode 300 provides a faster and more convenient way of putting information into housekeeping memory. A text file containing all the information and the slots into which it is to be put is prepared and saved on disk. Then, from mode 300, the disk file is loaded into the buffer. *Voila!* Everything winds up where you want it and is waiting for you. The really nice thing about this mode is that it allows you to enter data in the form of alphanumeric characters rather than their ASCII codes.

Mode 400 gets you a printout of the status of the printer buffer, along with all the information stored in its housekeeping memory.

The fifth mode, mode 500, is used for the REPRINT function. Up to 99 copies of a document can be requested. A SELECTIVE REPRINT function is also available in this mode. It lets you reprint a document from any starting point, providing a means of searching through the data buffer for the text you want to print. By entering a decimal number representing a memory address within the buffer and pressing the ENT key, 80 bytes worth of data, starting at the address you indicated, can be printed out. It is relatively easy to find the portion of text you want in this manner and it can then be output to the printer until you give the command to stop printing or until the device has printed everything from that point on in its memory.

Will a buffer provide proper graphics support?

As you might expect, the Printer Optimizer has full "busy" control of the computer from both the PAUSE and "flying start" print modes.

All the printer buffers tested worked well. Which one is for you depends on how complex your needs are and how much room there is in your budget.

Finally, a note of caution. If you are going to be using a printer buffer for dumping graphics to your printer, be sure it can handle the codes representing the special characters used and that, in general, it can handle your graphics requirements. Some units may work well in one mode but not in another. (The Angel is one of these—it will not properly support graphics or proportional spacing in PAGE mode.) Before you purchase, make certain—by actual testing or, at least, by carefully scrutinizing the manual—that the buffer will do everything you expect of it. ◇

Circle No. 36 on Free Information Card

Circle No. 50 on Free Information Card

Circle No. 14 on Free Information Card

4164 64K DYNAMIC 200 NS $5.95 TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
TC5514	1024 x 4	(650ns) (cmos)	2.49
TC5516	2048 x 8	(250ns) (cmos)	9.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	39.95
MCM68766	8192 x 8	(350ns) (5v) (24 pin)(pwr dn.)	42.95
27128	16384 x 8	(300ns) (5v)	29.95

5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

EPROM ERASERS

SPECTRONICS CORPORATION

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

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6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	9.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

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8035	5.95
8039	5.95
INS-8060	17.95
INS-8073	49.95
8080	3.95
8085	4.95
8085A-2	11.95
8086	24.95
8087	CALL
8088	29.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	29.95
8748	24.95
8755	24.95

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68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	19.95
CRT5037	24.95
TMS9918A	39.95
DP8350	49.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 Mhz

Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 Mhz

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	19.95
Z80B-SIO/2	39.95

ZILOG

Z6132	34.95
Z8671	39.95

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1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

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AY3-1015	6.95
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4006	.89	4538	1.95
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4008	.95	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
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74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
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74LS123	.79	74LS378	1.18
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74LS153	.55	74LS668	1.69
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74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S132	1.24	74S225	7.95
74S02	.35	74S133	.45	74S240	2.20
74S03	.35	74S134	.50	74S241	2.20
74S04	.35	74S135	.89	74S244	2.20
74S05	.35	74S138	.85	74S251	.95
74S08	.35	74S139	.85	74S253	.95
74S09	.40	74S140	.55	74S257	.95
74S10	.35	74S151	.95	74S258	.95
74S11	.35	74S153	.95	74S260	.79
74S15	.35	74S157	.95	74S273	2.45
74S20	.35	74S158	.95	74S274	19.95
74S22	.35	74S161	1.95	74S275	19.95
74S30	.35	74S162	1.95	74S280	1.95
74S32	.40	74S163	1.95	74S287	1.90
74S37	.88	74S168	3.95	74S288	1.90
74S38	.85	74S169	3.95	74S289	6.89
74S40	.35	74S174	.95	74S301	6.95
74S51	.35	74S175	.95	74S373	2.45
74S64	.40	74S181	3.95	74S374	2.45
74S65	.40	74S182	2.95	74S381	7.95
74S74	.50	74S188	1.95	74S387	1.95
74S85	1.99	74S189	6.95	74S412	2.98
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74S112	.50	74S195	1.49	74S472	4.95
74S113	.50	74S196	1.49	74S474	4.95
74S114	.55	74S197	1.49	74S482	15.25
74S124	2.75	74S201	6.95	74S570	2.95
				74S571	2.95

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7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
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L = TO-92

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7400

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7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

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9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

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LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37	CA 3039	1.29	CA 3083	1.55
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25	CA 3046	1.25	CA 3086	.80
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50	CA 3059	2.90	CA 3089	2.99
LM308H	1.15	LM358	.69	NE571	2.95	LM1871	5.49	CA 3060	2.90	CA 3096	3.49
LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49	CA 3065	1.75	CA 3130	1.30
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25	CA 3080	1.10	CA 3140	1.15
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95	CA 3081	1.65	CA 3146	1.85
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75			CA 3160	1.19
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49				
LM312H	1.75	LM380	.89	LM723	.49	LM2877	2.05				
LM317K	3.95	LM380N-8	1.10	LM723H	.55	LM2878	2.25				
LM317T	1.19	LM381	1.60	LM733	.98	LM2900	.85				
LM318	1.49	LM382	1.60	LM741	.35	LM2901	1.00				
LM318H	1.59	LM383	1.95	LM741N-14	.35	LM3900	.59				
LM319H	1.90	LM384	1.95	LM741H	.40	LM3905	1.25				
LM319	1.25	LM386	.89	LM747	.69	LM3909	.98				
LM320 (see 7900)		LM387	1.40	LM748	.59	LM3911	2.25				
LM322	1.65	LM389	1.35	LM1014	1.19	LM3914	3.95				
LM323K	4.95	LM390	1.95	LM1303	1.95	LM3915	3.95				
LM324	.59	LM392	.69	LM1310	1.49	LM3916	3.95				
LM329	.65	LM393	1.29	MC1330	1.69	MC4024	3.95				
LM331	3.95	LM394H	4.60	MC1349	1.89	MC4044	4.50				
LM334	1.19	LM399H	5.00	MC1350	1.19	RC4136	1.25				
LM335	1.40	NE531	2.95	MC1358	1.69	RC4151	3.95				
LM336	1.75	NE555	.34	MC1372	6.95	LM4250	1.75				
LM337K	3.95	NE556	.65	LM1414	1.59	LM4500	3.25				
LM337T	1.95	NE558	1.50	LM1458	.59	RC4558	.69				
LM338K	6.95	NE561	24.95	LM1488	.69	LM13080	1.29				
LM339	.99	NE564	2.95	LM1489	.69	LM13600	1.49				
				LM1496	.85	LM13700	1.49				

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
		CA 3160	1.19

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
	75494	.89	

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
	LF357	1.40	

LED DISPLAYS

HP 5082-7760	.43"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49
TIL-311 4x7	.270"	HEX W/LOGIC	9.95

LED LAMPS

	1-99	100-up
JUMBO RED	.10	.09
JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED MOUNTING HARDWARE	.10	.09

BYPASS CAPS

.01 UF DISC	100/5.00
.01 UF MONOLITH C	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

ALL MERCHANDISE 100% GUARANTEED

Circle No. 22 on Free Information Card

7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price
SN7400N	14	.25
SN7401N	14	.25
SN7402N	14	.25
SN7403N	14	.25
SN7404N	14	.25
SN7405N	14	.25
SN7406N	14	.45
SN7407N	14	.29
SN7408N	14	.25
SN7409N	14	.25
SN7410N	14	.25
SN7411N	14	.25
SN7412N	14	.49
SN7413N	14	.39
SN7414N	14	.49
SN7416N	14	.25
SN7417N	14	.25
SN7420N	14	.19
SN7421N	14	.49
SN7422N	14	.49
SN7423N	16	.59
SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.25
SN7428N	14	.59
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	1.25
SN7444N	16	1.25
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459N	14	.25
SN7460N	14	.39
SN7470N	14	.29

Part No.	**Pins	Price
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.79
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74104N	14	1.19
SN74105N	14	1.19
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.69
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.89
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59

Part No.	**Pins	Price
SN74156N	16	.59
SN74157N	16	.59
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.95
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	1.19
SN74184N	16	2.49
SN74185N	16	2.49
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	2.49
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	**Pins	Price
74LS00	14	.25
74LS01	14	.25
74LS02	14	.29
74LS03	14	.25
74LS04	14	.35
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	.29
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.39
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.49
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.65
74LS85	16	.89
74LS86	14	.39
74LS90	14	.55

Part No.	**Pins	Price
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.89
74LS125	14	.59
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.89
74LS139	16	.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.29
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.95
74LS190	16	.89
74LS191	16	.89

Part No.	**Pins	Price
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.49
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

Part No.	**Pins	Price
74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	2.49
74S86	14	.55
74S112	16	.55
74S113	14	.55

Part No.	**Pins	Price
74S114	14	.55
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	1.19
74S175	16	1.19
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49

Part No.	**Pins	Price
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	1.19
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

Part No.	**Pins	Price
CA3010H		1.35
CA3039H		1.35
CA3046N	14	1.35
CA3059N	14	2.95
CA3060N	16	2.95
CA3065E	14	1.49
CA3080E	8	.89

Part No.	**Pins	Price
CA3081N	16	.99
CA3082N	16	1.19
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.49

Part No.	**Pins	Price
CA3130E	8	.89
CA3140E	8	.79
CA3160H		1.95
CA3161E	16	2.95
CA3162E	16	6.95
CA3189E	16	1.59
CA3401N	14	.59

CD—CMOS

Part No.	**Pins	Price
CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	1.19
CD4007	14	.29
CD4009	16	.59
CD4010	16	.59
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	1.19
CD4015	16	.39
CD4016	14	.49
CD4017	16	1.19
CD4018	16	.99
CD4019	16	.59
CD4020	16	1.19
CD4021	16	1.19
CD4022	16	1.19
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	1.29
CD4030	14	.39
CD4034	24	2.49
CD4035	16	1.49

(More in Catalog)

Part No.	**Pins	Price
CD4040	16	1.19
CD4041	14	1.19
CD4042	16	.89
CD4043	16	.79
CD4044	16	.79
CD4046	16	1.19
CD4047	14	1.29
CD4048	16	.59
CD4049	16	.39
CD4050	16	.39
CD4051	16	.99
CD4052	16	.99
CD4053	16	.99
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	1.49
CD4066	14	.59
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	1.19
CD4078	14	.49
CD4081	14	.29
CD4082	14	.29
CD4093	14	.49

Part No.	**Pins	Price
CD4098	16	1.95
CD4506	16	1.19
CD4507	14	1.19
CD4508	24	3.95
CD4510	16	1.29
CD4511	16	1.19
CD4512	16	1.19
CD4514	24	2.49
CD4515	24	2.49
CD4516	16	1.19
CD4518	16	1.19
CD4519	16	.59
CD4520	16	1.19
CD4526	16	1.49
CD4528	16	1.49
CD4529	16	1.69
CD4543	16	1.95
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.69
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$2.95
MCS6502	40	MPU w/Clock	5.95
MCS6502B	40	MPU w/Clock at 3MHz	9.95
6809	40	CPU—8-bit (Internal Clock) 1MHz	14.95
6809E	40	CPU—8-bit (External Clock) 1MHz	14.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N	40	CPU-Sgl chip 8-bit (128bts Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-P10	40	Parallel I/O Interface Controller	3.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-S10/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-P10	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-S10/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-P10	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6500/6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6502A	40	MPU with clock and RAM (2MHz)	6.95
MC6520	40	Peripheral Inter. Adapter	4.95
MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

Part No.	**Pins	Function	Price
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8080A	40	CPU	2.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

Part No.	**Pins	Function	Price
INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95
6843P	40	Floppy Disk Controller (1MHz)	29.95

SPECIAL FUNCTION

Part No.	**Pins	Function	Price
DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int	5.95
COP470N	20	32-seg VAC Fluor. Drvr. (20-pin pkg.)	3.25
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	16	4096x1	(250ns)	2.49
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1	(200ns)	5.95 - 8/44.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	22	2048x1	(365ns)	.49 - 8/1.95
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

Part No.	**Pins			Price
1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	1.95
2114	18	1024x4	(450ns)	1.49 - 8/9.95
2114L	18	1024x4	(450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4	(200ns)	1.75 - 8/11.95
2114L-2	18	1024x4	(200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	4.95
TMS4045	18	1024x4	(450ns)	3.95
TMS40L47-45	20	1024x4	(450ns)	2.95
5101	22	256x4	(450ns) CMOS	2.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	5.95
HM6116-4	24	2048x8	(200ns) CMOS	4.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8	(150ns) CMOS	39.95
27LS00	16	256x1	(80ns) L.P.	9.95
7489	16	16x4	(50ns) 3101	2.25
74C920	22	256x4	(250ns)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

PROMS / EPROMS

Part No.	**Pins			Price
1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	5.95
TMS2532	24	4096x8	(450ns) NMC2532	6.95
TMS2564	28	8192x8	(450ns)	14.95
TMS2716	24	2048x8	(450ns) 3 voltage	9.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	5.95
27160-5	24	2048x8	(550ns)	4.49
2732	24	4096x8	(450ns)	6.95
2732A-3	24	4096x8	(300ns)	7.95
2732A-4	24	4096x8	(450ns) 21V	6.95
27320-4	24	4096x8	(550ns)	5.95
2758Q-A	24	1024x8	(450ns)	2.95
2764-4	28	8192x8	(450ns)	9.95
2764-3	28	8192x8	(300ns)	14.95
MM52040	24	512x8 (1us)		4.95
MCM68764	24	8192x8	(450ns)	24.95
27128	28	16,384x8	(450ns) 128K EPROM	59.95
74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S476	18	1024x4	PROM T.S.	6.95
74S478	24	1024x8	PROM T.S.	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	4.95
74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	2.95
82S129	16	256x4	PROM T.S. (27S21)	2.95
82S130	16	512x4	PROM O.C. (27S12)	3.95
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
82S190	24	2048x8	(80ns)	14.95
82S191	24	2048x8	(80ns)	14.95
DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4	PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4	PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4	PROM O.C. (82S190)	14.95
DM87S191N	24	2048x8	PROM T.S. (82S191)	14.95

DATA ACQUISITION

Part No.	Pins / Function	Price
DC10	Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18 Floppy Disk Read AMP System	4.95
MC1408L7	16 7-bit D/A Converter (DAC0807LCN)	1.49
MC1408L8	16 8-bit D/A Converter (DAC0808LCN)	2.25
ADC0803LCN	20 8-bit A/D Converter (± 1/2LSB)	4.95
ADC0804	20 8-bit A/D Converter (1LSB)	3.49
DAC0806	16 8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28 8-bit A/D Converter (8-Ch. Multi.)	4.49
ADC0817	40 8-bit A/D Converter (16-Ch. Multi.)	9.95
DAC1000	24 10-bit D/A Conv. Micro. Comp. (0.05%)	7.95
DAC1008	20 10-bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1020	16 10-bit D/A Conv. (0.05% Lin.)	7.95
DAC1022	16 10-bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18 12-bit D/A Conv. (0.20% Lin.)	6.95
LM334Z	Constant Current Source	1.19
LM335Z	Temperature Transducer	1.40
LM399H	Temp. Comp. Prec. Ref. (5ppm/C°)	5.00
AY-5-1013A	40 30K Baud Uart (TR1602)	3.95

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-up
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

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	1-9	10-99	100-up
8 pin SG	.30	.27	.25
14 pin SG	.43	.39	.37
16 pin SG	.47	.43	.41
18 pin SG	.53	.49	.47
24 pin SG	.69	.65	.61
28 pin SG	.81	.76	.72
36 pin SG	1.09	1.03	.97
40 pin SG	1.21	1.14	1.08

LP

SG

ST

WW

SOLDERTAIL STANDARD (TIN)

	1-9	10-99	100-up
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16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
20 pin ST	.45	.43	.41
24 pin ST	.49	.46	.43
28 pin ST	.69	.67	.63
40 pin ST	.99	.95	.89

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	1-9	10-99	100-up
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10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
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Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ . . . . $34.95 ea.
MM54104 Processor Chip . . . . $14.95 ea.

DT1057 - Expands the DT1050 vocabulary from 137 to over 260 words. Includes 2 ROMs and specs.
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INTERSIL

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Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
FE0203D		3½ Digit LCD Display for 7106 & 7116	19.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
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7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
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7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
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7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
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7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

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Part No.	**Pins	Price
74HC00	14	.59
74HC02	14	.59
74HC03	14	.75
74HC04	14	.59
74HCU04	14	.65
74HC08	14	.59
74HC10	14	.59
74HC11	14	.59
74HC14	14	.85
74HC20	14	.59
74HC27	14	.59
74HC32	14	.75
74HC42	16	.99
74HC51	14	.75
74HC58	14	.75
74HC73	14	.79
74HC74	14	.79
74HC75	16	.89
74HC76	16	.79
74HC85	16	1.59
74HC86	14	.69
74HC107	14	.79
74HC109	16	.79
74HC112	16	.79
74HC113	14	.79
74HC132	14	.99
74HC137	16	1.95
74HC138	16	1.09

Part No.	**Pins	Price
74HC139	16	.99
74HC147	16	1.19
74HC151	16	.89
74HC153	16	.99
74HC154	24	2.49
74HC157	16	.89
74HC158	16	.89
74HC160	16	1.29
74HC161	16	1.29
74HC162	16	1.29
74HC163	16	1.29
74HC164	14	1.29
74HC165	16	2.79
74HC173	16	1.69
74HC174	16	.99
74HC175	16	.99
74HC192	16	1.39
74HC193	16	1.39
74HC194	16	1.09
74HC195	16	1.09
74HC237	16	2.95
74HC240	20	1.95
74HC241	20	1.95
74HC242	14	1.95
74HC243	14	1.95
74HC244	20	1.95
74HC245	20	2.49

Part No.	**Pins	Price
74HC251	16	.89
74HC253	16	.99
74HC257	16	.89
74HC259	16	1.49
74HC266	14	1.19
74HC273	20	2.89
74HC280	14	3.95
74HC373	20	2.39
74HC374	20	2.39
74HC390	16	1.49
74HC393	14	1.49
74HC533	20	2.39
74HC534	20	2.39
74HC595	16	3.95
74HC688	20	3.19
74HC4002	14	.59
74HC4017	16	2.19
74HC4020	16	1.39
74HC4024	14	1.59
74HC4040	16	1.39
74HC4060	16	1.39
74HC4075	14	.59
74HC4078	14	.69
74HC4511	16	2.69
74HC4514	24	3.79
74HC4538	16	2.39
74HC4543	16	3.49

74HCU04 is unbuffered. All others are buffered.

NEW Programmable Array Logic (PALS)

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PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	3.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	3.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	3.95
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PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	7.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	7.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	7.95

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74C—C/MOS

Part No.	**Pins	Price
74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.69
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19

Part No.	**Pins	Price
74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	1.19
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39

Part No.	**Pins	Price
74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.69
80C97	16	.69

LINEAR

Part No.	**Pins	Price
TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35

Part No.	**Pins	Price
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LF347N	14	1.49
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	3.95
TL496CP	8	1.19
NE531V	8	2.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79

Part No.	**Pins	Price
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
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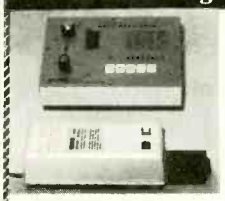

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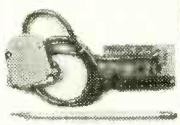

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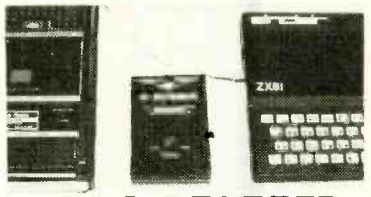

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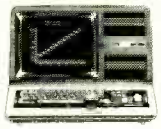

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Letters

(Continued from page 12)

REFINING THE REAL-TIME CLOCK

I just finished building the Real-Time clock for the TRS-80 described in your December issue and would like to alert your readers to come changes that must be made to the hardware as well as the software if the clock is to work properly.

First, becuase the 8255 PPI (IC2) comes up with its ports in the high-impedance, or tri-state, mode, the hold input to the clock chip is pulled high when the TRS-80 is turned on. It will stay in the hold mode until the clock is written to, or read from, which may or may not be a substantial length of time. This, of course, will cause a loss of accuracy. The solution is to tie *R11* and *R10* to ground instead of 5 V dc. In addition, *R9* and *R10* should be tied to ground since both the read and write enables are valid high inputs.

To keep the number of interconnect wires to a minimum, I removed *R14* and D and connected 5V dc to the anode of *D1*. Since the +12V dc was clamped to 5.6 V dc by *D2* and approximately 30 mA of current was being wasted as heat in *R14*, I couldn't see the need for the extra circuitry.

Secondly, the Clock Setup Routine (Table I) almost works, but not quite. Due to the internal workings of the computer where 8 is sometimes 7.999999999, some values could not be written to the clock. The output of the clock is through a port where the values must be 0 to 255 and any variable sent through the port is automtically converted to an integer. So 7,999999999 is sent as 7. The solution is to do the math in such a way that the you are slightly over (not under) the value desired.

To do this, change all the lines that calculate the 1's to the following form: A(2)=A(20)-10*FIX(A20)/10). This applies to lines 1160, 1180, 1200, 1220, and 1240.

—N. BENEDICT
Irvine, CA

ADVERTISERS INDEX

RS no.	ADVERTISER	PAGE no.
50	Active Electronics	107
9	Atari	4-5
	C & D Electronics	103
	Classified Advertising	113-119
	Cleveland Institute of Electronics, Inc	28-31
29	Commodore Computer	C-4
19	Communications Electronics	99
60	CompuServe	7
11	Computer Mail Order	27
14	Digi-Key Corp.	108-109
	Fuji SVEA	12
	Grantham College of Engineering	120
4	Halix Institute	106
24,28	Heath Co.	C-3, 41
	Hume Publishing	1
	ICS	103
	Information Unlimited/ Scientific Systems	106
10	Inmac	35
21	Jameco Electronics	112
22	JDR Microdevices	110-111
23	J & R Music World	35
20	Leading Edge	Cover 2
34	Micro Ware	120
	National Technical Schools	18-21
	NRI Schools	8-11
40	Protecto	13
	Radio Shack	3
36	Sintec Co	107
1	Sweet Gum, Inc.	105
39	Tab Books	23
42	Tam's Inc.	105
	Timex	14-15
79	Univair, Inc.	101