YOUR CHOICE-smart either way

- Over 140 software driven functions
- 82 x 24 or 82 x 20 screen format — software selectable
- High resolution 7 x 12 matrix characters — P-31 green phosphor
- Upper/lower case character set — plus graphics character set
- 56-key alphanumeric keyboard — plus 12-key cursor, numeric pad
- Internal editing functions — insert, delete, scroll, roll, slide, etc.
- Parallel printer I/O port
- 50 to 38,400 baud operation — programmable
- Cursor type, cursor position, print control characters, protected fields, shift inversion, dual intensity and many other features

8212 — twelve-inch diagonal screen or 8209 — nine-inch diagonal screen
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The above diagram shows in a functional way one of the most complete lines of computer cards in the industry. Look it over carefully. It could be well worth your while.

These are all cards that plug into our S-100 bus microcomputers.

You can also assemble them into a custom system in convenient Cromemco card cages.

MULTI-PROCESSING AND INTELLIGENT I/O

The range of capabilities and versatility you can draw upon is enormous.

In processors, for example, you have a choice of CPU's including our extremely useful new I/O Processor. This can be used as a satellite processor to do off-line processing, multi-processing, and to form intelligent I/O. It opens the door to a whole new group of applications and tasks. Ask us about it.

HIGH RESOLUTION COLOR GRAPHICS

Again, you can have beautiful high-resolution color graphics with our color graphics interface. You can select from over 4000 colors and have a picture with a resolution at least equal to quality broadcast-TV pictures.

You have an unprecedented selection of memory including our unusual 48K and 16K two-port RAMs which allow high-speed color graphics.

LOTS OF STORAGE

These days you often want lots of disk storage. So you can select from our disk controller card which will operate your 5" and 8" floppy disk drives (up to 1.2 megabytes). Or select our WDI interface to operate our 11-megabyte hard disk drives.

POWERFUL SOFTWARE AND PERIPHERAL SUPPORT

There's much more yet you can do with our cards. And, of course, there's an easy way to put them to work in our 8-, 12-, and 21-slot card cages. Our PS8 power supply makes it simple to get the system into operation.

Finally, Cromemco offers you the strongest software support in the industry with languages like FORTRAN, COBOL, ASSEMBLER, LISP, BASIC and others. There is also a wide choice from independent vendors.

To top it all off, you can draw from a substantial array of peripherals: terminals, printers, color monitors and disk drives.

CONTACT YOUR CROMEMCO REP

There is even more capability than we're able to describe here. Contact your Cromemco rep now and get this capability working for you.

CROMEMCO COMPUTER CARDS

• PROCESSORS — 4 MHz Z-80 A CPU, single card computer, I/O processor • MEMORY — up to 64K including special 48K and 16K two-port RAMS and our very well known BYTESAVERS with PROM programming capability • HIGH RESOLUTION COLOR GRAPHICS — our SDI offers up to 754 x 482 pixel resolution. • GENERAL PURPOSE INTERFACES—QUADART four-channel serial communications, TUR-ART two-channel parallel and two-channel serial, 8PIO 8-port parallel, 4PIO 4-port isolated parallel, D+7A 7-channel D/A and A/D converter, printer interface, floppy disk controller with RS-232 interface and system diagnostics, wire-wrap and extender cards for your development work.
Get the professional color display that has BASIC/FORTRAN simplicity

LOW-PRICED, TOO

Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

The SDI then maps computer display memory content onto a convenient color monitor to give high-quality, high-resolution displays (756 H x 482 V pixels).

When we say the SDI results in a high-quality professional display, we mean you can't get higher resolution than this system offers in an NTSC-conforming display.

The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283

HIGH RESOLUTION

The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

To achieve the high-quality display, a separate output signal is produced for each of the three component colors (red, green, blue). This yields a sharper image than is possible using an NTSC-composite video signal and color TV set. Full image quality is readily realized with our high-quality RGB Monitor or any conventional red/green/blue monitor common in TV work.

Model SDI plugs into Z-2H 11-megabyte hard disk computer or any Cromemco computer

DISPLAY MEMORY

Along with the SDI we also offer an optional fast and novel two-port memory that gives independent high-speed access to the computer memory. The two-port memory stores one full display, permitting fast computer operation even during display.

CONTACT YOUR REP NOW

The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.
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In This Issue

It's the operating systems that turn a hunk of hardware into a clever machine. As Robert Tinney's cover drawing depicts, they are the brains behind the brawn of today's computing systems.

This month two articles analyze the most popular operating system, "CP/M: A Family of 8- and 16-Bit Operating Systems," by Gary Kildall, and James Larson's "The Ins and Outs of CP/M." If you can get beyond the title of Christopher Morgan's editorial — "The New 16-Bit Operating Systems, or, the Search for Benutzerfreundlichkeit" — you'll discover what form the operating systems of the future may take. And Robert Greenberg presents what may be the next popular operating system in his article, "The UNIX Operating System and the XENIX Standard Operating Environment."
"...stands well above other S-100 graphics displays in its price and performance range."
BYTE, Product Review

"...better monochromatic display..."
ELECTRONIC DESIGN, 1981 Technology Forecast

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**HIGH RESOLUTION GRAPHICS SINGLE BOARD COMPUTER**

512 x 480 resolution black and white and vivid color displays

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- 60 hertz real-time clock
- 8 level interrupt tie-in
- IEEE S100 bus compatible

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A 4K byte operating system resident in PROM on MicroAngelo™. Pak I emulates an 85 character by 40 line graphics terminal and provides over 40 graphics commands. Provisions exist for user defined character sets and directly callable user extensions to Screenware™ Pak I.

**Screenware™ Pak II**

An optional software superset of Pak I which adds circle generation, polygon flood, programutable split screen for separate graphics and terminal I/O, relative coordinates, faster vector and character plotting, a macro facility, full UCSD Pascal compatibility, and more.

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The new MicroAngelo™ Palette board treats from 2 to 8 MicroAngelos as "bit planes" at a full 512 x 480 resolution. Up to 256 colors may be chosen from 16,8 million through the programmable color lookup table. Overlays, bit plane precedence, fade-in, fade-out, gray levels, blinking bit plane, and a highly visual color editor are standard.

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PLAN80® lets you tackle any numeric problem that can be defined in worksheet format. It performs complex calculations quickly and precisely and lets you examine "What if?" questions so you can evaluate more planning alternatives in greater detail.

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PLAN80® requires 56K RAM & CP/M. Specify 280, 8080 or COOS. Formats: 8" single density IBM soft-sectored, Cromemco COOS, 5¼" NorthStar DD, Micropolis Mod II, Superbrain 3.0.


The New 16-Bit Operating Systems, or, The Search for Benützerfreundlichkeit

by Chris Morgan, Editor in Chief

"Benützerfreundlichkeit: (literally 'user friendliness') The philosophy that a system should be constructed with the interests of the user as the chief concern."


Sam Goldwyn, the "G" of MGM, was famous for his inside-out logic. He once said, "A verbal agreement isn't worth the paper it's written on." This month's topic prompted me to coin a "Goldwynism" of my own: "The best time to talk about the future is before it happens."

In one sense 16-bit microcomputers are definitely here, yet in another they are strangers to us. The personal-computer community still lives in an 8-bit world, straining all 8 bits of every word to perform miracles.

But all that can and must change. Opponents of 16-bit systems cite cost and software conversion problems as the two main justifications for staying with 8 bits. Yet, how can software keep pace with the increased demand for more sophisticated graphics, to name only one area, unless we can address more than 64 K bytes of memory? How will we be able to access the staggering amounts of information in future memory banks without an increase in word size? And then there are the exciting new languages like Smalltalk that demand 16 bits for their operation. Simply put, 16 bits is the only way to go. The 16-bit operating system, therefore, becomes a critical link in the computing chain.

Doing It Right the Second Time

The operating system is the "master controller" of the computer: it gets us going when we turn on our computers, keeps track of files, lets programs talk to one another, performs input/output tasks, and so on. Put charitably, most operating systems in the 8-bit world have been afterthoughts or compromises in design. Even CP/M, a de facto standard in our field, has been criticized as being awkward for nontechnical users. But CP/M's ubiquitousness is responsible for the development of a lot of valuable software that would otherwise probably not have been written.

The sin of inefficiency is venial compared to the mortal sin of "user-unfriendliness." I'd buy an operating system any day that takes a long time to run a given program but which makes me more productive by communicating with me in useful ways. Let's face it: most of us don't have to worry about real-time process control and its inherent time constraints. And the cost of a line of code is becoming astronomical.

KEVIN COHAN 1956-1981

Kevin Cohan, BYTE technical editor, died April 22nd when the car he was driving left the road, striking a tree. He was 24 years old. Kevin joined the BYTE staff in November, 1980, after attending Dartmouth College, and was a valuable and well-liked member of our "family." He will be missed.
Percom Mini-Disk Drive Systems for TRS-80* Computers .

Now! Add-On and Add-In Mini-Disk Storage for your Model III.

The industry leader in microcomputer peripherals, Percom not only gives you better design, better quality and first-rate service, but you pay less to boot.

New for the TRS-80* Model III

Patterned after our fast-selling TFD Model I drives, and subjected to the same reliability controls. These new TFD mini-disk systems for the Model III provide more features than Tandy drives, yet cost far less.

- Flippy Capability: Both internal (add-in) and external (add-on) drives permit recording on either side of a diskette.
- Greater Storage Capacity: Available with either 40- or 80-track drive mechanisms, Percom TFD mini-disk systems store more. A 40-track drive stores up to 180 Kbytes — formatted — on one side of a 5-inch diskette. An 80-track drive stores a whopping 364 Kbytes.
- 1.5 Mbyte On-line: The Percom drive controller (included with the initial drive) handles up to four drives. With four 80-track mini-disk drives you can access over 1.5 million bytes of on-line file data. Moreover, the initial drive may be either an internal add-in drive or an external add-on drive. And whichever configuration you get, the initial drive kit comes complete with our advanced 4-drive controller, interconnecting cables, power supplies, installation hardware, a DOS and of course the drive mechanism itself.
- First Drive Includes DOS: OS-80™. Percom's fast extendable BASIC-language disk operating system, is included on diskette when you purchase an initial drive. Originally called MicroDOS, OS-80 was favorably reviewed in the June 1980 issue of Creative Computing magazine.
- Works with Model III TRSDOS: Besides being fully hardware compatible, Percom's Model III 40-track drive systems may be operated with Tandy's Model III TRSDOS — without any modifications whatsoever. And, TRSDOS may be easily upgraded with simple software patches for operating 80-track drives.

Percom TFD add-on drives start at only $399. Model III Drive kits start at only $749.95.

Quality Percom products are available at authorized dealers. Call toll free 1-800-527-1592 for the address of your nearest dealer or to order direct from Percom.

Still #1 for Model I

As if greater storage capacities, exceptional quality control measures and lower prices aren't reasons enough to make Percom your first choice for Model I add-on drives, all Percom Model I drives are also rated for double-density operation.

Add our innovative DOUBLER™ adapter to your Model I Expansion Interface, and with Percom drive systems you can enjoy the same double-density storage capability as Model III owners.

The DOUBLER includes a TRSDOS*-like double-density disk operating system called DBLDOS™

We also offer a double-density Model I version of OS-80 as well as DOUBLEZAP programs for modifying NEWDOS/80 and VTOS 4.0 for DOUBLER compatibility.

Of course you don't have to upgrade your computer for double-density operation to use Percom mini-disk drive systems. In single-density operation, our TRS-80* Model I compatible 40-track drives store 102 Kbytes of formatted data on one side of a diskette, and our 80-track drives store 205 Kbytes. By comparison, Tandy's standard drive for the Model I stores just 86 Kbytes.

And like our Model III drives, Model I add-on drives are optionally available with "flippy" storage capability.

System Requirements:

Model III: 16-Kbyte system (min) and Model III BASIC. The second internal drive may be installed after the first internal drive is installed, and external drives #2, #3 and #4 may be added if either an internal or external first-drive kit has been installed. External drives #3 and #4 require an optional interconnecting cable.

Model I: 16-Kbyte system (min), Level II BASIC, Expansion Interface, disk operating system and an interconnecting cable. For double-density storage, a Percom DOUBLER™ adapter must be installed in the Expansion Interface and DBLDOS (comes with the DOUBLER) or other double-density DOS must be used. For single-density operation, a Percom SEPARATOR™ adapter, installed in the Expansion Interface, will virtually eliminate “CRC ERROR — TRACK LOCKED OUT” read errors.

Prices and specifications subject to change without notice.

*Trademark of Tandy Radio Shack Corporation which has no relationship to Percom Data Company.

†Trademark of Virtual Technology Corporation.
A simple algorithm
We work with the serious systems integrator... on terms that make sense to you. That means giving you a set of products which expand your limits, not reduce them.

We manufacture the most complete family of high quality IEEE/696 S-100 mainframes on the market. Choices include three mainframes in rack-mount or table-top packages with complete board sets, to serve as the building blocks for your 8 or 16 bit system. We also provide other options ranging from complete floppy disk systems right up to our proven Pascal development system.

The $\epsilon$ factor: one source.
No matter which option you choose, you get the benefit of working with completely integrated products... fully assembled and tested... under one warranty and one price structure... leaving you free to concentrate on value-added application development and sales.

Choose from mainframe options...
Select from three packaging options: Rack-mount, tabletop or front panel models. All three feature our 20 slot S-100 motherboard with 25 amp power supply and are delivered fully assembled and tested with our Series II board sets. Any board configuration you choose works with any DPS-1 version, allowing you to vary your package offering, or develop on one version and market another.

- Front Panel model — a powerful development and diagnostic tool for Z-80 systems, which can be used for prototyping, servicing, debugging, and software or hardware development. Use its features to set breakpoints, trigger scopes, single step, slow step and more.
- Front Panelless desk top model — a lower cost option for OEM or other turnkey operations which do not require the extra capability of our Front Panel.
- Rack Mount version — features a heavy gauge frame designed to fit into standard 19" racks. CVT power supply for brown out immunity is standard.

*In Calculus, a fundamental statement in the definition of limit; interpreted here to imply: "For your integration problem, Intersystems has a solution."
Board level options...

Intersystems mainframe packages, equipped with Series II boards, are operational in both 8 and 16 bit settings and support extended addressing in both I/O and memory space, recognizing 16 bit I/O addresses and 24 bit memory addresses. Just look at these individual features:

- MPU-80—uses a Z-80, 8 vectored interrupt lines and two 4K windows to address up to 1 Megabyte of RAM without bank select.
- MPU-8000 — available with the non-segmented Z-8002, which directly addresses 64K, or the segmented Z-8001, which can directly address 8 Megabytes.
- FDC II—can DMA up to a full track into 16 Megabytes of memory. Optionally generates interrupts and handles up to four 8" floppies.
- V/0 — has two serial ports; two 8-bit parallel output and two 8-bit parallel input ports plus 8 individually controllable command lines and 16 levels of vectored interrupts.
- FDC II—can DMA up to a full track into 16 Megabytes of memory. Optionally generates interrupts and handles up to four 8" floppies.
- MPU-8000 — available with the non-segmented Z-8002, which directly addresses 64K, or the segmented Z-8001, which can directly address 8 Megabytes.

Extended systems options...

Interfacing disk drives is not a trivial matter, so when your objectives and resources dictate you spend your energy elsewhere, use our resources to perform the service for you. We can add our disk drive package to any Z-80 or Z-8000 configuration we provide ... again, fully assembled and tested and covered under one warranty.

Or our complete Pascal Development System.

We use it for our own hardware and software development. It includes either table-top mainframe, two 8" floppy disks, 128K RAM, CP/M*, and Intersystems Pascal/Z™ compiler and Cache BIOS™. THIS SYSTEM IS FAST! Why? Because our ultra-fast Cache BIOS automatically buffers whole tracks, eliminating most disk accesses. This delivers up to three times the throughput of any other floppy-based system we know and is equal to many small hard disk systems.

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And it's reliable. The Cache BIOS System runs continuous memory tests when idle, and verifies with a Read after Write and Read after Read.

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**Editorial**

Now we have a chance to start with a clean slate. Software manufacturers are filling their 16-bit tabula rasas with offsprings of UNIX, an operating system developed at Bell Labs in 1969 by Kenneth Thompson and Dennis Ritchie. (See Robert Greenberg’s article, “The UNIX Operating System and the XENIX Standard Operating Environment,” page 248.) A software engineer was quoted in a recent issue of *Electronics* magazine (March 24, 1981, page 119) as saying that UNIX is “like sitting behind the wheel of a well-tuned sports car—when you press the gas, it goes, and when you hit the brakes, it stops. It’s the ultimate in responsiveness, and yet all the while you are riding in comfort.” UNIX deserves such accolades. Its hierarchical file structure lends much needed order to the chaotic approaches found in many personal computer operating systems; it is designed for truly efficient multiuser operation; the elegant idea of the pipe allows data to flow from program to program efficiently; and the shell program acts as a user-friendly interface to the rest of the operating system. An excellent example of UNIX’s versatility, described in Greenberg’s article, shows how the user can add a simple spelling correction program to a system, with just one line of code.

**New Programs**

Several software vendors have taken out licenses to adapt UNIX to 16-bit personal computer systems. These include Microsoft, Whitesmiths, Zilog, and Onyx, the developers of XENIX, Idris, Zeus, and Onix, respectively. Among non-UNIX-related 16-bit operating systems, OASIS, developed by Phase One Systems Inc, has received high marks from many professional programmers. And judging from its past track record with CP/M, Digital Research’s new CP/M-86 should also become a major factor in the market. (See “CP/M: A Family of 8- and 16-Bit Operating Systems,” by Gary Kildall, page 216.)

Despite the recent relaxation of UNIX licensing fee conditions by Western Electric, the UNIX offspring will not be cheap. Operating system software could sell for more than $2000. However, Lifeboat Associates’ version of XENIX will probably retail for less than $1000 by the end of the year.

The 8-bit computer is far from dead. There is too much good 8-bit software around for this to happen. And, for many applications, it’s hard to beat the price-performance ratio of the 8-bit machine—at least by today’s prices. Sixteen-bit and 8-bit machines will coexist for many years to come. I don’t believe in the “mutually exclusive” school of computer punditry. Just as no high-level language has ever supplanted another (can readers give me an example of this?), 8-, 16-, 32-, (etc) bit microcomputers will coexist in the future.

In our field, the future becomes the present overnight. You don’t need a crystal ball to state emphatically that we have not seen the end of the 8-bit versus 16-bit debate. But the new operating systems do add a welcomed layer of professionalism to personal computing.
SSM helps you get the most from your Apple II* computer. Choose from three general purpose interface boards. With flexibility and prices that translate to big savings. Now, and when you upgrade.

Serial (ASIO™). Our ASIO gives you a full-duplex RS-232 interface. Plus jumper-selectable rates from 110 to 9600 baud. You also get software control, three handshaking lines and two output plugs—so you can connect your Apple to a modem or to a terminal/printer without modifying the cable.

Parallel (APIO™). For parallel interfaces, our APIO offers two 8-bit bidirectional ports. We also include additional interrupt and handshaking lines, plus software control of the interface configuration and data direction. Cables for Centronics and other printers are optional.

Or Both (AIO™). Choose our tried and proven AIO when you need a sometimes-serial or a sometimes-parallel operation. This single-board solution packs a lot of performance for the price. Thousands are now being used. It even lets you operate both ways—simultaneously—under Pascal, or with special drivers.

All three boards feature powerful firmware so you don’t have to write software to use them. The ASIO and AIO include cables.

Whether you’re an OEM or end-user, we can supply virtually any quantity you need. Quickly. Even in kit form.

For the latest word on these, see your local computer dealer. Or call us today. You may also want to look into our cost-effective A488™ board which converts your Apple II into an IEEE-488 controller.

SSM Microcomputer Products, Inc., 2190 Paragon Drive, San Jose, CA 95131. (408) 946-7400. (TWX 910-338-2077. Telex 171171.)

*A488 is a trademark of SSM Microcomputer Products, Inc.
OSI Still In Personal-Computer Business

As a result of “Ohio Scientific Sold” (“BYTELINES,” March 1981 BYTE, page 246), we have had several telephone calls from dealers who were disturbed by BYTE’s report that “In all likelihood OSI will move away from personal computing and into the small-business market.” This statement is a false and damaging “projection.”

When Ohio Scientific was founded in 1975, our first products were designed for, and directed to, the personal-computer market. In 1977, when other small-computer manufacturers were entering the “fun and games” computer market, OSI introduced the Challenger C3B Business Systems, featuring a three-processor system with 74-megabyte Winchester hard-disk storage.

As a pioneer in small business-computer systems, we feel we moved into the small-business market some time ago. Our first business-system advertisements appeared in BYTE in 1978!

As for our personal-computer systems, now and for the future—in May 1980, we announced an enhanced version of our Challenger C1P and introduced our Challenger C1P Series 2. In total units and dollar volume, we are counting heavily on our personal-computer line to carry a full share of Ohio Scientific’s continued success.

W Paul Warren
Coordinator, Marketing Communications
Ohio Scientific
1333 S Chillicothe Rd
Aurora OH 44202

We are sorry for any misinterpretations of Sol Libes’s speculation on the future of OSI’s marketing strategy. We were not implying that OSI will drop its personal-computer line, but that we feel that there may be a shift in its marketing emphasis.

... MH

BYTELINES Makes Waves

I have always enjoyed reading Sol Libes’s “BYTELINES,” and consider him to be a good source of information on the personal-computer industry, except for one annoying trait. Because Mr Libes is professionally associated with products that use the S-100 bus, his information is strongly biased toward Intel and S-100 products. For example, I recently counted six issues in a row where he discussed UNIX-like software to be introduced for Intel and S-100 users. At no time did he mention that the Motorola/S-50 users have had UNIX-like systems available for some time. Certainly he has seen the advertisements in BYTE for UNIFLEX for the 6809 by TSC (Technical Systems Consultants). If Mr Libes hasn’t heard of the UNIX-like OS-9 by Microware, it is only because he looks at the world through S-100 blinders. Perhaps “BYTELINES” should be expanded to include associate editors who would supply information on other computer buses and the popular “no-bus” systems.

Leo Taylor
18 Ridge Ct W
West Haven CT 06516

Sol Libes Replies:

I am pleased that Leo Taylor enjoys reading my column and considers it “a good source of information.” There is no doubt that I have a bias toward S-100-based systems—I guess it’s my upbringing. I try to control it and present a balanced picture of the personal-computing field. I feel that I am successful 99% of the time, and that no one can be 100% unbiased.

When I wrote the UNIX items for “BYTELINES” during the spring and summer of 1980, TSC had not yet announced UNIFLEX, so I was not aware that it was coming. Additionally, nowhere in TSC’s advertisements is it specifically stated that UNIFLEX is “UNIX-like,” although the description sure sounds like it is.

The OS-9 operating system fell into the same category as UNIFLEX. Despite the fact that its advertisements refer to OS-9 as UNIX-like, a product review, in the December 1980 issue of 68 Micro Journal, stated that “the similarity to UNIX is mostly superficial.”
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Letters

Treasure on Disk

I enjoyed the reviews and comments on
the Adventure-like games in the December 1980 BYTE, especially Jerry Pournelle's "User's Column." (See "BASIC, Computer Languages, and Computer Adventures," page 222.) I would, however, like to point out for the benefit of BYTE's readers that the original version of Adventure ("The Colossal Cave") has been available from the Heath Users' Group for over two years, for a mere $10. This version comes on a 5-inch disk that runs on the Heath H-8 (with disk drive) or the H-89 computers. A minimum of 32 K bytes of memory is required, and the game plays very fast. Unlike other issues, Heath's version (written by Gordon Letwin before he left to join Microsoft) can be easily copied for backup and safe keeping—a distinct plus.

I'd also like to point out that while there are several maps and guides available to the Colossal Cave, none help that much. They may assist in reducing the search for treasures, but they won't help in avoiding some of the more subtle pitfalls, and certainly won't help in the Final Adventure.

D C Shoemaker
2000 A Foxridge
Blacksburg VA 24060

More GOTOS Changing

In David Carew's article "Change Your
GOTOS into FOR...NEXT Loops" (Janu-
ary 1981 BYTE, page 334), a better ap-
proach to the problem would have been
(if step 0 not allowed):

510 FOR I=1 TO 2
520 READ X
530 IF X=K THEN I=2
540 NEXT I

However, the best way, for systems that
allow it, is:

510 FOR I=0 TO -1 STEP -1
520 READ X
530 I=X=K
540 NEXT I

For the TRS-80 (and, I think, all Microsoft
BASICS), line 530 treats the second equals
sign as a logical operation, giving a -1
(true condition) if equal, and a 0 (false
condition) if not equal. Some BASICSs
have a different convention for true and
false (some represent true as 1 and false as
0) so the statement would be FOR I=0
TO 1. Another advantage of this form is
that it can be embedded in the middle of a
long line as follows:

500 .... : FOR I=0 TO -1 STEP -1
510 READ X : I=X=K : NEXT :....

Both of these examples are faster than
the published counterparts—always set-
ing I to 1 is faster than the test (even if
false), because there are fewer characters
to interpret, and the same goes for the
other example. Also, both of these ex-
amples use less memory for the program.

Carey Tyler Schug
POB 585
Chicago IL 60690

CMOS Is Boss

A few important points need to be
made in connection with Larry Malakoff's
article "Memory: Making an Intelligent
Decision." (See the February 1981 BYTE,
page 142.) Mr Malakoff generalizes that
dynamic memories are superior in the
areas of packing density, power consump-
tion, and cost. Unfortunately, he has
overlooked one of the most exciting
memory techniques currently available:
CMOS (complementary metal-oxide
semiconductor) static memories.

While we at Hitachi are active in the
dynamic memory business (especially the
4816-type 16 K by 1-bit and the 4864-type
64 K by 1-bit devices), we recognize that,
for many reasons, static memory is often
desirable. This approach is typified by our
CMOS 6116-type fully static 2 K by 8-bit
memory.

Responding to each of Mr Malakoff's
points:

Density: Using the 6116, a 64 K-byte
static memory board is not only feasible,
but Godbout Electronics will soon release
an S-100-compatible board, called RAM
17. The increased size of the 6116's
package (24 pins versus 16 pins for the
4116-type dynamic device) is easily offset
by the total lack of "tricky" refresh logic
required by dynamic memory.

Power Consumption: The 6116's power
requirements (operating and standby) are
equal to or less than most 16 K-bit
dynamic devices. The power supply to
Godbout's 64 K-byte static board is con-
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Letters

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A few other points:

- Compatibility: The 6116 is easy to interface and is fully compatible with all processors, DMA (direct memory access) controllers, front panels, etc. Boards like those mentioned in the article may not work with faster processors (eg: 6809, 8088) now available for the S-100 bus.
- Versatility: The 6116 is pin-compatible with the 2716 EPROM (erasable programmable read-only memory) and Hitachi's new 48016 EEPROM (electrically erasable PROM), and so the user can configure a board to contain the best combination of memory types for a given application.
- Speed: The 6116 is available for speeds rated as fast as 120 ns (more than fast enough for microprocessor applications). Godbout's board will work with Z80 microprocessors running at 6 MHz with no wait states. I do not believe that there is a dynamic board that can do the same.
- Design Simplicity: No "black art" transparent refresh or special circuitry (eg: DMA, Reset) is needed; consequently, the time and the cost of the design process have been reduced. (For systems with more than 64 K bytes of memory, the best solution is to adopt the IEEE 696 Extended Addressing Standard, not the cumbersome nonstandard bank-select scheme.)

As CMOS manufacturing processes continue to approach NMOS in density, cost, and performance, companies like Hitachi have the capability to bring their CMOS expertise to bear on applications like memory devices and peripheral controllers. As devices become more complex, and applications more demanding, CMOS technology will be required to overcome thermal dissipation problems.

Thomas Cantrell
Microprocessor Product Marketing
Hitachi America Inc
1800 Bering Dr
San Jose CA 95112

Table 1

<table>
<thead>
<tr>
<th>Rank (N)</th>
<th>Number of Elements in Table (2^N)</th>
<th>Williams's Algorithm</th>
<th>Modified Algorithm</th>
<th>Ordinary Lookup N2N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4 + 2(1) - 1 = 5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8 + 2(5) - 1 = 17</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>20</td>
<td>16 + 2(17) - 1 = 49</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>56</td>
<td>32 + 2(49) - 1 = 129</td>
<td>160</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td>144</td>
<td>64 + 2(129) - 1 = 321</td>
<td>384</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td>352</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 gave the heat value of various fuels, and as far as I can see, it's correct. Unfortunately, the heat values are theoretical maxima, and to compute cost savings you need to make allowances for inefficiencies in extracting that heat. In practice, efficiencies range from (essentially) 100% for electricity to 20% or less for a fireplace. (A small fire in a large fireplace on a cold night can actually run at negative efficiency—losing more heat up the chimney than it contributes to the house.) Efficiencies tend to vary with the quality of the heating hardware, and (I suspect) with whether they are measured in the laboratory or in a more conventional environment. In general, you would not be wrong to expect 100% for electricity; 60% to 70% for gas or oil heat; 40% to 50% for wood or coal stoves; and something pretty dismal for an unaugmented fireplace.

The conventional means of accounting for this are either to reevaluate the fuel's heat value by the efficiency, or to alter the equation C=Z^*Q/H to read C=Z^* Q*E/(100*H), where E is the efficiency in percent. In this case, I would modify the routine to use the latter method, because it lets you evaluate the effect of switching to a more efficient heat source.

Anyone seriously planning to tackle his or her home-heating problem should construct a paper-and-pencil thermodynamic model of his or her house. This is nowhere near as difficult as it sounds. Any public library has some books (mostly those dealing with solar heating) that can help.

Thermodynamic Flaws

Richard Hetherington's excellent "Programming Quickie" in the February 1981 BYTE contains one flaw that can cause the user of his routine to arrive at some misleading results. (See "Energy-Saving Cost/Benefit Analysis," page 266.)

Table 2 gave the heat value of various fuels, and as far as I can see, it's correct. Unfortunately, the heat values are theoretical maxima, and to compute cost savings you need to make allowances for inefficiencies in extracting that heat. In practice, efficiencies range from (essentially) 100% for electricity to 20% or less for a fireplace. (A small fire in a large fireplace on a cold night can actually run at negative efficiency—losing more heat up the chimney than it contributes to the house.) Efficiencies tend to vary with the quality of the heating hardware, and (I suspect) with whether they are measured in the laboratory or in a more conventional environment. In general, you would not be wrong to expect 100% for electricity; 60% to 70% for gas or oil heat; 40% to 50% for wood or coal stoves; and something pretty dismal for an unaugmented fireplace.

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Anyone seriously planning to tackle his or her home-heating problem should construct a paper-and-pencil thermodynamic model of his or her house. This is nowhere near as difficult as it sounds. Any public library has some books (mostly those dealing with solar heating) that can help.

Hand-Held Computer Algorithm Improvement

I read with interest Gregg Williams's description of the Panasonic and Quasar hand-held computers, especially the data-compression techniques. (See "The Panasonic and Quasar Hand-Held Computers," January 1981 BYTE, page 34.)

In figure 3, page 41, a permutation of four elements encoded with 6 bits (001010, by rows) is demonstrated. However, according to the text, the first box will always be unswitched. Since it is constant, the first box (or first bit) need not be stored explicitly. This leaves 5 bits instead of 6 to encode the permutation (01010 for the example). The recursive nature of the algorithm should compound the savings significantly for larger permutations. In table 1, I have reproduced Mr Williams's table 2 with an additional column.

Craig R Ewert
400 Raymondale #16
South Pasadena CA 91030

Gregg Williams Replies:

Your analysis of the requirements of the algorithm is completely correct, although this does not necessarily mean that even more space can be saved within the HHC (hand-held computer). I compiled the table of results you referred to based on a description of the algorithm, and I did not realize that the box in the upper-left corner did not need to be encoded. Although I was unable to contact the person who had written the code implementing the algorithm, your interpretation of the algorithm does, in fact, allow permutations to be stored with less memory. My thanks to you (and to Paul E Black, of Oquirrh City, Utah, who wrote a similar letter) for pointing this out.
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Mr Hetherington's routine is only as good as the data you put into it, and if you don't know how much heat you are putting into your house, and where it is going out, you may not recognize bad data when you use it.

Donald Kenney
291 S Main St
Andover MA 01810

Computers Can Help People

I read Mark Dahmke's editorial and would like to share with BYTE readers an interest of mine. (See “Computer Speech: An Update,” February 1981 BYTE, page 6.)

I'm an academic adviser at Michigan State University and work with students in the Lower Division. Among our many academic services, we try to assist students in selecting majors that will help them attain their individual goals in life. I have very realistic concern and at the same time very optimistic hope for one student in particular.

Kelly Watson is a quadriplegic and has a combination of athetoid and spastic cerebral palsy. She is a delightful young lady—bright, pretty, and her sparkling sense of humor helps her overcome frustration. Kelly, although just 20, became a sophomore at the end of this winter term. She has gotten this far in her academic career out of sheer determination, and I'm sure someday she will be the newspaper editor she plans to become.

Kelly uses a joystick-operated electric wheelchair and types with a headstick on an IBM electric typewriter. MSU's Artificial Language Laboratory hopes to be able to provide her with a word-processing system. With financial assistance from concerned communities, technologists such as Mark Dahmke and John Eulenberg will soon be able to make accessible to persons such as Bill Rush and Kelly Watson those opportunities we all enjoy. I foresee a great advancement in human concern.

Jane E Linnell
Michigan State University
Undergraduate University Division
Student Academic Affairs Office
East Lansing MI 48824

Simpler Starting Solution

Although Randy Soderstrom's approach to the problem of forcing the Z80 starting address was interesting, it is not the simplest solution. (See "Forcing the Z80 Starting Address," February 1981 BYTE, page 288.) His suggestion requires four integrated circuits, and an initial time delay is introduced. The circuit in figure 1 uses only two devices.

Upon reset of the system, the D flip-flop (IC1) is clocked, causing Q to go high. Although the processor's address bus and program counter contain all 0s, the memory addressed is hexadecimal F000. The 74LS32 quad OR gate (IC2) accomplishes this with one input per gate high. The system monitor can be stored at hexadecimal address F000 and can now handle its high-priority housekeeping without worrying about the address. A JP (jump immediate) to the next instruction will set the program counter correctly. The first OUT or IN instruction will activate the IORQ (input/output request), and then preset the D flip-flop, allowing signals on the address bus to pass freely through the 74LS32, and restoring the system to normal operation. As in Randy's circuit, there is no interference with memory refresh.

This technique is used on MOSTEK's STD Bus-based CPU-1 card. We feel this is the best and most economical approach to take.

Mitchell A Russo
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Letters

BASIC Problems

Samuel Bates's "Rotation Algorithm" was fascinating but frustrating for two reasons. (See the January 1981 BYTE, page 328.) First, there are many terms used from Hewlett-Packard's HP 3000 BASIC that are not common to other versions of BASIC. I can figure out what MAT R=ZER does (it puts 0 in every element of the array R) and duplicate it with a subroutine, and I can determine from context that # means <> (not equal). However, I'm stymied by FILES*, ASSIGN, ENTER, and READ#1,1. Please, BYTE, return to the old policy of inserting a box with explanations of uncommon terms! A flowchart would have been useful, too.

"Whose BASIC Does What?" by Teri Li was also welcome. (See the January 1981 BYTE, page 318.) I hope its idea will be extended both to cover more computers and to be more complete in terms. I hope that BYTE will eventually publish it as a separate reference booklet. There were, however, some errors in the article.

For the Commodore PET, the major errors of significance are:

HOME and CLS should be checked.
COLOR=n, FRE(x$), SPC(expr), and RANDOMIZE should not be checked.
CALL address should have SYS entered.
TI(expr) should be T1 or T1= expr.
TI$, a different real-time clock function, should be listed.

I don't need to say that BYTE is the best (I read six other journals regularly as well), so I'll just say "thanks and keep it up."

Frank Chambers
Rock House
Ballyoroy, Westport
County Mayo, Ireland

The Hewlett-Packard 3000 is correctly classified as a minicomputer, so only a small percentage of our readers will have access to a system similar to the one used by Mr. Bates. The BASIC statements that may be unfamiliar are defined in table 2. ■

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[Diagram and list of modules]
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All operating systems are available in either floppy or hard disk configurations. The disk drive selection includes single or double sided, double density 8-inch floppies with up to 2.52 megabytes of formatted storage per system, expandable to 5.04 megabytes, and an 8-inch 10 megabyte winchester hard disk.

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RAMCRAM
Memory Module for the Atari

Mark Pelczarski
1206 Kings Circle
West Chicago IL 60185

Axlon Inc has released an alternative for add-on memory for the Atari computers that might save some money for Atari 800 owners. RAMCRAM will also offer more memory for the Atari 400 than you may have thought possible.

For $320 you can buy a single module that contains 32 K bytes of programmable memory. The unit plugs into the middle memory slot of an Atari 800, and with the 16 K-byte module provided with your system, gives a full 48 K bytes of memory (it will not work with only an 8 K-byte module ahead of it).

In an Atari 400, the module can replace the built-in 8 K bytes of memory to give a 32 K-byte system. The Atari 400 would then be able to use any software for Atari 800 32 K-byte systems, plus it would contain enough memory to handle a DOS (disk operating system) and, therefore, a floppy-disk drive. With RAMCRAM, Personal Software's 17 K-byte VisiCalc will run on the Atari 400.

In an Atari 800, the top 8 K bytes of memory-address space are preempted if you have a cartridge in the left slot, such as BASIC, the Editor/Assembler, or Star Raiders. With a left cartridge installed you can use only 40 K bytes. Without a cartridge, but with RAMCRAM installed, you have 48 K bytes of memory which can be used for copying disks faster on a one-drive system. (DOS does not require a cartridge, and more programmable memory means swapping disks fewer times while copying.) You also have 48 K bytes for machine-language programs that do not need cartridges, such as VisiCalc, and languages could be loaded from disk without using cartridges.

Axlon also provides its dealers with a memory-diagnostic program that will analyze the memory of an Atari
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*Model VP-3303 with built-in RF modulator—$389.
*Suggested user price. Monitor and modem not included.

800, checking that the full 48 K bytes are functional. It performs three tests: the first tries to zero every bit in memory, the second checks for memory uniqueness by turning on bits and testing whether other bits were affected, and the third rolls a 1 bit through each location, checking that every bit can be turned on. The diagnostic program is available to customers for $15.

If you own an Atari computer and you’re the type of person that thinks ahead more than a year, it seems as though RAMCRAM is the way to go for memory expansion. If you own an Atari 400, it gives you memory that you couldn’t get otherwise. If you own an Atari 800, it gives you all the memory it can now hold and leaves one expansion slot open for future use. Given Axion’s plans for additional Atari-compatible products, that slot may be valuable.

** At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>RAMCRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Increases programmable-memory capacity of Atari computers</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Axion Inc 170 Wolfe Rd Sunnyvale CA 94086 (408) 730-0216</td>
</tr>
<tr>
<td>Dimensions</td>
<td>7.5 by 15.5 by 1.5 cm (3 by 6 by 5/8 inches)</td>
</tr>
<tr>
<td>Price</td>
<td>$320</td>
</tr>
<tr>
<td>Features</td>
<td>Expands Atari 800 to 48 K bytes, replaces existing memory in Atari 400 to give a total of 32 K bytes</td>
</tr>
<tr>
<td>Hardware needed</td>
<td>Atari 800 computer with 16 K bytes of programmable memory, or any Atari 400 computer</td>
</tr>
</tbody>
</table>

Circle 368 on inquiry card.
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Circle 291 on inquiry card.
LISP vs FORTRAN
A Fantasy

Laurie Rocheleau
C/o David Clay
Florida Institute of Technology
Melbourne FL 32901

Editor’s Note: David Clay, an instructor of computer science at the Florida Institute of Technology, sent us an interesting short story written by one of his students. In his cover letter, he wrote:

"I assigned a short term paper recently on the comparison of two programming languages, LISP and FORTRAN. Most papers were written in an expected style, outline of topics, and format—until I came to Laurie Rocheleau’s. I was surprised, entertained, and impressed. After reading it, I felt that others might find it a novel approach to a somewhat mundane academic chore—writing term papers.”

We, too, were surprised, entertained, and impressed, so we decided to publish this short story/term paper. We also want to thank Clay for rewarding such creativity: the cover letter of Rocheleau’s paper is marked “A+.”

As they wheeled her into the room her hopes began to fade. She had been praying that this place would be different from all the others. The last room had been so cold. Not only in temperature; no one had even attempted a conversation the entire eight months she had been there. This new room seemed to be a copy of the last, and all the others she had been in. They placed her in a corner, and after plugging in all of her tubes and wires, they left. It was terribly quiet and dark.

Suddenly she began to receive something from someone across the room. She was absolutely ecstatic. Someone was trying to communicate with her. The language was a bit strange, it was some form of output statement:

PRINT*, What is your name?"

It was sort of hard to understand yet they were characters, her specialty, and after a bit of interpretation, she decided upon a method of replying. She had no PRINT statement in her memory, but she did have a trick up her circuit board. She sent her interpreter the instruction:

(CONS(’My name is LISP. What is yours?”))

As the other received her message, she could almost sense a chuckle. Soon she received his reply:

PRINT*, My name is FORTRAN. Why must you com-
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municate in such a strange way? Don't you have input and output commands?

She felt a bit embarrassed, yet she knew that she had many advantages over this FORTRAN fellow. She replied:

(CONS('No, I don't have input or output commands. I have to use this CONS instruction with quotes to get something printed out. And I have other instructions to use as input instructions.))

His reply upset her greatly:

PRINT*, 'Ha, how cumbersome. I bet you can't even handle a simple addition without some complicated function call. Well anyway, I'll grace you with a little knowledge about myself. I was one of the world's first high-level programming languages. And today I am probably the most widely used language for programming of scientific and engineering computations.'

She sat for a few nanoseconds, organizing her cut-down:

(CONS('All right, blowhard, listen to this; I and my various dialects are the primary languages in at least two areas of computer science: symbolic computation and artificial intelligence, which are concerned with programs that perform tasks that humans say require intelligence. Has anyone ever said you have intelligence? I bet not!)))

PRINT*, 'Intelligent! How can you even consider yourself intelligent if you can't deal with numbers. I mean numbers make the world go around. Look, even your insides are numbers—all zeros and ones, and you don't even understand them. I bet you can't deal with decimals, or even take the square root of a number—real or integer. You're useless.'

Quickly she replied:

(CONS('No, I can't take the square root of a number, but I can do quite a bit with numbers. Just take a look at this, these are some more of my functions:

(PLUS X1, ... , Xn) = X1 + ... + Xn
(DIFFERENCE X Y) = X - Y
(MINUS X) = -X
(TIMES X1, ... , Xn) = X1 * ... * Xn
(ADD1 X) = X + 1
(SUB1 X) = X - 1
(QUOTIENT X Y) = X/Y
(LESSP X Y) = T if X < Y else NIL
(GREATERP X Y) = T if X > Y else NIL
(ZEROP X) = T if X = 0 else NIL
(NUMBERP X) = T if X is a number else NIL
(LENGTH X) = Length of list X

They may not be as simple to understand as your method of manipulating numbers, but remember this: numbers are just a minor part of my abilities. Why, unlike you, I can even distinguish between a character and a number with my NUMBER function.

I realize that you are very graceful when it comes to dealing with numbers, but when it comes to character manipulation, a programmer would be crazy to use you. With me, the programmer can easily deal with characters and do a little with numbers if need be. You see, I'm not quite so one-sided as you are.)))

PRINT*, 'OK Miss LISP, how about subroutines? They're simple. All I have to do after the END statement (I do hope you understand everything so far) is execute the main body of the subroutine and when the execution is finished, a RETURN statement returns control to the statement following the CALL statement in the calling program. The parameters in the parameter list are reference parameters, using the chainning, the copying, or the value/result method. Why, my subroutines can even call other subroutines if they want to. ... I'm waiting for your response!'

(CONS('I love the way you quickly changed the subject—away from letters and numbers. But, OK, here's my response: I will add to my argument of input and output while describing my "subroutines," which I call Procedures. I don't need explicit input and output statements

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Technical Forum

because “data” is provided in the form of arguments in procedure calls and because the value produced by a procedure called at the top level is automatically output by my interpreter.

I have taken a good look at your basic structure—Blah! At my top level, your main program, I have no need for variable declaration, assignments, loops, tests, etc. This is so because usually the first environment where such things are meaningful is the environment established by a procedure called from my top level.

To show you how I “call” a procedure, I must first say that nearly all of my commands are procedure-related. And all of my procedures return a value—thus, they are function procedures.

First I define a procedure, then I call it—just the opposite of your goofy subroutines. To define a procedure, I merely say:

LISP PROCEDURE Name(parameters list)

Body

where the body is much like the body of your subroutines. It is simply instructions to perform the task of the procedure. Some of the instructions can even be Procedures themselves.

As far as calling goes, I don’t even have to say Call. All I have to do is write the name of the procedure along with its parameter list, for in essence my procedures are functions.

Name(parameters list)

This is all that is needed. The parameters are usually values. But I can pass arguments in the unevaluated form—Name Parameters. And my procedures can call themselves: this is called recursion, the all-important function that you can’t even handle. You’re nothing but an old man that’s constantly being updated. They’ll soon phase you out. No recursion—ha ha!)

PRINT*,‘OK, so I am old, but you ain’t no spring chicken yourself. I have been doing a bit of research while you were babbling. We were both invented in the late ’50s. So don’t talk to me about old.

Oh, and there’s one little thing you left out—how about Global Variables? You don’t even have such a thing. Why, when I call a subroutine, I can have a COMMON statement in both the calling and the called routines, in which there are variables which are global to the called routine. They can be changed if need be by the called routine, or they can just be used in evaluations. These changes, if any, affect the values in the calling routine. Why, I can even name my common statements, like this:

COMMON / Name / variables

This way, different subroutines can have different globals with their calling routines. Can you top that????

(CONS!’(I sure can . . .)))

Suddenly the lights came on. The humans were back. Oh well, their talk would have to wait. Maybe this place wouldn’t be so bad after all.
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The imminent release of not one but two versions of the Logo language for personal computers may be one of the most exciting software developments of the year.

The Logo programming language was developed at the Artificial Intelligence Laboratory at MIT (Massachusetts Institute of Technology). According to the Logo Project's originator and driving force, MIT Professor Seymour Papert, "Logo is the name of a philosophy of education in a growing family of computer languages...."

In the same passage, Professor Papert is quick to point out that Logo is not merely a children's language, although since its development over twelve years ago it has always been intended to facilitate discovery learning by young children. In fact, it represents a kind of "Copernican revolution." Rather than the child being programmed by the computer (as with computer-aided instruction), the child learns by teaching the computer—and has a good deal of fun in the process. In the past, this has been the overriding purpose of the Logo Project. However, Professor Papert states: "An example of a powerful use of list structure is the representation of Logo procedures themselves as lists of lists so that Logo procedures can construct, modify, and run other Logo procedures." (Mindstorms: Children, Computers and Powerful Ideas. New York: Basic Books Inc, 1980, page 217.)

Apple Logo and TI Logo are the first versions of this language that are intended for use with personal computers. TI Logo was developed for the Texas Instruments 99/4 computer, while Apple Logo runs on the Apple II or Apple II Plus computer. Each is a descendant of earlier implementations written in LISP and Pascal for larger computers, and this heritage is evident in both versions of the language.

**TI Logo**

The first "draft" of Logo for the TI 99/4 was prepared by the Logo Project at MIT. Texas Instruments modified this draft according to its priorities and has done some impressive code compression in order to increase available memory for the production version of TI Logo.

**Hardware for TI Logo**

In addition to the TI 99/4 computer and a color monitor, memory expansion (from 16 K bytes up to 48 K bytes) and the language in EPROM (erasable programmable read-only memory) are the only requirements for running the prototype of TI Logo. In the prototype, both memory expansion and the language are contained in an actual black box (see photo 1, inset).

TI Logo has two production versions. The currently available version requires a disk controller, a 5-inch floppy-disk drive, a 32 K-byte memory expansion unit, and a TI Logo command module or ROM (read-only memory) cartridge. The second version, scheduled for release later this year, will require only the memory expansion unit and the command module (see photo 1).

**Features**

TI Logo can perform arithmetic operations on integers from $-32,768$ thru $32,767$, and can generate random integers from 0 thru 9, perform basic logical operations, and evaluate logical relationships. It can also assign numerical values to words (values to variables), assign names to numbers (so that something can be called by name instead of number), and it has functions for structuring and modifying lists. In addition, there is a fine program editor for writing and modifying procedures (Logo programs).

Other Logo features in Texas In-
Instruments' version include powerful yet easy-to-use graphics capabilities that employ a turtle for drawing and thirty sprites for creating dynamic displays.

The Turtle

One of the best-known features of Logo is turtle graphics, or the line-drawing turtle—a small triangle on the video display (see photos 2 and 3). A variety of simple instructions move the turtle, tell it to face a certain direction, move it a given distance, and instruct it to draw, not draw, or erase a line.

Early MIT versions of Logo actually controlled a floor robot that resembled a turtle. This floor turtle had a pen that could be raised or lowered for tracing the path that the turtle was instructed to follow. Originally, the state of the art made use of a mechanical robot easier than computer graphics. When young children were involved, the floor turtle also seemed to facilitate the transition to using the screen turtle. (The significance of turtle graphics has been recognized outside MIT for some time. For example, a subset of Logo called Turtletalk, has been included in the Smalltalk language designed by Alan Kay for Xerox. Turtlegenetics is also a program in the library of the Apple version of Pascal.)

TI Logo has a screen turtle that can be controlled by simple primitive instructions (see text box on turtle primitives). These primitives can be used for immediate turtle instructions or to create procedures (sequential lists of instructions) which define new instructions.

An important feature of TI Logo is that while all primitives can be spelled out in full, many can be abbreviated to two-letter instructions (eg: CS can be used anywhere in place of CLEARSCREEN). Such abbreviations can make Logo more accessible to such nontypists as the very young or the handicapped.

Sprites

The inclusion of thirty sprites and
dynamic sprite graphics is unique to TI Logo. As shown in photos 4 and 5a, sprites are TI Logo “beings” (software constructs) that assume various shapes and colors and move in a number of directions at different speeds. (See also listing 1.) Of themselves, sprites possess none of these “physical” characteristics—these must be given to them, once again, by use of simple primitives (see text box on sprite primitives).

Sprites can assume (carry) any one of twenty-eight possible shapes. The first six shapes (turtle, truck, plane, rocket, ball, and box) are predefined in TI Logo (see photo 6). The remaining twenty-two shapes must be user-defined.

A new shape can be created, or an existing one modified (you can change the six predefined shapes), by calling a 16 by 16 square MAKE-SHAPE grid (see photo 5b) and blacking out the desired shape. Each square of the grid represents one pixel (picture element) on the video display. The shape is formed (blacked out) by moving the cursor from square to square within the grid. Once a shape has been defined, any or all of the sprites can carry that shape.

(Displaying sprites seems to be a major capability of Texas Instruments' TMS9918A Video Display Processor. TI has released the TMS9918A, and the unit is beginning to appear in products from independent manufacturers. See “Video Display Processor Simulates Three Dimensions,” by Karl Guttag and John Hayn, Electronics, November 20, 1980, page 123.)

Characters

TI Logo also allows you to define (or redefine) alphanumeric characters and static designs by using any of the 256 8 by 8 square grids, called tiles. Letters, numbers, and other keyboard characters are predefined tiles, but they can be changed. If the predefined keyboard characters are modified (eg: made lowercase), the modified character appears when the appropriate key is typed.

New characters or designs can be defined and placed anywhere on the display screen (see photo 5c). While tiles can be located anywhere on the screen, they cannot move about as
can shapes that are carried by sprites. You can assign colors to tiles and use them in either the turtle or sprite modes to form titles, explanations, or parts of “pictures.”

Procedures

Procedures can be considered as either Logo programs or definitions of words that, once defined, can be used like primitives. Procedures are lists of instructions made of primitives and/or the names of previously defined procedures (see photos 7a and 7b, and listings 1, 2, and 3). Resident or defined shapes, colors, and movements can be assigned to sprites in procedures. The turtle can be instructed to draw figures by simply entering the name of a procedure.

It is often easier to define procedures, whether they contain instructions for the turtle, the sprites, or nongraphic operations, rather than enter the individual instructions needed to carry out such tasks. One reason is that several sophisticated programming techniques become quite simple in Logo. It’s possible to nest level upon level of procedures by having one procedure call another which, in turn, can call another, and so on. A nested procedure is called by entering its name as an instruction in the procedure being written. Iteration is accomplished by merely having the procedure repeat a list of instructions a certain number of times. Recursion
Photo 5: The shapes and characters used in the FISHBOWL (photo 5a) were specifically defined (see listing 1 for the procedures). Shapes are defined by blacking out the desired shape on a 16 by 16 square grid (photo 5b). Characters are similarly defined on an 8 by 8 grid (photo 5c).

is a simple matter of using the name of the procedure being defined as an instruction in that procedure—the procedure then calls itself from within itself.

It is also possible to construct a procedure so that it modifies itself. This can be done by having the procedure change the values of local variables and/or by having it define new, or modify already-nested procedures. This type of recursion causes the procedure to produce a different effect at each recursive level—the procedure performs its task, changes itself, performs its modified task, etc. Listing 2 demonstrates how these powerful concepts and techniques become virtual child's play with Logo.

In addition to the ease of writing procedures and all that can be learned in the process, there is another advantage to working with procedures rather than immediate instructions. After entering all of the individual instructions for the turtle or sprites, it would then be necessary to enter the entire sequence each time that activity was to be performed. If the instructions are included in a procedure, it's simply a matter of entering the procedure's name to have the activity performed. In addition, procedures, along with user-defined shapes and characters, can be saved for future recall. In the TI Logo prototype this is done on cassette. In the production versions it will be possible to do this on disk—a preferable method with regard to both speed and reliability. The production versions of TI Logo have hard-copy capability via a thermal printer. In some settings this can be extremely useful.

Listing 1: The FISHBOWL procedure turns the video display into a simulated aquarium (see photo 5a) with fish swimming in various directions and bubbles rising to the surface. FISHBOWL first calls TITLE, which places the tiles (see photo 5c) containing the specially designed letters of “Fish Bowl” at the center bottom of the display. The FISHBOWL procedure then tells the background (BG) to set its color (SC) to dark blue (4), and calls the procedures FISHRIGHT, FISHLEFT, BUBBLES, and SHARK. These four procedures assign shapes, colors, and motion to various sprites. For example, FISHLEFT tells three sprites (4, 5, and 6) to carry the shape (7) of a fish swimming to the left (see photo 5b), and sets different colors, headings (SH), and speeds (SS) for each sprite. In BUBBLES, the SETX primitive is used to horizontally fix the two columns of bubbles. The numbers input are the x coordinates of the desired columns.

The Editor

TI Logo has a full-screen, real-time edit mode that is extremely helpful for writing, modifying, and debugging procedures. While in the edit mode, the cursor can be moved anywhere in the displayed text to

TO FISHBOWL
TITLE
TELL BG SC 4
FISHRIGHT
FISHLEFT
BUBBLES
SHARK
END

TO TITLE
CS
PUTTILE 12 20 100
PUTTILE 13 20 101
PUTTILE 14 20 102
PUTTILE 15 20 103
PUTTILE 16 20 104
PUTTILE 17 20 105
END

TO FISHRIGHT
TELL [1 2 3] CARRY 6
TELL 1 SC :RED SH 95 SS 20
TELL 2 SC 8 SH 75 SS 18
TELL 3 SC :YELLOW SH 105 SS 16
END

TO FISHLEFT
TELL [4 5 6] CARRY 7
TELL 4 SC :ORANGE SH 273 SS 19
TELL 5 SC :GREEN SH 265 SS 21
TELL 6 SC :LEMON SH 279 SS 17
END

TO BUBBLES
TELL [7 8 9] CARRY 8
EACH [SC :WHITE SETX -50]
EACH [SH 0 SS 3*YN]
TELL [10 11 12 13] CARRY 8
EACH [SC :WHITE SETX 70]
EACH [SH 0 SS 2*YN]
END

TO SHARK
TELL 14 CARRY 10
SC :GRAY SH 271 SS 40
END

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Turtle Primitives

The basic turtle primitives are virtually identical in TI and Apple Logo. Differences are noted in parentheses, as are acceptable abbreviations. All primitives can be fully spelled out and most can be entered as two-letter abbreviations.

The turtle mode is entered by the instruction TELL TURTLE (DRAW in Apple Logo). This places the triangular-shaped turtle at the center of the “drawing pad.” In TI Logo this position is the origin of a coordinate system whose horizontal (x) axis goes from -128 to 128, whose vertical (y) axis ranges from -96 to 96.

There are four text lines under the pad for entering instructions and receiving messages. The Apple version is almost the same in the split-screen turtle mode (actually the horizontal axis goes from -140 to 138). This is normal turtle mode. Apple Logo, however, also offers a full-screen turtle mode that allows the turtle to draw on the entire pad but eliminates the text lines (see photos 9 and 10a).

Both versions employ the following instructions for moving the turtle:

- **FORWARD (FD) number**  { The number represents the number of turtle steps that the turtle is to move.
- **BACK (BK) number**
- **RIGHT (RT) angle**  { The angle represents the angle, in degrees, that the turtle is to turn.
- **LEFT (LT) angle**

It is possible to move the turtle anywhere on the drawing pad and trace virtually any shape with these instructions.

More interesting figures can be obtained by having the turtle draw only part of the time. The following commands, in both versions, control the turtle’s pen:

- **PENDOWN (PD):** Causes the pen to leave a trace of the turtle’s path (the pen is down when the turtle mode is entered).
- **PENUP (PU):** Allows the turtle to move about without leaving a trace.
- **PENERASE:** Causes the turtle to erase a line it has drawn if the original path is retraced.
- **PENREVERSE:** Instructs the turtle to draw lines where there are none and erase lines where they are present.

**HOME** sends the turtle back to the center of the drawing pad. **CLEARSCREEN (CS) in TI** Logo erases all drawing and text and returns the turtle to the home position. **DRAW** does almost the same thing in Apple Logo but it does not erase text.

In order to exit the turtle mode, enter the instruction NOTURTLE (NODRAW in Apple Logo). This will return you to the Logo monitor.

Limiting Features

The video hardware of the TI 99/4 does not allow more than four sprites carrying shapes to be displayed on a horizontal row at one time (see photos 8a and 8b). If a fifth sprite is placed on the same row, the first one disappears, and so on. The process is reversible, so as soon as the newcomers move on, the original residents begin to reappear. Once you are aware of this problem, you can work around it.

An annoying occurrence in TI Logo is that the turtle sometimes runs out change, delete, or insert characters, words, or entire lines. It’s also possible to move lines up or down and merge them with other lines.

The editor in the production version of TI Logo is automatically activated for writing procedures. (The prototype does not have this feature.) Several features can be written in the edit mode and all of them entered into memory by exiting the edit mode. One advantage to writing procedures in the edit mode is the ease with which you can change and correct the procedure as it is being written.

You can also use the editor’s capabilities as a basic text editor. This is an important feature, since learning to write with a text editor relieves the tedium of making pencil-and-paper corrections and revisions.
These photos illustrate a slight problem caused by the TI 99/4's video hardware when running Logo. As long as there are no more than four shapes in a horizontal row, there is no difficulty (photo Ba), but as soon as a fifth shape is moved onto a row (the black square in photo Bb), the first shape in that row disappears (the red square that was at the center in photo Ba is gone in photo Bb). The first shape reappears when the fifth shape is moved to another row, so there can never be more than four visible shapes in a row at one time.

Apple Logo

At present, the 5-inch disk version of Logo for the Apple II and Apple II Plus computers is still under development at MIT. (For convenience, we refer to this version as "Apple Logo," as does the Logo Project staff. To our knowledge there is no connection with Apple Computer Inc.) Representatives of MIT and the National Science Foundation, which funded portions of the Logo Project, are involved in discussions concerning distribution rights for Apple Logo. This issue should be resolved soon, and Apple Logo will, it is hoped, be available this summer.

This review is based on a preproduction prototype, and in fact, an updated prototype that will include color is being completed. This feature will allow you to choose the color of the display background and the lines drawn by the turtle.

Apple Logo has three modes: a nongraphics mode, a graphics (turtle) mode, and an edit mode—but no sprites. However, the Apple version does have much more power in the other modes than TI Logo.

Hardware for Apple Logo

An Apple II or Apple II Plus computer with 48 K bytes of memory, one disk drive, and an Apple Language Card are all that is needed to run the Apple version of Logo.

Nongraphic Features

Apple Logo can handle floating-point as well as integer arithmetic. It also accepts and outputs numbers (when large or small enough), in exponential notation. For example, 2.7E3 can be used in place of 2.7X10^3 = 2700, and -4.3N4 can

of lines. At this point, the turtle stops in its tracks, the procedure halts, and the following message is printed:

NO MORE LINES

Apparently, workspace allocations have to accommodate both sprite and turtle graphics modes. Some tradeoff was necessary, and this message appears to inform you that the workspace (memory) allocated for graphics in the turtle mode has been used up.

Sprite Primitives

Some of the primitives used to instruct the sprites (available only in TI Logo) are as follows:

TELL sprite number(s): Gets the attention of the sprite(s) that you wish to address. You can address one or any combination of sprites from 0 thru 29. To talk to all thirty sprites, the phrase :ALL (read "dots ALL" in Logo jargon) is used in place of a number.

CARRY shape: Tells the sprite(s) which shape to assume. Shapes can be identified either by name or number.

SETCOLOR (SC) color: Identifies, either by name or number, the color of the shape being carried.

SETHEADING (SH) number: Gives the sprite(s) the direction to travel. The number entered corresponds to a compass heading.

SETSPEED (SS) number: Tells the sprite(s) how fast to move.

The displays produced with these five instructions can be amazing, especially when multiple instructions are combined in procedures. A few other primitives can also be used in interesting ways. HOME causes all active sprites to go to the center of the display screen but, if they have headings and speed, only momentarily. FREEZE stops all active sprites and holds them in place. They will not resume movement until THAW is entered.

Sprites will also respond to the FORWARD (FD), BACK (BK), RIGHT (RT), and LEFT (LT) primitives as used in the turtle mode.
replace \(-4.3 \times 10^{-4} = -0.0043\).

Apple Logo can also return the sine and cosine of an input in degrees. This means, in effect, that it has full trigonometric capability. The other trigonometric functions can be easily defined in terms of the sine and cosine. Apple Logo can return a random integer in the range of 0 to \(n - 1\), where \(n\) is an integer input by the user. There is, in addition, a randomizing feature to ensure that each sequence of random numbers will be unique.

Apple Logo has features for evaluating logical relationships, assigning values to variables, words to numbers, and working with list structures. The Apple version of Logo also has provisions for going from Logo to the Apple monitor, calling machine-language subroutines, and determining the current amount of free workspace in Logo. (Texas Instruments omitted similar features in order to save memory space.) And it's worth pointing out that the primitives that instruct the turtle are similar in both the Apple and the TI versions of Logo.

**Turtle Procedures**

The draft of the Apple Logo manual, by MIT Professor Harold Abelson, contains over twenty-five pages of turtle geometry projects of rapidly increasing complexity (see photos 9, 10a, and 10b). This manual also contains some interesting discussions of recursion—in fact, the author suggests a level of recursion that can be used to have the turtle draw a "binary tree" (see listing 3).

The additional mathematical capabilities of Apple Logo, as compared with the TI version, can be used to increase the power of turtle procedures, even though these mathematical features are not graphics features per se. That is, the floating-point, trigonometric, and randomizing features can be employed to give straightforward instructions to the turtle that will result in figures otherwise difficult, if not impossible, to produce.

**The Editor**

The Apple Logo editor functions in essentially the same manner as the production-version TI Logo editor. As soon as you begin to write a procedure, you're automatically in the edit mode. Therefore, all of the editor's features are available whenever procedures are being written. It is also possible, as with TI Logo, to employ these features as a text editor.

There is, however, one confus- ing sidelight. The command to abort a procedure (rub out what has just been written and exit the edit mode) in Apple Logo is very nearly the same command used in TI Logo to enter the procedure into memory and exit the editor. This could cause considerable confusion if you work with both versions side by side.

**An Annoying Feature**

If the turtle tries to draw beyond the drawing pad in the turtle mode of Apple Logo, everything stops and you are told that the turtle just went OUT OF BOUNDS. If you are in the process of modifying a procedure to fit onto the pad, this is quite a nuisance. In the TI version, if the turtle leaves his pad he simply wraps around the display, and the procedure continues to execute. This approach seems preferable, because you can visualize the final product. (In the large-machine versions of Logo you can choose between wrapping and not wrapping—an ideal arrangement.)

**Conclusions**

Both personal computer versions of Logo are exciting, valuable products. Seymour Papert has said on more than one occasion that Logo provides easy access to very powerful ideas, but the question remained—would this be true of Logo designed for small personal computers? The answer, relative to both versions, is clearly affirmative, whether the user is a young child, a physically handicapped individual, or an adult who discovers computing for the first time.

It's difficult to find anything to criticize in either product. Given their common background of over ten years of development and testing in the Logo Project at MIT, such a situation is not hard to understand. Still, a few items in each version might have been handled differently.

One such example occurs when you attempt to use the Apple and TI Logo nongraphics instructions in the immediate mode. These functions do not simply return a value. For example, in TI Logo:

\[3 + 4\]

returns:

**TELL ME WHAT TO DO WITH 7**

It will not return just the value 7. Similarly, in Apple Logo:

\[\text{SIN 30}\]
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returns:

YOU DON'T SAY WHAT TO DO WITH .5

The reason for this, apparently, is that these functions are intended for use in instructions in procedures where the value returned will be used for a variable. It would be useful, however, if these functions could be used immediately, and if they returned only the appropriate values: they could then be used more easily for mathematical or logical evaluations, either in planning procedures or for other purposes.

If you type PRINT in front of the statement to be evaluated, only the value is returned. For example:

```
PRINT 3 + 4
```

will return only the value 7. Still, it would be useful to obtain this kind of return without typing PRINT, especially when you are not “talking” to sprites or the turtle.

Another inconvenience occurs in TI Logo when you have active sprites on the screen and want to go to the turtle mode. There is no easy way to get the active sprites off the video display. While you can go from the turtle mode to the sprite mode and remove the turtle with everything it has drawn (by entering NOTURTLE), the reverse is not possible. You can leave the sprites there and work with the turtle, but the moving sprites can be distracting. You can also enter the necessary instructions to remove the colors, shapes, speeds, and headings of the sprites, but this can be time consuming. A third alternative is to leave Logo and then restart it. This is often the quickest solution. In any case, it would be helpful to have a single command that would remove all active sprites from the video screen.

There may be features in the production versions of Logo that are not present in the prototypes—in addition to the possibility of color in Apple Logo, there is discussion of including music capability in both personal computer versions of Logo. Texas Instruments has mentioned this possibility, while the Apple Logo documentation already contains some explanation of how to use the music features, even though they are not present in the prototype.

The prototypes of Apple and TI Logo are currently being used in pre-school through high school classrooms (see *Computing* , Summer 1981, for details) on a “pilot project” basis, and evidence of its value to students is growing rapidly. This evidence deals not only with amount of material learned, but also with a heightened self-awareness and self-esteem derived from the student controlling a powerful machine and thus his or her own learning. It seems inevitable that Logo will become a forceful learning tool, both in the school and in the home.

Having acquired at least a passing familiarity with these two Logo implementations, I see them as complementary, rather than competitive. Anyone who is seriously interested in education and learning on any level should examine both versions. TI Logo easily attracts user interest (the sprites are a definite attention-getter) and it encourages fundamental exploration of a variety of significant concepts. Apple Logo provides a somewhat deeper exploration of the same concepts. The development of Logo for other popular personal computers such as the Radio Shack TRS-80 and Atari will probably not be far behind.

For More Information
To add your name to the Apple Logo mailing list, write: Apple Logo, The Logo Project, 545 Technology Square, Cambridge MA 02139. For $1 they will also send a bibliography of papers produced in conjunction with the project.

For information on TI Logo, write: TI Logo, Texas Instruments Inc, Corporate Engineering Ctr, 12860 Hillcrest Wing E M/S 376, Dallas TX 75230.

Listing 2: The COILGROW procedure has CIRCLEMOVE and CIRCLE nested within it. CIRCLE, in turn, is nested in CIRCLEMOVE. Both COILGROW and CIRCLE employ iteration by repeating the instructions in the brackets. COILGROW is a recursive procedure—it calls itself. COILGROW produces a coil consisting of connected circles of increasing diameter. The procedure is run by entering its name and values for the variables NUMBER, DISTANCE, and ANGLE. (The 360/(:ANGLE) in CIRCLE causes an interesting “bending” of the coil, since it returns an integer that may be slightly more or less than the number of iterations required to produce an exact circle. HIDETURTLE, in the CIRCLE procedure, speeds up drawing since the turtle itself need not be redrawn at each “step.” SHOWTURTLE causes the turtle to reappear.)

```
TO COILGROW :NUMBER :DISTANCE :ANGLE
REPEAT :NUMBER [CIRCLEMOVE :DISTANCE :ANGLE]
CIRCLE :DISTANCE :ANGLE
MAKE "ANGLE :ANGLE - 3
COILGROW :NUMBER :DISTANCE :ANGLE
END

TO CIRCLEMOVE :DISTANCE :ANGLE
CIRCLE :DISTANCE :ANGLE
FORWARD :DISTANCE
END

TO CIRCLE :DISTANCE :ANGLE
HIDETURTLE
REPEAT 360/(:ANGLE) [FORWARD :DISTANCE RIGHT :ANGLE]
SHOWTURTLE
END
```

Listing 3: MYSTERY requires that an integer be input for the variable NUMBER. It then prints the integers 1 thru NUMBER in an unexpected order: the STOP in the recursive procedure produces the MYSTERY effect; when the technique is used in a V-drawing procedure, the turtle can draw a “binary tree.”

```
TO MYSTERY :NUMBER
IF :NUMBER = 0 STOP
MYSTERY :NUMBER - 1
PRINT :NUMBER
END
```
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Recently I was at a local electronics store looking at DVMs (digital volt-ohmmeters). I didn't want to buy one, but, like looking at new cars, I wanted to reestablish the cost-effectiveness of what I already owned.

Most of the meters in the showcase were 3½-digit units with five or more ranges and many ancillary functions. The sales pitch for every one sounded alike.

While not trying to be cute, I stopped the clerk in midsentence and asked if he had any DVMs that "talked." He completely ignored the question. I had to interrupt him twice to get his attention, and even then, he thought I was being difficult.

Eventually, he said that he had no talking DVMs and never expected to see any. Even though I anticipated his answer, I was testing his response to the idea. Considering that we now have talking toys, talking hand-held DVMs shouldn't sound that strange. In fact, such use would be a relatively minor application of synthesized speech. Someday they will be very common.

While I wouldn't consider this salesman a total loss, there are some people who have to go to Missouri to believe the state exists. I trust, however, that you have an open mind to new technology.

Cost-Effective Speech Synthesis

Advances in the production of high-density LSI (large-scale integrated) circuits and new techniques to synthesize speech have reduced the cost of voice-output systems dramatically. Attaching a speech synthesizer to your computer is now as reasonable financially as adding any other peripheral device.

The cost of a synthesizer is a function of the number of words the synthesizer can speak. Limited-vocabulary synthesizers, such as the TMS0280 unit in the Texas Instruments Speak & Spell toy or any others that have their vocabulary stored totally in ROM (read-only memory), are generally less expensive. Speech interfaces using phoneme synthesis, such as the Votrax SC-01, usually require the help of a computer program running on an external processor to generate extensive voice output. The added complexity makes this type of synthesizer more expensive. Of course, a phoneme synthesizer can have an unlimited vocabulary by using a text-to-speech program running on the external processor.

This article describes the construction of a cost-effective limited-vocabulary voice-synthesis speech-processor board called the Micromouth. It uses the new Digitalker DT1050 integrated circuit set from National Semiconductor, which has a stored vocab-

---

Photo 1: Assembled Micromouth speech-processor board. The 40-pin integrated circuit is the MM54I04 speech processor, and the two 24-pin packages are 64 K-bit ROMs, which contain 144 digitized expressions. The 40-pin edge connector on the right is plug-compatible with the Radio Shack TRS-80 Model I, and the 50-pin edge connector on the bottom is plug-compatible with the Apple II. The heat sinks shown in the photo are not generally required but were included on this particular unit for testing.
ulary of 144 expressions. For about $120, you can build this board and add voice output to monitoring functions, computer games, and calculations. It can say “The time is 6:40 pm” and “Number 4 is set at 6.35 volts” just as easily as “Control error...” or “Danger...a star is on the left at 8.2 million meters.” While a limited-vocabulary synthesizer may never have appealed to you before, I am sure the low price and simple system integration of this speech interface will spark your interest.

The Micromouth speech-processor board I am presenting is plug-compatible with the Apple II and Radio Shack TRS-80 Model I computers. (It can be used with the TRS-80 Model III using an adapter cable.) It is signal-compatible with other microcomputers, such as the Digital Group product line or the Heath H-8, and can be connected to any computer with an 8-bit parallel I/O (input/output) port, such as a printer port. It requires no external controlling software except a simple BASIC statement to say any expression in its vocabulary. For example, executing OUT 127,120 on the TRS-80 (or POKE -16001,120 on the Apple II) will cause the board to say “Please.”

The design and features of the Micromouth speech-processor board are discussed in detail here. But, first, a little background on speech-synthesis techniques, in general, and then details of National Semiconductor’s Digitalker system, in particular.

Speech-Synthesis Techniques

Three techniques are presently used to synthesize the human voice: formant synthesis, linear-predictive coding, and waveform digitization. They differ primarily in the number of bits per second of data required to construct a word.

Formant synthesis is essentially a modeling of the natural resonances of the human vocal tract. The bands of resonant frequencies defined are called formants. In an electronic synthesizer, these frequencies are generated by excitation sources and are then passed through variable-parameter filters.

One form of the formant technique is called phoneme synthesis. In this, the spectral parameters are derived from basic sound units that make up words. A phoneme generator, in turn, reproduces these sounds. In such a circuit, each phoneme has been assigned a code, and the synthesizer module (or chip) utters the corresponding phoneme sound for each code it receives. Creation of continuous speech, therefore, is simply a
System Log

3:10 P.M. - System Down!

4:45 P.M. - Problem diagnosed using DIAGNOSTICS II.
Board replaced and system back on line.

DIAGNOSTICS II

Diagnostics II is SuperSoft's expanded Diagnostic package. Diagnostic II builds upon the highly acclaimed Diagnostics I. It will test each of the five areas of your system:

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<tr>
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</table>

Every test is expanded.

Every test is "submit"-able. A "submit" file is included in the package which "chains" together the programs in Diagnostics II, achieving an effective acceptance test. All output can be directed to a log file for unattended operation, for example over night testing. Terminal test is now generalized for most crp terminals. A quick-test has been added for quick verification of the working of the system.

The memory test is the best one we have encountered. It has new features, including:
- default to the size of the CP/M Transient Program Area (TPA)
- printout of a graphic memory map
- burn in test
- bank selection option
- memory speed test

Diagnostics-II still includes the only CPU test for 8080/8085/Z80.

A Spinwriter/Diablo/Qume test has been added, which tests for the positioning and control features of the Spinwriter/Diablo/Qume as well as its ASCII printing features. (Serial Interface only)

And, as with all SuperSoft products, a complete online HELP system and user manual is included.

Price: $100.00 (manual only): $15.00

Requires: 32K CP/M
CP/M Formats: 8" soft sectored, 5" Northstar, 5" Micropolis
Mod II, Vector MZ, Superbrain DD/DD

The Digitalkker speech processor uses a comprehensive data-compression algorithm.

In most cases, the electronic voice generated is quite intelligible, but it may have a mechanical quality about it. Continuous speech using phoneme synthesis can generally be generated with a data rate of less than 400 bps (bits per second). This technique is used by the Votrax Division of Federal Screw Works in the SC-01 Speech Synthesizer Chip and other products.

Linear-predictive coding is similar to formant synthesis. Both techniques are based in the frequency domain and use similar hardware to model the vocal tract. Rather than using a simple phoneme code, however, linear-predictive coding stores parameters for filter coefficients, gain, and excitation frequencies. The term "linear-predictive coding" refers to the programmed activities of the multistage lattice filters that produce the desired formants. Adequate-quality speech can generally be achieved with data rates of 1200 to 2400 bps. This synthesis technique is used by Texas Instruments in several products, including the Speak & Spell and the TI 99/4 Text to Speech Translator. It is also used by General Instrument Corporation in its Orator VSM2032 Voice-Synthesis Module.

The third method is waveform digitization. This very old technique produces speech by generating a waveform with the time-domain characteristics of voice, in contrast to the previously considered parameter-encoding methods, which represent speech in terms of frequency. The simplest form is uncompressed digital data recording, called PCM, for pulse-code modulation. (In the June 1978 BYTE, my article entitled "Talk to Me: Add a Voice to Your Computer for $35," page 142, discussed how to build a simple digitized speech interface.)
And in conclusion, I'll only use my exceptional powers for the good of mankind.

"That's a vow all we Vector 3005s make. And it's not one we make lightly. "After all, being the only product on the market with a Vector 3 terminal, a 5½" floppy, and a 5½" Winchester rigid disk drive that provides 5 megabytes of storage is quite a responsibility. It used to take 20 floppies to give you that kind of capacity.

"Our powers don't stop there, however. Each 3005 also comes with a 32-bit error-correcting code—the first time sophisticated IBM-style technology has been available on a small business system. This lets us detect and correct errors, and almost completely eliminates data loss on disks due to dirt, wear, or damage.

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"And we're reliable. Our powers won't diminish, our abilities won't fade, and dedication to mankind won't weaken.

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"Thank you all for coming today. And I hope we'll have the chance to do business together in the future."
In simple PCM recording, the analog speech waveform is sampled at a rate twice that of the frequency of the highest voice component and converted to digital format through an A/D (analog-to-digital) converter. Once stored, the digital signal can be played back through a D/A (digital-to-analog) converter and a low-pass filter. One major advantage of digitally encoded speech is its human-like quality. Since it is in essence a recorded voice, the reproduced speech retains the inflections and accents of the original voice. Thus, in addition to male and female voices, it is possible to have a speech synthesizer that reproduces regional or foreign accents. The clarity of the reproduction depends on the speech-compression method used.

Unfortunately, one problem in using PCM alone is that it requires very high data rates. Rates above 100 kbps are not unusual with this method. To reduce the data rate, it is necessary to compress the speech data to remove redundant information. One compression method is called delta modulation. As in PCM, the analog speech waveform is sampled, but this time only the changes in amplitude (delta values) between samples are stored. Since speech contains many redundant sounds and silences, these changes are much smaller than the absolute amplitude of the waveform, and fewer bits are required to store the smaller values. Delta modulation, therefore, reduces the amount of memory required to store a list of words.

![Block diagram of the National Semiconductor Digitalker MM54104 speech-processor chip](image)

Figure 1a: Block diagram of the National Semiconductor Digitalker MM54104 speech-processor chip. This figure and figure 2 were provided through the courtesy of National Semiconductor Corporation.

![Pinout specifications of the DT1050 system](image)

Figure 1b: Pinout specifications of the DT1050 system, which comprises the MM54104 speech-processor chip and the associated MM52164 SSR1 and SSR2 ROMs (read-only memories). The ROMs are designed to be used in sets of two; the chip-select (CSI) signals are set up in complementary fashion.
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Ultimately, the total amount of memory required for continuous speech becomes a function of exotic compression algorithms. Data rates as low as 2400 bps have been achieved. The Digitalker speech-synthesis chip set uses data-compressed digitized speech.

**Digitalker Components**

The Micromouth synthesized-speech-processor board is based upon the National Semiconductor Digitalker DT1050 speech-synthesizer chip set, which consists of a speech processor (SPC) and two 64 K-bit ROMs (read-only memories).

The speech processor uses PCM encoding with a comprehensive data-compression algorithm developed by Forest Mozer at the University of California, Berkeley. The primary compression method employed is delta modulation. As previously described, this concept recognizes that speech waveforms are generally smooth and continuous. Rather than storing the absolute amplitude of the voice signal, the differences between successive samples are stored instead. During speech reconstruction, successive amplitudes in the output waveform are obtained by adding these delta values to the previous values, allowing us to avoid using large numbers of bits to store large voltages.

The speech processor also uses phase-angle adjustment and half-
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period zeroing compression techniques. Phase-angle adjustment is based on the concept that the intelligibility of speech is not affected by the phase angle of the sine-wave components of the Fourier-transformed waveforms. Therefore, these values can be adjusted to produce a waveform with mirror symmetry; only half the data need be stored.

In half-period zeroing, the low-amplitude portions of a signal are reproduced as silence. For the most part, only the center half of any pitch period needs to be stored since the center half contains most of the energy. The remainder of the waveform is relatively insignificant and can be discarded.

The 144-expression Digitalker vocabulary was initially recorded through a microphone, then differentiated and digitized. A computer program operated on the data to perform phase-angle adjustment, delta modulation, and half-period zeroing. The redundant pitch periods and phonemes were reduced to individual stored periods and a record of the number of times they are repeated (usually 3 to 8 times). The resulting data containing frequency, amplitude, and control information is stored in the two 64 K-bit speech ROMs.

Figure 1a is a block diagram of the speech-processor chip. Each block of speech data contains a control word specifying the location in ROM of an audible expression, the type of waveform generated, and the number of repetitions. Text continued on page 58

Figure 2: Simplified schematic diagram of a minimum-configuration speech demonstration system, in which mechanical switches are used to set up the desired word. The momentary switch is a single-pole, two-position type. The crystal is a 4.0 MHz Electro Dynamics Corporation HC18 20 pF unit.
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Figure 3: Schematic diagram of the Micromouth speech-processor board. The board is plug-compatible with the Apple II and TRS-80 Model I computers and can be plugged into the TRS-80 Model III with a simple adapter. Several features and options in the circuit are activated by selection of jumper connections; see table 3, on page 58, for a list of jumpers and their purposes. Interface signals are compatible with other microcomputers, including Digital Group, Heath H-8, and S-100-bus systems.
Text continued from page 56:

stored expressions to be uttered is done by loading a numeric word code into a register in the speech processor. The code, selected from the list in Table 1, is latched when the write-enable and chip-select lines are strobed. The speech processor immediately utters the selected expression.

If the input code is 0, the message “This is Digitalker” is spoken, in about 1.3 seconds. To say a word like “at” takes much less time. If another word-selection address is strobed into the speech processor while it is speaking, it will terminate the current output and begin speaking the newly selected expression. To keep the unit from jamming one word on top of another, a handshaking signal (INTR) goes to a low logic condition when the device is talking.

The simplest Digitalker system can consist of as little as the three speech-system integrated circuits, a 4 MHz oscillator, and an amplifier/filter (as shown in figure 2). Different expressions can be accessed by attaching eight switches to the SW1 thru SW8 input lines and a pushbutton switch to momentarily pulse the write-enable line.

Full use of the Digitalker’s capabilities, however, can only be achieved when it is connected to a computer and exercised under program control. Figure 3, on pages 56 and 57, is the schematic diagram of the Micromouth speech-synthesizer interface, which incorporates the Digitalker chips. It is designed to be bus-signal-compatible with a number of computers, and it can be operated through a parallel I/O port. Assembled on the printed-circuit board shown in photo 1, it is plug-compatible with the Apple II and TRS-80 Model I personal computers. The pin numbers listed in the figure for connector J2 correspond to the TRS-80 Model I TRS-BUS edge connector, and pin numbers listed for J1 correspond to the Apple II’s I/O card slots. A source for the Micromouth speech-processor assembled unit, blank boards, and components is given in the text box on page 68.

**Micromouth Versatility**

The Micromouth board is designed to accommodate bidirectional as well as unidirectional data buses. The data-bus lines are normally attached to pins 8 thru 15 of IC1, the speech-processor component. The bus line from the speech processor, INTR, is jumpered (by either jumper connection JP4 or JP5) to meet the requirements of the particular bus being used. For both the TRS-80 and Apple II, which have bidirectional data buses, jumper JP5 is inserted to connect the INTR output to the D0 bus.
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The controlling computer can read the status of this line with an input instruction; only the least-significant bit will be affected. For a unidirectional data bus, as in a Digital Group computer, JP4 would be inserted and pin 5 of IC6 connected to the least-significant bit of the input bus.

The logic gates of IC4, IC5, and IC6 perform address decoding and chip selection. The I/O-port address of the board is set by inserting jumper JP1 or JP2. With JP1 installed, the address is port hexadecimal 7F (decimal 127). With JP2 installed, it is port hexadecimal FF (decimal 255). On the Apple II, the port address depends upon the slot in which the board is inserted. Table 2 is an address map for the Micromouth speech-processor board installed in an Apple II.

The speech-processor chip requires +7 to +11 V for normal operation, while the ROMs and other integrated circuits require only a +5 V supply. To accommodate the different ranges, I used two separate voltage regulators. IC9, a 7805 regulator, can safely be fed an input-voltage range of +9 to +24 V. When installed in an Apple II it receives a +12 V supply from the I/O bus. When the board is used with the TRS-80, a separate full-wave power supply using a 22 V center-tapped power transformer supplies approximately +15 V RMS. IC9 and associated components regulate the output to the speech processor to about +9 V.

IC10, another 7805, in turn, reduces the +9 V to the +5 V required by the rest of the components.

The typical maximum current requirement of the Micromouth speech-processor circuitry is about 250 mA. Most of this is consumed running the two 64 K-bit ROMs, which are used only a few microseconds at a time. A memory-enable signal, ROMEN, can be used with a transistor (Q1) to gate the power on and off to the ROMs. The average current required ends up being about 80 mA.

The final section for consideration is the filter and amplifier, IC7 and IC8. As in any digitized analog-signal output, a low-pass filter is required. For low-pitched male voices, the cutoff frequency should be about 100 Hz; for high-pitched female or children’s voices it should be 300 Hz. The filter in figure 3 has a cutoff frequency around 150 Hz. That limit wasn’t set mathematically; I simply chose a pleasant-sounding range. The frequency response of the output speaker and its enclosure can also affect sound quality. In my opinion, the sound output by this circuit is quite human-like. Any additional filtering usually serves only to eliminate background noise.

Using a Parallel Port

The Micromouth board can also be jumpered so that it can be driven by a parallel I/O port. This is accomplished by inserting jumpers JP8 and JP9. With the input lines to IC5 and IC6 left open, a constant chip-select signal will be generated. The 8-bit parallel output from the computer is attached to pins 8 thru 15 on the speech processor. The same signal that latches the bit values into the output port can be used as the WR strobe on IC1 pin 4. The speech-processor-busy status indication is handled by directly reading the INTR line via an input-port line.

Basic Software Simplicity

The best thing about a fixed vocabulary “canned-speech” synthesizer is the low software overhead. Text-to-speech synthesizers, on the other hand, usually require at least an 8 K-byte driver program, which must be integrated into the existing operating system. With the Micromouth speech-processor board, any or all of the 144 expressions can be spoken using a simple BASIC OUT or POKE statement.

For example, to say “twenty” using the board connected to a TRS-80 system, you would execute an OUT 127,20 statement in BASIC. With the Apple II, the appropriate statement would be POKE -16001,20 if the board were installed in slot 1. As you can see, the control information communicated to the board, a decimal 20,
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If you would like more information on how the DS180’s low-cost total printer package can fill your application, give us a call at Datasouth. The DS180 is available for 30-day delivery from our sales/service distributors throughout the U.S.
Listing 1: A BASIC program for the Radio Shack TRS-80 Model I that will cause the Micromouth speech-processor board to say “At the mark the time is 2:45 pm... beep.” A program for the Apple II would use the POKE keyword to achieve the same effect as the OUT statement.

```
100 DIM N(15)
110 DATA 61,138,105,71,138,139,96,2,4,5,47,44,71,71,65
120 FOR X = 1 TO 15:READ N(X):NEXT X
150 FOR X = 1 TO 15:OUT 127,N(X):GOSUB 1000:NEXT X
160 GOTO 1999
1000 IF INP(127) = 1 THEN
110 STOP
1000 IF INP(127) = 1 THEN 1000 ELSE RETURN:REM check end of word
300 REM
310 OUT 127,139:GOSUB 290:OUT 127,129:GOSUB 290:RETURN
320 REM say TIMES
```

is the same even though the keywords differ. (Since my program illustrations consistently use OUT statements directed to port 127, I will not bother to restate the conversion in subsequent examples, but you should recognize the direct relationship.)

Having the board speak in a series of words can be handled in one of two ways. One way is to use timing loops or other program-execution steps to allow enough time for a word to be spoken before loading the speech processor with the next word code. The preferred method is to check the busy line (INTR) before loading the next word. In this way, speech can sound continuous regardless of the length of each word. The INTR status bit is read as the least-significant bit of port 127 by the function INP(127). In my examples, while the speech processor is talking, the decimal value returned by INP(127) equals 1; while it is not talking, INP(127) equals 0.

Therefore, saying the number twenty-one, which consists of saying “twenty” and “one” successively, goes as follows:

```
100 OUT 127,20:GOSUB 1000
110 STOP
1000 IF INP(127) = 1 THEN
1000 IF INP(127) = 1 THEN 1000 ELSE RETURN:REM check end of word
300 REM
310 OUT 127,139:GOSUB 290:OUT 127,129:GOSUB 290:RETURN
320 REM say TIMES
```

Listing 2: A BASIC program that will cause the Micromouth speech-processor board to recite multiplication results for any number between 1 and 10.

```
100 PRINT "MULTIPLICATION TABLE EXERCISER"
110 OUT 127,0:REM Say This is Digi-Talker
120 PRINT:PRINT"Which table do you want to review (1 to 10)?"
130 INPUT N
140 FOR X = 0 TO 10
150 PRINT X;"X";N;=";X*N:J=X*N
160 IF J = 0 THEN OUT 127,31:GOSUB 290:GOTO 180
170 IF J = 10 THEN OUT 127,1:GOSUB 290:OUT 127,129:GOSUB 290
200 J = J+10
210 IF J = 10 THEN OUT 127,1:GOSUB 290:OUT 127,129:GOSUB 290
220 IF J = 0 THEN OUT 127,31:GOSUB 290:GOTO 260
230 IF J = 20 THEN OUT 127,1:GOSUB 290:GOTO 260
240 OUT 127,18+J:GOSUB 290
250 IF J = J+10 THEN OUT 127,1:GOSUB 290:GOTO 260
260 NEXT X
270 PRINT:GOTO 120
280 REM
290 IF INP(127) = 1 THEN 290 ELSE RETURN:REM check end of word
300 REM
310 OUT 127,139:GOSUB 290:OUT 127,129:GOSUB 290:RETURN
320 REM say TIMES
```

Having the board speak in a series of words can be handled in one of two ways. One way is to use timing loops or other program-execution steps to allow enough time for a word to be spoken before loading the speech processor with the next word code. The preferred method is to check the busy line (INTR) before loading the next word. In this way, speech can sound continuous regardless of the length of each word. The INTR status bit is read as the least-significant bit of port 127 by the function INP(127). In my examples, while the speech processor is talking, the decimal value returned by INP(127) equals 1; while it is not talking, INP(127) equals 0.

Therefore, saying the number twenty-one, which consists of saying “twenty” and “one” successively, goes as follows:

```
100 OUT 127,20:GOSUB 1000
110 STOP
1000 IF INP(127) = 1 THEN
1000 IF INP(127) = 1 THEN 1000 ELSE RETURN:REM check end of word
300 REM
310 OUT 127,139:GOSUB 290:OUT 127,129:GOSUB 290:RETURN
320 REM say TIMES
```

A similar program can be used to demonstrate the entire Digitalker vocabulary:

```
100 FOR N = 0 TO 143 : OUT 127,N : GOSUB 1000 : NEXT N
110 STOP
1000 IF INP(127) = 1 THEN
1000 IF INP(127) = 1 THEN 1000 ELSE RETURN
1999 END
```

Longer utterances are typically
When you decide to buy a microcomputer system, it usually gets down to one model versus another. Will it be the SuperBrain from Intertec... or one of those other models from Intertec's competitors? Well, there's really not much of a choice in the price/performance competition. The SuperBrain wins hands down! And it's a pretty tough contender if reliability, factory support and nationwide service are important to you. So what do you do? Choose our SuperBrain just because you know it's best? Or keep waiting for someone to announce something better?

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Listing 3: A BASIC program to demonstrate several different ways of using the speech interface.

50 DIM N(20), M(60)
55 DATA 71, 138, 139, 96, 71, 12, 69, 93, 129, 71
60 DATA 17, 69, 110, 129, 71, 71, 71, 71, 71, 71, 71
65 FOR T = 1 TO 19: READ N(T): NEXT T
70 DATA 65, 71, 76, 71, 71, 75, 81, 71, 71, 105, 71, 7, 20, 47, 44, 71
75 DATA 83, 125, 96, 1, 28, 21, 6, 85, 129, 32, 110, 71, 71, 104, 133
80 DATA 2, 12, 28, 049, 047, 044, 60, 131, 83, 125, 2, 1, 28, 10, 85
85 DATA 129, 32, 110, 71, 71, 71, 71, 71
90 FOR T = 1 TO 56: READ M(T): NEXT T
100 REM DIGI-TALKER TEST PROGRAM
110 PRINT "DIGI-TALKER TEST PROGRAM"
120 PRINT: PRINT "1. Say entire vocabulary"
130 PRINT "2. Count from 0 to 20"
140 PRINT "3. Tones"
145 PRINT "4. Speech example A"
150 PRINT "5. Speech example B"
155 PRINT "6. Say 'THIS IS DIGI-TALKER'"
160 PRINT: PRINT "Enter choice (1-5) "$: INPUT A
170 IF A = 1 THEN GOSUB 250
180 IF A = 2 THEN GOSUB 300
190 IF A = 3 THEN GOSUB 350
200 IF A = 4 THEN GOSUB 400
210 IF A = 5 THEN GOSUB 450
220 IF A = 6 THEN OUT 127, 0: GOSUB 1000
230 GOTO 110
250 REM speak entire word list
260 FOR T = 0 TO 143: OUT 127, T: GOSUB 1000
270 NEXT T: RETURN
300 REM speak numbers 0-20
310 OUT 127, 31: GOSUB 1000
320 FOR T = 1 TO 20: OUT 127, T: GOSUB 1000
330 NEXT T: RETURN
350 REM 80 Hz and 400 Hz tone
360 FOR T = 0 TO 5: OUT 127, 65: GOSUB 370
370 NEXT T: RETURN
380 REM speak Time
390 FOR B = 0 TO 5: OUT 127, 65: FOR C = 0 TO 2: OUT 127, 71: GOSUB 1000: NEXT C
400 NEXT B
410 REM 80 Hz and 400 Hz tone
420 FOR T = 1 TO 18: OUT 127, M(T): GOSUB 1000: NEXT T
430 FOR T = 0 TO 5: OUT 127, 65: FOR S = 0 TO 100: NEXT S: NEXT T
440 RETURN
450 REM example of use as error detector and verbal annunciator
460 FOR T = 1 TO 55: OUT 127, M(T): GOSUB 1000: NEXT T
470 RETURN
480 IF INP (127) = -1 THEN 1000 ELSE RETURN
490 IF INP (127) = -1 THEN 1010 ELSE RETURN

LISTING 4: The printed output of the program in listing 3. Due to the limitations of magazine printing, we cannot reproduce the audible output produced by the program.

run DIGI-TALKER TEST PROGRAM
1. Say entire vocabulary
2. Count from 0 to 20
3. Tones
4. Speech example A
5. Speech example B
6. Say 'THIS IS DIGI-TALKER'
Enter choice (1-5) ?

handled by storing all the word codes in an array. Such a technique can be used to say, "At the mark the time is 2:45 pm...beep," using the BASIC statements in listing 1.

I have included a few program examples to demonstrate how the speech-processor board can be used. Listing 2 is a simple program for saying multiplication tables. This program asks the operator to choose a multiplication table for a number between 1 and 10. If 8 were chosen, for example, the program would say:

"Zero times eight equals zero."
"One times eight equals eight."
"Two times eight equals sixteen."
"Ten times eight equals eighty."

This is just a rudimentary example. The program could be modified easily to posit questions such as "Six times nine equals..." and wait for a typed response. Appropriate answers would be "Error...Please try again," or "Right."

Listing 3, on page 66, is a menu-driven program that further exercises the interface and demonstrates a few more applications. Speech example A says, "beep... beep... beep... beep... beep... beep... beep. The time is... twelve hours... seventeen minutes... beep."

In Conclusion

Applications that would be enhanced by speech output are limitless. I have demonstrated just a few examples dealing with process control and time.

Many handicapped persons could benefit from speech output. It would be possible, for example, to attach a speech-output device to the user-terminal keyboard of a personal computer. As the keys are pressed, the corresponding letters are spoken aloud. (A simple ROM containing Digitalker equivalents for ASCII [American Standard Code for Information Interchange] characters could be used to interface the speech-processor board.) A similar connection can be made to the printer output (using the INTR-signal handshaking to slow it down) to allow the operator to hear what would otherwise be printed.

I did not attempt to modify any computer games as illustrations. Computer games could easily be made to talk using a few extra BASIC
The best news since CP M... customizable full screen editing

As a serious computer user you spend much of your time editing, whether it be for program development or word processing. Make the best use of your time with the help of VEDIT, an exceptionally fast and easy to use full screen editor. VEDIT is a highly refined and proven editor which is easy enough for novices to learn and use. Yet its unequalled set of features also makes it the choice of computer professionals. And because VEDIT is user customizable, it adapts to your keyboard, hardware, applications and preferences.

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statements that are independent of the program flow.

What I’d like to leave you with is an appreciation for the price/performance advantages and ease of use inherent in this speech interface. Soon other Digitalker ROMs will be available, containing specialized vocabularies for medical, aeronautical, or even space-war applications. These other ROMs will be available eventually thru the MicroMint.

[Editor’s Note: National Semiconductor Corporation is providing a brief telephone demonstration of the Digitalker speech-synthesis system at (408) 737-3939...RSS]

The invention of Digitalker does not mean the demise of other approaches to computer-generated speech. Instead, it introduces low-cost speech output into areas that could never have justified the expense previously. Eventually, hand-held talking digital volt-ohmmeters will be mass-produced, and I don’t think it will be too far into the future. But that is merely one application. You can expect to see (or rather hear) speech emanating from many commercial products.

Those who work with other speech-synthesis techniques have not been standing still during the development of “canned-speech” chips. Phoneme synthesizers, such as the Votrax SC-01, now accomplish on a single chip what once required a whole circuit board. My investigation of speech synthesis doesn’t stop here. In the months ahead I hope to demonstrate other computer-speech techniques, interfaces, and applications.

Next Month:
Would you think that a computer system capable of running a BASIC interpreter could fit on a 4-inch-square circuit board? Find out how to build one in next month’s Circuit Cellar.

Bibliography
1. Ahrens, Paul; Klaus Skoge; David Vetter; and John Stork. "Speech Chip Timeshares a 2-Pole Section to Create a 12-Pole Filter," Electronics, March 10, 1981, page 177.

Editor’s Note: Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458. Ciarcia’s Circuit Cellar covers articles that appeared in BYTE from September 1977 thru November 1978. Ciarcia’s Circuit Cellar, Volume II presents articles from December 1978 thru June 1980.

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<tr>
<th>Item</th>
<th>Kit</th>
<th>Assembled and Tested</th>
</tr>
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<td>Apple II Micromouth speech-processor board</td>
<td>$120</td>
<td>$150</td>
</tr>
<tr>
<td>TRS-80 Model I Micromouth speech-processor module (includes circuit board, power supply, 40-conductor cable, and enclosure; deduct $10 if you don't want the enclosure)</td>
<td>$150</td>
<td>$175</td>
</tr>
<tr>
<td>TRS-80 Model III Micromouth speech-processor module (includes board, power supply, adapter cable, and enclosure)</td>
<td>none</td>
<td>$200</td>
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<tr>
<td>Blank printed-circuit board for Micromouth speech-processor board (without components)</td>
<td>$29</td>
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</table>

The Apple II version of the Micromouth speech-processor board is suitable for use with parallel-I/O-port and other non-plug-compatible computer connections. The assembly/operation instructions include directions for attaching the board to S-100 bus, Digital Group, and Heath H-8 computers.

All printed-circuit boards are solder-masked and silk-screened. They come with assembly instructions and program examples.

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Many academic disciplines have used computers for modeling biological, physical, economic, and social systems. Modeling complicated systems once was time-consuming, expensive, and cumbersome. Yet, as computer-related technology advanced, the magnitude of these problems has dwindled, and the potential for less-expensive modeling and simulation tasks in all disciplines has increased.

My purpose is to demonstrate how useful microcomputers can be in mathematical simulations. I will introduce you to modeling the behavior of a system by describing it mathematically with a system of time-invariant linear differential equations. I will show how to solve systems of differential equations by two separate numerical methods. As a framework for the simulation tasks, I will use a simple model as an example for you to follow: a hydrologic model of the forested uplands surrounding Okefenokee swamp in Georgia. (See reference 3.)

The Conceptual Model
To simulate a system, you must be able to conceptualize it into some logical framework. A flow diagram consisting of compartments and connecting flows satisfies this requirement. (See figure 1.) Each compartment in

About the Author
Randall E Hicks is a graduate student at the University of Georgia working toward his PhD in Ecology at the Institute of Ecology. He is employed by Ecology Simulations Inc, Athens, Georgia, as a marine systems modeling consultant.

Photo 1: Zero-input response of the Okefenokee swamp hydrologic model simulated with the program in listing 2.

the diagram represents a place for the potential accumulation of energy, matter, or information. A system is defined as the collection of compartments that have been outlined and the potential interactions among them. The flows between compartments describe how the system interacts with itself through transfers of the compartmental contents.

The boundaries of the system must also be defined. The environment of the system is the area outside the system’s periphery. If the system does not interact with its environment, it is called a closed system, and the model will not receive inputs from or yield losses to its surroundings. In other words, the system is self-contained. In the Okefenokee swamp uplands hydrologic model, the system is said to be open because it interacts with its environment. In the conceptual model (figure 1), this is visualized by an input from the environment to the system and by an output from the system to the environment.

The input to the system ($Z$) is the sum of the flows to each compartment ($f_{in}$) from all environmental inputs. The environment surrounding the system is represented by the numeral 0. In the hydrologic model, there is only
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Figure 1: A conceptual model of the hydrology of the forested uplands surrounding Georgia's Okefenokee swamp. The model is subdivided into a system and its environment. The system receives environmental inputs ($Z$) and yields losses ($Y$) to the environment. Compartments represent areas of potential water accumulation. Flows and their direction are indicated by connecting arrows. Flows within the system are also given numerical designations. The first number represents the recipient-compartment number and the second represents the donor-compartment number.

$Z = \sum_{i=1}^{4} f_{1i}$

where the numerical designation of $Z_k$ represents an input from environmental input $k$ to the system. Flows within the system are represented by lines connecting compartments; arrows show the direction of flow. These flows are classified by two numbers. The first number indicates the compartment that receives the flow, and the second represents the compartment that yields (ie: produces) the flow. In figure 1, $f_{21}$ designates an actual flow of moisture from vegetation moisture (compartment 1) to soil moisture (compartment 2). The output from the system ($Y$) back to the environment is the sum of the losses from each compartment $i$ ($f_{0i}$). The purpose of the model is to be able to describe the response of each compartment (ie: how much water is present) at all times in the future.

Figure 2: Geometric interpretation of Euler's method for solving differential equations. Compartment size ($x$) is plotted versus time ($t$). Actual and predicted compartment sizes are shown.

$Z = f_{10} + f_{20} + f_{30} = z_1$
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The Mathematical Model

The flows into and out of each compartment can be represented by a difference, or a differential, equation. In the model, the flows have been balanced so that no compartment will have a net gain or loss of moisture. The system is said to be at steady-state, and the corresponding model will be static in nature. The relationships in the flow diagram can be depicted by a system of linear differential equations. In the steady-state example, each differential equation representing a compartment is equal to 0, since inflows and outflows are equal.

For compartment 1 (vegetation moisture), the differential equation would be of the form:

\[ \frac{dx_1}{dt} = f_{10} + f_{12} - f_{21} - f_{01} \]

(Note: In this equation, I have used a dot centered over a variable to simplify notation. Henceforth, this will mean the derivative of a variable with respect to time.)

The actual flows \( f_{ij} \) can be divided by the steady-state size of the corresponding donor compartment \( x_j \), or by the environment input \( z_k \), to give two types of coefficients: intercompartmental rate coefficients and environmental input coefficients:

\[ a_{ij} = \frac{f_{ij}}{x_j} \]

and:

\[ b_{ik} = \frac{f_{0k}}{z_k} \]

where:

- \( l \) = the recipient compartment
- \( j \) = the donor compartment
- \( k \) = an environmental input number

Notice that the intercompartmental coefficients \( a_{ij} \) (of matrix A) have the same numerical designation as their corresponding flows. Also notice that the environment is represented by a 0 in flows. When environmental input coefficients are formed, you subdivide the total environmental input \( Z \) into the different types \( (k) \) of environmental inputs. These coefficients \( b_{ik} \) of matrix B are dimensionless and express the percentage of an environmental input \( z_k \) of vector \( Z \) that each compartment receives. These numerical notations define the position of each coefficient in an appropriate coefficient matrix. For compartment 1 (vegetation moisture), the differential equation then becomes:

\[ \dot{x}_1 = a_{11}x_1 - a_{12}x_2 + b_{11}z_{11} \]

After redefining all the differential equations into coefficients multiplied by the appropriate donor-compartment size or environmental-input size, you can organize the system of equations into a single matrix equation:

\[ \dot{X}_{n1} = A_{nn}X_{n1} + B_{nm}Z_{m1} \]

where:

- \( n \) = the number of compartments
- \( m \) = the number of environmental inputs to the system
- \( \dot{X}_{n1} \) = a column vector of differential equations
- \( A_{nn} \) = an \( n \) by \( n \) matrix of intercompartmental rate coefficients
- \( B_{nm} \) = an \( n \) by \( m \) matrix of input rate coefficients
- \( X_{n1} \) = a column vector of initial compartment sizes
- \( Z_{m1} \) = a column vector of environmental inputs

Photo 2: Zero-state response of the Okefenokee swamp hydrologic model simulated with the program in listing 2.
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and:
\[ Z_{m1} = \begin{bmatrix} z_1 \\ \vdots \\ z_m \end{bmatrix} \]

The matrices and vectors for the hydrologic model are:
\[
A = \begin{bmatrix} -0.369 & 0.035 & 0.0 & 0.0 \\ 0.189 & -0.0483 & 0.0 & 0.0 \\ 0.0 & 0.0 & -0.1632 & 0.000161 \\ 0.0 & 0.012 & 0.000444 & -0.000623 \end{bmatrix} \times 1/(10 \text{ years})
\]

\[
X = \begin{bmatrix} 0.6500 \\ 2.8940 \\ 0.5250 \\ 55.4400 \end{bmatrix} \times 10^8 \text{ m}^3 \text{ water} \quad B = \begin{bmatrix} 0.60 \\ 0.07 \\ 0.33 \\ 0.00 \end{bmatrix}
\]

and:
\[
Z = [0.233] \times 10^8 \text{ m}^3 \text{ water} / (10 \text{ years})
\]

At best, this is a brief treatment of the use of linear differential equations in simulating the behavior of a collection of components. The hydrologic model herein is described by a deterministic general linear model (GLM) of donor-controlled differential equations. This type of model is among the simplest and the most straightforward to use; it has found wide acceptance in many fields. There are many books on general-systems theory and modeling that go into more detail than I can in this article. (For further reading, see references 4 and 5.) Higher-order differential equations can also be used to describe the time-varying changes in flows between compartments in a model. (See reference 2.) A nonlinear model would incorporate higher-order differential equations.

Numerical Solution of Differential Equations

Now that the model has been described with a system of linear differential equations, a method to solve these equations on a computer is needed. Several numerical methods are available for solving differential equations, but I will discuss only two methods and their implementation on microcomputers: the Euler and Runge-Kutta methods. I will briefly describe each method and list a corresponding algorithm written in BASIC (Disk BASIC 8001, for the Compucolor II microcomputer) for implementation on a microcomputer. For a more detailed description of these and other methods for solving differential equations, consult a book on numerical analysis or modeling. (See references 1 and 5.)

Euler's (Rectangular) Method

Euler's method is a simple but computationally inefficient method for solving finite differential equations. First, let's look at a geometric interpretation of this method. (See figure 2.)

Knowing the present value (state) of a compartment \((x_i)\), you want to be able to predict the next value \((x_{i+1})\). Your differential equation for the compartment defines the slope of the line at time \(t\). You project this slope to the next point in time \((t+1)\), and add the change in \(x\)'s value (called \(\Delta x\)) to the value of \(x\) at time \(t\) \((x_i)\). In many cases (such as in figure 2), the slope of the actual path of the compartment size may not be equal to the predicted value. In these instances, this algorithm has incorporated some error into the predicted value for the compartment size at the new time. In the Euler method, this error is proportional to the time step \((\Delta t)\). This error can be reduced by decreasing the time step; however, that will increase the algorithm execution time on the computer.

The algorithm for the Euler method is:

1. \(\dot{x}_i = f(x_i, Z_i, t)\)
2. \(x_{i+1} = x_i + \Delta t(\dot{x}_i)\)

First, compute the slope of the line at \(t\), which you assume is the same at \(t + 1\). In the hydrologic model, this is already determined by the time-invariant differential equations for each compartment. Second, you compute the new compartment size \((x_{i+1})\). Then you return to step 1 and continue the process for as many times as you wish. If you want to reduce the error in the algorithm, you can decrease your time step and perform the algorithm several times. In this way, you increase the number of iterations of the algorithm before you calculate your final value. Listing 1 is a program for the Euler algorithm written in Disk BASIC 8001.

Runge-Kutta Method

Runge-Kutta is a multistep, look-forward method for the numerical solution of differential equations. I will

![Figure 3: Geometric interpretation of the fourth-order Runge-Kutta method for solving differential equations. Compartment size \((x)\) is plotted versus time \((t)\). Actual and predicted compartment sizes are shown.](image)
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discuss the fourth-order Runge-Kutta method. It is computationally more involved than Euler's method, but it incorporates less error into the prediction of the next compartment size \((x_{i+1})\). The geometric interpretation of this method is shown in figure 3.

As with the Euler method, knowing the present compartment value \((x_i)\), you want to predict the next compartment value \((x_{i+1})\). First, you find the slope \((XD)\) of the line at time \(t\). Then, as in Euler's method, you calculate the compartment size \((P)\), but at time \(t + \frac{1}{2}\). After you calculate the slope \((XP)\) at \(P\), make a second prediction of the compartment size \((Q)\) at time \(t + \frac{1}{2}\). Again, calculate the slope \((XR)\). Next, take a weighted average of all the slopes you calculated and determine your final prediction of the compartment size \((x_{i+1})\) at time \(t + 1\). As with Euler's method, the Runge-Kutta method incorporates some error into your predictions; however, the error is now proportional to the fourth power of the time step \((\Delta t)\) and is greatly reduced. The error can be reduced further by decreasing the time step.

The algorithm for the fourth-order Runge-Kutta method is:

1. \(\dot{X}_i^D = f(X_i, Z_i, t)\)
2. \(X_{i+\frac{1}{2}}^P = X_i + \Delta t/2(\dot{X}_i^D)\)
3. \(X_{i+\frac{1}{2}}^P = f(X_{i+\frac{1}{2}}^P, Z_{i+\frac{1}{2}}, t + \frac{1}{2})\)
4. \(X_{i+1}^Q = X_i + \Delta t/2(\dot{X}_{i+\frac{1}{2}}^P)\)
5. \(\dot{X}_{i+1}^Q = f(X_{i+1}^Q, Z_{i+1}, t + \frac{1}{2})\)

Listing 1: Compucolor II Disk BASIC 8001 program segment of Euler integration algorithm.

```
190 REM ************ START SIMULATION ************
195 FOR IJ=1 TO 100
200 DT=1/KK
210 REM ************ START EULER INTEGRATION LOOP ************
215 FOR JI=1 TO KK
220 FOR I=0 TO N
230 AX(I)=0
240 FOR J=0 TO N: AX(I)=AX(I)+A(I,J)*X(J): NEXT J
250 FOR K=0 TO NN: AX(I)=AX(I)+B(I,K)*Z(K): NEXT K
260 NEXT I
270 FOR I=0 TO N: X(I)=X(I)+DT*AX(I): NEXT I
275 NEXT J
280 FOR I=0 TO N: XX(I,I)=X(I): NEXT I
290 NEXT I
300 REM ************ END OF SIMULATION ************
```

6. \(X_{i+1}^R = X_i + \Delta t(\dot{X}_{i+\frac{1}{2}}^Q)\)
7. \(\dot{X}_{i+1}^R = f(X_{i+\frac{1}{2}}^R, Z_{i+\frac{1}{2}}, t + 1)\)
8. \(X_{i+1} = X_i + \Delta t(\frac{1}{2}(\dot{X}_i^D) + \frac{1}{2}(\dot{X}_{i+\frac{1}{2}}^P) + \frac{1}{2}(\dot{X}_{i+\frac{1}{2}}^Q) + \frac{1}{2}(\dot{X}_{i+1}^R))\)

If you wish to reduce the error in the algorithm, you can decrease the time step \((\Delta t)\), perform the algorithm several times, and save the last prediction of the compartment size. The Runge-Kutta integration method is incorporated into the GLM program in listing 2.

**General Linear Model Program**

So far, I have discussed the general linear model form and two different algorithms for the numerical solution of differential equations. I have combined these two topics and written a general-user program for mathematically modeling a system of components described by linear differential equations, solved for 100 time increments with a Runge-Kutta integration algorithm. This program was written in Disk BASIC and is given in listing 2. To use this program, you enter the number of compartments in and environmental inputs to your system, an intercompartmental rate coefficient matrix \((A)\), the initial compartment values, an input coefficient matrix \((B)\), and the environmental input values. You must also enter the desired number of iterations of the Runge-Kutta algorithm. This value is the reciprocal of the...
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Listing 2: A general-user program written in Disk BASIC 8001 for mathematical modeling with a system of time-invariant linear differential equations. The equations are solved for 100 user time increments with a fourth-order Runge-Kutta integration algorithm. As the program is written, the simulation results are scaled and plotted versus time on a video monitor (Compucolor II microcomputer). This section of the program will have to be modified for other microcomputer systems. See table 1 for further information on the PLOT command.

10 REM ****** GENERAL LINEAR MODEL SIMULATION PROGRAM ******
11 REM ****** WITH RUNGA-KUTTA INTEGRATION ******
12 REM ****** COPYRIGHT 1980 ******
24 PLOT 12
25 PRINT "GIVEN:";
20 PRINT "1) THE-NUMBE R OF MODEL COMPARTMENTS"
21 PRINT "2) A VECT OR OF INITIAL COMPARTMENT SIZES"
45 PRINT "5) A MATRIX OF ENVIRONMENTAL INPUT COEFFICIENTS"
47 PRINT "6) A VECTOR OF ENVIRONMENTAL INPUT SIZES AND"
50 PRINT "7) THE NUMBER OF ITERATIVE INTEGRATION STEPS --"
51 PRINT "52 PRINT "THE MATCHES THE BEHAVIOR OF YOUR SYSTEM"
53 PRINT "54 PRINT "USING A RUNGA-KUTTA INTEGRATION ALGORITHM WITH THE"
55 PRINT "56 PRINT "OUTPUT PLOTTED AS A GRAPH ON THIS TERMINAL!"
74 PRINT "57 PRINT "HOW MANY COMPARTMENTS IN YOUR MODEL (N=1,7)?" IN
90 N= N + 1 "PRINT"
95 INPUT "HOW MANY INPUT ENVIRONMENTS IN YOUR MODEL (M=1,3)?" IN
99 NN= NN + 1
100 DIM A(N,N),B(N,NN),X(N),AX(N),XD(N),XP(N),XC(N),XRC(N)
105 PRINT "ENTER MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS"
110 PRINT "EFFECTIVE MATRIX OF INITIAL INPUT SIZES"
115 PRINT "EFFECT OF THE SIZES OF YOUR INITIAL INPUTS:";
120 PRINT "BEFORE INTEGRATION COMPLETED:";
125 PRINT "THIS PROGRAM WILL USE A SYSTEM OF TRANSITION"
130 PRINT "EQUATIONS TO SIMULATE THE BEHAVIOR OF YOUR SYSTEM"
135 PRINT "USING A RUNGA-KUTTA INTEGRATION ALGORITHM WITH THE"
140 PRINT "OUTPUT PLOTTED AS A GRAPH ON THIS TERMINAL!"
145 PRINT "THE NUMBER OF ITERATIVE INTEGRATION STEPS --"
150 PRINT "ENTER THE SIZES OF YOUR ENVIRONMENTAL INPUTS"
155 PRINT "ENTER THE NUMBER OF ITERATIONS OF THE ALGORITHM"
160 PRINT "ENTER THE NUMBER OF ITERATIONS OF THE ALGORITHM"
165 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
170 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
175 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
180 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
185 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
190 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
195 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM"
200 DT= 1/100
205 REM ****** START INTEGRATIVE LOOPT ************
210 FOR I= 1 TO N
215 FOR J= 1 TO N
220 FOR K= 1 TO NN:AX(J)= AX(J)+ K:NEXT K
225 FOR K= 1 TO NN:AX(J)= AX(J)+ K:NEXT K
230 FOR K= 1 TO NN:AX(J)= AX(J)+ K:NEXT K
235 FOR K= 1 TO NN:AX(J)= AX(J)+ K:NEXT K
240 REM ****** START INTEGRATIVE LOOP ************
245 FOR I= 1 TO N
250 FOR J= 1 TO N
255 FOR K= 1 TO N
260 FOR J= 1 TO N
265 FOR J= 1 TO N
270 REM ****** START INTEGRATIVE LOOP ************
275 FOR I= 1 TO N
280 REM ****** START INTEGRATIVE LOOP ************

Listing 2 continued on page 84
MULTIUSER

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Listing 2 continued:

299 FOR J= 0 TO N: NEXT J
300 FOR K= 0 TO N: NEXT K
310 FOR I= 0 TO N: NEXT I
315 FOR J= 0 TO N:
320 REM MAKE ESTIMATE OF STATE(X) AT TIME J
325 REM COMPUTE FINAL VALUES FOR STATE AT TIME J
330 REM STORE COMPARTMENT SIZES AT TIME J IN MATRIX
335 REM END OF ITERATIVE INTEGRATION LOOP
340 REM START OUTPUT
345 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
350 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
355 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
360 PRINT "INTEGRATION WAS:"; N+1
365 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
370 PRINT
375 REM END OF SEARCH
380 FOR I= 0 TO N: NEXT I
385 REM START PLOT OF OUTPUT MATRIX
390 FOR J= 0 TO N:
395 REM SCALE VALUES CALCULATED
400 REM "THE MODEL"
405 REM END OF SIMULATION
410 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
415 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
420 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
425 PRINT "INTEGRATION WAS:"; N+1
430 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
435 PRINT
440 FOR I= 0 TO N: NEXT I
445 NEXT J
450 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
455 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
460 PRINT "INTEGRATION WAS:"; N+1
465 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
470 PRINT
475 REM END OF SEARCH
480 FOR I= 0 TO N: NEXT I
485 REM START PLOT OF OUTPUT MATRIX
490 FOR J= 0 TO N:
495 REM SCALE VALUES CALCULATED
500 REM "THE MODEL"
505 REM END OF SIMULATION
510 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
515 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
520 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
525 PRINT "INTEGRATION WAS:"; N+1
530 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
535 PRINT
540 FOR I= 0 TO N: NEXT I
545 REM END OF SEARCH
550 REM START PLOT OF OUTPUT MATRIX
555 FOR J= 0 TO N:
560 REM SCALE VALUES CALCULATED
565 REM "THE MODEL"
570 REM END OF SIMULATION
575 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
580 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
585 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
590 PRINT "INTEGRATION WAS:"; N+1
595 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
600 PRINT
605 FOR I= 0 TO N: NEXT I
610 REM END OF SEARCH
615 REM START PLOT OF OUTPUT MATRIX
620 FOR J= 0 TO N:
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630 REM "THE MODEL"
635 REM END OF SIMULATION
640 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
645 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
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655 PRINT "INTEGRATION WAS:"; N+1
660 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
665 PRINT
670 FOR I= 0 TO N: NEXT I
675 REM END OF SEARCH
680 FOR J= 0 TO N:
685 REM SCALE VALUES CALCULATED
690 REM "THE MODEL"
695 REM END OF SIMULATION
700 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
705 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
710 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
715 PRINT "INTEGRATION WAS:"; N+1
720 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
725 PRINT
730 FOR I= 0 TO N: NEXT I
735 REM END OF SEARCH
740 FOR J= 0 TO N:
745 REM SCALE VALUES CALCULATED
750 REM "THE MODEL"
755 REM END OF SIMULATION
760 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
765 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
770 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
775 PRINT "INTEGRATION WAS:"; N+1
780 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
785 PRINT
790 FOR I= 0 TO N: NEXT I
795 REM END OF SEARCH
800 FOR J= 0 TO N:
805 REM SCALE VALUES CALCULATED
810 REM "THE MODEL"
815 REM END OF SIMULATION
820 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
825 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
830 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
835 PRINT "INTEGRATION WAS:"; N+1
840 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
845 PRINT
850 FOR I= 0 TO N: NEXT I
855 REM END OF SEARCH
860 FOR J= 0 TO N:
865 REM SCALE VALUES CALCULATED
870 REM "THE MODEL"
875 REM END OF SIMULATION
880 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
885 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
890 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
895 PRINT "INTEGRATION WAS:"; N+1
900 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
905 PRINT
910 FOR I= 0 TO N:
915 REM END OF SEARCH
920 FOR J= 0 TO N:
925 REM SCALE VALUES CALCULATED
930 REM "THE MODEL"
935 REM END OF SIMULATION
940 PRINT "THE NUMBER OF COMPARTMENTS IN THE MODEL IS:";N+1
945 PRINT "THE SIMULATION HAS CONTINUED FOR 100 USER TIME UNITS."
950 PRINT "THE NUMBER OF ITERATIONS OF THE ALGORITHM FOR EACH"
955 PRINT "INTEGRATION WAS:"; N+1
960 PRINT "THE MATRIX OF INTERCOMPARTMENTAL RATE COEFFICIENTS IS:
965 PRINT
970 FOR I= 0 TO N:
975 REM END OF SEARCH
980 FOR J= 0 TO N:
985 REM SCALE VALUES CALCULATED
990 REM "THE MODEL"
995 REM END OF SIMULATION

More than 125,000 microcircuit resistors per hour can be adjusted by ESI's PDP-11/04 controlled laser trimming systems. The Pascal-1 compiler has given ESI fast, precise control since 1976. ESI's Don Cutler says, "Pascal-1 offers two big advantages—real-time performance and real problem-solving power."

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Free case study.
Read why ESI, one of Oregon Software's 1700 customers, chose Pascal-1. Order your free copy of this eight-page case study by calling Oregon Software collect at (503) 226-7760 or by using the reader service card.
Text continued from page 80:

desired time step. The program will then simulate the system of compartments for 100 time units and plot a graph of the compartments versus time. To graph the compartment sizes, you must scale the simulation values and plot them on some output device. I have included code for this in listing 2, which will run unmodified on a Compucolor II microcomputer. If you intend to run this program on another computer, check to see if Disk BASIC 8001 coding is compatible with your system. See table 1 for information on the Compucolor PLOT command.

Using the GLM Program

When the Okefenokee swamp uplands hydrologic model is simulated with this program on a microcomputer (on an 8080 microprocessor), the execution time of the Runge-Kutta algorithm is 210 seconds. When Euler's method is used, the execution time is reduced to 51 seconds. This time savings can be beneficial, depending upon the computational accuracy of the microprocessor and systems software. It can be cost-effective to use the Euler algorithm if the computer computational error is larger than the difference in the error between the Euler and Runge-Kutta methods. To give you an idea of the memory requirements necessary for a simulation, the hydrologic model can be simulated with the program in listing 2 on an 8080 microprocessor, the execution time of the Runge-Kutta algorithm is 210 seconds. When the Okefenokee swamp uplands hydrologic model is simulated with the program in listing 2, photo 1 shows the zero-input response of the hydrologic model simulated with the program in listing 2. Photo 2 shows the zero-state response of the hydrologic model simulated with the same program.

You can start the simulation with different compartment sizes, a different environmental input size, or change the intercompartmental rate or input coefficients, and see how any or all of these changes will affect the outcome. I suggest that you devise a model that can be described with linear differential equations and simulate it at steady-state conditions. A good domestic simulation would be a model of heat losses, subsidies, and circulation within your home. If you have a slant toward business, you can simulate the flow of material or information into, within, and out of a commercial enterprise. As long as all the compartments and flows can be described in the same units, almost any type of measure can be simulated. Once you have completed the steady-state simulation, you can experiment with the GLM program to suit your taste. If you want to make the model more realistic, you can program the inputs to the system as sine waves, square waves, exponential functions, or an impulse function, instead of being constantly added as they are now. You can also test a compartment's sensitivity to a certain parameter by varying that parameter over its range and noting the differences in the compartment.

One warning: you must always be careful to analyze your simulations and decide if they actually mimic the real-world situation before you make sweeping generalizations and claims that you can predict how a system will behave under any given set of circumstances. With a little imagination, interesting and sometimes eye-opening results will be seen in mathematical simulations.

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The Dialog Information Retrieval Service

Stan Miastkowski, Technical Editor

No matter where we go or what we do, we're inundated with data. Each day magazines, newspapers, books, technical journals, and the broadcast media spew forth an amazing amount of material. One quickly learns that there is no way to possibly digest more than a tiny fraction of this material, and that's why this uncontrollable avalanche of paper and words has been aptly named the "information explosion." Fueling the frustration is the Herculean task of sifting through library-card catalogs and indexes to locate specific documents. It's a difficult and inefficient way to find the information you need. In addition, new problems crop up when you attempt to physically locate the texts you managed to find references to.

A much better method is available—if you have access to a modem (modulator-demodulator) and a terminal (or personal computer with communication software). The Dialog Information Retrieval Service (part of the Lockheed Missile and Space Company, Inc) offers on-line interactive access to literally millions of references and abstracts. With Dialog, you can locate information on any subject you can possibly imagine just by typing in words or phrases describing the topic you're interested in. You can search for references by names or companies, authors or publications, dates, product codes, or patent numbers (to name only a few). By combining terms, the information you come up with can be as narrow or as broad as you want it to be. And, reprints of the articles or papers you've found references to can be ordered directly from your terminal.

When speaking of the amount of information available on the Dialog system, the numbers become mind-boggling. Dialog has some 50 billion bytes of information available on-line in some 130 individual data bases. That works out to a rough total of about forty million individual bibliographic abstracts and references (referred to as citations). If all the citations were printed on 8½-by 11-inch paper, the stack would reach higher than the Empire State building.

The newspaper and magazine indexes are among the most popularly oriented data bases—although Dialog also offers a number of specialized data bases for those in education, industry, applied science and technology, and social science and the humanities. Business information and forecasts are also available. Eighteen new data bases were added to the system in 1980, and at least a dozen more will be available by the end of the year. The system is available 110 hours a week in fifty countries, and all data bases are updated regularly. Each day tens of thousands of new citations are added. Also, if you wish to create your own private data bases for use on the system, Dialog provides this service.
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- 70 to 100 bits-per-second speech synthesizer

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Type-'N-Talk™ is covered by a limited warranty. Write Votrax for a free copy.
At first glance, Dialog seems expensive. Each data base has an individual charge ranging from $15 to $300 per hour of connect time. (It should be stressed that the most-used data bases cost an average of $50 an hour.) The cost becomes much more reasonable when you realize that an exhaustive search of any subject can be completed in an average of ten minutes. (Simple searches often take only a minute or two.) In addition, Dialog’s response time is extremely fast because of the computer power available. Even during peak-use times, there is seldom a wait of more than ten seconds for the system to respond to a query.

It should be stressed that there are dangers inherent in using the Dialog system—especially if you’re an “information junkie.” It’s extremely easy to become so enamored of Dialog’s capabilities that you keep on calling up references and lose all track of time. The shock comes at the end of the month, when a very large bill arrives in the mail.

There are two ways to avoid this: the first is to plan what you’ll be doing when you’re logged on the system (explained in more detail below). The second is to keep track of your connect charges. Each time you log off or change data bases, Dialog prints an estimated charge. It’s a good idea to keep a pad and a pencil next to your terminal and to keep a running total of charges at the end of every session.

Once you locate what you want, you can have the references and abstracts typed on your printer, although this can get expensive at the normal speed of 300 bps (bits per second). A better way is to have the citations printed by Dialog’s off-line high-speed printer. The cost is minimal (normally $0.10 to $0.25 per citation) and they are mailed out the next day. Or, as mentioned above, you can order actual reprints directly from your terminal.

**Dialog History**

Dialog started modestly as an in-house research and development project at Lockheed in 1963. At that time, an information sciences laboratory was established to deal with what was then recognized as the coming “information explosion.” Two years later, what was essentially the first truly interactive information retrieval system was on-line for internal company use.

In 1968, Lockheed won a contract from NASA to design, program, implement, and maintain a computerized index for the half-million documents produced by the American space program. Called RECON (Remote Console Information Retrieval Service), the development process enabled Lockheed to fine-tune the specialized information retrieval command language, which was called Dialog.

After gaining more experience preparing information retrieval systems for the AEC (Atomic Energy Commission), the US Office of Education, and a number of other organizations, Lockheed, in 1972, decided to offer commercial service and officially named the system Dialog.
State-of-the-art hardware demands state-of-the-art software
Operating Systems & Support Software from Technical Systems Consultants

To perform to its fullest capabilities, your hardware demands software designed to meet the specialized requirements of today's microprocessors. State-of-the-art software from Technical Systems Consultants keeps pace with the rapid advancements in computer technology so your hardware can live up to its full potential. Our complete line of state-of-the-art software includes:

The UniFLEX™ Operating System
UniFLEX, a true multi-user, multitasking system for the 6800 and 6809 microprocessors, supports such features as:
- hierarchical file systems
- device independent I/O
- four Gigabyte disk capacities
- full file protection
- inter-task communication via pipes
- I/O rediretion
- task swapping
- full random-access files
- comprehensive shell command language

UniFLEX, structured for large-scale microprocessor systems, will not run with minimal systems and thus has avoided design compromise. (Off-the-shelf versions and OEM licenses are available.)

The FLEX™ Operating System
FLEX, a powerful, easy-to-use operating system designed for the 6800 and 6809 microprocessors, includes:
- dynamic filesystem allocation
- random files
- batch job entry
- automatic space compression
- English error messages
- user environment control
- disk resident commands
- flexible device I/O
- printer spooling

Plus, FLEX can accommodate hard disks as well as floppies. The System is available off-the-shelf for a variety of systems and in a field-adaptable version. (OEM licenses available.)

Support Software
Technical Systems Consultants offers a full line of state-of-the-art support software compatible to FLEX and UniFLEX, some of which are:
- native C and Pascal compilers for advanced programming
- extended BASIC for business and educational applications
- text editing and processing software
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- variety of absolute and relocatable assemblers
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... and more. Write or call today for our brochures describing our complete product line.
Industrial users continue to be Dialog’s largest customers since much of the information in the specialized data bases (such as WORLD ALUMINUM ABSTRACTS or SURFACE COATING ABSTRACTS) is virtually unavailable anywhere else. Government agencies are also heavy users of Dialog’s services—followed closely by educational institutions and libraries. Although personal computer users currently make up a very small percent-

age of Dialog customers, Lockheed officials told me they are in the process of adding more general-interest data bases to attract more individuals.

A Visit to Dialog

Dialog’s facilities are located in Palo Alto, California. As might be expected, the hardware needed to handle the enormous amount of information contained within the Dialog system has taken over a large portion of its building. For those used to working with a personal computer and a floppy disk or two, a visit to Dialog’s computer room is a humbling experience. Two mainframe computers (an IBM 3033 and an AS-9000) are both online at all times. When I visited Dialog in January, the AS-9000 had just been put on-line. This so-called “supermainframe” is sold in the United States by National Advanced Systems. Since its claimed speed far exceeds that of any other mainframe, a Dialog spokesman told me he expects it to greatly increase the system’s capacity.

The most interesting part of Dialog’s facilities are the hard-disk drives—some 200 of them. Most are CDC (Control Data Corporation) units capable of storing 637 megabytes per drive. Although direct dial-up numbers are available, the majority of Dialog users access the system through Tymnet or Telenet (national data-communication networks that have local telephone numbers in many communities).

Lockheed officials term Dialog a value-added on-line service supplier. All of the approximately 130 data bases are put together by seventy data base producers who have contractual agreements with Dialog. The process of producing and updating each of the data bases is a large one involving literally thousands of people who review publications, journals, and newspapers—many on a daily basis. Many reviewers work at home and transfer their citations to floppy disks, which are sent to the data base producers. The final step is to transfer all the citations to IBM magnetic tape. Between ten and twenty of these tapes, each containing about 20,000 new citations, arrive at Dialog headquarters every day. Before the information is added to the system, every word in all citations is indexed. This is one of the most powerful searching features of the system.

Popular Data Bases

Although many of Dialog’s data bases are extremely specialized (such as AQUACULTURE, BHRA FLUID ENGINEERING, or PHARMACEUTICAL NEWS INDEX), a number of the existing data bases are of general interest or of special significance to BYTE readers. Among them are:

- **ERIC** — One of the first Dialog data bases available, ERIC (Educational Resources Information Center) indexes some 700 publications of interest to every segment of the educational profession. About 3000 citations are added every month.
- **COMPENDEX** — This data base contains abstracted information from approximately 2000 of the world’s
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*Suggested U.S. retail price.
This data base contains bibliographic references only.

- **MAGAZINE INDEX** — Perhaps the most popularly oriented Dialog data base, this is a cover-to-cover index of about 370 popular American magazines since 1976 and contains some 300,000 citations. It’s particularly useful for most general-purpose reference questions since it indexes all articles, news reports, editorials, product evaluations, biographical pieces, short stories, poetry, recipes, and reviews. Approximately 5000 citations are added to this data base monthly.

- **SSIE CURRENT RESEARCH** — Compiled by the Smithsonian Science Information Exchange, this data base lists and summarizes most government-funded research projects either in progress or completed within the past two years.

- **GPO MONTHLY CATALOG** — This is the catalog (updated monthly) of US government publications.

- **ENERGYLINE** — This data base contains bibliographical citations as well as abstracts on all aspects of energy.

- **CONFERENCE PAPERS INDEX** — This is an index to meetings and symposia on all scientific and technical fields. Also included are references to conference papers (many of which have never been published). This is a very large data base to which about 10,000 citations are added each year.

- **NATIONAL FOUNDATIONS** — This lists all US private foundations that award grants for charitable purposes.

- **DISCLOSURE** — This data base, updated weekly, provides extracts of reports filed with the SEC (Securities and Exchange Commission) by all publicly owned companies in the United States.

- **NATIONAL NEWSPAPER INDEX** — This data base contains front-to-back indexing of The New York Times, The Wall Street Journal, and The Christian Science Monitor since January 1, 1979. It contains bibliographical references to everything included in the papers, with the exception of advertisements, weather charts, stock market tables, crossword puzzles, and horoscopes. About 15,000 new citations are added monthly.

- **NEWSEARCH** — This is a daily update of the MAGAZINE INDEX, MANAGEMENT CONTENT, the LEGAL RESOURCE INDEX, and the NATIONAL NEWSPAPER INDEX; it is invaluable for locating references within days of an article’s appearance.

- **ENCYCLOPEDIA OF ASSOCIATIONS** — This data base contains detailed information on approximately 15,000 national nonprofit organizations. Included are listings for professional societies, trade associations, labor unions, and cultural and religious organizations.

- **STANDARD AND POOR’S NEWS** — Provides extensive news coverage as well as financial reports on
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The Xerox 9700 high-speed printer used by Dialog for off-line printing of references. The printer operates at two pages a second and offers Dialog users a considerable savings over having their references printed out while logged onto the system. The average cost of having references printed off-line and mailed to you is $0.10 to $0.25 per citation.

over 9000 companies. This data base is the equivalent of the Standard and Poor's Daily News and Cumulative News and often features full-length news stories.

- DIALINDEX — This is perhaps the most useful of the Dialog data bases and contains a collection of the file indexes for all data bases. DIALINDEX is a low-cost data base that allows you to ascertain which data bases contain the information you're searching for.

- NTIS — Compiled by the National Technical Information Service of the US Department of Commerce, this data base contains citations to more than 700,000 US reports covering government-sponsored research and development and engineering. Information on almost any subject imaginable is contained within this massive data base.

In addition, there are data bases covering psychology, chemistry, agriculture, medicine, biology, physics, and many other fields and disciplines. Dialog provides a free catalog of all the available data bases.

The Dialog staff and data base producers are continually adding new data bases to the system. By the end of this year, plans call for the addition of a biography index with over five million names, a book review index, an index of the Congressional Record, the Federal Index, a grants index, data from the Bureau of Labor Statistics, and Medline (a medical information data base designed for both physicians and consumers).

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This fully static RAM board offers you the best of two worlds. Automatically switches between 8-bit or 16-bit operation, depending upon your CPU. High reliability, low noise design. 200 nsec. chips allow 8 Mhz. 8086 operation. Has extended addressing which can be disabled by a single switch. Prices: 1-9, $280; 10-19, $260.

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16K STANDARD RAM—this fully static RAM is frequently used by OEMs in systems which do not require bank select. High reliability, low noise circuits. Uses 200 nsec. chips. Addressable to any continuous 16K on 4K boundaries. Any 4K block may be disabled. Prices: 1-9, $265; 10-19, $245.

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AVAILABLE JULY 6—This state-of-the art board uses 2167 16K static 70/100 nsec. chips in a "power down" mode. This means you can expect the first 64K in a system to use 1.6 amps with subsequent boards using about .8 amps each. Built for the same high reliability you have come to expect from using our other boards. Has 24-bit extended addressing which can be disabled. Initial quantities will be limited—reserve yours now to ensure early delivery. Prices: 1-9, $1295; 10-19, $1195.

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CCS Parallel Print Cd. 7720A ........... 155
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ROMPLUS (keyboard filter extra) .... 159
SSM AIO Serial/Parallel I/O
Assembled & Tested .................... 189
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Intro 1-X10 Controller Only ......... 169
M&R Sup-R-Term 80 column board ..... 329
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number of advanced searching functions are available; however, they probably won't be needed until you have quite a bit of experience on the system. Dialog's searching commands are simple, straightforward, and easy to learn. Dialog representatives do offer formal training classes on a regularly scheduled basis at locations throughout the country. However, they're mainly designed for those with no computer experience and those who will be using Dialog as a regular part of their job (such as librarians). New users are given some free time on the system in order to have an opportunity to get a feel for how Dialog works.

Listing 1: A typical search on the Dialog Information Retrieval Service—using the MAGAZINE INDEX database. For the most efficient use of the system, as well as lower cost to the user, the search strategy (steps) should be planned on paper before logging in. See the text box of Basic Dialog Commands for a summary of the Dialog language. A SELECT statement can be up to 240 characters (when Boolean operators are used). Each search can create up to 98 sets, and there is a limit of one million citations per search.

```
? SELECT COMPUTER?
   1 4231 COMPUTER
?
? SELECT MICROCOMPUTER?
   2 308 MICROCOMPUTER
?
? SELECT STEPS PERSONAL (W) COMPUTER? OR MHOME (W) COMPUTER?
   3 122 PERSONAL (W) COMPUTER?
   4 185 HOME (W) COMPUTER?
   5 185 3 OR 4
?
? SELECT SS AND JN =BYTE
   6 24 JN=BYTE
   6 26 JN=BYTE

? TYPE 6/1/1
   1536795

? TYPE 6/2/1
   6/2/1 1536795
   FCC regulation of personal- and home-computing devices. (Federal Communications Commission)
   Mahn, Terry G.
   Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ
   DESCRIPTORS: United States. Federal Communications Commission-rules and regulations; computers-rules and regulations
   IDENTIFIERS: personal computers-rules and regulations

? TYPE 6/3/1
   6/3/1 1536795
   FCC regulation of personal- and home-computing devices. (Federal Communications Commission)
   Mahn, Terry G.
   Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ

? TYPE 6/4/1
   6/4/1 1536795
```

Listing 1 continued on page 104
You'll be a little richer after building one of these.

Richer in knowledge
Once you build your own computer, you'll know it inside out. You'll know how to make it work for you, how to make it grow as your skills grow.

Richer in savings
Build-it-yourself kits cost less—about 30% less than comparable assembled computers. And you'll probably never need to pay someone for service because no one will know your computer better than you.

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Heath offers you innovative programs for running your home or business, and exciting games for your family. You can have Microsoft™ BASIC™, one of the most powerful and widely used languages.

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Listing 1 continued:

FCC regulation of personal- and home-computing devices. (Federal Communications Commission)

? TYPE 6/3/1-20
6/3/1
1536795
FCC regulation of personal- and home-computing devices. (Federal Communications Commission)
Mahn, Terry G.
Byte v5 p180(7) Sept 1980 CODEN: BYTEDJ

6/3/2
1522838
The Heath H-89 computer. (evaluation)
Dahmke, Mark
Byte v5 p46(6) Aug 1980 CODEN: BYTEDJ
illustration

6/3/3
1508584
Bills introduced in Congress. (dealing with personal computers)

6/3/4
1508580
A personal computer on a student's budget.
Johnston, J.C.
Byte v5 p186(6) June 1980 CODEN: BYTEDJ
illustration

6/3/17
1017592
User's report: the PET 2001. (evaluation)
Fylstra, Dan
Byte v3 p114(9) March 1978

6/3/18
1017578
Personal computers in a distributed communications network.
Steinwedel, Jeff; S
Byte v3 p80(8) Feb 1978

6/3/19
1017469
Speech recognition for a personal computer system.
Boddie, James R.
Byte v2 p64(7) July 1977

6/3/20
1017464
Personal computer network.
Byte v2 p59(2) Sept 1977

? END/SAVE
Serial number of search strategy (steps used)

Listing 1 continued on page 106
POWER-ONE
D.C. POWER SUPPLIES

Our customers select their favorite models

The choice wasn't easy. Not with 105 open frame linears and a full switcher line to choose from. Still, the top models of the past year — proudly pictured below — have been named.

Actually, this is a statement of Power-One's most popular D.C. power supplies — as determined by our customers. Obviously, applications vary widely, from small floppies and micro-computers to large mainframe systems.

But one thing they all have in common. They’re built by Power-One. Which means the most reliable power supplies available, at the lowest cost possible.

So take a look at our entire line. Send for our new 1981 Catalog and Facilities Brochure for details.

### Switchers
- Hi-Tech Design
- High Efficiency - 75% min.
- Compact/Light Weight
- 115/230 VAC Input
- 20 msec Hold-up
- Totally Enclosed Packaging
- Two Year Warrantee
- 24 Hour Burn-in

### SINGLE OUTPUT
- 5V to 24V Models
  - SD, 60W: $115.00
  - SP, 100W: $170.00
  - SK, 200W: $250.00

### MULTIPLE OUTPUT
- 150 Watts
  - 5V @ 20A
  - 12V @ 5A
  - 5V to 24V @ 3.5A
  - User Selectable
  - SHQ-150W: $295.00

### QUME PRINTER SUPPLY
- 5V @ 10A
- ± 15V @ 4.5A/16A Peak
- SP305: $345.00

### Disk-Drive
- Powers Most Popular Drives
- 7 "Off the Shelf" Models
- Powers Drives & Controller
- UL & CSA Recognized
- 115/230 VAC Input

### 5¼" FLOPPY SUPPLIES
- CP340, 1 Drive: $44.95
- CP323, Up to 4 Drives: $74.95

### 8.0" FLOPPY SUPPLIES
- CP205, 1 Drive: $69.95
- CP206, 2 Drives: $91.95
- CP182, Up to 4 Drives: $120.00

### WINCHESTER SUPPLIES
- 2 Models to Power any Manufacturer's Drive
- CP379, CP384: $120.00

### Open-Frame Linear
- Industry Standard Packages
- 115/230 VAC Input
- ±.05% Regulation
- Two Year Warrantee
- UL & CSA Recognized
- Industry's Best Power/Cost Ratio

### SINGLE OUTPUT
- 5V @ 3A
- 12V @ 1.7A
- 15V @ 1.5A
- HB Series: $24.95
- 24V @ 1.2A
- 28V @ 1.0A
- 250V @ 0.1A

### SINGLE OUTPUT
- 5V @ 6A
- 12V @ 3.4A
- 15V @ 3.0A
- HG Series: $44.95 to $49.95

### DUAL OUTPUT
- ± 12V @ 0.8A
- ± 15V @ 0.5A
- HAA15-0.8: $39.95

### TRIPLE OUTPUT
- 5V @ 3A
- ± 12V @ 1A or
- ± 15V @ 0.8A
- HBAA-40W: $69.95

### TRIPLE OUTPUT
- 5V @ 2A
- ± 9V to ± 15V @ 0.4A
- HTAA-16W: $49.95

### POWER FAIL MONITORS
- Indicates pending system power loss.
- Monitors AC line and DC outputs.
- Allows for orderly data-save procedures
- PFM-1: $24.95
- PFM-2: $39.95

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Listing 1 continued:

```sql
? BEGIN [111]
File11i: National Newspaper Index
(Copr. IAC)
Set Items Description (+=OR; *=AND; -=NOT)
--------- --------- ---------

? .EXECUTE 40D1
1588 COMPUTER?
7 MICROCOMPUTER?
23 PERSONAL(W)COMPUTER?
19 HOME(W)COMPUTER?
35 3 OR 4
0 JN=BYTE

? BEGIN 47
File47+: Magazine Index
(Copr. IAC)
Set Items Description (+=OR; *=AND; -=NOT)
--------- --------- ---------

? EXPAND COMPUTER
Find all index terms alphabetically close to specified term

Ref Index-term Type Items RT
E1 COMPUTATIONAL COMPLEXITY 1
E2 COMPUTATIONS-------------- 1
E3 COMPUTE------------------ 4
E4 COMPUTED----------------- 3
E5 COMPUTE----------------- 2
E6 COMPUTER----------------- 3228
E7 COMPUTER AIDED DESIGN---- 24
E8 COMPUTER AND BUSINESS EQUIPMENT MANUFACTUR-- 2
E9 COMPUTER AND COMMUNICATIONS ASSOCIATION------ 1
E10 COMPUTER AND COMMUNICATIONS INDUSTRIES ASS---- 1
E11 COMPUTER AND SYSTEMS ENGINEERING LTD.-- 1
E12 COMPUTER ANIMATION----- 5
E13 COMPUTER APPLICATIONS CORP.----------------- 2
E14 COMPUTER ARCHITECTURE-- 2
```

Text continued from page 102:

**Searching**

A Dialog spokesman stressed to me the importance of developing a general search strategy. This means sitting down with paper and pencil before logging on to the system, organizing questions or topics into logical groups, and then combining the groups through the use of logical (Boolean) relationships. This is an important point since wasting time with an inefficient searching strategy can become very expensive.

Since every word in every citation is indexed, the key to efficient searching is being as specific as possible. For example, the MAGAZINE INDEX contains 1.3 million individual citations; searching for all references to COMPUTER? (the ? is a "wildcard" character that matches any letters at the end of the word) yielded 4251 citations (see listing 1). Obviously, steps must be taken to pare down the number of citations by being much more specific. Searching for MICROCOMPUTER? yielded 308 citations, still a healthy number. HOME(W)COMPUTER? OR PERSONAL(W)COMPUTER? yields 185 citations. (The (W) indicates the two words must be adjacent to one another.)

Besides the every-word indexing, all Dialog data bases contain special indexes that vary from file to file. If I wish to search for all home and personal computer articles in BYTE, I can AND my set of 185 citations with JN=BYTE—giving me a total of twenty citations. There are also special indexes which allow you to specify publication year, author name, article type (such as product review), or a number of other special features. Obviously, sitting down beforehand and planning your search
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*Runs on most 286/8080/8085 microcomputers with CP/M (TM of Digital Research). 48K, and terminal with addressable cursor.

Apple computer installation requires MicroSoft Softcard and 80 column video board.
Basic Dialog Commands

Although there are many commands available in the Dialog searching language, a small number are the only ones used for the majority of searches. They include:

- **EXPLAIN** — an on-line help file that provides a detailed description of any specified command. The file also contains a list and description of all available data bases and system news.
- **SELECT** — sets aside index terms or groups of terms you specify into numbered sets (up to 98). More than one term can be combined into a single SELECT statement by inserting Boolean operators between terms. For example:
  
  ```
  SELECT PETROLEUM AND PRICES AND OPEC AND PY=1979
  ```
  
  A command line can contain up to 240 characters.
- **SELECT STEPS** — similar to SELECT, except that each individual item in a single command statement is assigned its own set number.
- **EXPAND** — used to display a listing of index terms that are alphabetically close to the term entered. Each term is given a reference number that can be SELECTed, and the number of individual entries for each term is listed.
- **TYPE** — displays records on-line from the sets you've previously retrieved. A number of different formats and ranges can be entered. For example, the Dialog reference number, the title only, or the full record can be displayed.
- **PRINT** — orders the specified search results to be printed off-line using Dialog's high-speed printer. The printouts are normally received in three to four days. If you've retrieved a large number of references and/or abstracts, having them printed off-line is considerably less expensive than using connect time to dump them to your own printer.
- **END/SAVE** — ends a search session and saves the search strategy (individual steps) you've used in an individual data base. The strategy is saved until the end of the calendar day and in that period can be used in other data bases by using the .EXECUTE command.
- **.EXECUTE** — searches a data base using the search strategy saved by the END/SAVE command. This eliminates the time and expense of having to enter individual steps every time a different data base is entered.
- **END/SDI** — ends a search session and instructs the Dialog system to run the same search strategy in the specified file each time the file is updated. If new information is found, it is printed off-line and mailed to you. (This service is not available on all Dialog files.)
- **KEEP** — saves the references and/or abstracts you specified in a special set from which documents may be ordered using Dia/Order.
- **.ORDER** — automatically orders reprints specified by the KEEP command. The document supplier can be specified from a list supplied by Dialog.

For more information on Dialog and an application for service, contact:

Dialog Information Retrieval Service
Department 52-89/BT
3460 Hillview Ave
Palo Alto CA 94304
(800) 772-3545, ext 518
California (800) 772-3545, ext 518

makes the process proceed much more quickly, smoothly—and inexpensively.

If you have problems finding the correct search strategy, there is a toll-free hotline number to Dialog's Customer Service Department, which is open twelve hours a day. Besides helping beginning searchers, there is a specialist on each data base available who can help with a particularly complicated search.

Other Features

Dialog allows you to reconnect to the system within ten minutes of a disconnect (such as being dropped by one of the networks). Up until this time limit, all the set you've created will still be in the user area. Unfortunately, if the disconnect lasts longer, you'll have to start again from the beginning.

Users who wish to keep their own private data bases on the Dialog system can do so through the Private File Service. The cost for storage of data is $12 per million characters per month. Currently, in order to take advantage of the Private File Service, users must supply Dialog with IBM reel-to-reel tapes. However, Dialog's staff is in the process of developing a method that will enable users to build up their personal data bases from their own terminal.

Summary

Dialog is an invaluable service for anyone who needs to locate information on any imaginable subject from aardvarks to zymurgy. (Remember, the system is not designed to be everything to all people. Unlike the Source or Micronet, you can't play games or get the latest news from one of the wire services; not only are those services unavailable, but the cost of just "browsing" adds up very quickly.) Although the cost of the service seems expensive, the system's speed, efficiency, and interactive nature make it a net time and money saver when it's used for its intended purpose—finding references to information.

A Dialog staffer put it this way: "On the system, searching is an adventure." I can add that this adventure is much less frustrating than the computer game of the same name.
<table>
<thead>
<tr>
<th>ATARI</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Special 32K 800 System</td>
<td>$935</td>
<td>800 (16K)</td>
<td>$770</td>
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<tr>
<td>400</td>
<td>Call</td>
<td>810 Disk Drive</td>
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<td>825 Printer</td>
<td>$710</td>
<td>850 Interface</td>
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<td>410 Recorder</td>
<td>$70</td>
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<td>Zenith</td>
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<td>Z-89 48K</td>
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<td>BASF</td>
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<td>Scotch</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>5½-0, 10, 16 Sector (Qty 100) $250</td>
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<tr>
<td></td>
<td></td>
<td>8½-0, 32 Sector (Qty 100) $260</td>
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<table>
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<th>MONITORS</th>
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<tr>
<td>APF - 9&quot; Monitor</td>
<td>$115</td>
<td>Sanyo - 9&quot; Monitor</td>
<td>$165</td>
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<th>SOFTWARE</th>
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<td>Centa Systems</td>
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<td>Adds</td>
<td>Call</td>
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<td>IQ 120</td>
<td>Call</td>
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<tr>
<td></td>
<td></td>
<td>IQ 135</td>
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A Computer-Based Laboratory Timer

John Gibson
Physics Department
Alma College
Alma MI 48801

Accurate time measurement is a fundamental requirement of every elementary physics laboratory. Thanks to modern electronics, most laboratories now use digital timing devices that are activated by photocells or microswitches. This is a great improvement over the hand-operated mechanical stop-clocks that were prevalent only a few years ago, but most electronic timers are still unsatisfactory in one important respect: only the most sophisticated (and expensive) are able to rapidly make and record a succession of elapsed-time measurements.

Data acquisition and logging are natural provinces of the microcomputer. Since small microcomputers and microcomputer trainers are now so widely available, it is only natural to try to adapt them for use in a variety of laboratory measurements. This article will show how a very modest microcomputer can be wired and programmed for use as a sophisticated laboratory timer.

First we will examine the system-independent design considerations for a microcomputer-based, two-channel, data-logging, millisecond timer. Then we will build this design on a Heath ET-3400 microprocessor trainer used with the ETA-3400 expansion accessory.

The Programmable Timer

The heart of this design is a microcomputer peripheral device called a programmable timer. This device connects directly to the microcomputer bus and may be configured (by software) to perform the timing measurements required. When the programmable timer and microcomputer are connected for use as a laboratory timer, there is a clear division of labor: the programmable timer performs the time measurements, and the microcomputer records the results.

Figure 1 is a programming model of a common programmable timer. In addition to its connections to the microcomputer bus, the timer also has a gate input \( G \), an external clock input \( C \), and an output \( O \). Inside the timer are three addressable registers:

- An 8-bit, write-only control register that is used to establish the timer’s operating mode, in much the same way as a control register configures the operation of a common PIA (peripheral interface adapter);
- A 16-bit write-only latch. Its contents are divided into two 8-bit bytes, called \( M \), for the more-significant (or high-order) byte, and \( L \), for the less-significant (or low-order) byte. The latch’s contents are preset to hexadecimal FFFF on system power-up or \( \text{RESET} \), and they may be changed at any time by the program running in the microcomputer;
- A 16-bit write-only counting register. A momentary logic-0 level at the timer’s gate input causes this register to be loaded with bytes \( M \) and \( L \) from the latch. The counting register then decrements on each cycle of a specified timing signal. Further operating details are dictated by the timer’s operating mode.

Text continued on page 114
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BYTE June 1981 113
The programmable timer is a versatile device with several operating modes, two of which are useful for elapsed-time measurements:

- **Pulse-width-comparison mode**, in which the timer measures the length of time its gate input is held at logic 0;
- **Frequency-comparison mode**, in which the timer measures the time between two successive logic Os at its gate input.

These two types of time measurement are illustrated in figure 2.

**Time-Interval Measurement**

Each elapsed-time measurement consists of six steps. The first three steps are performed by the programmable timer, and the last three are performed by the microcomputer.

The following three measurements are those performed in sequence by a timer programmed for operation in the **pulse-width-comparison mode** (by storing hexadecimal 58 in its control register):

1. The timer’s gate input, normally at logic 1, is pulled to logic 0 at the beginning of the timed event. This loads the timer’s counting register with bytes M and L from the latch.
2. The counting register then decrements on each cycle of a timing signal applied to the timer’s external-clock input and continues to do so while the gate input is held at logic 0.
3. The gate input is driven back to logic 1 at the end of the timed event. If this occurs before the counting register reaches zero, the count stops, and the timer generates a program interrupt by pulling the microcomputer’s active-low IRQ (interrupt-request) line to logic 0.

The three measurement steps performed by a timer programmed for operation in the **frequency-comparison mode** (by storing hexadecimal 48 in its control register) are as follows:

1. The timer’s gate input, normally at logic 1, is pulled to logic 0 at the beginning of the timed event. This loads the timer’s counting register with bytes M and L from the latch.
2. The counting register then decrements on each cycle of a timing signal applied to the timer’s external-clock input and continues to do so while the gate input is held at logic 0.
3. The gate input is driven back to logic 1 at the end of the timed event. If this occurs before the counting register reaches zero, the count stops, and the timer generates a program interrupt by pulling the microcomputer’s active-low IRQ (interrupt-request) line to logic 0.

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logic 1, is momentarily pulled to logic 0 at the beginning of the timed event. This loads the timer's counting register with bytes M and L from the latch.
2. The counting register then decrements on each cycle of a timing signal applied to the timer's external-clock input and continues to do so, even though the gate input returns to logic 1.
3. The gate input is again momentarily pulled to logic 0 at the end of the timed event. If this occurs before the counting register reaches zero, the count stops, and the timer generates a program interrupt by pulling the microcomputer's IRQ line to logic 0.

For either operating mode, the timer ends its three-step sequence by signaling the microcomputer over its IRQ line. The microcomputer's task begins when it receives the interrupt signal indicating that the timer has finished a count. The microcomputer then takes over the last three steps and:
4. Reads the timer's counting register.
5. Transforms the count into a useful measurement of elapsed time.
6. Saves the result.

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measurement steps in detail.
Step 1 is initiated by the gating
device (e.g., a photocell) that is con­
ected to the programmable timer's
gate input. Figure 3 shows two cir­
cuits for coupling phototransistors to
the timer.
In figure 3a, the phototransistor is
illuminated normally, and the pro­
grammable timer's gate input is held
at logic 1. An object passing in front
of the phototransistor will cause the
programmable timer's gate input to
be pulled to logic 0 and held there for
as long as the light is blocked. If the
timer is operating in the pulse-width­
comparison mode, it will measure the
length of time the light is blocked. If it
is operating in the frequency-com­
parison mode, the timer will measure
the elapsed time from the first extinc­
tion of the light to the second.
In figure 3b, both phototransistors
are normally illuminated, and the
timer's gate input is held at logic 1.
An object passing in front of either
phototransistor produces a momen­
tary logic 0 at the programmable
timer's gate input. A second momen­
tary logic 0 occurs as the object passes
in front of the second phototran­
sistor. If operated in the frequency­
comparison mode, the timer will
measure the time from the first extinc­
tion of the light (at one phototran­
sistor) to the second (at the other
phototransistor).

Text continued on page 122

Pulse-Width
Comparison

Frequency
Comparison

Figure 2: The time intervals measured by
the programmable timer for the pulse­
width and frequency-comparison modes.
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<td></td>
<td>No.'s 1-4</td>
<td>$70</td>
</tr>
<tr>
<td></td>
<td>No.'s 5-8</td>
<td>$70</td>
</tr>
<tr>
<td></td>
<td>Post. &amp; hand. ($3 in US, $6 overseas)</td>
<td>$...</td>
</tr>
</tbody>
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Step 2 states that the counter decrements on each cycle of an external timing signal. The period of this timing signal therefore becomes the limit of resolution of any time measurement. My applications required elapsed-time measurements that were accurate to the nearest ms (millisecond). This resolution was achieved by applying a 1 kHz timing signal to the timer's external-clock input. (Later I will describe how this timing signal is produced by using another programmable timer to scale the microprocessor's clock frequency.)

Step 3 says that the count stops, and the microcomputer is signaled, if the timed event ends before the counting register decrements to zero. Recall that the timer's latch is preset to unsigned 65,535 (hexadecimal +sv).

Figure 3: Two circuits for connecting phototransistors to programmable-timer gate inputs. Figure 3a shows control of the timer gate by a single phototransistor; figure 3b shows control by two phototransistors.

These type-555 integrated circuits are not used as timers; instead, they serve as inverting comparators. A 555 component connected in this manner has an input hysteresis in excess of 1.6 V, twice that of a type-7413 Schmitt trigger.

The 10 k-ohm resistor is chosen to saturate the phototransistor when illuminated, and hold it near its cutoff point when the light is blocked. The 10 k-ohm resistance is optimal for a 1 W incandescent bulb located 5 cm (approximately 2 inches) in front of the phototransistor. Other setups may require a different resistor.
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Circle 67 on inquiry card.
Listing 1: Interrupt-service routine for reading a programmable timer's counting register, converting the number to a decimal elapsed time and saving the result.

<table>
<thead>
<tr>
<th>Line</th>
<th>Label</th>
<th>Op Code</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LDA A M</td>
<td>LDA B L</td>
<td>Read the timer's counting register and clear the timer's interrupt request.</td>
</tr>
<tr>
<td>2</td>
<td>LDX POINT</td>
<td>CPX #LAST+3</td>
<td>Fetch the pointer.</td>
</tr>
<tr>
<td>3</td>
<td>STA A 0,X</td>
<td>ARE all memory locations loaded?</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>INX</td>
<td>INX</td>
<td>Branch if all are loaded.</td>
</tr>
<tr>
<td>5</td>
<td>INX</td>
<td>BSR B0</td>
<td>Perform a subroutine that converts the 2-byte hexadecimal number in 0,X, 1,X and 2,X to a 2½-byte BCD number in 0.X, 1.X and 2.X.</td>
</tr>
<tr>
<td>6</td>
<td>COM A</td>
<td>COM B</td>
<td>Complement the count to get the hexadecimal elapsed time.</td>
</tr>
<tr>
<td>7</td>
<td>STA A 1,X</td>
<td>STA B 2,X</td>
<td>Save the hexadecimal elapsed time in this memory location.</td>
</tr>
<tr>
<td>8</td>
<td>STA A 1,X</td>
<td>STA B 2,X</td>
<td>Save the hexadecimal elapsed time in this memory location.</td>
</tr>
<tr>
<td>9</td>
<td>LDA A #$80</td>
<td>STA A 0.X</td>
<td>Set bit 7 to show that this memory location has been loaded.</td>
</tr>
<tr>
<td>10</td>
<td>LOA A 1,X</td>
<td>STA A 0.X</td>
<td>Perform a subroutine that converts the 2-byte hexadecimal number in 1.X and 2.X to a 2½-byte BCD number in 0.X, 1.X and 2.X.</td>
</tr>
<tr>
<td>11</td>
<td>INX</td>
<td>INX</td>
<td>Advance the pointer to the next 3-byte memory location.</td>
</tr>
<tr>
<td>12</td>
<td>STX POINT</td>
<td>Save the new pointer value.</td>
<td></td>
</tr>
</tbody>
</table>

Step 4 begins the program's interrupt-service routine by reading the timer's counting register. Aside from fetching the counting register's contents, this step has another purpose: the read operation causes the programmable timer to release the microcomputer's IRQ line. This is important, because it is the only way the timer's interrupt request can be cleared.

Step 5 indicates a need for transforming the count. The quantity read from the timer's counting register (for a 1 kHz timing signal) is the hexadecimal number of milliseconds remaining until the counter decrements to zero. To be useful, this number should be transformed into the decimal number of milliseconds elapsed during the timed event. This transformation is a two-step process:

5a. Convert the hexadecimal milliseconds remaining to hexadecimal milliseconds elapsed during the timed event.

5b. Convert the hexadecimal milliseconds to decimal milliseconds.

Step 5a is easily performed. If the timer's counting register is set to hexadecimal FFFF at the beginning of the count, the hexadecimal number of elapsed milliseconds is equal to FFFF—n, where n is the remainder read from the counting register at the end of the timed event. But, since FFFF—n is just the one's complement of n, step 5a simply requires taking the one's complement of the number read from the counting register.

Step 5b is a hexadecimal-to-decimal conversion routine. Any appropriate routine may be used here. Listing 2 contains a fully documented demonstration program that includes a suitable hexadecimal-to-decimal conversion routine.
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Step 6 states that the microcomputer must save the result (i.e., save the transformed time measurement). If several time measurements are made in rapid succession, the computer must log these results in a manner that permits easy access.

Successive time measurements are saved in successive 3-byte memory locations in a reserved memory block. Why 3 bytes? Although the binary number read from the timer's counting register is contained in only 2 bytes, that number converted to decimal form may require five BCD (binary-coded decimal) digits (for a maximum elapsed time of 65,535 ms). Stored in "packed" BCD form, such a number occupies 2½ bytes of memory. I allow 3 bytes, because I use bit 7 of the most-significant byte as a flag that is set when the memory location has been loaded with a measured time.

Listing 1 is a set of MC6800 instructions for accomplishing steps 4, 5, and 6 of the measurement sequence. This interrupt-service routine reads the timer's counting register, transforms the count into a decimal-radix elapsed time, and saves the result.

Lines 3, 4, and 5 of the listing merit further explanation. POINT always contains the address of the next memory location in which a time measurement will be stored. Line 3 loads the index register with this pointer. Line 4 examines the pointer to see if the allocated memory space has been exceeded. If it has, line 5 causes a skip of the remaining steps.

Notice that the testing of the pointer does not occur until after the timer's counting register has been read (lines 1 and 2). The counting register must always be read, whether or not the results are to be saved. Otherwise the timer's interrupt request will not be cleared.

**A Programmable-Timer Module**

Thus far, I have described how a single programmable timer may be used with a microcomputer to measure and log elapsed times of successive events. I now wish to show how a particular commercial device, the Motorola MC6840 programmable-timer module, may be used in the design of a two-channel event timer.

Figure 4 is a pin-assignment diagram for the MC6840. This integrated circuit contains three independent programmable timers, each with gate input, external-clock input, and output. There are ten addressable registers. Nine of these are the control registers, latches, and counting registers for the three timers; the tenth is a status register containing interrupt flags. (Details of register selection for the MC6840 were described in my earlier article, "A Computer-Controlled Light Dimmer," January 1980 BYTE, page 56.)

A two-channel event timer requires the use of one programmable timer for each channel. If timer 1 is assigned to channel 1 and timer 2 is assigned to channel 2, then timer 3 may be used to scale the microprocessor clock frequency to provide the timing signal required by timers 1 and 2.

To operate as a frequency scaler, timer 3 must be configured for use in the continuous operating mode. This is achieved by grounding the timer's gate and loading hexadecimal 82 into its control register. The timer then produces a square wave whose frequency is equal to that of the microprocessor clock frequency.

![Pin-assignment diagram for the Motorola MC6840 programmable-timer module.](image-url)
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The status register is an 8-bit, read-only register containing interrupt flags. It shares an address with control register 2 (CR2). The R/W line selects whether CR2 is written or the status register is read. Individual bits of the status register are assigned as shown in table 1.

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Figure 5: Connection of the MC6840's timer-section 3 for use as a frequency scaler. The microprocessor's clock frequency is divided by \(2(n+1)\) to provide a timing signal to timers 1 and 2.

comparison mode or the frequency-comparison mode, then its individual interrupt flag is set whenever the timer completes a time measurement before its counting register decrements to zero. The flag is automatically cleared when the status register and the timer's counting register are read (in that order).

The composite interrupt flag is the logical OR of the individual interrupt flags. For the operating modes that I have selected for the three timers, the composite interrupt flag will be clear only if both the timer 1 and timer 2 flags are clear. (Timer 3's configuration as a scaler prevents it from affecting the composite interrupt flag.)

The MC6840 pulls the microcomputer's IRQ line low when the composite interrupt flag is set, which, for these operating modes, is whenever the timer 1 or timer 2 individual interrupt flags are set. The IRQ line is released only when both timer 1 and timer 2 individual interrupt flags are cleared.

Upon receipt of the interrupt request (IRQ line pulled low), the microcomputer performs an interrupt-service routine that examines the status register to find which timer's interrupt flag is set. With that deter-

----------

**Table 1: Assignment of bits in the status register of the Motorola MC6840 programmable-timer module.**

| Bit 0 | Timer 1 individual interrupt flag. |
| Bit 1 | Timer 2 individual interrupt flag. |
| Bit 2 | Timer 3 individual interrupt flag. |
| Bit 3 | Composite interrupt flag. |
| Bits 4 thru 7 | All read as zero. |

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### Listing 2: Complete timer-demonstration program for using the Motorola MC6840 with Heath’s ET-3400 microcomputer trainer

The demonstration program (see listing 2) assumes the availability of 340 bytes of memory for program storage. This exceeds memory available in the trainer alone, unless some page-zero memory is used for this purpose. Addition of the ETA-3400 expansion accessory easily provides the additional program-storage space required.

Figure 6 is a complete circuit diagram for the two-channel, millisecond timer. The entire circuit (except for the phototransistors) may be wired on the trainer’s built-in breadboard socket (see photo 1).

Figure 6 contains one system-dependent feature that requires explanation. The ET-3400 trainer uses a bidirectional buffer to couple its data bus to outside devices. Normally set in the write (output) state, this buffer is placed in the read (input) state by pulling the trainer’s RE (read enable) line low. The 7445 binary-to-decimal decoder in figure 6 provides the address decoding needed to do this each time the trainer reads the MC6840 registers.

**Text continued on page 144**
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Listing 2 continued:

00030 0003 L1 EQU CR143
00032 0004 M2 EQU CR144
00033 0005 L2 EQU CR145
00035 0006 M3 EQU CR146
00036 0007 L3 EQU CR147

00038 * THESE ET-3400 MONITOR SUBROUTINES ARE USED.
00040 FCBC REDIS EQU $FCBC /RESETS DISPLAY TO 1ST LED
00041 FE2B OUTFTH EQU $FE2B /DISPLAYS HEX DIGIT FROM 'A'
00042 FE3A OUTFCH EQU $FE3A /DISPLAYS CODED CHARACTER
00043 FDBB ENCODE EQU $FDBB /RETURNS KEY'S HEX VALUE
00044 FD7B DISPLAY EQU $FD7B /DISPLAYS HEX DIGIT STRING
00046 * THESE STEPS INITIALIZE TimERS 1 AND 2 FOR USE IN
00047 * THE PULSE WIDTH COMPARISON MODE IN WHICH AN IRQ
00048 * INTERRUPT IS GENERATED AT THE END OF EACH TIMED
00049 * INTERVAL. TIMER 3 IS USED TO SCALE THE 1MHZ
00050 * MICROPROCESSOR CLOCK TO PROVIDE A 1KHZ EXTERNAL
00051 * CLOCK FREQUENCY TO TIMERS 1 AND 2.
00053 0100 ORG $100 /START FROM THIS ADDRESS.
00055 0100 0F START SEI /MASK IRQ INTERRUPT
00057 0101 CE 01F3 LDX #499 /SCALING FACTOR = (2499+1)
00058 0104 FF 8006 STX M3 /INITIALIZE TIMER $3
00060 0107 B6 B2 LDA A #582 /CONFIGURE TIMER $3 FOR USE
00061 0109 B7 8000 STA A CR3 /AS A SCALAR
00063 010C B6 59 LDA A #559 /CONFIGURE TIMERS $1 AND $2
00064 010E B7 8001 STA A CR2 /FOR PULSE WIDTH COMP MODE;
00065 0111 B7 8000 STA A CR1 /INTERNALLY RESET ALL TIMERS
00067 0114 4A DEC A /CLEAR INTERNAL RESET BIT
00068 0115 B7 8000 STA A CR1 /TO ENABLE ALL TIMERS
00070 ONIRQ, THE ET-3400 VECTORS TO LOCATION
00071 * UIRQ, WHERE IT MUST FIND A JUMP INSTRUCTION
00072 * AND A VECTOR TO TRANSFER TO THE PROGRAM'S
00073 * IRQ SERVICE ROUTINE AT LOCATION #POLL.
00075 0116 86 2E LDA A #57E /LDA A WITH JUMP COMMAND
00076 011A 97 F7 STA A UIRQ /STORE JUMP COMMAND AT UIRQ
00077 011C CE 01BE LDX #POLL /JUMP TO THIS LOCATION
00078 011F DF 08 STX UIROH1 /STORE #POLL AT UIRO VECTOR
00080 0120 0E CLI /CLEAR IRQ INTERRUPT MASK
00083 * INITIALIZE THE MEMORY LOCATION POINTERS
00085 0122 CE 0009 LX #721
00086 0125 DF 16 STX POINT2
00088 0127 CE 0000 LDX #711
00089 012A DF 14 STX POINT1
00091 * CLEAR ALL MEMORY LOCATIONS
00093 012C 00 00 CLEAR CLR 0X /CLEAR THIS BYTE
00094 012E 00 INX /POINT TO THE NEXT BYTE
00095 012F 00 0102 CFX #723-3 /DONE YET?
00096 0132 26 8F BNE CLEAR /GO CLEAR THE NEXT BYTE

00099 * MAIN PROGRAM LOOP
00100 0134 86 11 RUN BSR SHOW /SHOW LETTERS OF LOGGED TIMES
00101 0136 86 30 BSR KEY /RETURN DEBOUNCED KEY IN 'A'
00102 0138 24 FA BCC RUN /GO BACK IF NO KEY PRESSED
00104 013A 4D TST A /TEST A
00105 013F 27 03 BCC RUN /GO TO START ON '0' KEY
00107 0133 86 35 BSR SETX /POINT TO KEYED LOCATION
00108 013F 24 F3 BCC RUN /BRANCH IF KEYS 1-9 PREVIOUSLY
00110 0141 8D 44 BSR READOU /SHOW KEYED ELAPSED TIME
00111 0143 8D 02 BSR RELEASE /WAIT FOR KEY RELEASE
00112 0145 20 ED BFA RUN /RETURN TO SHOW LETTERS

Listing 2 continued on page 138
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Listing 2 continued:

00114 * THIS ROUTINE DISPLAYS LETTERS FOR MEMORY

00115 * LOCATIONS IN WHICH ELAPSED TIMES ARE LOGGED.

00117 0147 CE 0000 SHOW LDX $11 / POINT TO THE FIRST LOCATION

00118 0146 86 0A LDA A $04A / INITIALIZE DISPLAY LETTER

00119 014C BD FCBC JSR REDIS / INITIALIZE DISPLAY POINTER

00120 214F E6 00 SHOW1 LDA B 0X / TEST BIT? FOR TIME LOGGED

00122 0151 2A 05 BPL SHOW2 / BRANCH IF NO TIME LOGGED

00124 0153 BD FE28 JSR OUTHEX / SHOW THE LETTER FROM ‘A’

00125 0155 20 06 BRA SHOW3

00127 0158 36 SHOW2 PSH A / SAVE THE LETTER FROM ‘A’

00128 0159 4F CLR A / PREPARE TO SHOW A BLANK

00129 015A BD FE3A JSR DUTCH / SHOW A BLANK HERE

00130 015B 30 32 PUL A / RESTORE KEYED LETTER TO ‘A’

00132 015E 4C SHOW3 INC A / INC ‘A’ TO THE NEXT LETTER

00133 015F 08 INX / ADVANCE THE POINTER TO THE

00134 0160 00 INX / NEXT 3-BYTE MEMORY LOCATION

00135 0161 09 INX / NEXT 3-BYTE MEMORY LOCATION

00136 0162 BC 0012 CPX #23H / DONE YET?

00137 0163 26 0B BNE SHOW1 / EXAMINE THE NEXT LOCATION

00139 0167 39 RTS

00141 * THIS ROUTINE DEBOUNCES A PRESSED KEY AND RETURNS

00142 * ITS HEX VALUE IN ACC A; THE ROUTINE ALSO

00143 * RETURNS CARRY SET IF KEY PRESSED; CARRY CLEAR

00144 * CLEAR FOR NO KEY PRESSED;

00146 0168 26 14 KEY LDA B #20 / INITIALIZE DELAY COUNTER

00148 0169 1E 00 FDD8 KEY1 JSR ENCODE / RETURNS KEY VALUE IN 'A'

00149 016A 24 04 BCC KEY2 / BRANCH IF NO KEY DOWN

00151 016F 5A INC B / DECREMENT THE DELAY TIME

00152 0170 26 0B DEC B / NEXT 3-BYTE MEMORY LOCATION

00154 0172 00 SEC / SET CARRY IF KEY DOWN

00156 0173 39 KEY2 RTS

00158 * THIS ROUTINE USES THE HEX VALUE (IN ACC A)

00159 * OF THE KEY PRESSED TO POINT X TO THE PROPER

00160 * MEMORY LOCATION, THE ROUTINE RETURNS CARRY

00161 * IF KEYS A-F PRESSED, CARRY CLEAR

00162 * IF KEYS 1-9 ARE PRESSED.

00164 0174 CE 0000 SETX LDX #11 / POINT X TO FIRST LOCATION

00165 0177 C6 0A LDA B #00A / INITIALIZE 'B'

00167 0179 11 SETX1 CBA / DOES 'B' EQUAL KEY VALUE?

00168 017A 27 09 BEQ SETX2 / BRANCH IF EQUAL

00170 017C 0C CLC / CLEAR THE A-F KEY FLAG

00171 017D 28 07 BMI SETX3 / RTS IF 'B' > KEY VALUE

00173 017F 08 INX / ADVANCE THE POINTER TO THE

00174 0180 08 INX / NEXT 3-BYTE MEMORY LOCATION

00175 0181 08 INX / INCREMENT 'B' AND

00176 0182 5C INC B / NEXT 3-BYTE MEMORY LOCATION

00177 0183 26 04 BRA SETX1 / GO COMPARE AGAIN

00179 0185 00 SETX2 SEC / SET THE A-F KEY FLAG

00181 0186 39 SETX3 RTS

00183 * READOUT ROUTINE: DISPLAYS KEYED LETTER AND

00184 * ELAPSED TIME STORED IN THIS LOCATION. THE

00185 * DISPLAY IS IN SECONDS WITH RESOLUTION TO

00186 * 1 MILLISECOND. LEADING ZEROS TO THE LEFT

00187 * OF THE DECIMAL POINT ARE SUPPRESSED.

00189 0187 E6 00 READDU LDA B 0X / FETCH BIT?

00190 0189 2A 27 BPL READ2 / BRANCH IF NO TIME LOGGED

00192 018B 36 PSH A / SAVE KEY VALUE (FROM 'A')

00193 018C BD FCBC JSR REDIS / INITIALIZE DISPLAY POINTER

00194 018F C6 03 LDA B #03 / TO DISPLAY 3 BYTES

00195 0191 BD FE3F JSR DISPLAY / DISPLAY THIS ELAPSED TIME

00197 0194 BD FCBC JSR REDIS / RESET THE DISPLAY POINTER

00198 0197 32 PUL A / RESTORE KEY VALUE TO 'A'

Listing 2 continued on page 140
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- 8748 EPROM version. (Similar packages 24-pin plug replaces PROM(s) in your machine, saving expensive equipment. Develop...
- 8048 DEVELOPMENT PACKAGE
- assembler. Then plug our EPR-48 board for 8051 and TMS9940E coming soon."

- PSB-100 PROM Emulator.. $445.00 w/ manual
- PROM EMULATOR BOARD

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Listing 2 continued:
00199 019D BD FE2B JSR OUTHEX / SHOW KEY PUSHED (FROM 'A')
00201 019D A4 00 LDA A 0-X / GET 1ST DIGIT (AND BIT 7)
00201 019D B4 00 AND A #40F / MASK TO FIRST DIGIT
00203 019F 26 0C BNE READ1 / BRANCH IF NOT LEADING ZERO
00205 01A1 BD FE3A JSR OUTHEX / BLANK 2ND 7-SEGMENT LED
00207 01AA A6 01 LDA A 1-X / GET 2ND (AND 3RD) DIGIT
00208 01AA 84 F0 AND A #F0 / MASK TO 2ND DIGIT
00209 01A8 26 03 BNE READ1 / BRANCH IF NOT ALSO ZERO
00211 01AA BD FE3A JSR OUTHEX / BLANK 3RD 7-SEGMENT LED
00213 01AB 86 01 READ1 LDA A #01 / LIGHT 3RD DECIMAL POINT
00214 01AF 87 C147 STA A #C147
00216 0182 39 READ2 RTS

00218 01B3 04 F0 * THIS ROUTINE WAITS FOR A KEY RELEASE
00220 01B3 04 F1 RELEASE LDA B $20 / INITIALIZE DELAY COUNTER
00221 01B3 04 F2 LSR A / GET KEY RELEASE CONDITION
00223 01B3 04 F3 BCX RELEAS / KEEP TRYING UNTIL RELEASE
00225 01B3 04 F4 DEC B / DECREMENT THE DELAY TIME
00226 01B3 04 F5 BNE READ / GO BACK IF DELAY NOT DONE
00228 01B3 04 F6 RTS

00230 01B3 04 F7 * THIS BEGINS THE IRO SERVICE ROUTINE THAT
00231 01B3 04 F8 * READS AND LOGS THE MEASURED TIMES.

00233 01B3 04 F9 00 POLL LDA A STATUS / GET THE INTERRUPT FLAGS
00235 01B3 04 FA LSR A / SHIFT TIMER1 FLAG INTO 'C'
00236 01B3 04 FB PSH A / SAVE THE TIMER2 FLAG
00237 01B3 04 FD BCX POLL2 / BRANCH IF NO TIMER1 FLAG
00239 01B3 04 FF LDA A M1 / READ THE TIMER1 COUNT AND
00240 01B3 04 00 LDA B L1 / CLEAR THE TIMER1 FLAG

00242 01B3 04 01 LDR DE 14 DEC B / POINT TO THE T1X LOCATION
00243 01B3 04 02 LDR DE 00 0009 CFX #713-3 / TIMER1 MEMORY BLOCK FULL?
00244 01B3 04 03 LD 20 27 04 BCS POLL2 / BRANCH IF FULL

00246 01B3 04 04 LDR 20 18 BSR LOG / LOG COUNT, ADV POINTER
00247 01B3 04 05 LDR 14 DF 14 STX POINT1 / SAVE THE NEW POINTER

00249 01B3 04 06 LDR 32 PULL2 LDA A M2 / RESTORE THE TIMER2 FLAG
00250 01B3 04 07 LSR A / SHIFT TIMER2 FLAG INTO 'C'
00251 01B3 04 08 BCC DONE / BRANCH IF NO TIMER2 FLAG

00253 01B3 04 09 LDA A M2 / READ THE TIMER2 COUNT AND
00254 01B3 04 0A LDA D F6 0005 / CLEAR THE TIMER2 FLAG

00256 01B3 04 0B LDR E0 16 LDX POINT2 / POINT TO THE T2X LOCATION
00257 01B3 04 0C LDR E0 BC 0012 CFX #723+3 / TIMER2 MEMORY BLOCK FULL?
00258 01B3 04 0D LD 27 04 BED DONE / BRANCH IF FULL

00260 01B3 04 0E LDR 03 BD 03 BSR LOG / LOG COUNT, ADV POINTER
00261 01B3 04 0F LDR 16 DF 16 STX POINT2 / SAVE THE NEW POINTER

00263 01B3 04 10 LDR 3B DONE RTI

00265 01B3 04 11 LDR E0 43 * THIS SUBROUTINE TRANSFORMS AND LOGS THE
00266 01B3 04 12 LDR E0 44 * MEASURED TIMES AND ADVANCES THE POINTER.

00268 01B3 04 13 LDR E0 53 LOG COM A / COMPLEMENT THE COUNT TO GET
00269 01B3 04 14 LDR E0 B8 COM R / HEXADECIMAL ELAPSED TIME
00270 01B3 04 15 LDR E0 BD 5F BSR SAVE / SAVE THE HEX ELAPSED TIME
00272 01B3 04 16 LDA A #500 / SET BIT 7 TO SHOW THAT THIS
00273 01B3 04 17 LDR E0 A7 00 STA A 0-X / MEMORY LOCATION IS FILLED
00274 01B3 04 18 LDR E0 BD 04 BSR 80 / CONVERT HEX TIME TO DECIMAL

00276 01B3 04 19 LDR E0 F8 INX / ADVANCE THE POINTER TO THE
00277 01B3 04 1A LDR E0 F9 INX / NEXT 3-BYTE MEMORY LOCATION
00278 01B3 04 1B LDR E0 FF INX

00280 01B3 04 1C LDR E0 39 RTS / THIS ROUTINE CONVERTS THE 2-BYTE HEX NUMBER IN

00282 01B3 04 1D 01-X AND 2-X TO A 3-BYTE DECIMAL NUMBER IN

Listing 2 continued on page 142
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<table>
<thead>
<tr>
<th>Source Operating Systems</th>
<th>Target Machines</th>
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<tr>
<td>8080/280 CP/M</td>
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<td>LSI-11/PDP-11</td>
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<td>VAX-11</td>
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<td>M68000</td>
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<td>8080/280 CP/M</td>
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<td></td>
<td>Pascal: $880</td>
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<tr>
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<td>C: $1130</td>
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<td>Pascal: $1380</td>
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<td>C: $630</td>
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<td>Pascal: $1380</td>
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<tr>
<td>VAX-11</td>
<td>C: $1130</td>
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<tr>
<td>Unix/V32</td>
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<td>VMS</td>
<td>C: $630</td>
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<td>Pascal: $880</td>
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<tr>
<td>M68000</td>
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<td>VERSAdos</td>
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</tbody>
</table>

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Listing 2 continued:

<table>
<thead>
<tr>
<th>Decimal Code</th>
<th>ASCII Code</th>
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<tr>
<td>00284</td>
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<th>Code</th>
<th>ASCII Code</th>
<th>Character</th>
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<tbody>
<tr>
<td>00286 01FA 7F 0012 0D</td>
<td>CLR TEMP1</td>
<td>/TO HOLD 1000'S &amp; 1000'S COUNT</td>
</tr>
<tr>
<td>00287 01FD 7F 0013 0D</td>
<td>CLR TEMP2</td>
<td>/TO HOLD 100'S COUNT</td>
</tr>
<tr>
<td>00289 0200 0D 48 0D4</td>
<td>BSR FETCH</td>
<td>/FETCH REMAINDER</td>
</tr>
<tr>
<td>00290 0202 0D 24 0D4</td>
<td>SUB B #10</td>
<td></td>
</tr>
<tr>
<td>00291 0204 0D 27 0D4</td>
<td>SBC A #27</td>
<td>/SUBTRACT 10,000</td>
</tr>
<tr>
<td>00292 0206 0D 26 0D4</td>
<td>BCS 003</td>
<td>/BRANCH IF REMAINDER NEGATIVE</td>
</tr>
<tr>
<td>00294 0208 0D 45</td>
<td>BSR SAVE</td>
<td>/SAVE REMAINDER</td>
</tr>
<tr>
<td>00295 020A 0D 60 0X</td>
<td>INC 0X</td>
<td>/INCREMENT 10,000'S COUNT</td>
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<tr>
<td>00296 020C 0D F2</td>
<td>BRA 0D4</td>
<td>/GO SUBTRACT ANOTHER 10,000</td>
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<tr>
<td>00298 020E 0D 3A 0D3</td>
<td>BSR FETCH</td>
<td>/FETCH REMAINDER</td>
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<tr>
<td>00299 0210 0D 08</td>
<td>SUB B #10</td>
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<tr>
<td>00300 0212 0D 03</td>
<td>SBC A #03</td>
<td>/SUBTRACT 100</td>
</tr>
<tr>
<td>00301 0214 0D 25 0A</td>
<td>BCS 002</td>
<td>/BRANCH IF REMAINDER NEGATIVE</td>
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<td>00303 0216 0D 37</td>
<td>BSR SAVE</td>
<td>/SAVE REMAINDER</td>
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<tr>
<td>00304 0218 0D 15</td>
<td>LDA A TEMP1</td>
<td>/GET 1000'S COUNT</td>
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<tr>
<td>00305 021A 0D 10</td>
<td>ADD A #10</td>
<td>/INCREMENT 1000'S COUNT</td>
</tr>
<tr>
<td>00306 021C 0D 07</td>
<td>STA A TEMP1</td>
<td>/SAVE 1000'S COUNT</td>
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<tr>
<td>00307 021E 0D 20</td>
<td>BRA 0B3</td>
<td>/GO SUBTRACT ANOTHER 1000</td>
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<td>00308 0220 0D 28 0D2</td>
<td>BSR FETCH</td>
<td>/FETCH REMAINDER</td>
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<td>00310 0222 0D 64</td>
<td>SUB B #64</td>
<td>/SUBTRACT 100</td>
</tr>
<tr>
<td>00311 0224 0D 00</td>
<td>SBC A #00</td>
<td>/SUBTRACT 100</td>
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<tr>
<td>00312 0226 0D 07</td>
<td>BCS 001</td>
<td>/BRANCH IF REMAINDER NEGATIVE</td>
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<td>00314 0228 0D 25</td>
<td>BSR SAVE</td>
<td>/SAVE REMAINDER</td>
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<tr>
<td>00315 022A 0D 12</td>
<td>INC TEMP1</td>
<td>/INCREMENT 1000'S COUNT</td>
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<tr>
<td>00316 0222 0D 0F</td>
<td>BRA 0B2</td>
<td>/GO SUBTRACT ANOTHER 100</td>
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<tr>
<td>00318 022F 0D 19</td>
<td>BSR FETCH</td>
<td>/FETCH REMAINDER</td>
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<tr>
<td>00319 0231 0D 0A</td>
<td>SUB B #0A</td>
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</tr>
<tr>
<td>00320 0233 0D 00</td>
<td>SBC A #00</td>
<td>/SUBTRACT 10</td>
</tr>
<tr>
<td>00321 0235 0D 0A</td>
<td>BCS 000</td>
<td>/BRANCH IF REMAINDER NEGATIVE</td>
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<td>00322 0237 0D 16</td>
<td>BSR SAVE</td>
<td>/SAVE REMAINDER</td>
</tr>
<tr>
<td>00323 0239 0D 13</td>
<td>LDA B TEMP2</td>
<td>/GET 100'S COUNT</td>
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<tr>
<td>00324 023B 0D 10</td>
<td>ADD B #10</td>
<td>/INCREMENT 100'S COUNT</td>
</tr>
<tr>
<td>00325 023D 0D 07</td>
<td>STA B TEMP2</td>
<td>/SAVE 100'S COUNT</td>
</tr>
<tr>
<td>00327 023F 0D 20</td>
<td>BRA 0B1</td>
<td>/GO SUBTRACT ANOTHER 10</td>
</tr>
<tr>
<td>00329 0241 0D 12</td>
<td>BSR LDA A TEMP1</td>
<td>/GET 1000'S &amp; 1000'S COUNT</td>
</tr>
<tr>
<td>00330 0243 0D 13</td>
<td>LDA B TEMP2</td>
<td>/GET 100'S COUNT</td>
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<tr>
<td>00331 0245 0D 02</td>
<td>ADD B #02</td>
<td>/ADD REMAINDER TO 100'S COUNT</td>
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<tr>
<td>00332 0247 0D 06</td>
<td>BSR SAVE</td>
<td>/SAVE DECIMAL COUNTS</td>
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<td>00333 0249 0D</td>
<td>RTS</td>
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<tr>
<td>00335 024A 0D 01</td>
<td>FETCH LDA A 1X</td>
<td>/FETCH THESE VALUES</td>
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<tr>
<td>00339 024C 0D 02</td>
<td>LDA B 2X</td>
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<td>00340 024E 0D</td>
<td>RTS</td>
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<td>00343 024F 0D 01</td>
<td>FETCH STA A 1X</td>
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<tr>
<td>00347 0251 0D 02</td>
<td>STA B 2X</td>
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<tr>
<td>00349 0253 0D</td>
<td>RTS</td>
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<td>00351</td>
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**Symbol Table**

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<td>001E</td>
</tr>
<tr>
<td>T32</td>
<td>001F</td>
</tr>
</tbody>
</table>

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All five PHOENIX™ general accounting packages (General Ledger, Accounts Receivable and Payable, Payroll and Inventory) were designed by CPA's based on similar packages from mini and mainframe computers. The programs are COBOL with an integral assembly-language data base. They are fully integrated to allow automated posting to the General Ledger. An internal screen handler permits full-screen data entry for speed and ease of use. Although we made cosmetic enhancements prior to distribution, the basic programs have been user-tested for at least eighteen months.

PHOENIX™ Accounting also includes a growing number of specific application packages. We have completed or scheduled for completion Fixed Assets, Tenant Processing, Mail Management, Financial Projections and Time/Billing. Each package stands alone, but many also work in conjunction with other PHOENIX™ packages. For example, PHOENIX™ Mail Management will work very well by itself, but we also designed it to fit in easily with the merging capabilities of PHOENIX™ Word Processing.

With PHOENIX™ Accounting we have, as always, given special attention to documentation. Not being content to describe which buttons to push, we have taken the time to explain the accounting principles behind the programs and how each package fits into an automated office. To this end we created the fictional town of Smallville with a fictional company, Moustache Manufacturing. By seeing how Mr. Small and his employees use PHOENIX™ Accounting at 2AM, you learn to apply it to your office as well. The Smallville sections are amusing as well as informative, and you will likely read the manual just to find out what Sidney, Mr. Small’s incompetent brother-in-law, will do next.

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The demonstration program was used to time the motion of two colliding air cars on a linear air track. [This apparatus is a cousin to an air-hockey table....] Each timer was controlled by one phototransistor illuminated by a 1 W incandescent bulb, and each air car carried an opaque vane 10 cm long (see photo 2). The vane blocked the light as the car passed in front of the phototransistor. With timers 1 and 2 operating in the pulse-width-comparison mode, the microcomputer measured how long each phototransistor was blocked as the cars approached and then recoiled from the collision. These measured times, the known lengths of the opaque vanes, and the cars' masses were then used to calculate momenta before and after the collision.

I required that each timer be able to record three elapsed times. Each timer therefore has three memory locations reserved for saving its measurements. Labeled T11 thru T23 in the demonstration program, these memory locations are accessed during readout as times A, B, and C for timer 1 and times D, E, and F for timer 2.

The trainer's six 7-segment LEDs (light-emitting diodes) are used for data display. Each experimental trial begins with the LEDs dark. The 7-segment LEDs then light individually to show letter labels of the elapsed times as they are measured (see photos 3 and 4). When the experimental trial ends, each of the keys A thru F, when pushed, will produce a display of the corresponding elapsed time (see photo 5). Pushing the zero key clears all six memory locations to prepare for another trial.

Although the demonstration program specifies operation of timers 1 and 2 in the pulse-width-comparison mode, it will just as easily support their operation in the frequency-comparison mode. To make the conversion, simply change the number stored at hexadecimal location 010D from hexadecimal 59 (for pulse-width-comparison mode) to hexadecimal 49 (for frequency-comparison mode).

Conclusion
This computer-based timer has been a stable and dependable measurement tool in my introductory physics laboratory. The students enjoy using it and appreciate the repeatability of results attained with it. I hope that you too will find it useful, and I would be interested to hear from readers who develop their own applications.
The dedicated power of this complete single board computer is provided to each user, making the DISCOVERY MULTIPROCESSOR unique among multi-user systems. With the power and expandability of distributed processing • With the economy of shared peripherals • With the flexibility of shared and public files • And all of this with full CP/M* and S-100 compatibility.

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Microcomputers in Education: 
A Concept-Oriented Approach

George Wolfe, James Madison University 
Harrisonburg VA 22807

In the wake of new technologies, there generally comes an abundance of dreams and possibilities. Inherent in these possibilities is the seed of some new transformation of great or modest proportion. Such a transformation first occurs externally, manifesting itself in the conveniences or specialized abilities the new technology offers. But soon it touches us subjectively and we find ourselves perceiving reality differently. We construct new paradigms to help us understand our changed relationship with the world, and structure new vocabularies of experience.

Familiar examples of such technologies surround us—the electric light bulb, radio and television, satellite communication, medical technology, and nuclear energy. Each of these has altered our way of life to such an extent that any citizen of our culture from a century ago could not have entertained the world view we, by nature, have today. But, the technology that possesses the greatest potential to transform society and human life is just now entering the home: the microcomputer. Unlike some previous technological advances, the computer is not merely a specialized device fulfilling a specialized function. The convenience it provides is less tangible than bringing light into the home or Broadway entertainment into the living room. The computer's role and potential are much more abstract and profound. The new promise it offers is that of AI (artificial intelligence), which we not only create, but also, via the computer, communicate and interact with.

One of the most constructive fields to apply AI (to capitalize on its capacity to transform) is education. Various applications of microcomputers are already in the classroom and their effect has been found to be highly reinforcing to the learning process. These applications can be placed into the following categories:

- cataloging and processing of information
- learning to program a computer
- using the computer as an instructional tool; ie: CAI (computer-aided instruction)

The first two categories are self-explanatory and may even be somewhat familiar. There is no doubt that the computer can greatly increase the efficiency of a system through data processing, and that skill in computer programming is a growing necessity in our society. The third category may be somewhat less known, but clearly it is growing in use. It involves using computer programs designed to supplement students' assignments in the classroom. Such programs are usually in the form of drills, information exercises, or educational games. They often provide students with a moderate degree of interaction with the computer.

CAI has been defined in various ways and various opinions have been expressed as to its effectiveness. Certainly the value and success of CAI lies in the creative design of the programs and the appropriate setting for their use. Unfortunately, many teachers seem to view CAI as merely an automated drill instructor. Indeed, there is some value in having the computer play this role—it can hold pupils' attention and effectively reinforce their learning. Also, students learn to operate a computer long before any formal programming skill is acquired. But there is one application of CAI which as yet is relatively

About the Author

George Wolfe is a music graduate of Indiana University and has been teaching at James Madison University for the past three years. He is a member of the Association for Integrative Studies and has been privately researching integrative education and the role of the microcomputer in the classroom. Mr Wolfe has also been developing integrative arts related television programs on a grant from the School of Fine Arts and Communications at James Madison University.
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<th>YES</th>
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<td>Send reports to screen or printer</td>
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<td>Sort on up to 6 fields at a time</td>
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<td>Multiple formats for mailing labels</td>
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<td>Query library stores executive queries for Run-On-Demand</td>
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<td>REQUEST™ will interface with Source™, VisiCalc™, and word processing packages</td>
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<td>Disks are readable and copyable by normal DOS</td>
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- REQUEST™ can be used with a modem
- On the APPLE™ REQUEST™ is compatible with 80 column boards
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unexplored. This is the use of the microcomputer to aid students in developing the ability to conceptualize. It is my belief that the transforming value of the microcomputer will be most fully realized through a concept-oriented approach to computer-aided instruction. The purpose of this article is to awaken educators to the solutions concept-oriented computer instruction offers our educational system.

Artificial Intelligence and Specialization

Inherent in the growth of technology is the need for specialization. New information and research, vocational training, and industrial development must accompany advancing technologies. Along with these also comes the expertise necessary to maintain that growth. With the surge of technological and industrial growth in the twentieth century modern education has shifted away from the liberal arts toward pragmatism and specialization. As this trend has increased the classical ideal of a liberal arts education has fallen by the wayside. (See reference 2, page 407.)

While certainly necessary in a technological society, there is a danger which emerges if specialization is carried too far. This danger is dependence and the loss of comprehensive viewpoints. We have seen how a technological society can become dangerously dependent on foreign energy sources needed to drive that society and maintain its standard of living. We have also witnessed how the interaction among nations, motivated by their own individual interests, demands a perspective in world leaders that must be holistic if a stable peace is going to be achieved and sustained. Thus, the many specialized technologies that have brought nations closer together and made them dependent on one another have ironically recreated the need for the Integrated Person; someone who is able to recognize and effectively apply fundamental concepts to numerous, rapidly changing, and adaptively taxing circumstances. Such an individual must necessarily possess a more comprehensive understanding of the various academic disciplines, so that he or she can make decisions that are universally beneficial.

The common belief among educators today is that this ideal is impossible to achieve. It certainly appears that way when we examine the flood of information present within every discipline. Education, in keeping pace with technology, has become so oriented toward information gathering and retention that the conceptual links among
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the academic disciplines have been all but lost. The advent of artificial intelligence has the potential to change this, because computer technology provides a means through which information within all disciplines can be effectively handled, processed, and made available. It turns out that mechanical brains manage information better than human brains (i.e., a computer's memory and processing capabilities are in many ways superior in efficiency and organization to our own). Thus, the availability of information can be increased in quantity and reliability with microcomputers in the learning environment. The preoccupation of education with information can now be relieved somewhat. Rather than boring students primarily for absorbing and retaining data, their attention can be directed toward the abilities to conceptualize, abstract, and apply available information creatively. These higher abilities remain uniquely human. We should no longer neglect their formal development for the sake of having students retain enormous amounts of information.

A movement in American education dedicated to promoting a concept-oriented approach to teaching began several decades ago with a small circle of scientists, most of whom had been strongly influenced by general systems theory. Among this group's members were Henry Margenau of Yale University and author-scientist Ervin Laszlo. Their efforts enjoyed a brief period of international recognition during the 1950s and 1960s under the auspices of the Center for Integrative Education. (See reference 1, pages v thru vii.) Their ideas have never been fully realized in the American classroom, but the microcomputer now makes the fulfillment of their approach a definite possibility. The computer is certainly the catalyst through which the integration of knowledge can be achieved in modern education and the direction of teaching changed to include principles and fundamental concepts, as well as specialized information.

Fundamentals of an Integrative Approach

The first and foremost demand of concept-oriented education is the development of thinking skills. Today, we devote much time to cultivating reading and mathematical skills, artistic abilities, and other talents in our students. But we tend to ignore the abilities to think rationally, evaluate circumstances and information accurately, and integrate two or more disciplinary perspectives. As a result, high school and college students often lack the intellectual faculties needed to grasp issues in a sharp and accurate focus.

As with other abilities, developing thinking skills takes practice, something teachers do not always have the time and understanding to offer. Properly structured and applied computer programs, however, can provide the time and mental exercise needed to sharpen students' reasoning faculties.
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It is possible, for example, to develop a series of logic programs ranging in difficulty from simple reasoning using concrete ideas, to complex reasoning employing abstract ideas. The relationship between logical and mathematical proof can also be incorporated into such programs. The format could be a kind of logical dialogue between student and computer. For example,

Student: Very good! We simply have to recognize that illusions do exist and that seeing something does not always mean that what we are seeing is really happening or really there.... Now consider this next statement.

"The sun appears to be rising in the sky." Is this statement true or false?

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Another series of programs can be composed to help students learn to discriminate between objectively, rationally, and intuitively derived conclusions. The aim is to develop discernment in the student and provide the time and practice necessary for one to become adept at applying such thinking skills.

Interdisciplinary perspectives can be the theme of still another thinking-model program. Here, the goal is to arrive at the most plausible explanation for something by considering information from various disciplines. For example, students examine explanations based on economic influences, historical factors, or any other perspectives that are appropriate to the subject being considered.

Such a program, in addition to the ones mentioned above, can be designed for educational levels ranging from junior high school through college. (Anyone interested in more information regarding the programs discussed in this article can write the author in care of the Music Department, James Madison University, Harrisonburg VA 22807.)

With thinking skills heightened, we are now ready to pursue the second most important aspect of integrative education, concept development. Concept development often utilizes basic rules and principles, many of which have several exceptions. The idea is for the students to find the exceptions and be able to adapt the principles to suit varying circumstances. To illustrate this, let us compare the steps of an information-oriented approach to a concept-oriented one.

The information-oriented approach is basically an inductive one. That is, we begin by giving out specific facts and data, then we draw conclusions, and finally derive our concepts. (Unfortunately, many teachers today never follow through to the final step of deriving the basic concept!) A concept-oriented approach is deductive rather than inductive. After prerequisite definitions are given, students are taught a generalized concept. From there, students speculate on probable conclusions and hypotheses, then search out the necessary information in an effort to test the conclusions. What the deductive, concept-oriented approach develops is the ability to apply a general concept, and the skills to resourcefully and efficiently locate the information needed to test one's speculative conclusions. To accelerate, simplify, and reinforce this process, the needed information could be made available through a computer retrieval system.

Let us consider how this method can be employed within a discipline through the use of the microcomputer. The following example pertains to basic music theory. The prerequisite information required of the student are knowledge of the definition and labeling of music intervals, the definition of a triad, and how to read treble clef.

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This means that by choosing an interval, and stacking notes on top of one another at the interval you have selected, you can form various types of triads and harmonic textures.

Let us begin by selecting one of the following notes on the treble clef staff shown in figure 1.

**Student:** A.

**Computer:** Now choose one of the following intervals:
- second
- third
- fourth
- fifth

**Student:** Fourth.

**Computer:** Very good. Now build the triad out of fourths using the note you selected as the root of the chord. (List the two added notes.)

**Student:** D and G.

**Computer:** Correct! (See figure 2.)

Because this triad is built in fourths, it is called a quartal triad. Quartal harmony has been used by many twentieth-century composers. Now check the text file for information on quartal harmony and answer the following questions...

Now choose another interval...(etc)

**Computer:** This is a basic principle for building triads. Usually, students only learn about tertian harmony (chords built in thirds) in the early years of music theory. But by using this concept, you can jump ahead and learn to write triads which are usually considered advanced...

A third important element of concept-oriented education is the interdisciplinary transfer of knowledge. Here, we are dealing with unifying relationships among disciplines, usually closely related disciplines. In the arts for example, there are certain fundamental aesthetic elements that are common to media. Among these are contrast, intensity, and proportion. The techniques used to employ these elements in an artwork are different for every medium, but the aesthetic purpose served is essentially the same. Microcomputer programs could be developed to teach such interdisciplinarity, isomorphic relationships. If used early enough in a child’s education, a network of unity could be structured among the disciplines. Then, even when specialization becomes necessary later on, a holistic perspective would always remain with the student.

**References**

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We Interrupt This Program...

Gary V Small
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The phrase "we interrupt this program to bring you an important announcement" is as applicable to computers as it is to radio or television. The interrupt system of a computer stops the program being processed to perform a more important task.

What is an interrupt? It is a computer control-signal input that is sampled by the microprocessor during every instruction cycle. If an external device has asserted (activated) the interrupt line, the microprocessor will cease processing the normal flow of instructions, put an interrupt vector on the address lines, and load the program counter with the address pointed to by the interrupt vector. The microprocessor can then begin execution of the interrupt-handling program found at this address.

Simply stated, an interrupt is a forced, immediate branch to some specified memory address in response to an externally generated control signal. A computer system will generally use additional hardware to implement a number of possible interrupts, each with its own priority and interrupt-handling routine.

Why Interrupt?
At present, few microprocessor-based systems are interrupt driven. Any program requiring I/O (input/output) operations, or timing functions, must employ a timing loop (a sequence of instructions that takes a known interval to execute) until the operation is complete. As an example, writing eighty characters to a teletypewriter at a rate of 110 bits per second would require about eight seconds. The processor uses most of this time to constantly sample the transmitter ready status of the interface involved. In eight seconds, an 8080A microprocessor could process about four million instructions. As you can see, sitting in a status-checking loop is not an efficient processing method.

Now suppose that the transmitter-ready signal from the interface is used to assert the interrupt line to the microprocessor. Whenever the interface is ready to accept another character, the processor is forced to branch to the output routine. It sends the next character, then returns to the main program. For the specific example we are using, this fairly simple procedure results in making four million additional instruction periods available.

Obviously, in many low-level applications, it really doesn't matter how much time is spent in an I/O loop because the user won't be proceeding with the program until the output is complete. However, in many higher-level applications, such as multiprogramming and high-speed instrumentation programs, it becomes imperative that the processor not be tied up. Interrupt-driven software and hardware become essential. Multiuser, multiprogramming systems become feasible only in an interrupt-driven environment.

Any programming that requires timing or periodic functions can also benefit from the use of interrupts in conjunction with a programmable timer. Tasks such as keyboard scanning or display refreshing are very simple to accommodate using an interrupt system. There is very little impact on the main program task by occasional interrupts, and a little software can replace additional hardware.

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Multilevel Interruption

A computer system generally has several interrupting devices. To sort out these interrupts a priority scheme is generally used. The priority scheme assigns each device in the system a priority level, according to its importance. This allows the most important I/O devices to be serviced before those of lower priority. Except in the simplest interrupt implementations, a higher-level interrupt is allowed to interrupt the current routine of a lower-priority interrupt. In this way, several interrupt routines could conceivably be nested in a busy system.

Most microprocessors have only one general-purpose interrupt input, and external hardware must be used to resolve priorities between the various interrupt lines. The hardware may also provide for additional functions, such as individually selectable interrupt levels and nesting of interrupts. The hardware involved in a very simple interrupt system is shown in figure 1a. In this system, once an interrupt occurs, the interrupt system should remain disabled until completion of the interrupt routine. With this very simple implementation a high-level interrupt may not interrupt a lower-level routine once it is in progress.

For an interrupt to be recognized by the microprocessor an enable interrupts instruction must have been previously executed by the program. Additionally, some devices will require that a special interrupt register be set with the proper vectoring data. When an interrupt is recognized, the contents of the program counter will be pushed onto the stack, and the start address of the interrupt routine will replace the old program-counter data.

When an interrupt occurs, the return address is saved on the stack, and the processor branches unconditionally to the interrupt routine. The microprocessor will also disable its internal interrupt system whenever an interrupt occurs. Software must enable interrupts again before other interrupts will be recognized by the device.

An interrupt routine should also do some housekeeping to insure a successful return to the interrupted program. First, the contents of all the registers should be saved so that their contents can be restored prior to resuming the interrupted program. Depending upon your hardware, you may need to output the priority level of the current interrupt for comparison with incoming interrupts.

In the case of serial devices, such as terminals or cassette decks, the microprocessor is usually interfacing with a UART (universal asynchronous receiver-transmitter). These devices have signals indicating "receiver ready" and "transmitter ready" to assert interrupt lines. The signals can be used as independent interrupts (one per device) or can...
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Technical Forum

be combined into a single interrupt. In the latter case, software can examine the device status to determine the required operation. The act of servicing the UART will clear the condition of the signals.

In dealing with parallel devices such as printers, the usual feedback is in the form of a "busy" signal; inverted, this becomes a "ready" signal that can be used to generate an interrupt. Here again, servicing the device will clear the interrupt signal.

In a good system, the interrupt hardware will allow interrupt nesting and individual selection of interrupts (see figure 1b). The computer interrupt system is a truly useful and efficient tool for increasing the throughput and general capabilities of a microprocessor-based computer system. With interrupts a whole world of high-level applications, such as multiuser systems, becomes feasible. Once understood, the interrupts system becomes an indispensable programming tool.

Figure 1: Hardware for handling multiple-level interrupts. This system allows a computer to handle the requests of peripheral devices in order of priority. The arrangement in figure 1a has the capacity to service eight separate priority levels. Each interrupt is completed before others are allowed. A more sophisticated scheme is shown in figure 1b. It has the ability to halt current interrupt service if a higher-level interrupt occurs (when the higher-level interrupt is finished, control is returned to the lower-priority interrupt and its service is completed).
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Among the problems familiar to experienced programmers is that of table lookup: given a value (the argument, or key), search through a list of values of the same kind to find a matching entry. Then, once a match is found, extract the corresponding entry (the function, or result) from a second list, often of a different kind of data. This article discusses a single table-lookup routine (written specifically for a Zilog Z80 microprocessor) that, given an 8-bit value, finds a corresponding 16-bit value. As such, this article is of primary interest only to Z80 programmers. But it shows them how the special instructions peculiar to the Z80 can be used to good effect.

The routine, ZTL, is shown in listing 1. It achieves a great economy of program size, and a good economy of execution time, by using the special Z80 block-search instruction, CPDR (Compare, Decrement and Repeat). The similar search instruction, CPIR (Compare, Increment and Repeat), may seem more natural to use. But for the routine presented here, CPDR provides more easily used "leftover information" in the BC register pair.

To show how the routine works, consider the following example. A computer-system monitor is being written. The system user types a single character command, and the system responds by performing an indicated action. The commands are:

- I — Initialize system
- D — Display hexadecimal memory dump
- G — Get a file from external media
- X — Execute a program
- E — Enter hexadecimal data into memory
- B — Set a breakpoint

Some of the commands need additional data, such as the address at which a breakpoint is to be set. However, the only current concern is to identify the command and branch to the address of the corresponding command-handling routine. Listing 2 shows the memory arrangement of the table for ZTL. (Values given for the addresses of the command-handling routines are purely arbitrary.)

The call to use the ZTL routine is shown in listing 3. Listing 4 shows a step-by-step illustration of the contents of each register involved, assuming that the program has extracted a G command from the typed input.

The first two instructions simply copy the contents of the BC register pair (used to hold the byte count) into the DE register pair (to be used later). The next instruction is the Z80 CPDR. It is executed four times in the current example. On the first execution, the G in register A is compared to the B at the location (hexadecimal 12F5) indicated by the HL register pair, the contents of HL are decremented from hexadecimal 12F5 to 12F4, and the byte count is decremented from 6 to 5. Since the bytes compared did not match, and the byte count did not go to zero, the instruction is repeated, using the new values in the HL and BC register pairs.

On the fourth execution of the CPDR instruction, the G in register A is compared to the G at the location indicated by the HL register pair (hexadecimal 12F5) indicated by the HL register pair, the contents of HL are decremented from hexadecimal 12F5 to 12F4, and the byte count is decremented from 3 to 2. Since the bytes compared did not match, and the byte count did not go to zero, the instruction is repeated, using the new values in the HL and BC register pairs.

On the fourth execution of the CPDR instruction, the G in register A is compared to the G at the location indicated by the HL register pair (hexadecimal 12F2) indicated by the HL register pair, the contents of HL are decremented from hexadecimal 12F2 to 12F1, and the byte count is decremented from 2 to 1. Since the bytes compared did match, the instruction is not repeated. Notice that the HL register no longer points to the G in the table; it points one location below the G. This is a nuisance caused by Zilog's choice of a "post-test
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loop" approach instead of a "pre-test loop." It is not difficult to compensate for it, but it is easy to forget.

The next instruction executed is a RET NZ (return on not zero), which provides an exit when the byte for which a match is sought does not occur in the table. In the current example, this return is not taken. Following the RET NZ is an instruction to increment the contents of the HL register pair. This instruction is used to compensate for the incorrect value stored in the HL register, described above.

The next two instructions compute the address of the first (low-order due to high/low storage reversal) byte of the sought argument—the corresponding entry in the second part of the table. Suppose \( B \) is the beginning address of the first part of the table, \( L \) is the length of the first part of the table, and \( I \) is the position of the sought byte in the table, \( I \) ranging from 1 to \( L \). The second part of the table starts at address \( B + L \), and the sought entry starts at address \( B + L + (I - 1) \times 2 \). At this point in the execution of the routine, BC holds \( I - 1 \), because the CPDR decrements the byte count once too often, as well as the address in HL. Furthermore, the address in HL is \( B + (I - 1) \) (compensated). So, when the routine adds BC to HL:

\[
HL = B + (I - 1) + (I - 1)
\]

Then, adding the table length \( L \), saved in DE:

\[
HL = B + (I - 1) + (I - 1) + L
\]

so:

\[
HL = B + L + (I - 1) \times 2
\]

which is the address of the sought argument.

---

Listing 1: ZTL, a table-lookup routine for the Z80 microprocessor. The use of the Z80's block-search instructions makes this routine short and fast, but some of the microprocessor's idiosyncrasies need compensation.

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Programming Quickies

Listing 1 continued:

```assembly
EX DE,HL ; PUT RESULT INTO HL (MORE USEFUL THERE)
RET ; DONE
```

Listing 2: Arrangement of the table in memory for use by ZTL.

<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>12F0</td>
<td>49</td>
</tr>
<tr>
<td>12F1</td>
<td>44</td>
</tr>
<tr>
<td>12F2</td>
<td>47</td>
</tr>
<tr>
<td>12F3</td>
<td>58</td>
</tr>
<tr>
<td>12F4</td>
<td>45</td>
</tr>
<tr>
<td>12F5</td>
<td>42</td>
</tr>
<tr>
<td>12F6</td>
<td>00</td>
</tr>
<tr>
<td>12F7</td>
<td>00</td>
</tr>
<tr>
<td>12F8</td>
<td>AA</td>
</tr>
<tr>
<td>12F9</td>
<td>06</td>
</tr>
<tr>
<td>12FA</td>
<td>0B</td>
</tr>
<tr>
<td>12FB</td>
<td>07</td>
</tr>
<tr>
<td>12FC</td>
<td>12</td>
</tr>
<tr>
<td>12FD</td>
<td>01</td>
</tr>
<tr>
<td>12FE</td>
<td>08</td>
</tr>
<tr>
<td>12FF</td>
<td>0A</td>
</tr>
</tbody>
</table>

Listing 3: Sample of the call to ZTL.

```
LD BC, 6 ; LOAD LENGTH OF ARGUMENT TABLE
LD HL, 12F5H ; ADDRESS OF LAST TABLE ENTRY
LD A, H ; FIND ADDRESS IN FUNCTION TABLE CORRESPONDING TO BYTE IN A
CALL ZTL ; Z80 TABLE LOOKUP
JP (HL) ; GO TO THE ADDRESS SO FOUND
```

Listing 4: Register contents as ZTL executes (see the text for an explanation of the specific example).

```assembly
INSTRUCTION REGISTER CONTENTS TABLE BYTE EXECUTED A Z-FLAG B C D E H L (HL) ZTL ROUTINE CALLED
47 ?? 00 06 ?? ?? 12 FS 42
LD D, B ; COPY LENGTH FROM BC (BYTE COUNT)
47 ?? 00 06 ?? 00 12 FS 42
LD E, C ; INTO DE (TO SAVE FOR LATER)
47 ?? 00 06 00 12 FS 42
CPDR ; SEARCH DOWN ARGUMENT ENTRIES
47 ?? 00 04 00 06 12 F3 45
CPDR (INSTRUCTION REPEATS ITSELF)
47 NZ 00 04 00 06 12 F3 98
```

Listing 4 continued on page 174
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Listing 4 continued:

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Purpose</th>
<th>Memory References</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPDR</td>
<td>Repeat instruction</td>
<td>47</td>
</tr>
<tr>
<td>CPDR</td>
<td>Repeat instruction</td>
<td>47</td>
</tr>
<tr>
<td>RET N2</td>
<td>Return if not zero</td>
<td>44</td>
</tr>
<tr>
<td>INC HL</td>
<td>Compensate for CPDR overshoot</td>
<td>44</td>
</tr>
<tr>
<td>ADD HL,DE</td>
<td>Add original length</td>
<td>45</td>
</tr>
<tr>
<td>LD E,(HL)</td>
<td>Pick up low-order byte</td>
<td>0B</td>
</tr>
<tr>
<td>INC HL</td>
<td>Add HL,BC</td>
<td>45</td>
</tr>
<tr>
<td>ADD HL,DE</td>
<td>Add original length</td>
<td>45</td>
</tr>
<tr>
<td>LD D,(HL)</td>
<td>Pick up high-order byte</td>
<td>0B</td>
</tr>
<tr>
<td>EX DE,HL</td>
<td>Put result into HL (more useful there)</td>
<td>??</td>
</tr>
<tr>
<td>RET</td>
<td>Done</td>
<td>??</td>
</tr>
</tbody>
</table>

Text continued from page 170:

The next instructions pick up the low-order byte, increment HL, and pick up the high-order byte of the sought argument word. They are put directly into the DE register pair by means of the HL register indirect instructions. If the answer is useful in DE, the routine can be ended here with a return; but, since an answer is generally more useful in the HL register pair, the routine as shown includes an exchange of DE with HL.

Finally, the routine ends with a simple unconditional return statement. It is important to note that none of the instructions following the CPDR will affect the zero flag. This allows the calling routine to easily determine if a match was found by examining the zero flag. The fact that the 16-bit ADD (without including previous carry) instructions do not set the zero flag is often a nuisance. But in this routine it is an advantage.

Beyond Tables

This article described a simple routine with a great deal of power. The example of usage presented dealt with finding the address of a software routine when given a single character command. However, the same routine can be called whenever you want to find 16 or fewer bits of information from a single 8-bit value. For example, it could be used to interpret single-byte codes used to store 3-digit telephone prefixes. Or it might be useful in a compiler to store a table of kinds of variables and their attributes. Hopefully, you will find that problems of your own can be solved with this simple and efficient routine.
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Four Word Processors for the Apple II

The world of word processors has expanded rapidly in the past few years, and it appears to be only the beginning. We have seen a flourish of office automation machines from the big manufacturers, but with few exceptions the small machine software manufacturers have led the way. And, after reviewing some of the word-processing systems designed for microcomputers, we discovered that they have several advantages.

It was a temptation when reviewing these word processors to compare them to their large mainframe brothers. Eventually we stopped resisting that temptation. Both Steve and I have access in our work to such mainframe word processors as those by Wang and Honeywell. The comparison hardly seems fair, but in reality most of the microcomputer word processors offer the features found in their larger brothers: in fact, a few of them are easier to use and learn, while still providing all of the features a user could possibly want. This will be evident in specific reviews.

There are two kinds of word processors: screen- or cursor-oriented, and line-oriented. Cursor-oriented means that the editing and entry take place at the cursor, which is moved throughout the text. In line-oriented word processors, all text is entered and referred to with line numbers. Neither method appears to have a distinct advantage over the other: they are merely different ways of referencing the text.

Super-Text
Super-Text is a super word processor that, despite minor problems, exhibits some of the power-packed features you would expect in a word processor designed for a much larger machine. Super-Text (from Muse Software) can be easily adapted to your current equipment, as well as any you may acquire in the future.

<table>
<thead>
<tr>
<th>Name</th>
<th>Super-Text II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Word processor</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Muse Software</td>
</tr>
<tr>
<td>Manufacturer Address</td>
<td>330 N Charles St, Baltimore MD 21201</td>
</tr>
<tr>
<td>Price</td>
<td>$150</td>
</tr>
<tr>
<td>Format</td>
<td>5-inch floppy disk</td>
</tr>
<tr>
<td>Language</td>
<td>6502 machine language</td>
</tr>
<tr>
<td>Computer</td>
<td>Apple II or II+ with 48 K bytes of memory and one disk drive</td>
</tr>
<tr>
<td>Documentation</td>
<td>82 pages, 15.5 by 23 cm (6 by 9 inches); three-ring binder</td>
</tr>
<tr>
<td>Audience</td>
<td>Anyone needing a word-processing system</td>
</tr>
</tbody>
</table>

![Photo 1: Apple word processors: the Datadoc Scribe, the Rainbow Write-On!, the IVS EasyWriter Professional system, and the Muse Super-Text II. (The cream-colored binder in the upper left corner is for Super-Text II, which has been discontinued by Muse.)](image-url)
Now proven baZic can be run on any Z80® computer under CP/M®. baZic is written entirely in Z80 code—runs faster than any other BASIC interpreter. The greater execution speed is significantly advantageous for heavy number crunching, multi-user and multi-tasking operations.

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Hard fact:
$150 makes your Z80-based computer run up to 40% faster!
With the Dan Paymar lowercase adapter (which allows the Apple to display lowercase letters), this processor supports true lowercase.

Super-Text also allows conversion of files for use with the Paymar lowercase adapter. However, it does not allow the reverse, so you must either keep two copies of the text file or always use an Apple II with the lowercase adapter. Most of the other Apple II word processors use reverse-video to represent uppercase letters on the screen. If you don’t have a Paymar lowercase adapter, Super-Text places a reverse-video A in front of the character to be capitalized, instead of highlighting the character itself. This can be confusing until you get used to it, because the reversed A does not print when you print the file. We found that we had a tendency to compensate for the nonprinting character when lining up text. You have to use the control key as a shift, but Super-Text will support the use of the shift key with a minor modification to the keyboard. (Muse provides the short piece of wire and instructions for the modification.)

Super-Text does not support an 80-column board, but it simulates 80 columns by using a preview mode. This mode allows you to see what your text will look like on paper, with obvious limitations on color, super­/

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Mince (Amethyst text editor) $125 manual $15 demo disk $10
Scribble (Amethyst text formatter) $125 manual $15
Mince and Scribble ordered together $175

48K CP/M<sup>R</sup> required. Available on 8" soft sector diskettes. Mince and Amethyst require a cursor-addressable terminal. Dealer, site, OEM, and **NIX versions and licenses available.

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“hot zone” to prompt for hyphenation, but if you want hyphenation with Super-Text you must perform it manually. By embedding control characters in the text, you can instantly invoke format changes, tab stops, automatic paragraph indentation, word centering, and left margin changes. These control characters appear as reverse video letters. Super-Text formats the text upon printout, so the effects of these control characters are visible only on printout or during preview mode.

The only files Super-Text will accept, other than those written by itself, are Dr Memory files. (Dr Memory is the predecessor of Super-Text.) Muse also has add-on modules that can produce form letters (available for $100), input files by telecommunication ($75), and plot graphs (no price quoted).

Super-Text’s ability to edit is excellent. The word processor is cursor-oriented, and it gives the user a full set of commands to move the cursor about the text. The cursor scrolls backward or forward by operator choice, and the direction is clearly marked in the lower left-hand corner. The replacement, deletion, insertion, and rearrangement of text processes are all easy to use and understand. However, one minor problem appears with insertion: normally insertion occurs in front of the current cursor location—with Super-Text, it occurs after the cursor location. This is unnerving and hard to get used to.

Super-Text can also copy blocks of text easily throughout the text file, and it can save and load blocks of text separately, a feature that is especially helpful with “boilerplate” files used in business correspondence.

Find-and-replace operations are easy and efficient. The operations even include a “wild card” notation that will match any number of intervening characters (including none). For example, an attempt to find “COMPUT#WORLD” would match “COMPUTER WORLD” or “COMPUTING WORLD”. Super-Text is loaded with prompts that make find-and-replace operations easy for the operator.
GAMES, SIMULATIONS, EDUCATION AND MISCELLANEOUS

BRIDGE 2 (Available for all computers) Price: $17.94 Certificate:$20.00 diskette

An attractive version of this most popular of card games. Your computer both plays the partnerships and makes the correct bidding decisions in the contracts, while you make your actual play. Bridge 2 contains instructions to help you learn the rules of the game. Bridge 2 also has a computer that can be programmed to play any style of bridge.

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MAIL LIST 2.2 is a powerful and versatile text formatting program that allows you to create professional-looking documents. The program provides a variety of formatting options and can be used for a wide range of applications, from letters and reports to invoices and contracts.

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FINDIT (North Star only) Price: $19.95 Certificate:$19.95 diskette

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Even more useful (and amazing) is autolink. Autolink allows Super-Text to find and replace across an unlimited number of files. This action can occur in forward, backward, or even circular directions. Simply enclose the next file in colon symbols, place it at the end of the file (or the beginning, for a backward or circular link), and set the autolink flag. Any further find or replace command automatically searches the current file, loads the next, and searches it as well. Needless to say, this is a powerful feature that is unavailable on some of the big word processors.

Another feature that is neglected by some of the larger manufacturers is the split-screen mode. It is fascinating to see such a sophisticated feature in a word processor for a microcomputer. However, we wondered about the value of this feature. What can it be used for? In any case, it exists in Super-Text, and if you can use it—so much the better. We suspect it has only dazzle value.

In addition to Super-Text's excellent editing, there is a math mode that performs as a four-function calculator for columnar and embedded numerical data. It features an accumulator with up to fifteen-digit significance, and a decimal point that can be set by the operator. This calculator also adds up columns—even across screens. Once sums are in the accumulator, they can be easily inserted in the text, and even automatically aligned on decimal points.

The printouts look clean and professional, which is dependent, in part, on the printer you use. We used a Centronics 737, which is a "smart" (microprocessor-controlled) printer that looks good even though it is a dot-matrix printer. The printer can do many things by itself, and this is where the adaptability of Super-Text becomes a factor. Right justification is performed by space insertion, and it has the appearance of being evenly proportioned since Super-Text seems to place spaces after punctuation first, and then randomly across the line. Super-Text does not perform true proportional spacing, but the Centronics 737 does this automatically with a proportional type font.

The Centronics responds to certain control characters that are sent to it to control particular features, such as underlining, choice of type font, superscripting and elongation of text (any type font may be printed as double-width characters). While Super-Text cannot directly control these printer functions, it allows six control characters which can be user-defined. (Four of these are configured for Diablo printers.) Some technical knowledge is required to redefine these control characters, but step-by-step instructions lead you through the process.

Although you can add an assembly-language printer driver to Super-Text, it is usually unnecessary. The first time you use Super-Text, you should configure it for your printer; this data is then saved on disk, and you should never again have to change your printer configuration (unless you get a different printer). The formatting parameters given at configuration time can be easily changed within the text.

Super-Text can use continuous form or single-sheet paper. It is difficult, however, to change back and forth, since you must reconfigure the printer every time that you switch. The operator can stop and start a printout at any time by the touch of a key. Page numbers can be suppressed, and made relative to the beginning of a chapter with the insertion of a control character. Page numbers can also be moved around the page for maximum flexibility. There is no provision that automatically locates the proper line for footnotes. The operator must count up lines for proper placement.

Human engineering is a weak point with Super-Text. The program does provide excellent prompts when necessary, including warnings for dangerous commands (eg: "PRESS # TO DELETE---" for deleting the entire text buffer) and multiple keystrokes to avoid accidental deletion. The problem, however, is that a lot of the control characters are not mnemonic. Also, multiple keystrokes for simple operations abound in Super-Text.
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- V200-Exidy version $1199.00
This problem can be avoided, as demonstrated by Write-On!, another word processor designed for Apple II. Some functions can be “undone” by using the escape key, but since most of the action takes place instantly, it is difficult to undo these commands. This is not the fault of Super-Text.

Text can be easily recovered from a “crash.” If you find yourself in the Apple II monitor (denoted by an asterisk at the beginning of the line), simply type “3DOG”, hit the return key, and then “CALL 4096”, followed by the return key. You are placed back in Super-Text! We have yet to enter a file that exceeds the capacity of the text buffer in Super-Text, so we don’t know what happens when it fills up. The manual states that the processor will warn you when the buffer is almost filled.

Super-Text appears to use its own disk operating system, but it does use BLOAD and BSAVE to load and save text files. These operations are quick and easy. The fact that Super-Text can’t be copied is probably the biggest problem. Perhaps Muse has realized how inconvenient this is, because it has provided two disks of the program. We understand its reluctance to put a copyable program on the market, but we feel there are other ways to avoid piracy. One solution is to create a disk that can be copied a limited number of times but that produces uncopyable copies. In any event, there is a replacement policy, but there is also a $10 media replacement charge.

Super-Text documentation comes in the form of an instruction manual. As a teaching tool, this manual is insufficient. The features are explained well, and some are supplemented with examples from the Super-Text disk. However, no quick reference card is provided, and it is sorely needed. The commands summarized at the end of each chapter explain the modes, but this is not enough, since you must leaf through the manual...
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until you have memorized all of the commands. There are no listings of the program, but as it can't be modified this makes little difference. In all fairness, the program provides for any modification you might want to make, so listings are unnecessary.

Super-Text is a very good word-processing program, and it generally works very well, especially after the user has adapted to the processor's particular methods. We won't give numerical ratings, as too much depends on the user's needs, but we'll give you a hint. We prepared part of this article with the Super-Text word processor.

Write-On!

Write-On!, like Super-Text, varies little between versions. The additional features of Write-On! II include preset script margins, personalized form letter capabilities using data files, data-file editing and input, and a system for preformatting text files for the printer. Write-On! II can also convert other files into data files.

Write-On! (from Rainbow Computing) is, for the most part, written in BASIC, and it lacks the speed of Super-Text or the Datapace Scribe. Therefore, it is almost a necessity to preformat text files for the printer. Unlike Super-Text, however, the added features are worth the price: in fact, the ability to print personalized form letters justifies the expense.

The following comments apply to both versions of Write-On!, unless otherwise noted.

Write-On! is a super word processor, but that name was already taken. Although it lacks some of the flexibility of the other word processors, it provides a full range of commands to process text.

Write-On! supports display of lowercase letters through the use of the Paymar lowercase adapter. It would appear that Mr. Paymar and his adapter have become a standard with Apple. [Paymar had the field to himself for some time, but other companies (particularly Lazer Systems) are also producing lowercase products for the Apple II...GW] The shift key can be enabled by modifying the keyboard, as mentioned above, but Rainbow Computing does not provide the wire—just the instructions. Without the shift modification, Write-On! uses reverse video and the ESC (escape) key to denote a capital letter. The shift lock is enabled by hitting the ESC key twice.

Write-On! does not support an 80-column board, and since it does its formatting when it prints out, there is no provision for viewing a text file in its final form on the screen. There is a feature in Write-On! II that allows print image files to be saved on disk, but the main purpose of these files is

---

**At a Glance**

**Name**  
Write-On! I and II

**Type**  
Word processor

**Manufacturer**  
Rainbow Computing  
9719 Reseda Blvd  
Northridge CA 91324  
(213) 349-5560

**Price**  
Write-On! I, $99.95  
Write-On! II, $150

**Format**  
5-inch floppy disk

**Language**  
Applesoft BASIC with some 6502 machine-language subroutines

**Computer**  
Apple II or II+ with Language Card or ROM Applesoft, 48 K bytes of memory, and one disk drive

**Documentation**  
67 pages, 22 by 28 cm (8.5 by 11 inches); three-ring binder; Quick Reference Card

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to speed up output to the printer. (The files display gibberish when loaded and viewed on the Apple screen.)

The processor uses the wraparound technique to divide words, so touch typists can enter text quickly and easily. Unfortunately, there is no provision for hyphenation. (This seems to be the rule rather than the exception in word processors for microcomputers.) Write-On! uses control symbols embedded in the text to control tabs, text width, margins, page numbering, text centering, and paragraph indentation. These symbols take the form of "backslash-some characters-backslash" and they are also highlighted on the screen.

Write-On! will accept files not written by itself. Understandably, the process is slower than loading its own files, but the feature does exist. After we tried this command, we found that the files had to be text files in thirteen-sector format. The files that Super-Text saved would not even show up with the CATALOG command because Super-Text uses BLOAD to save its files. The ability to edit previously created text files is an important consideration when you convert from one word processor to another.

Write-On! performs its editing chores with ease and speed. The processor is line-oriented, and although I feel it is more difficult to work with, this is largely a matter of personal preference. An asterisk appears to the left of the line that is currently operating. The replace and find commands are facilitated by machine code, so they are even quicker. Blocks of text can be moved, copied, deleted, or saved easily. Write-On! does not have an autolink command for editing, so you cannot edit across files (as you can with Super-Text) but it does have a merge command similar to that in Datacope's Scribe. Text from a disk file can be inserted anywhere in the text that you are currently editing. Overall, the editing commands are easy to learn and use.

The standard Apple DOS (disk operating system) is used. However, text files are loaded and saved using BLOAD and BSAVE, which reduces waiting time considerably. The saving and loading commands are clear and understandable, and have prompts that lead the user through the process. If you are a programmer, you can modify this function quite easily, because Write-On! is completely modifiable and copyable. There are some machine-language subroutines for find and replace functions, but those subroutines work well so there is little need to change them. The program runs in 48 K-byte machines only, but there is adequate room for lengthy files. The manual doesn't tell you what happens if the text buffer fills up, but we never encountered that problem.

There does appear to be a problem where output is concerned: there is no provision for a machine-language driver (sometimes used to drive a nonstandard printer). When initially configured, Write-On! only asks what slot your printer is in. In addi-
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<th>TEXT COMMANDS</th>
<th>GRAPHICS COMMANDS</th>
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<td>Change to New Command Character</td>
</tr>
<tr>
<td>Let CTRL-G Ring Printer Bell</td>
<td>Turn Back to Command Character</td>
</tr>
<tr>
<td>Output High Bit</td>
<td>Turn off Video, Set Line Length to n</td>
</tr>
<tr>
<td>Turn on Video Screen, Set Line Length to 40</td>
<td>Output Hi-Res Page 1</td>
</tr>
<tr>
<td>Don't Append LF's onto CR's</td>
<td>Output Hi-Res Page 2</td>
</tr>
<tr>
<td>Set Left Margin to n</td>
<td>Output Hi-Res Page 1 Inverse</td>
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<tr>
<td>Set Page Length to n</td>
<td>Output Hi-Res Page 1 Rotated 90°</td>
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<td>Output Hi-Res Page 1 Double Size</td>
</tr>
<tr>
<td>Dump Text Screen to Printer</td>
<td>Commands May Be Used Together:</td>
</tr>
<tr>
<td>Don't Output High Bit</td>
<td>Output Page 2 Inverse Rotated 90°</td>
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</table>

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tion, it is not very adaptable to particular features of different printers. Although Write-On! has several features such as underlining and bold-face, it needs some user-defined control characters because it does not provide for such conditions as different type fonts, super-/subscripting, different color ribbons, or proportional spacing. It will justify to the right margin, and it does a good job of it. The text doesn’t look thin in any particular spot.

Write-On! changes easily from sheet to continuous form. Page numbers can be moved to any position on the page, and numbering can be suppressed. While we were investigating page numbering, we encountered a mystery: Write-On! only allows an absolute page number, yet the manual, which was written with Write-On!, has chapter-relative page numbers (eg: 3 - 4). It seems there is a command that allows a string to be printed to the left or the right of the page number. The chapter must have been inserted as that string and then changed at the beginning of every chapter. This is still mysterious, however, because the manual makes no mention of it. (Except for the EasyWriter Professional word processor, none of these word processors have provisions for footnoting, and Write-On! is no exception.) Write-On! also provides predefined titles. You can define up to twenty titles, which will appear at the beginning of each page.

Write-On! II even provides for form letters using data files. You can build a file of personal or company names, or addresses, and then insert them into a form letter upon printout. This is a tremendously powerful and useful feature (especially for the price). As if this is not enough, Rainbow includes a data-file converter program that takes files from mailing lists and general ledgers and automatically converts them to the proper data-file format. If you want to insert data while your text is printing, Write-On! will accept input from the keyboard and print it where you have embedded the special control character. It even provides for a string that will print on the screen to prompt for the proper information. These are undoubtedly the most powerful features found in a microcomputer-based word processor.

The human engineering in Write-On! is superb. All of the commands are mnemonic and provoke little confusion. Most of the commands use only one keystroke, thus simplifying matters even further. Although the print module is separate from the editor program, its use is simplified by prompts and a menu selection. All of the editing and printing commands are prompted, and error traps are included so that it is difficult to inadvertently destroy several hours of typing.

Along with the excellent human engineering, Write-On! provides superlative documentation. This documentation leads the user by the hand; explanations of the various features are clear and concise, and even the complex operations make sense.

Text continued on page 196

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John Whitney is on the Faculty in the Department of Art at the University of California, Los Angeles.

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special characters are items that we will have to live with, at least for now. The Datacope Scribe does, however, provide a feature that allows us to view the text without all the special control characters; this will be described later in the review.

The Datacope Scribe utilizes two techniques found in several of the word processors for the Apple II: use of the ESC key for shift and use of Control-A for shift lock. The word processor accommodates touch typists and eliminates the need to worry about margins. Hyphenation is indicated by a hyphen when you execute the "implementation" command (the command that causes the word processor to execute all the other commands you have given it). Scribe then prompts for your approval (press RETURN). If you wish to change the location of the hyphen, press either of the arrow keys until the hyphen is where you want it, then press RETURN.

Tabs are input through the use of control-Y. Each time a control-Y is pressed, an inverse ^ appears on the screen. This prints the next character at the next tab position (as given by the values in the tab position table). The word processor supports line centering, underlining and indentation.

The Datacope Scribe has the ability to specify, during input, locations where keyboard input is desired during printing. This feature is nice for adding personal touches to form letters or addresses to letters. Text files on a disk other than the one being worked on must be appended to the current file (ie: they cannot be inserted into the middle of the file). This requires that you preplan in detail before you enter text.
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<td>Price</td>
<td>EasyWriter, $99.95; EasyWriter Professional, $250</td>
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<td>Language</td>
<td>FORTH (threaded 6502 machine language)</td>
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<tr>
<td>Computer</td>
<td>Apple II or II+ with 48 K bytes of memory and one disk drive</td>
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<tr>
<td>Documentation</td>
<td>50 pages, 15.5 by 23 cm (6 by 9 inches); three-ring binder</td>
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<tr>
<td>Hardware</td>
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- Assembled and Tested $17.95

The LNW Data Separator provides you with a reliable and inexpensive means of solving your disk data read error problems for your 5" single density drives. Compatible with both the LNW System Expansion and Tandy's Expansion Interface. Some soldering is required.

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- **LNW CASE** $84.95

The streamline design of this metal case will house the LNWBO, System Expansion, LNWBO Keyboard, power supply and fan, LNDoubler®, or LNW Data Separator. This kit includes all the hardware to mount all of the above. Add $12.00 for shipping

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  - 6 chip set $26.00
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  - LNWBO Transformer LNWBO-3 $18.00
  - LNWBO Keyboard cable LNWBO-4 $16.00
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**ORDERS & INFO. NO. 714-552-8946**

**ACCEPTED**

Add $3.00 for shipping

**SERVICE NO. 714-641-8850**
this display is that only the letter displayed in inverse is made uppercase.

EasyWriter displays the least amount of extraneous information with the text of all the word processors covered in this review. Shift is accomplished by pressing the ESC key once; twice for shift lock. The Professional version also uses the ESC key, but allows for the wire between the shift key and 16-pin game I/O port (the game paddle connector) for easier use by a touch typist.

The method of ending paragraphs has also been improved. The original EasyWriter uses two shift-Ms, whereas the Professional uses only a return. The original version used one shift-M to end a line. The Professional's reference manual warns the typist to use the return only to start new paragraphs.

Paragraphs may be formatted to automatically indent through the use of special embedded commands, which are placed between text lines. These commands may appear more than once, thus providing the opportunity to change indentation formats several times in any document. Both versions of EasyWriter support the centering of lines of text, but the method of implementation varies. The original version uses the embedded command technique, while the Professional uses a special editing tool that will be described later.

The 40-column version does not provide a method for viewing the text in final form, but the Professional’s 80-column display is the image of the output. And since it is the direct image, an added capability is provided to align text, both after input and prior to printing. Through the use of “additional commands” (which have their own menu screen), the Professional version allows you to realign margins, center lines of text, set and reset tabs, and, for use with printers such as Qume, Diablo, and Spinwriter, vary spacing between letters.

The Professional EasyWriter can translate files from the original 40-column version for use with the 80-column display. Both versions use various control keys to scroll up or down by page or line. Left or right movement on any line is performed with the Apple’s normal arrow keys.

Editing is a pleasure with either version. Global search and block movement of text is supported in both versions, but global replace is supported only in the Professional. After you have finished editing, output can be tailored to each document, or you can rely on the default values. The original version accomplishes tailoring with embedded commands; the Professional version uses the additional commands to realign text (as described above), as well as optional

**EasyWriter has the least amount of extraneous Information displayed with text.**
When Eight Is Not Enough: CP/M-86™ and CBASIC/86™

"In 1977 Compiler Systems, Inc. introduced CBASIC™ as a CP/M® programming language. It quickly became the most widely used BASIC dialect. Since then CBASIC has been adapted for use on systems supporting MP/M™ and TRSDOS."

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—Gordon Eubanks, CSI president

Today CSI offers CBASIC/86 designed for 16-bit microcomputer-based systems running under CP/M-86. CBASIC/86, now available worldwide, is based on concepts first used by CBASIC including such business-oriented features as: BCD arithmetic with fourteen-digit precision; full format control of printed reports; random and sequential records of any length (not limited to 256 bytes); aids to structured design, i.e. multiple line functions and control structures as well as excellent file-handling and stringing capabilities.

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OEMs contact us for pricing

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Sierra Madre, CA 91024, (213) 355-1063

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WORDSTAR Apple Version
Finally, the 'Mercedes-Benz' of Word Processing Systems comes configured for one of America's favorite micros. Has all the features of the Standard WORDSTAR. Requires Microsoft CP/M card, Video Vademecum 80 x 24 screen conversion card (or equivalent), and at least 48K RAM.
List Price: $375.00
Microhouse Price: $245.00/$40.00
\MICRO-WSAPPL
MAILMERGE for Apple
Custom type letters to whole lists of people, create documents using already existing paragraphs, write stock letters using `ask variables' to insert names and addresses for one-at-a-time use. One of the most useful options on favorite micros. Has all the features of the market today.
List Price: $125.00
Microhouse Price: $65.00/$25.00
\MICRO-MMAPP
WORDSTAR
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List Price: $465.00
Microhouse Price: $325.00/$40.00
\MICRO-WORDST
MAILMERGE
For CP/M-based systems other than Apple. 
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Microhouse Price: $110.00/$25.00
\MICRO-MALM
WORDSTAR CUSTOMIZATION
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List Price: $150.00
Microhouse Price: $95.00
\MICRO-WSCUST
SUPERSORT I Apple Version
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Microhouse Price: $130.00/$40.00
\MICRO-SSLSS
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Microhouse Price: $170.00/$40.00
\MICRO-SLSS
SUPERSORT II
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Microhouse Price: $145.00/$40.00
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List Price: $120.00
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List Price: $350.00
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That's what the War of 1812 was all about.

But it would have been sink or swim for our Navy had Americans not bought $11,000,000 worth of government securities to keep our flag upon the waves.

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Today, over 9½ million modern Americans still take stock in America by buying U.S. Savings Bonds.

When you join the Payroll Savings Plan, you help yourself to safe, automatic savings. And you help your country, too.

So buy U.S. Savings Bonds.
They'll keep your savings on an even keel.

Now E Bonds pay 6% interest when held to maturity of 5 years (4½% the first year). Interest is not subject to state or local income taxes, and federal tax may be deferred until redemption.
Conclusions
Choosing a word processor is similar to deciding on a microcomputer. Each has special features (see table 1), and none of the products have all the features.

If you want a word processor that performs math operations, the Super-Text II program is for you. If you're looking for a word processor that you can modify, and you know only BASIC, then Write-On! should satisfy your requirements. If you already have one of the 80-column cards, perhaps you should choose the EasyWriter Professional version. If you are looking for a workhorse processor that will handle bulk mailings, then the EasyWriter Professional version is for you, although Super-Text may meet this demand, and, with some pushing, Write-On! could meet the lower end of these requirements. Datacope has some very nice features, and if you only wish to process text at a 'UTILE GUYS' price tag.

About this time, you may be thinking, "This is a typical review that says all the products are great." Possibly this is true, but we speak with some experience as we used all of the processors while preparing this article. Each met our needs, and performed basic text processing in less than an hour.

A few years ago, such power in a small package, and at this price, was only a dream. And even today, some of the larger systems don't have equivalent features.

Acknowledgments
We would like to acknowledge David A. Lingwood for his "Word Processor Guidelines," presented in Call-Apple, September 1980, page 19.

<table>
<thead>
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<th>Program</th>
<th>Times</th>
<th>Global Search and Replace</th>
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<th>Form Letters with Data Files</th>
<th>User-Defined Control Characters</th>
<th>Disk-Copy Feature</th>
<th>Date-Stamp Feature</th>
<th>Print Multiple Pages</th>
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Table 1: Feature comparison of four popular word-processing programs for the Apple II.

Bower-Stewart & Associates SOFTWARE AND HARDWARE DESIGN

$GOLD DISK$: CP/M® Compatible Z-80 Software

Un-can your canned software!

Z-80 Disassembler Feel couped up with your canned software? Our Z-80 Disassembler recreates assembly language source files from absolute code enabling users to easily tailor programs to meet their specific needs. The Preconditioner works with the Disassembler to decode ASCII.

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Start out with a low cost multiuser Altos dual floppy based system with 208 K of RAM. It's perfect for inexpensive work stations or applications like accounting, word processing, mailing lists and more.

If you're already in need of more storage and greatly enhanced access speed, then look into the Altos 10Mb-58Mb hard disk systems. When combined with the standard 208 K of RAM, 6 serial I/O and 2 parallel ports, they become unusually fast and powerful 4-user business or scientific systems.

All Altos systems are packaged with single board Z80 CPU, quality Shugart 8-inch disk drives, and options such as DMA (required for OASIS) floating point processors, and a cartridge tape back-up subsystem.

So as you grow, just add onto your system. Without suffering the growing pains of eating the costs of your "first" computer.

Onyx: maximum integration in one sleek box.

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The 8-bit C8001/MU is an ideal multi-user system for business or word processing applications. It combines Z80 high speed processors, standard 128 K RAM, (expandable to 256 K), Winchester disk and integral cartridge tape drive in an efficient, compact package. And using reentrant BASIC application programs, it allows up to 5 simultaneous operators.

When you need the power of a 16 bit computer, you want the C8002. It uses a special edition of Bell Laboratories UNIX operating system to accommodate up to 8 users involved in product development or executing application programs in C, COBOL, PASCAL or C-BASIC II.

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SCREEN

2000 character display, organized into twenty-five 60-column lines
84 ASCII, 64 graphic characters
3 x 8 dot matrix characters
Green phosphor screen
Brightness control
Line spacing: 1/12 in Text Mode
1 in Graphics Mode

SCREEN EDITING
CAPABILITIES
Full cursor control (up, down, right, left)
Character insert and delete
Reverse character fields
Overstriking
Return key sends entire line to CPU regardless of cursor position

KEYBOARD
73-key typewriter style keyboard
with graphic capabilities
Repeat key functional with all keys

MEMORY
CBM 8016: 16K (15359 net)
random access memory (RAM)
CBM 8032: 32K (31743 net)
random access memory (RAM)

POWER REQUIREMENTS
Volts: 110V
Cycles: 60 Hz
Watts: 100

FIRMWARE
DOS version 2.0
Sequential file manipulation
Relative record files
Improved error recovery
Automatic diskette initialization
Automatic directory search
Command parser for syntax validation
Program load and save

CBM 8032 Computer $1795

CBM 8016: 16K (15359 net)
random access memory (RAM)

CBM 8032: 32K (31743 net)
random access memory (RAM)

HARDWARE SPECIFICATIONS

Dual Drives
Two microprocessors
974K Bytes storage on two 5.25" diskettes (ss)
Tracks 70
Sectors 17-21
Soft sector format
IEEE-488 interface
Combination power (green) and error (red) indicator lights
Drive Activity indicator lights
Disk Operating System Firmware (12K ROM)
Disk Buffer (4K RAM)

FIRMWARE
DOS version 2.0
Sequential file manipulation
Relative record files
Improved error recovery
Automatic diskette initialization
Automatic directory search
Command parser for syntax validation
Program load and save

CBM 8050
Dual Price $1795

CBM™ 8050 DUAL DRIVE FLOPPY DISK

The CBM 8050 Dual Drive Floppy Disk in an enhanced version of the intelligent CBM 2040 Disk Drive. The CBM 8050 has all of the features of the CBM 2040, and provides more powerful software capabilities, as well as nearly one megabyte of online storage capacity. The CBM 8050 supplies relative record files and automatic diskette initialization. It can copy all the files from one diskette to another without copying unused space. The CBM 8050 also offers improved error recovery and the ability to append to sequential files.

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BYTE June 1981

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IBM and Matsushita To Join Forces? Matsushita, the giant Japanese electronic conglomerate that markets Panasonic and Quasar products in the US, recently admitted that it had been approached by IBM in regard to manufacturing a personal computer for the US market. It’s been rumored for some time that IBM is planning to market a Japanese-made personal computer in the US. Although Matsushita officials released no details regarding their talks with IBM, another report that Matsushita has already designed and built a personal computer has prompted some observers to theorize that the unit will bear the IBM name when it is marketed in the US later this year.

How Are The Personal-Computer Makers Doing? Tandy Corporation, Radio Shack’s parent company, continues to have an outstanding growth record. Tandy’s sales for the 1979-1980 fiscal year rose to $1.4 billion, up from the previous year’s $1.2 billion. Its income has increased 35% since it joined the microcomputer business, which now totals 13% of its overall sales.

This year Tandy expects to add 400 more stores to its fold of nearly 8000. In the US, there will be 250 more stores and 50 computer centers. Tandy plans to open 100 outlets overseas. Foreign sales currently account for 25% of its total sales.

Each Radio Shack store stocks more than 2600 items. The largest portion of a store’s sales is parts and accessories (23%), with radios, tape recorders and phonographs second (19%), other audio components third (17%), and toys and microcomputers tied for fourth place (13%). Citizen’s Band radios (10%) and telephones (5%) constitute the remaining sales.

Tandy leads the field in microcomputer sales. It sold over 200,000 computers last year for a total of $180 million.

Tandy’s gross sales for the final half of calendar year 1980 were $869 million, and profits were $80 million, compared with $739 million and $60 million for the same period the previous year. The upward trend continues: sales this past January shot up to $141 million, from $112 million the year before.

You can still purchase a TRS-80 Model I in England. The Model I was pulled from US shelves in January because it did not comply with the Federal Communications Commission’s radio-frequency-interference regulations. Also in England, TRS-80s are sold through independent computer stores as well as through Tandy-owned TRS-80 Computer Centers. So, the same dealer selling Apple IIs and Commodore PETs has TRS-80s on the display shelf. Some dealers also carry the Video Genie EG3000, the Far-Eastern copy of the TRS-80.

Apple Computer Inc also chalked up record sales and income last year. Sales for the last quarter of 1980 were up 246%, and profits were up 180%. The demand for Apple products in the first quarter of 1981 was greater than anticipated, but the company considers it unlikely that this growth will continue into the second quarter of the year.

Apple revealed that the commissions required to sell its stock last year came to $93.3 million, or $1.30 a share. The stock initially sold for $20 to $25 a share; it peaked at a high of $35, and it’s currently selling in the neighborhood of $25 a share.

Apple has had problems getting its Apple III computer into production. Announced in May 1980, the first Apple IIIIs were not shipped until January 1981, and then only in limited quantities.

Commodore International’s sales for the last quarter of 1980 were $45 million, up from $37 million for the same period in 1979. Commodore has announced plans to construct a $5 million plant in the Philadelphia area to build its microcomputer systems. Commodore expects to hire 250 to 400 people for the operation and open it before year-end.

Sinclair Research, maker of the low-cost ZX80 personal computer, claims that it is number three in units shipped, behind Radio Shack and Apple.

Mattel’s keyboard-equipped Intellivision personal-computer system seems to be bumping up against the same sort of buyer resistance that Texas Instruments encountered with its TI 99/4. Consumers are put off by the keyboard unit’s $700 list price, plus $300 for the game-playing “master” component—total cost $1000. That’s several hundred dollars more than the TRS-80 Color Computer, the Commodore VIC, and even Texas Instruments’ TI-99/4. Further, Mattel has had delivery problems: it had originally intended to introduce the system in 1979. Intellivision’s marketing is mainly through department stores.

First Personal Computer With Built-in Winchester-Disk Drive: Vector Graphic Inc has unveiled the first personal-computer system with a built-in Winchester type hard-disk drive. The Model 3005 houses a video monitor, keyboard, 5100 motherboard, Z80 processor, 64 K bytes of programmable memory, a video interface called Flashwriter, a dual-mode disk controller, a Seagate Technology 5-inch Winchester drive, and up to three quad-density 5-inch floppy-disk drives. The system with one floppy-disk drive costs $7950.

Tandy Files Suit Against Competitor: Tandy Corporation has brought suit against Personal Microcomputers Inc (PMC), Mountain View, California. Tandy accuses PMC of conspiracy and infringement on the design of the Radio Shack TRS-80 personal computer. Included in the suit are five manufacturers and dealers for Personal Microcomputers’ PMC-80 personal computer. The PMC-80 is hardware- and
software-compatible with the TRS-80 Model I. Tandy is demanding damages and an injunction. Tandy claims that the PMC-80 contains "input/output programming copied from the plaintiff's TRS-80," and that the "defendants have marketed said microcomputer under the name PCM-80, which is confusingly similar to Tandy's registered trademark TRS-80."

**Chess Game Has Robot Arm**

The newest model of the popular Boris computer chess game has a robotic arm that moves and captures chess pieces. Called "Boris Handroid," it features the Boris 2.5 chess program that won the 1979 robotic arm that moves and captures chess pieces. The system allows the UCSD Handroid to work with the human opponent's moves, and Boris Handroid responds by moving its piece. The game costs $1495 with the arm or $295 without.

**UCSD Pascal Version 4.0 Being Tested**

Softech Microsystems' new 4.0 version of UCSD (University of California, San Diego) Pascal is being tested at selected user sites. Softech has not yet set a release date. The new version adds multitasking and upgraded screen-handling functions. Four new p-code instructions have been added, which will create problems for version 3 users.

The UCSD Pascal compiler translates Pascal statements into a series of p-code (pseudocode) instructions, which are then interpreted during execution by a p-code-interpreter program, except on the Western Digital (WD) Pascal Microengine, which executes p-codes according to hardware microcode. The p-code system allows the UCSD Pascal system to operate the same way on many different systems.

Western Digital has not yet decided on how it will upgrade machines currently in the field to work with the new p-codes. WD notes that its control-store memory still has about 25% free space; therefore, an "outboard" control store on the main computer board could be added, rather than changing the entire control store.

**Update On 32-Bit Microprocessors**

The International Solid-State Circuits Conference (ISSCC) met in New York last February and heard presentations on two 32-bit microprocessors and some disclosures on a third.

Intel released further details on its 32-bit iAPX432 processor. It is Intel's first departure from previous architecture and instruction sets, so there is no software compatibility with its 8086 (16-bit) and 8085 (8-bit) microprocessors. Each of the iAPX432's three integrated circuits has four lines of sixteen pins. There are two general processors and an I/O (input/output) processor. The iAPX432 can link to 8086s and existing peripheral and memory integrated circuits. Intel is boasting performance of up to 2 MIPS (million instructions per second).

It took five years to engineer the iAPX432, and the company estimates that $25 million was spent on the project. Intel expects to sell at least 10,000 sets in the first year of production, which is projected for 1982. The initial price for the set will be $1500. Intel started shipping evaluation sets in February and is offering a board-level evaluation kit for $4250.

Intel claims that each of the three integrated circuits contains about 200,000 transistors. Two chips operate as a pipeline pair: the 43201 processor, which contains the instruction decoder, and the 43202, which is the microexecution unit. The 43203 is the I/O processor. It provides an interface from the I/O subsystem to the protected-access environment of the central system. Each I/O subsystem uses an 8- or 16-bit microprocessor to control I/O, independent of the central system. An address space of more than 4 gigabytes (4 x 10^9 bytes) and a virtual memory-address space of a terabyte (10^12 bytes) is supported.

A protection scheme is provided to limit access to programs. The iAPX432 can perform floating-point operations on 32-, 64-, and 80-bit numbers. Hardware failures can be detected by interconnecting identical iAPX432 processors in a self-checking arrangement. The system uses compiled Ada code as its machine language. The language interpreter is contained in a 64-K-byte microcode ROM (read-only memory).

Intel has also released an Ada cross-compiler for the iAPX432. The compiler runs on a DEC (Digital Equipment Corporation) VAX-11/780 or an IBM 370. It costs $30,000. A $50,000 hardware link is needed to download the compiled code to Intel's $4250 development board.

With the iAPX432, Intel appears to have a two-year jump on its competition. At the conference, Hewlett-Packard (HP) disclosed that it is in the early stages of development on a 32-bit microprocessor. HP claims to have built and tested a single chip with 450,000 transistors (which is about what Intel has in its set of three integrated circuits). It operates with an 18 MHz clock and is microprogrammed in 9 K 38-bit words in an on-board ROM. HP will have four other peripheral devices: an I/O controller, a memory controller, a 128-K-bit programmable memory, and a 512-K-bit ROM. The device is still being developed and no production commitment or product use has been determined.

Texas Instruments announced that early next year it will unveil a 99000 processor. TI refuses to disclose details, but it appears that the 99000 will have 32-bit addressing without 32-bit processing.

**Chairperson Andrew Allison and his IEEE (Institute of Electrical and Electronics Engineers) working group is developing a bus standard to accommodate microprocessors from 8 to 32 bits in word length. The standard will have a 32-bit multiplexed address- and data-path compatible with 32-, 16-, and 8-bit microcomputers. It will allow up to thirty-two bus masters and multitasking via a serial interprocessor link that may use interrupt arbitration. A maximum initial clock rate of more than 10 MHz will be specified.

**Floppy-Disk Densities Increasing**

Ten years ago, IBM introduced an 8-inch disk drive capable of storing 400 K bytes of data (unformatted) on one side of a floppy disk. Shortly afterwards, double-density encoding schemes that allowed up to 800 K bytes of storage were introduced. Then in 1976, IBM came up with the double-sided drive, which increased data storage up to 1.6 megabytes. That same year Shugart Associates introduced a drive using a 5-inch floppy disk that could store 110 K bytes on a single-sided single-density disk. Later double-density double-sided (DDDS)
Innovative products that conform fully to the IEEE 696/S-100 standards. High speed operation frees you from obsolescence as CPU clock speeds increase, while low power consumption saves energy and promotes reliability.

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**DISK 1: A SUPERSD DMA CONTROLLER.**

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Disk 1 transfers data independently of CPU speed for efficient operation with older 2 MHz CPUs as well as the new high speed 8086s; handles up to 8" or 5 1/4" floppy disk drives (including 8 track high density mini-tapes), single or double sided. single or double density (soft sectored); includes BIOS for CP/M-80, as well as on-board boot for automatic startup and on-board 3 wire serial interface for system initialization; and is compatible with MP/M, OASIS, CP/M-80, and CP/M-86.

We weren't going to put out another me-too disk controller... and we didn't. Won't you? The manual is available separately for $20.
floppy-disk drives were introduced that could store up to 440 K bytes (unformatted).

Recently, Shugart announced 5-inch drives in which track density was increased from 48 tpi (tracks per inch) to 96 tpi, allowing up to 1 megabyte on a DDDS drive. However, increasing the track density on 8-inch drives is more difficult because the larger disks have deformation problems that result in errors. Drive and disk makers are trying to overcome the problems by changing the disk materials and drive designs. The current objective is to increase track density to 96 or 100 tpi by early next year. It is felt that 200 tpi is feasible with different materials.

Manufacturers are trying to obtain densities of 3 and 6.5 megabytes on 5-inch floppy disks and 5 to 10 megabytes on 8-inch floppy disks. The 3- and 5-megabyte densities appear to be achievable in the near future; however, reaching 10 megabytes on an 8-inch disk is expected to take longer to achieve.

In the meantime, PerSci inc has taken the wraps off an 8-inch floppy-disk drive with a storage capacity of 25 megabytes. It's the same size as a standard 8-inch drive, but uses four read/write heads to access both sides of two DDDS disks.

**IBM To Build Josephson Computer:** IBM is going to construct an experimental computer entirely based on exotic Josephson-junction devices. This will be the first of its kind, and IBM hopes to have it up and running in five years. The 5000-circuit processor, with 400 K bits of programmable memory, is expected to have a 2 ns cycle time and will be no larger than 18 by 20 by 41 mm.

Josephson-junction transistors are superconductive and can switch in less than 10 ps (picoseconds). They consume very little power (usually 500 nW) and typically require a +1 V power supply.

Such a computer could be fifty times faster than current high-speed computers. Engineers have hypothesized that a Josephson-junction-based computer could have a nonvolatile solid-state magnetic memory, and, because of the greatly reduced resistance within its super-cool liquid-helium immersion, thin connectors could be used. Additional attributes could include no crosstalk between devices and immunity to thermal noise. Problems are anticipated in testing and debugging because of the thermal stresses placed on the devices.

If the project is successful, IBM expects to pack a 300,000-circuit processor (about the capacity of an IBM 3033) with 256 K bytes of cache memory and 64 megabytes of main memory into a cube less than 15 cm on a side.

**Random News Bits:**

Zenith Radio Corporation has a special video display for automobile dashboards.

RCA has received a patent for a technique that stores up to 100 gigabits (ie: 100 billion bits) on a laser disk intended for video. A complete encyclopedia can be stored on such a disk.

Sears Roebuck will open five computer stores. If they are successful, Sears Roebuck will sell computers nationwide.

Marker Ski Bindings has a binding with a built-in microprocessor. The battery-powered unit costs $200 and must be custom programmed for the skier.

Ohio Scientific's new Challenger 8P-4HD personal computer has a Votrax voice-synthesizer output system and a voice-input system. It requires a 10-megabyte Winchester disk to function.

The Votrax SC-01 Voice Synthesizer Chip is now available from The MicroMint of Woodmere, New York. The Wood division of Votrax will not sell the device in quantities of less than five.

Zilog has reduced the price of the 16-bit Z8002 microprocessor from $45 to $19.90, in OEM quantities of 1000.

Intel may reduce its prices for the 8088 and 8086. IBM has a 32-bit microprocessor up and running in its labs.

Apple recently purchased its distributor in Great Britain, and now has well over 1000 employees.

**Miniaturization Continues:** Semiconductor manufacturers keep on packing more capability onto a single wafer of silicon. Intelligent controllers, especially, are benefiting from such efforts. Two of the most recent products are the National Semiconductor INS8073 and the Zilog Z8 system. The Zilog product line includes a microprocessor, designated Z8671, which contains a limited BASIC interpreter and debugging monitor on on-board read-only memory. Steve Ciarcia is using the Z8671 to build a complete computer system measuring 4 by 1 inches with serial and parallel I/O ports and 4 K bytes of user memory. Users can program process-control and monitoring functions using the BASIC interpreter. (See next month's "Ciarcia's Circuit Cellar.")

**Know Your Dealer:** Sources at Radio Shack report the company has been receiving a large number of complaints because of confusion over warranty service on TRS-80s. The problem stems from the fact that Radio Shack does not honor warranties on computers purchased from dealers who are not authorized by Radio Shack. A large number of unauthorized dealers have appeared in the past year—most offering extremely low mail-order
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- Precise lead screw actuator • Fast access time - 12 ms track-to-track • Low friction and minimum wear • Low power dissipation
- Additional features • Industry standard 5¼" media format • ISO standard write protect • Door lock out for media protection • Requires DC voltage only • Daisy Chain up to 4 drives • Heads load on command independent of loading media

Product Specifications

Performance Specifications • Capacity: Unformatted: 437.5K or 500K bytes; Qume Formatted: 286.7K or 327.7K bytes • Recording Density: 5456 BPI • Track Density: 48 TPI • Cylinders: 35 or 40 • Tracks: 70 or 80 • Recording Method: FM or MFM • Rotational Speed: 300 RPM • Transfer Rate: 250K bits/second • Latency (avg.): 100 ms • Access Time: Track-to-track 12 ms; Settling 15 ms • Head Load Time: 50 ms

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Design Features

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Product Specifications

Performance Specifications • Capacity: Unformatted: 1.6 Mbytes/disk; IBM Format: 1.2 M/bytes/disk • Recording Density: 6816 BPI • Track Density: 48 TPI • Cylinders: 77 • Tracks: 154 • Recording Method: MFM • Rotational Speed: 360 RPM • Transfer Rate: 500K bits/second • Latency (avg.): 83 ms • Access Time: Track-to-track 3 ms; Settling 15 ms; Average 91 ms • Head Load Time: 35 ms • Disk: Diskette 2D or equivalent

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BYTELINES

prices on TRS-80 systems. A Radio Shack spokesman said the company is attempting to close the pipeline to unauthorized dealers but declined comment on how the dealers are obtaining the equipment. He stressed that the majority of mail-order dealers are authorized and advertise the fact, but consumers are cautioned to be sure before ordering. If you need service on units purchased from unauthorized vendors, you'll have to pay full labor and parts rates.

DEC Drops LSI-11 Prices: Digital Equipment Corporation has lowered the prices on the 16-bit LSI-11 microcomputer products by almost 29%. Obviously, DEC is eager to compete with the new Intel 8086, Zilog 82000, and Motorola 68000-based systems now coming on the market. In fact, the new prices compete well with 8-bit microcomputer systems. A complete LSI-11 system with 32 K bytes of programmable memory and I/O interfaces, assembled in a cabinet, lists for $2090. Also, the DEC RT-11 and FORTRAN package is now only $640-$40 more than the cost of a Digital Equipment Corporation's FORTRAN package.

Packet Repeater Goes On The Air: The nation's first digital simplex packet-radio repeater (K66M, Menlo Park, California) for amateur radio use has gone into operation. A similar system went into operation earlier in Vancouver, British Columbia, Canada. The station serves as a packet repeater and beacon. It receives a message or block of data and, after verification, retransmits that message on the same frequency. The message may have some address or control bytes altered. The repeater extends the range and coverage of fixed and mobile stations. It is the first step in what promises to be a nationwide network of interconnected computer systems that allow for toll-free communications.

Ethernet Acceptance Spreading: Ethernet, the local networking system, appears to be emerging as the de facto network standard. Although created by Xerox, Intel and DEC have agreed to support it with integrated circuits and system interfaces. Now Zilog has acknowledged that it will implement Ethernet interfaces on its microcomputer systems. This is particularly noteworthy because Zilog is an Exxon subsidiary, and Exxon has announced its intention to develop a local-network system. Zilog's previously announced networking system Znet will be supported by the company, in addition to the Ethernet interface.

Hewlett-Packard has made public that it will include Ethernet interfaces in some of its products. Digital Research intends to provide an Ethernet-to-CP/M software package.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed stamped envelope.

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<th>SPECIFICATION</th>
<th>QUAY 500</th>
<th>HORIZON-2-32K-D</th>
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<tr>
<td>Architecture</td>
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<tr>
<td>Direct Memory Access (DMA)</td>
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<td>No</td>
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<tr>
<td>CP/M® disk operating system</td>
<td>Standard</td>
<td>Optional</td>
</tr>
<tr>
<td>Unit Price</td>
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<td>$3,095.</td>
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SPECIFICATIONS

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<th>QUAY 520</th>
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<td>$3,495.</td>
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CP/M: A Family of 8- and 16-Bit Operating Systems

Dr Gary Kildall
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This article is about microprocessors and CP/M: where they came from, what they are, and what they're going to be. Where they came from is history, what they are today is fact, and what they will become is, like any projection of technology, pure "science fiction" speculation. CP/M is an operating system developed for microcomputers. But as microprocessors changed, CP/M and its related programming tools evolved into a family of portable operating systems, languages, and applications packages.

The value of computer resources has changed dramatically with the introduction of microprocessors. Three major events have precipitated a revolution in computing: hand-threaded core memory has been replaced by mass-produced semiconductor memory; microprocessors have become plentiful; and IBM decided that the punched card is obsolete. Low-cost memory and processors have reduced the cost of computer systems to a few hundred dollars, but IBM's specification of the floppy disk standard has made the small computer system useful.

In the early days of the 8080 microprocessor, a small company called Shugart Associates was taking shape up the street from Intel. Shugart Associates, along with a number of other companies, viewed the floppy disk as more than a punched card replacement: at that time the primary low-cost storage medium was paper tape (used in applications ranging from program development to word processing). At a cost of $5, a floppy disk held as much data as two hundred feet of paper tape, and a disk drive retailed for only $500—an unbeatble combination. Memory, processor, and floppy-disk technology improved, and by the mid-1970s, a floppy-based computer could be purchased for about one quarter of a programmer's annual salary. Quite simply, it was no longer necessary to share computer resources.

Since that time, microprocessors have been applied to a variety of computing needs beyond replacement of low-end minicomputers. Due to applications such as machine-tool movement and sensing, data acquisition, and communications, current interest lies in real-time control. In a real-time operating system, process management can be separated from the I/O (input/output) system (which is not required in many applications). Real-time facilities allow the execution of interactive processes according to priority, and their addition or deletion in a simple fashion. This results in a custom operating system designed to solve a particular problem. In contrast to timesharing, real-time operating systems have minimal "interrupt windows" in which external interrupts are disabled. Real-time operating systems such as the Intel RMX and National Starplex packages provide this level of support.

The emerging interest in local networks poses a new challenge to designers of operating systems. Recently, Intel, DEC (Digital Equipment Corporation), and Xerox formed an alliance to promote Ethernet, a packet-switching network intended to provide point-to-point data transfer in an office environment. (In a packet-switching network, data from several slow-speed sources, such as user terminals, is collected over local lines by a single network node, which then periodically transmits the data to its destination at a much higher speed, in groups called packets.) In terms of evolution and potential, Ethernet is today what floppy disks were a decade ago. This inexpensive office network performs such tasks as the transfer of a form letter from data storage at one location to a memory typewriter in another part of the
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The Emergence of Software as a Problem-Solving Tool

Microprocessors are a natural consequence of our technology. I recently visited the British Science Museum, where two particularly interesting historical developments were on display. The first exhibit chronicled the development of the finely machined iron and brass steam engines, complete with magnificent gauges, gears, whistles, and valves, that founded the Industrial Revolution.

The second exhibit displayed progress in computing, beginning with Charles Babbage's inventions of the early 1800s. What did these exhibits have in common? They showed machines built with the same technology: Babbage's analytic engine might easily be mistaken for a small steam engine!

I followed the sequence of displays, from Babbage's difference and analytic engines to great brass engines, complete with valves, that founded steam engines, all the way to a single Intel 8080 microprocessor.

Examined in this way, the technological momentum was obvious. Microprocessors are a direct result of our pattern of refinement through engineering. Just as a Boeing 727 is a refined version of the original Wright Brothers' invention, the microprocessor is a consequence of "fine tuning" by scientists and engineers who strive to understand, simplify, and add function to mankind's tools. There were several conspicuous spaces waiting to be filled following the 8080 display.

In public television's "Connections" series, James Burke claimed that we are a society filled with machines that do everything: sew materials for our clothes, carry us from coast to coast, and print millions of newspapers daily. But the most important machines in our society do absolutely nothing by themselves. These multifunctional devices provide a variety of services depending upon our needs, and herein lies the essential advantage: in the past, we identified a need and built a machine to satisfy that need; today, technology provides us with a single machine that we can instruct, through a program, to solve almost any problem. Where are the 'Thomas Edisons' who used to build machines? Most are now inventing programs.

The evolution of our electronics industry typifies refinement through engineering. Beginning with electrical and electronic switches, we began manufacturing general-purpose function chips: put a value x on the input pins, define the function f by setting voltage levels on a second set of pins, and the result, f(x), magically appears on the output pins. Many examples of such integrated circuits exist, ranging from three-state logic gates to arithmetic/logic units.

With the introduction of microprocessors, the function f may be defined through instructions in a read-only memory allowing, in principle, the implementation of any function using a single device. A design that once required connecting resistors, capacitors, and logic gates has developed into a program that instructs a multipurpose machine to perform the same function. Controlling a stoplight and balancing a checkbook are now equivalent problems: both require the invention of a program.

Refinement through engineering: does this not also apply to software? To properly frame the answer, remember that the primary purpose of a computer is to be useful. Therefore, the application program is really the only important result of software engineering activity. Our primary goal in refining software tools is to provide the means for rapid and accurate generation of simple, understandable, and effective application programs. We do this through three levels of software support: system languages, operating systems, and application languages. These tools form an inverted pyramid underlying application software.
### BUSINESS 100 PROGRAM LIST

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<tr>
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<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RULE78: Interest Apportionment by Rule of the 78's</td>
</tr>
<tr>
<td>2</td>
<td>APPLY: Annual propration program</td>
</tr>
<tr>
<td>3</td>
<td>DATE: Time between dates</td>
</tr>
<tr>
<td>4</td>
<td>DAYYEAR: Day of year a particular date falls on</td>
</tr>
<tr>
<td>5</td>
<td>LEASEPT: Interest rate on lease</td>
</tr>
<tr>
<td>6</td>
<td>BREAKYN: Breakeven analysis</td>
</tr>
<tr>
<td>7</td>
<td>DEPRSL: Straightline depreciation</td>
</tr>
<tr>
<td>8</td>
<td>DEPSY: Sum of the digits depreciation</td>
</tr>
<tr>
<td>9</td>
<td>DEPRBR: Declining balance depreciation</td>
</tr>
<tr>
<td>10</td>
<td>DEPRDB: Double declining balance depreciation</td>
</tr>
<tr>
<td>11</td>
<td>TADEXP: Cash flow vs. depreciation tables</td>
</tr>
<tr>
<td>12</td>
<td>CHECK2: Prints NEBS checks along with daily register</td>
</tr>
<tr>
<td>13</td>
<td>CHECKBN: Checkbook maintenance program</td>
</tr>
<tr>
<td>14</td>
<td>MORTGAGE/A: Mortgage amortization table</td>
</tr>
<tr>
<td>15</td>
<td>MULTMOUNT: Computes time needed for money to double, triple, etc.</td>
</tr>
<tr>
<td>16</td>
<td>SALVAGE: Determines salvage value of an investment</td>
</tr>
<tr>
<td>17</td>
<td>RVRNAV: Rate of return on investment with variable inflows</td>
</tr>
<tr>
<td>18</td>
<td>RICONST: Rate of return on investment with constant inflows</td>
</tr>
<tr>
<td>19</td>
<td>EFFECT: Effective interest rate of a loan</td>
</tr>
<tr>
<td>20</td>
<td>PVAL: Future value of an investment (compound interest)</td>
</tr>
<tr>
<td>21</td>
<td>PVAL: Present value of a future amount</td>
</tr>
<tr>
<td>22</td>
<td>LOANPAY: Amount of payment on a loan</td>
</tr>
<tr>
<td>23</td>
<td>REGWTH: Equal withdrawals from investment to leave 0 over</td>
</tr>
<tr>
<td>24</td>
<td>SIMDISK: Simple discount algorithm</td>
</tr>
<tr>
<td>25</td>
<td>DATEVAL: Equivalent % nonequivanted dates for oblig.</td>
</tr>
<tr>
<td>26</td>
<td>AMNDEF: Present value of deferred annuities</td>
</tr>
<tr>
<td>27</td>
<td>MARKUP: %Markup analysis</td>
</tr>
<tr>
<td>28</td>
<td>SINKFUND: Sinking fund amortization program</td>
</tr>
<tr>
<td>29</td>
<td>BONDVAL: Value of a bond</td>
</tr>
<tr>
<td>30</td>
<td>DEPLETE: Depletion analysis</td>
</tr>
<tr>
<td>31</td>
<td>BLACKCH: Blackchoo depreciation</td>
</tr>
<tr>
<td>32</td>
<td>STOCVAL1: Expected return on stock via discounts dividends</td>
</tr>
<tr>
<td>33</td>
<td>WARVAL: Value of a warrant</td>
</tr>
<tr>
<td>34</td>
<td>BONDVAL2: Value of a bond</td>
</tr>
<tr>
<td>35</td>
<td>EPSEST: Estimate of future earnings per share for company</td>
</tr>
<tr>
<td>36</td>
<td>BETAULPH: Computes alpha and beta variables for stock</td>
</tr>
<tr>
<td>37</td>
<td>SHARPEI: Portfolio selection model i.e. what stocks to hold</td>
</tr>
<tr>
<td>38</td>
<td>OPTWRITE: Option writing computations</td>
</tr>
<tr>
<td>39</td>
<td>RTVAL: Value of a right</td>
</tr>
<tr>
<td>40</td>
<td>EXPVAL: Expected value analysis</td>
</tr>
<tr>
<td>41</td>
<td>BAYEYES: Bayesian decisions</td>
</tr>
<tr>
<td>42</td>
<td>VALPRF: Value of perfect information</td>
</tr>
<tr>
<td>43</td>
<td>VALADIN: Value of additional information</td>
</tr>
<tr>
<td>44</td>
<td>UTILITY: Derives utility function</td>
</tr>
<tr>
<td>45</td>
<td>SIMPLEX: Linear programming solution by simplex method</td>
</tr>
<tr>
<td>46</td>
<td>TRANS: Transportation method for linear programming</td>
</tr>
<tr>
<td>47</td>
<td>EQOQ: Economic order quantity model</td>
</tr>
<tr>
<td>48</td>
<td>QUEUEU: Single server queueing (waiting line) model</td>
</tr>
<tr>
<td>49</td>
<td>CPV: Cost-volume-profit analysis</td>
</tr>
<tr>
<td>50</td>
<td>CONDPROF: Conditional profit tables</td>
</tr>
<tr>
<td>51</td>
<td>OPTLOSS: Opportunity loss tables</td>
</tr>
<tr>
<td>52</td>
<td>FQOD: Fixed quantity economic order quantity model</td>
</tr>
</tbody>
</table>

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building. When modifications are completed, the letter is typed locally or sent to a laser (or other) printer that is a shared network resource.

Most timesharing systems handle a network through simple file transfers between the machines (nodes) in the net, but real refinements occur when the operating system itself is distributed among the nodes. File access is provided by one server node, while a computing function is performed by another. To the user, a requester node appears as a powerful computing facility, even though it may consist of only a local microprocessor, a console, and a limited amount of memory.

What refinements have been made to operating systems? Our models have been simplified; we understand primitive operations required for reliable process synchronization in real-time systems, and the human-oriented interface in interactive subsystems has been improved. We will, no doubt, continue to refine our models for timesharing and real-time operating systems, but the most exciting new operating system technology will develop around emerging network hardware.

Application Languages

Application languages form the top level of support for application programming. How does this level of language differ from other language levels? First and foremost, an application language contains the operations and data types suitable for expressing programs in a particular problem environment. FORTRAN (FORMula TRANslation), for example, was designed in the late 1950s for scientific applications; FORTRAN programs, therefore, consist primarily of algebraic expressions operating upon binary floating-point numbers expressed in scientific notation. However, FORTRAN contains only primitive file-access facilities and no decimal arithmetic, making it unsuitable for commercial data processing. COBOL (COMMON BUSINESS ORIENTED LANGUAGE) has the commercial facilities, but it excludes scientific features such as a complete transcendental-function library.

In contrast to system languages that run on a given machine, these application languages would ideally contain no machine-dependent features. An application language is either poorly designed or ill-suited for a particular problem if the programmer is forced to use extra-lingual constructs to access lower-level functions of the operating system or machine. The language must be a standard, without the necessity for various locally defined language extensions. An extended standard language is of limited value since the extensions are unlikely to exist in other implementations.

The evolution of PL/I (Programming Language/One) provides a good example of refinement in application languages. PL/I is not a new invention: rather, it was defined by a committee of IBM users in 1960 as a combination of ALGOL (ALGOrithmic Language), FORTRAN, and COBOL, with a liberal sprinkling of new facilities. ALGOL’s principal contribution was block structure and nested constructs, while FORTRAN contributed scientific processing and COBOL added commercial facilities. This combination produced a large, unwieldy language with twists and nuances that can trap the unwary programmer. Nevertheless, PL/I was quite comprehensive, and it served as the basis for uncounted numbers of application programs on large systems. One noted use of PL/I was in the implementation of the Multics operating system at MIT under Project MAC.

In 1976, an ANSI (American National Standards Institute) committee produced a standard language definition for PL/I. The standard is an implementation guide for compiler writers, and it precisely defines the form and function of each PL/I statement. Aware that PL/I was too large and complicated, the committee produced a smaller version for minicomputers, called Subset G. This new language excluded the redundancies and pitfalls of full PL/I but retained the
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useful application programming features. Recently approved by ANSI, Subset G has given new life to PL/I, with manufacturer support for the Data General Eclipse and MV/8000 computers, Prime computers, Wang machines, and DEC's popular VAX computer.

Strangely, the refinements found in application languages follow those of hardware and operating systems. Large, cumbersome languages have been rejected in favor of simple, Spartan programming systems that are consistent in their design. The resulting languages are easier to implement, simpler to comprehend, and allow straightforward program composition.

**PL/M: The Base for CP/M**

In 1972, MAA (Microcomputer Applications Associates), the predecessor of Digital Research, consulted with the small, aspiring microprocessor division of a semiconductor company called Intel Corporation. MAA defined and implemented a new systems-programming language, called PL/M (Programming Language for Microcomputers), to replace assembly-language programming for Intel's 8-bit microprocessor. PL/M is a refinement of the XPL compiler-writing language which is, in turn, a language with elements from Burroughs' Corporation's ALGOL and the full set of PL/I.

The first substantial program written by MAA using PL/M was a paper-tape editor for the 8008 microprocessor, which later became the CP/M program editor, called ED. PL/M is a commercial success for Intel Corporation and, although licensing policies have limited its general accessibility, it has become the standard language of the Intel microprocessor world, with implementations for the 8080, 8085, and 8086 families. MAA also proposed a companion operating system, called CP/M (Control Program for Microcomputers), which would form the basis for resident PL/M programming. The need for CP/M was obvious: 8080-based computers with 16 K bytes of main memory could be combined with

**System Languages**

A system language is a high-level machine-dependent programming language used to implement so-called "system software," including operating systems, text editors, debuggers, interpreters, and compilers. In the early days of computing, virtually all system software was implemented in assembly language. One revolutionary machine, the Burroughs B5500, used a variant of ALGOL-60 as its only system-programming tool and appeared in the early 1960s. The machine was a commercial success against the other major mainframes, proving that assemblers were no longer necessary. Many successful system languages followed Burroughs' ALGOL, including the C language, produced at Bell Laboratories in the late 1960s, which served as the basis for the UNIX operating system.

A system language, by definition, matches the architecture of a particular machine or class of machines; all facilities of the machine are accessible in the language, and the language contains no non-trivial extensions beyond the basic machine capabilities. The benefit is that a compiler for the system language is easy to implement and transport from machine to machine, as long as the architecture of each machine is similar. Further, a system language requires little runtime support since application facilities, such as extensive I/O (input/output) processing, are not generally embodied in the language.

Refinements in system languages are made by increasing their usability. Their acceptance as replacements for assembly languages is encouraging. Today, one can publicly admit that system software is implemented in a high-level language without implying that it must be rewritten in assembly language to be effective.

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Operating Systems

Operating systems, too, have become more refined. But why do we have operating systems at all? In the 1960s we used expensive mainframes with power-hungry central processors and magnetic-core memory. Downtime for complicated card readers, printers, and backup data-storage devices was high, requiring constant maintenance. A card-oriented “batch” operating system provided two functions. First, it allocated processor time, memory, and peripherals to application programs in an attempt to utilize each expensive component to its fullest. Second, common I/O subroutines were a part of the operating system to avoid duplication in each application program. In the early 1960s, batch operating systems began to incorporate online terminals that allowed the programmer to interact with the program—this is where things became interesting. With an online terminal, a program could write a prompt message, read the data entered by the operator, and write a response almost instantly.

The crude terminal systems evolved into today’s timesharing computers, where program interaction is the primary function, with batch processing in the background. General Electric and Digital Equipment Corporation led the way with BASIC-based 235 and multilingual PDP-10 computers. Countless timesharing operating systems followed, including IBM’s interactive APL and CP/CMS, along with UNIX from Bell Laboratories. These timesharing systems were the forerunners of personal computing: all assumed that the hardware was too expensive to dedicate, so each terminal became an emulation of a single computer.

The CP/M Family

CP/M was, however, completed by MAA in 1974. It included a single-user file system designed to eliminate data loss in all but the most unlikely situations, and used recoverable directory information to determine storage allocation rather than a traditional linked-list organization. The simplicity and reliability of the file system was an important key to the success of CP/M; file access to relatively slow floppy disks was immediate, and disks could be changed without losing files or mixing data records. And because CP/M is a Spartan system, today’s increased storage-media transfer rates simply improve overall response. The refinements found in CP/M are based on its simplicity, reliability, and a proper match with limited-resource computers.

By the mid-1970s, CP/M added a new philosophy to operating system design. CP/M had been implemented on several computer systems, each having a different hardware interface. To accommodate these varying hardware environments, CP/M was decomposed into two parts: the invariant disk operating system written in PL/M, and a small variant portion written in assembly language. This separation allowed computer suppliers and end users to adapt their own physical I/O drivers to the standard CP/M product.

Hard-disk technology added yet another factor. CP/M customers required support for disk drives ranging from single 5-inch floppy disks to high-capacity Winchester disk drives. In response, CP/M was totally redesigned in 1979 to become table-driven. All disk-dependent parameters were moved from the invariant disk operating system to tables in the...
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variant portion, to be filled in by the system implementer.

CP/M is now a multifunction program whose exact operation is defined externally through tables and I/O subroutines. The widespread use of CP/M is directly attributed to this generality: CP/M becomes a special-purpose operating system when it is field-programmed to match an operating environment. Through the efforts of system implementers who provide this field-programming, CP/M is used worldwide in close to 200,000 installations with over 3000 different hardware configurations.

**CP/M, PL/I, and PL/M have all played a role in the development of CP/M-86.**

**MP/M**

As single-user CP/M became widely accepted, Digital Research began to develop a new operating system for real-time processing. The design called for a real-time nucleus to support cooperating sequential processes, including a CP/M-compatible file manager with terminal-handling capabilities. This operating system, called MP/M (Multiprogramming Monitor for Microcomputers), is a further refinement of the process model found in Intel's RMX and National's Starplex. As a side effect, the combination of MP/M's real-time nucleus with the terminal handler and the CP/M file system produces a traditional timesharing system with multiprogramming and multiterminal features.

Timesharing allows programs to execute in increments of processor time in a "lock-step" fashion. In a timesharing context, a printer program, often called a spooler, might have the task of printing a series of disk files which result from program output. The spooler starts with a disk-file name and, by using increments of processor time allocated by the real-time nucleus, writes each line from the file to the printer. Upon completion, the spooler obtains another disk-file name and repeats
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the process. You can, for example, send the name of a disk file to the spooler and, while the file is being printed, edit another file in preparation for compilation. The spooler and editor share processor time to complete their respective tasks. In general, many such processes share processor time and system resources.

MP/M process communication is performed through queues (or waiting lines) managed by the nucleus. The spooler, for example, reads file names from an input queue posted by another process (which reads spooler command lines from the console). When the spooler is busy printing a file, additional file names may enter the input queue in a first-in-first-out order.

Process synchronization through queuing mechanisms is commonplace, but MP/M treats queues in a unique manner, simplifying their use and decreasing queue management overhead. Queues are treated as files: they are named symbolically so that a queue can be added dynamically. Like files, queues have queue control blocks that are created, opened, deleted, written, and read. In fact, the set of queue operations closely matches the file functions of CP/M so that MP/M provides a familiar programming environment.

The implementation of queues is transparent to an operator or system programmer, but it is important to MP/M's effective operation on limited-resource computers. Queues are implemented through three different data structures, depending upon the message length. So-called "counting semaphores" count the occurrence of an event with message length zero, and are implemented as 16-bit tallies. Single-byte messages are processed using a circular buffer. Similarly, queues containing addresses are processed using circular buffers. In all other cases, MP/M uses a general linked list, which requires additional space and processing time. It is this sensitivity to the capabilities of limited-resource computers that makes MP/M effective; while real-time operating systems often incur 25 to 40% overhead, MP/M has been streamlined to increase available compute time by 7% over single-user CP/M.

Like CP/M, MP/M is separated into variant and invariant portions. The file-system interface is identical to that of CP/M, with the addition of user-defined functions to handle non-CP/M operations (such as control of the real-time clock). Field-reconfiguration of MP/M allows a variety of device protocols including CP/M-style busy-wait loops, polled devices, and interrupt-driven peripherals. In fact, the variety of interface possibilities makes the MP/M implementer a true system-software designer, since a fine-tuned MP/M system may operate considerably faster than its initial implementation.

What are the refinements found in MP/M? First, it is a state-of-the-art operating system based on current process-synchronization technology and microprocessor real-time system design philosophies. Process communication is conceptually simple and requires minimal overhead. Finally, it is the only operating system of its type that can be field-tailored to match almost any computer configuration.
CP/NET

CP/NET, introduced in late 1980, leads a series of network-oriented operating systems that distribute operating system functions throughout a network of nonhomogeneous processors. CP/NET connects CP/M requesters to MP/M servers through the use of an arbitrary network protocol. Similar to CP/M and MP/M, CP/NET consists of the invariant portion, along with a set of field-reconfigurable subroutines that define the interface to a particular network. For purposes of CP/NET, this interface need only provide point-to-point data-packet transmission. Since the actual data transmission media are unimportant to CP/NET, any one of the number of standard protocols can be used, from low-speed RS-232C through high-speed Ethernet. Physical connections are also arbitrary, allowing active hub-star, ring, and common-bus architectures.

The invariant portions of CP/NET operate under a standard CP/M system to direct various system calls over the network to an MP/M server. The MP/M server, in turn, responds to network requests by simulating the actions of CP/M. This simulation is transparent to an application program: any program operating under standard CP/M operates properly in the network environment.

Suppose, for example, you wish to store common business letters in a central data base under CP/M and access these letters from a CP/M-based word processor. You begin by assigning one local disk drive to the MP/M master, using the CP/NET interface. You then direct your word processing system to read the particular letter on the assigned drive, causing the data to be obtained from the server rather than from the local disk. After local update using your word processor, you can print the result on your local printer or optionally assign your listing device to the network for printing at the MP/M server.

CP/NET is accompanied by three related network operating systems: CP/NOS, MP/NET, and MP/NOS. CP/NOS is, in effect, a diskless CP/M, which can be stored in read-only memory, and that operates with a console, memory, and network interface. MP/NET, on the other hand, is a complete MP/M system with an embedded network interface that, like CP/NET, allows local devices to be reassigned to the network. MP/NET configurations allow MP/M systems as both requesters and servers with CP/M requesters. Finally, MP/NOS contains the real-time portion of MP/M without local disk facilities. Like CP/NOS, MP/NOS performs all disk functions through the network.

The interface protocol is publicly defined so that non-MP/M or non-CP/M systems can participate in network interactions. A server interface for the VAX 11/780, for example, is under preparation so that it can perform I/O functions for a large number of MP/M and CP/M requesters.

The principal advantage of CP/NET is that all CP/M-compatible software becomes immediately available for operation in the network environment.
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Finally, we should note that 16-bit minicomputers are already outdated, and all serious manufacturers are pushing 32-bit machines. This leads to the following conclusion: if we are tracking the minicomputer world, we can assume that the future will be with the 32-bit processors.

Currently, however, 32-bit machines are not available in quantity. Even when they are available, there will be delays while manufacturers tool up for production. At the moment, the 16-bit processors offer an intermediate solution. Digital Research has provided initial support for Intel's 16-bit machines—iAPX-186 and iAPX-286—which are versions of its 8086 product line. Intel provided PL/M-86, rehosted from the 8080 line, which was used by Digital Research to generate CP/M and MP/M-86. In both cases, the fundamental design remains basically the same as that of the 8-bit version, with the addition of memory management and enhancements to the file system that match new computing resources.

A familiar program environment is retained so that program conversion is simplified.

CP/NET and related network software will be available sometime this year. Intel's 8087 (an arithmetic co-processor for the 8086) is of particular interest since it directly supports binary and decimal operations, which substantially increase PL/M-86 execution speed.

In addition to the 8086, the CP/M family will be adapted to the 16-bit machines that prove popular, with special interest in the 32-bit architectures as they become available. During this development and rehosting, however, the 8-bit processors will continue to be supported with new tools and facilities, since this constitutes, without doubt, our best customer base for some time to come.

Software Vendors

We've concerned ourselves with three levels of software tools that support the most important level: the application programs. A major reason for CP/M's popularity is the general availability of good application software. At last count, there were about 500 commercially available CP/M-compatible software products.

Through the combined efforts of CP/M distributors, independent vendors, and CP/M users, we are participating in a software commodity market with quality and variety that is unequaled by any minicomputer or mainframe manufacturer. The large CP/M customer base allows a vendor to produce and support a software package at low end-user cost. This increases the customer base, drawing more vendors with lower-cost good-quality products. This cyclic effect is, today, solving the "software crunch."

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Most UNIX-system utilities read from a standard input device and write to a standard output device. The Whitesmiths C compiler shows its heritage by doing the same. Until it informs you, for example, that there is a semi-colon missing on some line, you don’t notice that the source listing isn’t being printed. LIST is a program to print source listings. (See listing 1.) Each line is labeled like the compiler’s error listing. The version presented here is a system note, and you will probably want to add more features.

LIST reads the files named on command line and writes the listing to the standard output. If the files are not named, input is taken from the standard input. The standard input and output default to the user’s terminal but can be redirected to or from other devices or files, such as the line printer. Each file’s listing starts a new page. At the top of each page is the file’s name, the page number, and the date. Obtaining the date from the operating system depends upon your equipment; the code shown is for RT-11. The function DATE returns the number of bytes in the date and puts the date’s character string in its single argument.

The C language allows an #include statement. The preprocessor pass of the compiler replaces the #include statement with the contents of the file it names. As an option, LIST can insert the contents of the file after the #include statement. The -n flag on the command line turns on #include processing for nonheader files. The -h option includes header files. Header files are those with the extension .H (such as STD.H, which is the standard header file supplied by Whitesmiths). The depth to which #include can be nested depends on your stack size. Listing 1 was printed by the command:

```
list -n > lp: list.c
```

where lp: is the line printer. The #include processing was performed excluding header files. The angle brackets (< and >) indicate redirection of the standard input and output, respectively.

The subroutine PAGINATE uses a technique that is described in Principles of Program Design by M A Jackson. If each print line could be read from a scratch

Text continued on page 246
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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
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Listing 1: The program LIST. Normal operation produces a listing with pagination, top and bottom margins on each page, and a header on each page.

list.c 1: #include <stdio.h>
list.c 2: #include <local.h>
list.c 3: /* lister - list 'c' source files */
list.c 4: *
list.c 5: *
list.c 6: #include "p8in8.c"
list.c 7: *
list.c 8: #include "date.c"
list.c 9: *
list.c 10: *
list.c 11: *
list.c 12: *
list.c 13: *
list.c 14: *
list.c 15: *
list.c 16: *
list.c 17: *
list.c 18: *
list.c 19: *
list.c 20: *
list.c 21: *

Listing 1 continued on page 238
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Circle 305 on Inquiry card.
Listing 1 continued:

```c
23: if (tmp.all == 0) /* no date */
24: buf += itob(buf, tmp.day, 0); /* day of month */
25: buf = cpystr(buf, "", monthstr(month-1), ",", "NULL"); /* month of year */
26: buf += itob(buf, tmp.year+1972, 0); /* year A.D. */
27: return(buf-b);
```
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Circle 228 on inquiry card.
Listing 1 continued:

```
22: /* paginate - separate stream of buffers into pages */
23: paginate(buf)
24: TEXT *buf;
25:
26: BYTES date(), itob(), lenstr(), putlin();
27: static int line; /* line number within page */
28: static int page = 0;
29: TEXT tmp[20];
30:
31: if(page != 0) /* M. A. Jackson's program inversion technique used */
32: goto resume;
33: /* read */
```

```
34: while(buf != NULL) { /* while(!end_of_file) */
35: ++page;
36: line = skip(MARGIN1);
37: if(title != NULL) { /* output title, page # & date */
38: putlin(title, lenstr(title));
39: putlin(\t\t\t\t Page: \"\",12);
40: putlin(tmp, itob(tmp, page, 0));
41: putlin(\t\t\t\t Fi:1•e: \",12);
42: putlin(tmp, date(tmp));
43: line += skip(MARGIN2);
44: }
45: while(buf != NULL && line < page_size-MARGIN3) {
46: putlin(buf, lenstr(buf));
47: ++line;
48: /* read */
49: return;
50: resume;
51: }
52: skip(page_size-line);
53: line = 0;
54: }
55: page = 0;
56: }
```

```
/count include (file,ftn)
1: COUNT include(file, ftn)
2: /* include - include file in s */
3: FAST TEXT *file;
4: COUNT(\*ftn());
5: }
6: FAST COUNT return_code;
7: TEXT *bufbuf();
8: }
9: FAST FIO *fd;
10: FIO *fclose(\*, fopen());
11: return_code = NO;
12: fd = (FIO *) bufbuf(\*stdin, sizeof(FIO));
13: if(fopen(\*stdin, file, READ) == NULL)
14: diagnostic(NO, "can't open ", file, NULL);
15: else {
16: }
```

```
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```
incl.c  17:    return_code = (*fnl)(file);
incl.c  18:    fclose(stdin);
incl.c  19:  }

list.c  20:    cpybuf(stdin,fSel,sizeof(struct fio));
list.c  21:    free(fd);
list.c  22:    return(return_code);
list.c  23:  }

list.c  17:  
filenM.c  1:  
filenM.c  2: TEXT *prefix = "";  /* include prefix */
filenM.c  3:  
filenM.c  4:  /* get_name - extract file name from line */
filenM.c  5:  BYTES get_name(line,file)
filenM.c  6:  TEXT *file,*line;
filenM.c  7:  
filenM.c  8:  TEXT *delim;
filenM.c  9:  BYTES cpybuf(),instr(),lenstr(),n;
filenM.c 10:  
filenM.c 11:  while(*line == ' ' || *line == '\t')
filenM.c 12:    ++line;
filenM.c 13:  if(*line == '\n')
filenM.c 14:    n = lenstr(file);
filenM.c 15:  else {
filenM.c 16:    n = 0;
filenM.c 17:    if(*line == '\r') {
filenM.c 18:      delim = "\r\n";
filenM.c 19:      ++line;
filenM.c 20:    }
filenM.c 21:    else if(*line == '"') {
filenM.c 22:      delim = "\n";
filenM.c 23:      ++line;
filenM.c 24:      n = cpybuf(file,prefix,lenstr(prefix));
filenM.c 25:    }
filenM.c 26:  else
filenM.c 27:    delim = " \\
";
filenM.c 28:    n += cpybuf(file+n,line,instr(line,delim));
filenM.c 29:    *(file+n) = EOS;
filenM.c 30:  }
filenM.c 31:  return(n);
filenM.c 32:  }

list.c  19:  
list.c  18:  
list.c  19:  Minclude "detab.c"
detab.c  1:  
detab.c  2:  /* detab - replace tabs with blanks */
detab.c  3:  BYTES detab(s,d)
detab.c  4:  FAST TEXT *a,*d;

detab.c  5:  

detab.c  6:  FAST BYTES i;

Listing 1 continued on page 244
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Listing 1 continued:

detab.c 7: for(i = 0; rd = rd; ++i)
detab.c 8: if(\s == "\t")
detab.c 9: do

detab.c 10: while(++i20);
detab.c 11: else {

detab.c 12: ++i;

detab.c 13: ++d;

detab.c 14: }

detab.c 15: return(++i);

detab.c 16: }

detab.c 17: while ()

detab.c 18: }

detab.c 19: return (++i);

detab.c 20: }

detab.c 21: /* check_include - do possible include processing */
detab.c 22: check_include(line)

detab.c 23: FAST TEXT =line;

detab.c 24: }

detab.c 25: FAST BYTES n;

detab.c 26: TEXT file[MAXFILE+1];

detab.c 27: int list();

detab.c 28: }

detab.c 29: for( ; iswhite(#line); ++line) /* skip leading blanks */
detab.c 30: ;

detab.c 31: if(cmpbuf(line, "#include ", 9)) {

detab.c 32: n = get_name(line+9, file);

detab.c 33: if(cmpbuf(file[n-2], ",", 2)) /* header file */

detab.c 34: if(h_flag)

detab.c 35: include(file, &list);

detab.c 36: }

detab.c 37: else /* non-header file */

detab.c 38: if(n_flag)

detab.c 39: include(file, &list);

detab.c 40: }

detab.c 41: }

detab.c 42: }

detab.c 43: }

detab.c 44: /* list - label and print lines of "file" */

detab.c 45: list(file)

detab.c 46: TEXT *file;

detab.c 47: }

detab.c 48: BYTES getlin(), itob();

detab.c 49: TEXT *alloc(), *buf, *line, temp[4];
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Text continued from page 234:

file, this is what the subroutine would look like in pseudocode:

read line;
while(not end of file) {
do page header;
while(not (end of file || bottom of page)) {
print line;
read line;
do page footer;
}
}

For efficiency and simplicity, a pointer to each line is passed to PAGINATE instead of read from a file. A NULL pointer indicates end-of-file. The usual method is to turn the code inside out around the read statements. Jackson advocates keeping the structure the same and replacing each read statement by an assignment to a state variable, a return statement, and a label. The state variable serves as a “bookmarker,” so that execution can resume where it left off. A switch statement at the subroutine entrance will jump to the proper label on the next call. This technique may not be well received by the more fanatical GOTOless programming advocates, but this was the first paginate subroutine I have written that worked perfectly on the first try. In PAGINATE, the page counter is used as the state variable. If PAGE equals 0, then execution continues at the first read statement; otherwise, it jumps to the read in the innermost loop.

LIST did not spring full-blown from an exhaustive design process but evolved over a period of time. As with most computer efforts, I had only a general idea of the requirements—features were added, removed, and generalized. The header-file exclusion option originally only affected the standard header file STD.H. Functions were moved around within the code to tighten up the structure or to generalize a subroutine. Concatenating the file name, line number, and source line was originally done in PAGINATE. Moving it out allowed PAGINATE to be used in other programs. Several extensions are being contemplated, but the cost (in time) to implement them exceeds the cost of not having them. Being able to exclude an include file by name (-x filename) would be useful on large programs with a lot of previously developed code. When the preprocessor conditional compilation statements #if and #ifdef are used, it’s practical to have LIST handle them correctly. Each of these extensions would, however, require more time to implement than the existing program.
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The UNIX Operating System and the XENIX Standard Operating Environment

Robert B Greenberg
XENIX Product Manager
Microsoft
10800 NE Eighth, Suite 819
Bellevue WA 98004

Never has there been a greater demand for software that is easy to use and maintain, and independent of the hardware on which it runs. As the price of software rapidly outpaces that of computers, the need to increase software productivity and reduce duplication of effort has become paramount.

Microsoft's XENIX operating system offers one solution to the software crisis developing in the microcomputer world. Unlike the operating systems offered for 8-bit machines, the XENIX system is a powerful multiuser timesharing system with hundreds of utilities and is the basis for a highly productive software development environment and a general-purpose applications system.

The XENIX operating environment combines two key elements: the design of the widely acclaimed UNIX operating system and the inclusion of the major high-level languages that are standard within the 8-bit microcomputer world (see figure 1). Microsoft's transport of the XENIX system to major 16-bit microprocessors has made it the first hardware-independent operating system.

The heart of the XENIX system is the UNIX operating system developed at Bell Laboratories and licensed by Western Electric. The UNIX system's elegant design combines power, flexibility, and simplicity, and its vast array of software utilities greatly increases productivity. Thus, the UNIX system is an ideal candidate to serve as a solution to the software crisis.

Microsoft plans to make the XENIX operating system (which is an enhanced version of the UNIX system) into a commercial standard. And, in addition to supporting and enhancing the operating system proper, Microsoft will adapt high-level languages, such as its BASIC interpreter and compiler, FORTRAN, Pascal, and COBOL, and other software tools, such as data-base management and communications software, to run under the XENIX operating system.

To understand the elegance of the basic UNIX design and the further enhancements in the XENIX system, we must take a closer look at the software. In this article, I will describe the main features in the UNIX operating system, discuss some of its strengths and weaknesses, and conclude with a discussion of the evolution of the XENIX operating environment from the UNIX operating system, and how it can help solve critical software issues. First, a historical overview.

Origins of the UNIX OS

The UNIX operating system was originally developed at Bell Laboratories by Ken Thompson, an employee engaged in various programming research projects. With access to an abandoned DEC PDP-7 computer that had no software, Thompson decided in 1969 to write a set of programs that would aid him in software research. Over a period of several years, and with the help of fellow researcher Dennis Ritchie, this set of programs evolved into a full operating system. By 1972, it was recoded for the DEC PDP-11 computer in a newly designed high-level language, called C. The system gained recognition within the Labs and their parent company, Western Electric.

Word of the quality of Thompson and Ritchie's UNIX operating system spread rapidly. Universities, in particular, expressed interest in obtaining UNIX, and in 1973, Western Electric agreed to distribute the system to nonprofit organizations and promptly licensed several dozen educational institutions, including Columbia University, the University of Alberta (Canada), The Children's Museum (Boston), Princeton University, and Harvard University. By 1975, UNIX had become sufficiently popular in the academic world to justify the
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Figure 1: Microsoft's XENIX operating system. The five "layers" of the XENIX software structure are shown. XENIX, a superset of Bell Laboratories' UNIX operating system developed in the early 1970s, has a hierarchical structure. Each of the five layers depends on the layers beneath it for its operation. The bottom two layers represent the latest version of UNIX (version 7). The remaining three layers are the refinements that combine to make the XENIX system.
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creation of a UNIX users' organization, later called USENIX.

The first public release of the UNIX operating system, labeled version 5, was an unpolished snapshot of a research project that was still evolving. It was replaced in 1975 with version 6, a system that is still operating today at many sites. UNIX continued to evolve, benefitting from the feedback it received from scores of internal and external test sites.

In January 1979, Western Electric released version 7. By this time, hundreds of man-years' effort has been expended on UNIX's design and software utilities, with most of the system coded in C. Research had proven that UNIX was compatible with the concepts of memory-limited computers, machine transportability, networks, and multiple-processor designs.

Unfortunately, there was no single standard design for UNIX. Because the operating system was simple and easy to change, almost every site altered it to meet their specific needs. Harvard, the University of California at Berkeley, and the RAND Corporation each offered a set of modifications. A number of incompatible versions of UNIX existed within Western Electric.

In addition, there has been a legal impediment to the UNIX system's distribution. The system is available essentially free-of-charge for educational institutions. Legally, however, Western Electric cannot be in the software business, so the commercial world is offered the operating system under noncompetitive terms: source code as is and no warranty, support, or maintenance—a steep fee for software that was never intended to serve commercial applications outside of Western Electric.

In the second design goal is generality—that is, having a single method serve a variety of related purposes. For example, the same system calls are used to read and write disk files, devices, and interprocess message buffers. Likewise, the same naming, aliasing, and access protection mechanisms apply to data files, directories, and devices. As a final example, the same mechanism is used to trap software interrupts, user abort requests, and processor traps. The benefits of generality extend well
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beyond the simplicity of design; UNIX programming style is notably flexible, extensible, easily learned, and easily debugged.

The third goal is to accomplish large tasks by combining several small tasks whenever possible. UNIX's filters are an excellent example. A filter is a program that processes a single stream of input to generate one output stream. The UNIX system has a large variety of filters, including those that perform multicolumn formatting, string replacement, text processing, character translation, sorting, and graphics interfacing. Programs that generate output, such as the assembler, do not include facilities for listings; this task is accomplished by feeding programs directly to the various filters. This keeps the large programs simple to use, lets a user learn about each filter separately, and allows for special combinations of formatting without multiplying the options that each program would then have to support. It also leads to a uniform appearance of formatted output and the commands needed to produce it, and yields all the benefits of modular solutions to complex problems.

The vast number of utilities provided with the system and the ease of linking them together via pipes provide a surprising amount of functionality. For example, to find out how many people are currently using the system, you need only feed the output of the system "who" command to the utility that prints the number of lines in its input. Thus, the command line:

```
who | wc -l
```

causes the output of the who command, which might look like:

```
arw console Jan 30 14:20
bobg tty00 Jan 30 01:00
henry tty01 Jan 30 12:50
gordon tty03 Jan 29 10:08
```

to be fed to the program "wc," for "word count." The -l option tells wc, which normally prints the number of characters, words, and lines in a file, that we only want to see the number of lines. Thus, this composite command prints a number which is the number of users on the system:

```
> who | wc -l
4
```

As a final step, we can create a file called "users," which contains the line:

```
who | wc -l
```

Typing "users" causes the command interpreter (or shell) to execute that line, and type the number of current users. We have now created a new system command.

A more dramatic example is shown in the following sequence: take a program that puts each text word in a file (or files) onto a separate line. Connect the output to a program that sorts lines into alphabetical order.

---

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The output is a sorted list of all words in the text file(s). This list is fed to the program "uniq", which removes adjacent duplicate lines. The result is a data stream that contains one line for each different word in the original file(s). This stream is in turn connected to a program that reports differences between two files (one file being a list of 30,000 words from the dictionary). Thus, typing the line:
prep file | sort | uniq | comm wdlist
will result in a list of words present in "file" but not present in "wdlist". Without writing a line of code, you have created a simple spelling program! Now, by creating a file called "spell", which contains the line:
prep $* | sort | uniq | comm/usr/dict/words
you have created the command 'spell'. Note that the "$*" is replaced by the command line interpreter with the arguments typed to the spell command. The UNIX system's command

Figure 2: Hierarchical structure of the names and conventions for getting to any reference point in a typical XENIX file structure. In this example, it is assumed that the user is at reference point 5 (blue arrow). A list of instructions for getting to the various reference points appears beneath the diagram. (The file and directory labels shown here are actual labels used in the author's system.) To get to file 1, the user types "/USR/BOBG/WORK/B". XENIX then progresses down the tree from the root directory (at top) to the branches USR, BOBG, WORK, and B, arriving at point 1. Alternatively, the user can use the command "/./BOBG/WORK/B", where "/." refers to the parent node of the node currently in use. In XENIX, "/." refers to the node itself.

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interpreter, the shell, is a fully interactive language in its own right.

UNIX Operating System Design

The UNIX design introduces few new concepts because it borrows heavily from the better aspects of previously existing systems. UNIX contains numerous features found in the MULTICS and AOS operating systems, and the language C is modeled after BCPL. However, the coherence and simplicity with which the chosen features interact result in an unusually elegant design that has great merit of its own.

The UNIX operating system supports a multiuser, multitasking environment. Each user has full access to the resources of the computer on a timesharing basis. UNIX implements scheduling and swapping algorithms that allow the processor and memory to service more tasks, seemingly simultaneously, than would otherwise be possible. UNIX also includes various protection schemes that protect each user from the others. This functionality contrasts markedly with the current microcomputer systems that simplify hardware operation by providing device drivers but make little attempt to extend the computer's utility.

The UNIX file system is a recursive structure originating from a root directory. The root directory contains the names of files and subdirectories; the subdirectories contain names of other files and additional subdirectories, etc. When a user logs into the system, he is assigned a specific subdirectory as his current working directory. Full path names for files consist of a possibly null sequence of subdirectories separated by a slash, beginning with either the root or the current working directory, and followed by the file name. By convention, the file in each subdirectory called ".." refers to the parent directory (see figure 2). Thus the user has a concept of local and global files neatly organized into directory groupings.

File names refer to data files, the directories themselves, character devices such as user terminals, block devices such as magnetic tape, file systems mounted onto other disk devices, and interprocess communication devices known as multiplexed pipes. Multiple names (called aliases) can be assigned to any of these objects. A set of information, including owner and access permissions, is stored with each object; the directory entries only specify names for the objects.

Programs communicate with their environment with read and write calls directed to a set of open files. Each program starts with three open files: standard input, standard output, and error output. Normally, these files are connected to the user's terminal, but a powerful command-language program, the shell, allows easy and invisible reassignment of these channels. A program can also open any other object (file, device, etc) named in the file system to which it has appropriate access permission. Using a special call, a program can create pipes, data channels that allow for communication between the program and any other programs connected to an end of the pipe.

All I/O (input/output) operations are performed as byte streams, with all channels appearing to contain a sequence of bytes until a globally defined end-of-file condition is indicated. Random access is also supported, using a call to reposition within the stream. Neither record sizes nor file types are imposed by the operating system. The system handles all interrupts and buffering, and each I/O call is suspended until the requested I/O operation can be completed. All devices, files, and pipes are treated identically (with minor exceptions), which greatly simplifies I/O routines.

A program may initiate another program by issuing a system call to duplicate itself. The two programs then operate independently, with

---

Figure 3: Tree-structured process hierarchies in the XENIX system. Three users are currently on line. The term "shell" refers to that portion of the XENIX operating system program that "surrounds" the operating system and allows it to communicate with the outside world. User 1 is running a batch shell that is executing commands from a file. User 2 has suspended a BASIC session and entered a subshell to issue a command at the system-monitor level, perhaps to send a message to another user. User 2 can then return to BASIC and resume the session. User 3 has executed a command whose output is piped through a second command.
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UNIX timesharing between them (see figure 3). Typically, the parent process waits for the completion of its child, and the child process executes another program in the file system by issuing a system call. However, both programs may continue execution in parallel. To synchronize their operation, they can communicate via the file system, pipes, or signals. Signals are software asynchronous interrupts that are issued by one program to another to cause the second program to interrupt its execution, process the signal, and then resume normal execution. Signals are also generated by user interrupt requests and software failures, such as divide-by-zero.

Thus, when a user compiles and links a program test.c by typing:

```
> cc test.c
```

the shell runs the C compiler (cc) as a child process. After it has spawned the child process, the shell puts itself to sleep. When the child process (the C compiler) finishes, the shell awakens and issues another prompt.

However, by simply adding an ampersand character to the command line:

```
> cc test.c &
```

you can instruct the shell not to sleep, but rather to return immediately for another command. You can then edit your documentation or some further program, while the first one is compiling. Note that typing:

```
> filename
```

causes the shell to run a copy of itself as a child. This child shell then executes, one by one, the commands in "filename." By simply adding the "&" character to the following line:

```
> filename &
```

you now have the capabilities of a full batch system, for free, as a result of the UNIX system's flexibility.

This section has presented a brief overview of the UNIX system features. A more complete description is available in documents from Microsoft, Western Electric, and a number of universities. I will conclude this section with a discussion of an excellent example of UNIX's multitasking abilities.

**Multitasking**

The multitasking and interprocess communication features of the UNIX system provide power that is unavailable in existing 8-bit computer systems. RITA, a large interpreter language for UNIX that I helped create for the RAND Corporation, provides an extensive example of the utility of these features. The RITA interpreter consists of over 100 K bytes of instructions and more than 64 K bytes of data—much larger than the current limit on UNIX program size. The solution was to split RITA into three separate programs that communicate through the use of five pipes, as illustrated in figure 4. Furthermore, separate programs are created by the interpreter to edit programs, read RITA news files, and perform UNIX commands, such as obtaining...
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access to networks. Several files are written for analysis by still other programs. All this multitasking takes place invisibly: the user still thinks he or she is running a single program.

A further benefit of multitasking and device-independent I/O is an unexpected feature of RIT A’s three-program arrangement. Normally, the first program, UFE (user front end) allows you to type and edit program statements, which are then converted to internal form by the second program, the parser, which in turn stores them in the third program, the monitor, for evaluation. The UFE also allows the statements to be entered from a disk file; however, due to the complex parser program, loading a large file is too time consuming for many applications. A slight alteration to the UFE, the program which creates the other two programs and the five pipes, provides the solution. The new UFE (now called RC for RITA compiler), which requires no changes to the parser or monitor, funnels the output of the parser, normally fed to a pipe, into a disk file. Thus, RC produces “compiled” files whose contents can be fed directly into the monitor, bypassing the parser, when later loaded by RITA’s UFE.

An Assessment of UNIX

UNIX offers unparalleled power for such a straightforward system. For the programmer, the system is easy to learn and offers immediate functionality, even for beginners. For more experienced users, the wealth of software tools leads to a more productive environment than less complete systems.

In addition, the UNIX operating system comes with hundreds of utilities and software tools that make it a complete software development environment. There is software for accounting, text editing, formatting and typesetting, high-level languages,
Percom's DOUBLER II tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double-density plug-in module for TRS-80™ Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II™, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(Ed. Note: See "OS-80™: Bridging the TRS-80® software compatibility gap" elsewhere on this page.)

The circuitry on the Separation Circuit (DOUBLER II) is a proprietary design called a ROM-programmed digital phase-lock loop data separator.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides immunity to performance degradation caused by circuit component aging.

Circuit misapplication causes diskette read, format problems. High resolution key to reliable data separation

GARLAND, TEXAS — The Percom SEPARATOR™ does very well for the Radio Shack TRS-80™ Model I computer what the Tandy disk controller does poorly at best: reliably separates clock and data signals during disk-read operations.

Unreliable data-clock separation causes format verification failures and repeated read retries.

CRC ERROR—TRACK LOCKED OUT

The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the clock-data separation problem was traced by Percom to misapplication of the internal separator of the 1771 drive controller IC used in the Model I.

The Percom SEPARATOR substitutes a high-resolution digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

Separator circuits that operate at lower frequencies — for example, two- or four-megahertz — were found by Percom to provide only marginally improved performance over the original Tandy circuit.

The Percom solution is a simple adapter that plugs into the drive controller of the Expansion Interface (EI).

Not a kit — some vendors supply an untested separator kit of resistors, ICs and other paraphernalia that may be installed by modifying the computer — the Percom SEPARATOR is a fully assembled, tested plug-in module.

Installation involves merely plugging the SEPARATOR into the Model I EI disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only $29.95, may be purchased from Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1592.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty.

Circle 395 on inquiry card.

All that glitters is not gold

OS-80®: Bridging the TRS-80® software compatibility gap

Compatibility between TRS-80® Model I diskettes and the new Model III is about as genuine as a gold-plated lead krugerrand.

Most Model I diskettes are also non-compatible with the new Model III. The Model I TRS-80® diskettes can be read on a Model III. But first they must be converted and re-recorded for Model III operation.

And you cannot write to a Model I TRS-80® diskette; nor to a Model III. You cannot add a file. Delete a file. Or in any way modify a Model I TRS-80® diskette with a Model III computer.

Furthermore, your converted TRS-80® diskettes cannot be converted back for Model I operation.

TRS-80® is one-way street. And there’s no retreat. A point to consider before switching the company payroll to your new Model III.

Real software compatibility should allow the direct, immediate interchangeability of Model I and Model III diskette systems.

Once you install a DOUBLER II and connect it to your new Model III, you can run double-density Model III diskettes on a Model I.

What’s the answer? The answer is Percom’s OS-80® family of TRS-80® disk operating systems.

OS-80 programs allow direct, immediate interchangeability of Model I and Model III diskette systems.

You can run Model I single-density diskettes on a Model III, install Percom’s plug-in DOUBLER II adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There’s no conversion, no re-recording.

Simply install the DOUBLER II, slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa.

Just have the correct OS-80 disk operating system — OS-80, OS-80D, or OS-80D11 for OS-80D11 — and the system will work at the track sector level, defining and controlling data formats — in BASIC — to create simple or complex data structures that execute more quickly than TRS-80® files.

The Percom OS-80® DOS supports single-density operation of the Model I computer — price is $29.95; the OS-80D for double-density operation of the Model I computer — price is $49.95; and the OS-80D11 — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80D11 each sell for $49.95.

Prices and specifications subject to change without notice.

Prices do not include handling and shipping.

PERCOM DATA COMPANY, INC. 211 N. Kirby Street Garland, Texas 75042 (214) 272-3421

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assembly support utilities, sorters and index generators, communication facilities, tools that create parsers and lexical analyzers, graphics, games, mathematical function libraries, maintenance and performance utilities, and a host of file manipulators. Few needs cannot be met through a combination of these existing utilities.

The flexibility of UNIX allows easy alteration of its user interface. Various installations have demonstrated how easy it is to completely alter the appearance of UNIX in order to serve a different class of users. That UNIX cannot be everything to everyone is overshadowed by the fact that, as it is truly general-purpose, it can perform in almost any environment.

UNIX, as supplied by Western Electric, is not without its weaknesses. The general-purpose timesharing design limits UNIX's efficiency in real-time applications, such as process control. Its standard interface is highly terse, and though this is often considered desirable by programmers, the untamed UNIX will frighten almost everyone else. The origins of many of the command names are obscure; examples include a tape command "r" to write to a tape, command "cat" which types files, and "awk", a program for finding patterns in files. However, command names can be easily changed by the user.

UNIX has not been adapted for commercial use, where the issues of reliability, stability during hardware errors, full per-user accounting, reconfigurability for a large variety of environments, and security take on special importance. For example, less expensive disk packs for larger disk drives usually contain bad spots, and UNIX does not automatically adjust for them. In the environment for which the UNIX system was developed, it was cheaper to buy perfect packs than to write a "bad spot avoidance" routine. These issues must be addressed before UNIX can be considered a sturdy, robust, and commercial piece of software.

A crucial problem, and one not restricted to UNIX, is the lack of true applications software. Currently, there are few good accounts payable, invoicing, mailing list, income tax, or data-base management packages. UNIX provides an excellent software production environment because of its wealth of software tools utilities, but the system does not contain a similar variety of application-oriented software.

The XENIX System

Microsoft's XENIX operating system represents an attempt to preserve the strengths of the UNIX design and also meet the needs of the commercial microprocessor industry. To achieve this goal, Microsoft used the system as it was distributed by Western Electric and then added modifications, customizations, improvements, enhancements, support, and additional software.

Modifications included those necessary to transport the UNIX system from the larger PDP-11 minicomputer to the 16-bit microprocessors. Currently scheduled machines include the DEC LSI-11/23, Zilog's Z8001 and Z8002, Intel's 8086 and 286, and Motorola's MC68000. Numerous other processors are also being considered, and Microsoft will then customize the XENIX systems to the specific hardware environments of the various computer systems built around these processors. The company is also working closely with a number of hardware manufacturers to design products that will be capable of efficiently executing the XENIX software.

Improvements will include elimination of known bugs and recoding of certain routines to produce a smaller and faster operating system. XENIX will also incorporate hardware error recovery strategies, automatic file repair after crashes, power-fail and parity-error detection, and similar features, depending on the particular hardware requirements of each XENIX system.

The planned enhancements will add a number of new features to XENIX. These features include record locking, shared data segments, synchronous writing, and improved interprocess communication—all of which are designed to make XENIX commercially viable and more compatible with the newer hardware technologies that involve distributed data processing, networking, and multiple-CPU approaches.

XENIX is a dynamic, evolving system. In its first release, its code was very close to the original UNIX version 7 source. The improvements and enhancements that I have mentioned are part of an evolving process, and the exact selection and specification of features will be developed throughout the course of 1981. Updates to XENIX will result in systems upwardly compatible from its first release.

The adaptation of Microsoft's full line of system software products to XENIX will further strengthen XENIX's role as a software standard. These products, including the BASIC interpreter and compiler, COBOL, FORTRAN, and Pascal, have already established themselves as standards within the 8-bit market; they are also compatible with corresponding ANSI (American National Standards Institute) standards. Standard high-level languages will allow the rapid introduction of existing application software into the XENIX environment.

The XENIX system will offer an ever-expanding variety of software, including data-base management, financial planning, communication, and networking packages. Microsoft is establishing a clearinghouse, wherein quality software running under XENIX may receive widespread distribution, thereby reducing duplication of effort. The combination of the UNIX operating system's strengths and Microsoft's awareness of the needs of the commercial marketplace promises to make XENIX a very powerful defense against the looming software crisis. By establishing a universal operating environment, complete with software tools to increase productivity, flexible design to widen applicability, and multiple microprocessor support to improve availability, Microsoft hopes that XENIX will become the preferred choice for software production and exchange.
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- transfer of data between master and users via single Z80 block move command for highest speed
- random directory search provides immediate file access
- common file area for shared programs and files eliminates redundant files while individual user file areas protect each user's private files
- shared file update with record level lockout
- spool file can be displayed, updated, reprinted
- password security protects multiple user data bases
- MUSE supports standard CP/M* word processors, utilities, and languages: MBASIC, CBASIC, PASCAL, FORTRAN, COBOL, FORTH, C, PL/I, etc.

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|           | Survey of Graphic Packages Available for Micrs | 12 & 13 |
|           | All About Printers for Business          | 12 & 13 |
|           | Understanding the Cost of Business Software | 12 & 13 |
|           | The Computer as a Scientific research Tool | 12 & 14 |
|           | CP/M Update                             | 14      |
|           | Interfacing to the Real World           | 13 & 15 |
|           | The Multi-Lingual Microcomputer         | 13      |
|           | Introduction to COBOL for Microcomputers | 13 & 15 |
|           | Using a Microcomputer for Technical Analysis of Stocks & Commodities | 13 & 14 |
|           | Survey of Computer-Assisted Instruction | 13 & 15 |
|           | All About Printers for Personal Use      | 13      |
|           | The Next Five Years in Small Computers   | 14 & 15 |
|           | Applying PASCAL                         | 14      |
|           | Microcomputers and Medicine             | 14      |
|           | The Beauty of FORTRAN for Small Computers | 14 & 15 |
|           | The Future of the Home Terminal         | 15      |
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BYTE June 1981 267
The Ins and Outs of CP/M

CP/M (Control Program for Microprocessors) is the most commonly used 8080/8085/Z80 operating system. CP/M is easy to use and the Digital Research documentation is reasonably thorough and clear, especially by microprocessor-software standards. However, the documentation is lacking in one area: the explanation of I/O (input/output) and disk interfacing. This article will clarify and expand upon the documentation. A summary of the I/O and disk-interface routines, calling sequences, use of return codes, and typical subroutines using these will be presented. The use of file-control blocks (FCBs) and I/O buffers will also be explained. Finally, some details of the CP/M I/O functions and their workings will be presented.

Calling CP/M Routines

The procedure for calling CP/M routines is straightforward. I/O procedures are defined as a series of functions. Each function is assigned a unique function number. The function number is placed in the microprocessor's C register; the data required (entry parameter in CP/M parlance) is placed in the E register if only 1 byte is to be sent, or in the DE register pair if a word (2 bytes) is required. Some functions have no entry parameters. Results (called returned values) are either returned as a byte in the A register or as a filled buffer (whose address is usually sent as an entry parameter). Table 1 summarizes the basic I/O functions and calling sequences. Once the registers are properly loaded, a call to the CP/M entry point at hexadecimal memory location 0005 is made. It is important to know that CP/M does not preserve the contents of these registers, so any routine calling CP/M routines must protect any registers to be preserved. A typical subroutine to call a CP/M-utility routine is shown in listing 1. Refer to the examples for specific applications of this sequence. The function numbers and their purpose, entry parameters, and returned-value codes are summarized in table 1 and table 2.

I/O Routines

Listing 2 presents several useful subroutines that make calls to CP/M I/O routines. Calls to the punch device and reader device assume that these drivers exist in your version of CP/M, though they may or may not actually be driving a physical paper-tape reader/punch. As explained in the CP/M Features and Facilities Guide, logical devices may or may not correspond to actual physical devices. Writing and installing these drivers for CP/M is beyond the scope of this article.

Listing 3 shows the use of buffers for CP/M I/O. The address of the buffer is placed in the DE register pair and the call to the CP/M entry point is made. The contents of the print buffer are printed on the console until a dollar sign is encountered. The print buffer is not destroyed in this process. A typical print buffer is configured as:

```
c1 c2 c3 c4 .... ck $
```

where $k$ is the number of valid characters and $\$ $ signifies the end of the buffer. The read buffer is configured as:

```
m k c1 c2 c3 c4 .... ck
```

where $m$ is the maximum number of characters allowed in the buffer, and $k$ is the number of characters actually in the buffer. CP/M places characters in the buffer until a carriage return is encountered or the maximum buffer length is reached. The maximum length, $m$, may be from 1 to 256, and is defined by the user program. The value of $k$, the number of valid characters, is initially set to 0. It is set by CP/M to reflect the number of
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characters read into the buffer from the console. The CP/M line-editing features (control R, control C, etc) may be used with this routine. Other control characters will be echoed with a leading \* (called a circumflex), and will be inserted into the buffer. Any parity bits will be stripped by CP/M (this also applies to the single-character read functions in listing 2).

The final aspect of CP/M I/O that requires clarifying is the I/O status byte. This is a single byte at hexadecimal memory location 0003. It was apparently included in CP/M for compatibility with Intel software and must be specifically implemented by the user in BIOS (Basic I/O System). The I/O status byte, poorly described in the Interface Guide, is described much better in the System Alteration Guide, Section 6. By varying the value of this location, the user may reassign logical I/O devices without rewriting the system software.

CP/M Disk-Interface Routines
The use of the disk-interface routines provided by CP/M is more involved. But it is not too difficult once the basic concepts are grasped.

Text continued on page 274

<table>
<thead>
<tr>
<th>Function Number</th>
<th>Function Description</th>
<th>Entry Parameters</th>
<th>Returned Value</th>
<th>Typical Call **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read a character from the console.</td>
<td>(placed in DE) None</td>
<td>ASCII character</td>
<td>READ FUNCTION</td>
</tr>
<tr>
<td>2</td>
<td>Write a character to the console.</td>
<td>ASCII character None</td>
<td>None</td>
<td>CP/M ENTRY POINT</td>
</tr>
<tr>
<td>3</td>
<td>Read a character from the reader device.</td>
<td>None</td>
<td>ASCII character</td>
<td>CHARACTER IN E</td>
</tr>
<tr>
<td>4</td>
<td>Write a character to the punch device.</td>
<td>ASCII character</td>
<td>None</td>
<td>WRITE FUNCTION</td>
</tr>
<tr>
<td>5</td>
<td>Write a character to the list device (usually a printer).</td>
<td>ASCII character None</td>
<td>None</td>
<td>WRITE FUNCTION = 2</td>
</tr>
<tr>
<td>6</td>
<td>Get I/O status.*</td>
<td>None</td>
<td>I/O status byte</td>
<td>CHARACTER IN E</td>
</tr>
<tr>
<td>7</td>
<td>Set I/O status.*</td>
<td>I/O status byte None</td>
<td>None</td>
<td>PUNCH FUNCTION = 4</td>
</tr>
<tr>
<td>8</td>
<td>Output print buffer to console.</td>
<td>Address of a print buffer</td>
<td>None</td>
<td>WRITE TO PRINTER = 5</td>
</tr>
<tr>
<td>9</td>
<td>Input a character string from the console.</td>
<td>Address of a read buffer</td>
<td>The read buffer is filled to its maximum length or until a &lt;CR&gt; is typed.</td>
<td>ADDRESS OF BUFFER</td>
</tr>
<tr>
<td>10</td>
<td>Interrogate console for a character ready.</td>
<td>None</td>
<td>01 if a character is ready</td>
<td>ADDRESS OF BUFFER</td>
</tr>
</tbody>
</table>

*If implemented
**See listings 1, 2, and 3 for subroutines and program usage.
NTRY is the CP/M entry point (0005).

Table 1: Summary of the basic I/O functions available on a standard CP/M system.

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Circle 102 on Inquiry card.
<table>
<thead>
<tr>
<th>Function Number</th>
<th>Function Description</th>
<th>Entry Parameters and Comments (placed in DE)</th>
<th>Returned Value and Comments. (Returned in A or AB (A = LSB))</th>
<th>Typical Call*</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Lift head.</td>
<td>None</td>
<td>None—head is lifted from currently logged disk.</td>
<td>MVI C,12</td>
</tr>
<tr>
<td>13</td>
<td>Initialize CP/M disk access.</td>
<td>None</td>
<td>None—disk drive A is “logged in” for access. The DMA address is set to 0080H.</td>
<td>CALL MVI C,13</td>
</tr>
<tr>
<td>14</td>
<td>Select and log in disk.</td>
<td>Value corresponding to the desired disk: A = 0, B = 1, etc.</td>
<td>None—specified disk is selected for subsequent file operations.</td>
<td>CALL MVI E,DISKNO C,SELDSK ;DISK # IN E</td>
</tr>
<tr>
<td>15</td>
<td>Open file.</td>
<td>Address of FCB for the file to be opened</td>
<td>Byte address of the FCB in the disk directory, or 255H if file is not found—the disk map (DM) bytes in the FCB are filled by CP/M.</td>
<td>CALL LXI D,FCB NTRY ;ADDRESS IN DE</td>
</tr>
<tr>
<td>16</td>
<td>Close file.</td>
<td>Address of FCB for the file to be closed</td>
<td>Byte address of the FCB in the disk directory, or 255H if file is not found—the disk map of the FCB is written to the directory, replacing any existing data for that file.</td>
<td>CALL LXI D,FCB ;CLOSE = 16</td>
</tr>
<tr>
<td>17</td>
<td>Search for file.</td>
<td>Address of FCB containing name and type of file to search for.</td>
<td>Byte address of first FCB in directory that matches the name and type in the input FCB. If no match, 255H is returned.</td>
<td>CALL LXI D,FCB C,SEARCH NTRY ;SEARCH = 17</td>
</tr>
<tr>
<td>18</td>
<td>Search for next occurrence.</td>
<td>Address of FCB as in 17, but called after 17 before any other disk access</td>
<td>Byte address of next occurrence. 255H if no additional match.</td>
<td>CALL LXI D,FCB C,SEARCH NTRY ;SEARCH = 18</td>
</tr>
<tr>
<td>19</td>
<td>Delete file.</td>
<td>Address of FCB of file to be deleted</td>
<td>None—FCB in directory is marked as deleted. (ESH is placed in ET field.)</td>
<td>CALL LXI D,FCB C,DEL NTRY ;DEL = 19</td>
</tr>
<tr>
<td>20</td>
<td>Read record.</td>
<td>Address of FCB containing a disk map. Normal as a result of opening the file (15) and setting NR to the record to be read.</td>
<td>0 = successful read. 1 = read past logical end of file (+2) 2 = reading unwritten data. Data read is placed in memory at the DMA address (function 26).</td>
<td>CALL LXI D,FCB C,READ NTRY ;READ = 20</td>
</tr>
<tr>
<td>21</td>
<td>Write record.</td>
<td>Same as read, but NR is set to the record to be written</td>
<td>0 = successful write 1 = error in extending file 2 = end of disk data 255H = no more directory space—Data written is taken from memory starting at the DMA address.</td>
<td>CALL LXI D,FCB C,WRITE NTRY ;WRITE = 21</td>
</tr>
<tr>
<td>22</td>
<td>Create file.</td>
<td>Address of FCB of new file, all data set to 0 except name and type</td>
<td>Byte address of directory entry of new file or 255H if directory is full.</td>
<td>CALL LXI D,FCB C,CREATE NTRY ;CREATE = 22</td>
</tr>
<tr>
<td>23</td>
<td>Rename file.</td>
<td>Address of FCB with old file name and type in first 16 bytes and the new file name in the next 16 bytes</td>
<td>Directory address of old file, or 255H if not found. The file name and type are changed to that specified.</td>
<td>CALL LXI D,FCB C,RENAME NTRY ;RENAME = 23</td>
</tr>
<tr>
<td>24</td>
<td>Interrogate disk log-in.</td>
<td>None</td>
<td>Byte with 1 bit set for each disk logged in. LSB = disk A, etc.</td>
<td>CALL LXI D,FCB C,NOFILE NTRY ;HANDLE NOT FOUND</td>
</tr>
<tr>
<td>25</td>
<td>Interrogate drive number.</td>
<td>None</td>
<td>Number of disk to be used for next access.</td>
<td>CALL LXI D,BUFF NTRY ;BUFFER ADDRESS</td>
</tr>
<tr>
<td>26</td>
<td>Set DMA address.</td>
<td>Address of 128-byte buffer</td>
<td>None—subsequent reads and writes take data to/from memory beginning at this address.</td>
<td>CALL LXI D,BUFF NTRY ;DMA SET FUNCTION</td>
</tr>
<tr>
<td>27</td>
<td>Interrogate allocation.</td>
<td>None</td>
<td>Address of the current disk-allocation data. (Used by STAT—not well documented.)</td>
<td>CALL NTRY</td>
</tr>
</tbody>
</table>

*See listing 3 for subroutines and program usage.

Table 2: Summary of disk-access operations and disk-utility functions available on a standard CP/M operating system.
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PARITY — The Cl-1123 generates and checks parity for each byte of memory. Totally DEC compatible.
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Circle 00 on Inquiry card.
Text continued from page 270:
Proper use of these routines provides powerful capabilities for file manipulation, creation, and alteration. Tasks such as reading an application program into the proper region of memory, sending instructions with a file name, or detecting which disk drive a given file resides on (if any) are readily handled by CP/M. Let us see how these tasks may be accomplished.

Before a file can be manipulated by CP/M, its name must be made known to the system. This is done via the file-control block (FCB). A file-control block contains six types of information defined with 33 contiguous bytes in memory (0 to 32):

- Entry type (ET, byte 0)—assumed 0 by CP/M. CP/M places hexadecimal E5 here to signify a deleted file.
- File name (FN, bytes 1 to 8)—ASCII characters padded with ASCII blanks.
- File type (FT, bytes 9 to 11)—ASCII characters padded with ASCII blanks.
- File extent (EX, byte 12)—in 128-record segments. If file is longer than 128 records, this byte must be incremented to access the additional records. Normally, this will be initialized to 0.
- Initialize to 0 (bytes 13 to 14)—these bits may be used by some systems (such as Microchip), but should not be tampered with.
- Record count (RC, byte 15)—current file size in 128-byte records. Initialized to 0—correct value will be supplied by executing the OPEN statement.
- Disk allocation map (DM, bytes 16 to 31)—this map is used by CP/M to access the desired file. It is written into memory by the OPEN command, updated during access, and written back to the directory by the CLOSE command. It is not necessary to initialize this area if OPEN is used.
- Next record (NR, byte 32)—this is the number of the next record to access in the currently open extent. Normally, this will be initialized to 0 unless random access is desired or a file is to have something appended to it.

File-control blocks are written to the directory by each CLOSE command; they are read by each OPEN command. They maintain the disk-file allocation map, size (in 128-byte records), and extent (in 128-record segments). A separate FCB is maintained in the directory for each extent of the same file (each extent contains 128 128-byte records). That is, a file of 158 records will have an entry with extent=0 and record count=128 and another entry with extent=1 and record count=30, both having the same file name and file type.

The system maintains a default FCB at hexadecimal location 0000 and a default buffer at hexadecimal location 0080. These are used by CP/M to pass information to a user program. This is best explained by considering what happens when the program given in listing 4 is run. After it has been assembled and loaded, it is run by typing its name, as is any compiled program running under CP/M. However, in addition to its name, the name of the file to be processed must be entered. For this example program, the file to be processed must have a file type .DEM. This file is read into memory beginning at the first free memory location after the end of the program. The options...
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Listing 2: Examples of some simple I/O routines that utilize the CP/M I/O functions.


SUBROUTINE WCHAR—WRITES A SINGLE CHARACTER TO THE CONSOLE. ASSUMES THAT THE CHARACTER TO BE WRITTEN IS IN THE A REGISTER.

SUBROUTINE CLEAR—CLEAR THE SCREEN OF A SOROC IQ-120 TERMINAL. USES SUBROUTINE WCHAR TO SEND THE CHARACTERS TO THE TERMINAL.

HOME
- EQU 42 :HOMES CURSOR AND CLEAR SCREEN
- PUSH PSW :PROTECT STATUS FROM CALLING ROUTINE
- MVI A,27 :SEND ESCAPE CODE
- CALL WCHAR :WRITE HIM
- MVI A,HOME :CLEAR SCREEN AND HOME CURSOR
- CALL WCHAR :WRITE AGAIN
- POP PSW :RESTORE STATUS
- RET

Notice of Omission
Due to a processing error the Quantex Div. ad which appeared on page 329 of the May Byte had no Reader Service Number.

For more information regarding their “no problem trial offer” circle 470 on the inquiry card in this issue.
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Listing 3: Program to prompt for input, clear the screen, and echo the characters entered using the techniques discussed in this article. Except for the clear-screen codes, this routine works on any CP/M system.

```assembly
0100 ORG 0100H
0109 CN730H // BEGIN #skip to start of main routine

; EQUATES AND DATA STORAGE AREA

0000 = NTRY EQU 000SH // PRINT ENTRY POINT
0001 = PSRK EQU 9 // PRINT BUFFER FUNCTION
0002 = GSTR EQU 10 // READ BUFFER FUNCTION
0003 = WFUNC EQU 2 // WRITE CONSOLE FUNCTION
0004 = HOME EQU 42 // HOME CURSOR AND CLEAR
0005 = CR EQU 13 // CARRIAGE RETURN
0006 = LF EQU 10 // LINE FEED
0007 = LEN EQU 32 // DESIRED OUTPUT LINE LENGTH
0100 = OLESTK: DS 2 // OLD STACK POINTER
0105 = STR: DS 257 // INPUT STRING BUFFER
0204 454E544552 // PROMPT: DW 'EN','TE','RS'
020C 594F552057 // LEADER: DW 'YO','U','WR','OT','ES'

; SUBROUTINE PRINT -- PRINTS A STRING ENDING IN $ // PLACE STRING BUFFER STARTING ADDRESS IN DE REGISTER // PRESERVES REGISTER CONTENTS

0216 E5 PRINT: PUSH H // PRESERVE REGISTERS
0217 D5 PUSH D
0218 C5 PUSH B
0219 F5 PUSH PSW
021A 0E09 MVI C,PSTR // PRINT FUNCTION IN C REG
021C CD0500 CALL NTRY // DO IT
021F 81 POP PSW // RESTORE REGISTERS
0220 01 POP B
0221 D1 POP D
0222 E1 POP H
0223 C9 RET

; SUBROUTINE GETBUF -- GETS A BUFFER FULL FROM CONSOLE // PLACE INPUT BUFFER ADDRESS IN HL REGISTER - BUFFER // SHALL HAVE THE FIRST BYTE SET TO THE MAXIMUM BUFFER // LENGTH; THE NUMBER OF CHARACTERS PUT INTO BUFFER WILL // BE RETURNED AS THE SECOND BYTE OF THE BUFFER.

0224 E5 GETBUF: PUSH H // PRESERVE REGISTERS
0225 D5 PUSH D
0226 C5 PUSH B
0227 F5 PUSH PSW
0228 EB XCHG // PLACE ADDRESS IN DE FOR CALL TO CP'M
0229 0E0A MVI C,GSTR // READ BUFFER FUNCTION
022B CD0500 CALL NTRY // GET UM
022F 81 POP PSW // RESTORE
0230 C1 POP B
0231 D1 POP D
0232 E1 POP H

Listing 3 continued on page 280
```
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- 64K Dynamic Ram
- 4MHZ Z-80
- Serial Printer Port (150-19.2K)
- Double Density Disk Controller
- Programmable Baud Rate
- Programmable Keyboard Set

DISK STORAGE
- Dual Double Density 5¼ Single Sided Drives
- DOUBLE SIDED Option
- Double Sided, 77 Track, Option
- Color Matched Enclosure
- Self Contained Power Supply

OPTIONS:
- Dual 5¼" Double Sided MPI B51 (640K) add $225.00
- Dual 5¼" Double Sided MPI B91 (1.2MB) add $360.00
- Dual 8" SIEMANS FDD120-8 Drives (1MB) add $250.00
- Dual 8" QUME Double Sided Drives (2MB) add $625.00

1 YEAR PARTS WARRANTY!

320K MINI DRIVES SHOWN, 8" and 5¼" 10MB HARD DISK OPTIONAL
Listing 3 continued:

0232 C9

;*****************************************************************
; SUBROUTINES WCHAR AND CLEAR FROM EXAMPLE 1 INSERTED HERE
;*****************************************************************
0233 E5 WCHR; PUSH H ;PRESERVE REGISTERS
0234 D5 PUSH D
0235 C5 PUSH B
0236 F5 PUSH PSW
0237 5F MOV E,A ;PUT CHAR IN E REGISTER
0238 0E02 MOV C,WFUNC ;WRITE CHARACTER FUNCTION
0239 CD0500 CALL NTRY ;PRINT HIM
023A F1 POP PSW
023B C1 POP B
023C F1 POP D
023D E1 POP H
0240 C9 RET

;*****************************************************************
; SUBROUTINE CLEAR -- CLEARS SCREEN AND HOMES CURSOR ON
; A SOROC IQ-120 TERMINAL - PRESERVES REGISTERS
;*****************************************************************
0242 F5 CL.EAR: PUSH PSW ;PROTECT STATUS
0243 3E1B MOV A,27 ;SEND ESCAPE CODE
0245 CD3302 CALL WCHAR
0248 3E2A MOV f', HOME ;CLEAR SCREEN AND HOME CURSOR
024A CD3302 CALL WCHAR
024D F1 POP PSW
024E C9 RET

;*****************************************************************
; SUBROUTINE CRLF -- SENDS CRLF TO CONSOLE - PRESERVES REGISTERS
;******************************************************************
024F 3E0D CRLF: PUSH PSW
0250 3E0D MOV A,CR
0252 CD3302 CALL WCHAR
0255 3E0A MOV A,LF
0257 CD3302 CALL WCHAR
025A F1 POP PSW
025B C9 RET

;*****************************************************************
; SUBROUTINE SAVSTK -- SAVES THE OLD STACK POINTER AND SETS
; A NEW STACK AT CBASE (BASE OF CONSOLE COMMAND PROCESSOR)
; CBASE IS 800H BELOW FBASE (BASE OF THE DISK OPERATING SYSTEM)
; FBASE MAY BE READ AT NTRY+1.
;******************************************************************
025C C1 SAVSTK: POP B ;GET RETURN ADDRESS
025E 210000 LXI H,00 ;CLEAR HL
0260 3F DAD SP ;GET STACK POINTER
0261 220301 SHLD OLDSTK ;SAVE HIM
0264 2A0600 LHLD NTRY+1 ;GET FBASE
0267 7C MOV A,H
0268 D608 SUI 08H ;SUBTRACT CBASE OFFSET

Listing 3 continued on page 282
QUALITY DISK SOFTWARE
BACKED BY ONGOING APPLICATIONS SUPPORT

APPLE II & TRS-80

HOME FINANCE PAK 1:
Entire Series $49.95

CHECK REGISTER AND BUDGET: This comprehensive checking account management system not only keeps complete records, it also gives you the analysis and control tools you need to actively manage your account. The system provides routines for checking INCOME and EXPENSE, AUTOMATIC CHECK ENTRY, and BUDGET STATEMENT RECONCILIATION. CRT or printer reports are produced for ACTUAL EXPENSE vs BUDGET, CHECK REGISTER, and CHECK RECONCILIATION REPORT and CHECK REGISTER DISPLAY by month. Check entry is prompted by user-defined menus of standard purposes and recipient codes, speeding data entry and reducing disk storage and retrieval time. Six fields of data are stored for each check: amount, check no., date, purpose, recipient and TAX DEDUCTIBLE REMINDER. CHECK REGISTER routines allow searching on any of these data fields. Up to 100 checks can be stored.

SAVINGS: Account management system for up to 20 separate Savings accounts. Organizes, files and displays deposits, withdrawals and interest earned for each account. $14.95

CREDIT CARD: Get Control of your credit cards with this program. Organizes, stores and displays purchases, payments and service charges for up to 20 separate cards or bank loans. $14.95

UNIVERSAL COMPUTING MACHINE:
A user programmable computing system structured around a 50 row x 50 column table. User defines row and column names and equations forming a unique computing machine. Table elements can be multiplied, divided, subtracted or added to any other element. Hundreds of unique computing machines can be defined, used and recalled, for later use. Excellent for sales forecasts, budgets, inventory lists, income statements, production planning, project cost estimates and everything else that can be handled by a table. $49.95

COLOR CALENDAR:
$29.95

Everyday, organize it with Cale Color Calendar. Whether it's birthdays, anniversaries or business meetings or a regular office schedule, this program is the perfect way to schedule your activities. The calendar display is a beautiful Hi-Res color graphics calendar of the scheduled month with each scheduled day highlighted in color. Using the regular schedule, you can view any day of the month and schedule an event or activity in any one of 20 time slots from 8:00 A.M. to 5:30 P.M.

BUSINESS SOFTWARE:
Entire Series $159.95

MICROACCOUNTANT: The ideal accounting system for small businesses. Based on classic T-accounts and double-entry bookkeeping, this efficient program provides a journal for recording posting and reviewing up to 1,000 transactions per month to any one of 30 accounts. The program produces CRT and printer reports covering TRANSACTION JOURNAL. BALANCE SHEET. INCOME AND EXPENSE STATEMENT. ACCOUNT LEDGERS.

UNIVERSAL BUSINESS MACHINE: This program is designed to SIMPLIFY and SAVE TIME for the serious businessman who must periodically Analyze, Plan and Estimate. The program creates a report describing the Universal Computing Machine and it is programmed to provide the following planning and forecasting tools:

- CASH FLOW ANALYSIS
- SALES FORECASTER
- PROFIT & LOSS SOURCE AND USE OF FUNDS
- PROFIT & LOSS BALANCE SHEET
- REAL ESTATE INVESTMENT
- INVENTORY ANALYSIS

Price, including a copy of the Universal Computing Machine $89.95

BUSINESS CHECK REGISTER AND BUDGET: Our Check Register and Budget programs expanded to include up to 50 budgetable items and up to 200 checks per month. Includes bank statement reconciling and automatic check search. $49.95

ELECTRONICS SOFTWARE VOL I & II:
Entire Series $259.95

LOGIC SIMULATOR: SAVE TIME AND MONEY. Simulate your digital logic circuits before you build them. CMOS, TTL, or whatever. If it's digital logic, this program can handle it. The program is an interactive, menu driven, full-featured logic simulator that can simulate single-bit time responses of a logic network to user-specified input patterns. It will handle up to 1,000 gates, including NAND, NOR, INVERTER, FLOP, T-FLOP, JK-FLOP, D-FLOP, J-K FLOP, 4-BIT COUNTER and N-BIT SHIFT REGISTER. User interconnects gates using line graphics commands. Network descriptions for LOGIC SIMULATOR generated simultaneously with the CRT diagram being drawn. $159.95

MANUAL AND DEMO DISK: Instruction Manual and demo disk illustrating capabilities of both program(s). $29.95

ELECTRONIC SERVICES VOL III & IV:
Entire Series $259.95

CIRCUIT SIMULATOR: Tired of trial & error circuit design? Simulate & debug your circuits before you build them. With CIRCUIT SIMULATOR you build a model of your circuit using RESISTORS, CAPACITORS, INDUCTORS, TRANSISTORS, DIODES, VOLTAGE and CURRENT SOURCES, and simulate the waveform response to inputs such as PULSES, SINUSOIDS, SAWTOOOTH, etc., fully programmable. The output is displayed as an OSCILLOSCOPE-STYLE PLOT of the selected waveforms (Apple only) or as a printed table of voltage vs time. Handles up to 200 notes and up to 20 sources. Requires 48 RAM. $159.95

LOGIC DESIGNER: Interactive Hi-Res graphics program for designing electronic circuits. Draw directly on the screen up to 10 different component types, including those referenced above. Components interconnect list for CIRCUIT SIMULATOR generated automatically. Requires. $159.95

MATHEMATICS SERIES:
Entire Series $49.95

STATISTICAL ANALYSIS I: This menu driven program performs LINEAR REGRESSION analysis, determines the mean, standard deviation and plots the frequency distribution of user-supplied data sets. Printer, Disk, I/O routines. $18.95

NUMERICAL ANALYSIS: Hi-Res 2-Dimensional plot of any function. Automatic scaling. At your option, the program will plot the function, plot the INTEGRAL, plot the DERIVATIVE, determine the ROOTS, MAXIMA, MINIMA, INTEGRAL VALUE. $19.95

MATRX: A general purpose, menu driven program for determining the INVERSE and DETERMINANT of any matrix, as well as the SOLUTION to any set of SIMULTANEOUS LINEAR EQUATIONS. $19.95

3-D SURFACE PLOTTER: Explore the ELEGANCE and BEAUTY of MATHEMATICS by creating Hi-Res PLOTS of 3-dimensional surfaces from any 3-variable equation. Disk save and recall routines for plots. Menu driven to vary surface parameters. Disk save and recall routines. $18.95

ACTION ADVENTURE GAMES:
Entire Series $29.95

RED BARON: Can you outfly the RED BARON? This fast action game simulates a machine-gun DOGFIGHT between your WORLD WAR I Bi-PLANE and the Baron's. You can LOOP, DIVE, BANK or CLIMB and so can the Baron. In Hi-Res graphics plus sound. $18.95

BATTLE OF MIDWAY: You are in command of the U.S.S. HORNETS' DIVE-BOMBER squadron. Your targets are the Aircraft carriers. Akagi, Soryu and Kaga. You must fly your way through ZEROS and AA FIRE to make your DIVE-BOMB run. In Hi-Res graphics plus sound. $18.95

SUB ATTACK: It's April 1943. The enemy convoy is headed for the CONTROLLER. Your sub, the MORAY, has just sighted the CARRIERS and BATTLESHIPS. Easy pickings. But watch out for the DESTROYERS-they're fast and deadly. $14.95

FREE CATALOG:All programs are supplied on disk and run on Apple II w/Disk & Applesoft ROM Card & TRS-80 Level II and require 32K RAM unless otherwise noted. Detailed instructions included. Orders shipped within 5 days. Card users include card number. Add $1.50 postage and handling with each order. California residents add 8% sales tax. Foreign orders add $5.00 postage and handling.
Listing 3 continued:

MOV H, A  ; SET NEW STACK POINTER
SPHL B    ; SET RETURN ADDRESS
RET

; Subroutine GETSTK -- GETS OLD STACK POINTER AND RETURNS TO CPM

GETSTK: LHLD OLDSTK ; GET OLD STACK POINTER
SPHL ; PLUG IT IN
RET ; THIS WILL RETURN TO CPM

; Main Program -- Prompts for input, clears screen and echoes the input string in 32 character lines

BEGIN: CALL SAVSTK ; SAVE OLD STACK POINTER
LXI D, PFWMPT
CALL PRINT ; PRINT PROMPT
CALL CRLF
MVI A, 255
STA STR ; SET MAX BUFFER LENGTH
MVI A, 00
STA STR+1 ; ZERO CHARACTER COUNTER
LXI H, STR
CALL GETBUF ; GET A BUFFER FULL
CALL CLEAR ; CLEAR SCREEN
LXI D, LEADER
CALL PRINT ; PRINT LEADER
CALL CRLF
INX H ; ADDRESS STR+1
MVI B, M ; NUMBER OF CHARACTERS READ IN
PLIN: MVI A, LEN ; LINE LENGTH
CMP B
JNC ELIN ; PRINT LAST LINE
PLINE: INX C, A ; PLACE LEN IN COUNTER
MOV A, M ; GET HIM
MOV A, M
CALL WCHR ; WRITE HIM
DCE B
DCR C
JNZ PLIN ; KEEP PRINTING TILL DONE
JMP PLIN ; NEXT LINE
ELIN: INX H
MOV A, M ; GET CHARACTER
MOV A, M
CALL WCHR ; PRINT TILL DONE
DCE B
DCR C
JNZ ELIN ; NEXT LINE
CALL GETSTK ; RETURN TO CPM
END 100H

Text continued from page 274:

Now, let us discuss the use of the default FCB and buffer. When the command DSKUTIL TEST.PD is entered in response to the CP/M prompt, the system places TEST in bytes 1 thru 4 of the FCB beginning at location 0080. PD is placed in bytes 9 and 10. The string (as typed) is also placed in the default buffer at location 0080 in the following manner:

Available are P, which prints the file on the system printer, and D, which creates a copy of the input file having entered in response to the CP/M prompt. The system places TEST in bytes 9 and 10. The string (as typed) is also placed in the default buffer at location 0080 in the following manner:

- **P** places the file on A unless otherwise specified.
- **D** creates a copy of the input file. The input file may reside on drive A or B, but it is assumed to be on A unless otherwise specified. If option D is selected, the output file will be on the same drive as the input file.

Text continued on page 300
SPEND $62.40 TO READ THIS ADVERTISEMENT.*

A salesman generating 1.5 million dollars in sales annually for his company does so at the rate of $12.48 per minute. That's expensive time—should it really be used in rummaging through filing cabinets, writing long reports or talking to dozens of people looking for one small, crucial piece of information?

Of course not, so you hire an accounting staff, customer support personnel, and marketing people to support the business and let your salespeople sell. But the overhead takes a large slice of that $12.48.

A Delta system can do the work of a swarm of secretaries, a fleet of filers, a ton of telephones—simultaneously. It's a highly developed work processing system that can maintain files, generate reports, process orders and do all routine office work with speed and accuracy. It lets your people get on with the business of making money.

We at Delta Products have spent five years designing the most reliable, efficient Z80 based microcomputer available on the marketplace. It's fast—some models use multi processors to eliminate the delays associated with other multi user systems. It's expandable, allowing your Delta system to grow with your company's growth and change with your company's needs. And it's rugged; requiring a minimum of service or maintenance.

But the soul of any computer system is the software; therefore, having perfected the hardware technology, Delta is now dedicated to the development of application packages designed to warm the cockles of a corporate executive's heart. Our "Uni-form", for example, will keep purchase orders, account statements, sales and shipping orders indexed, cross-indexed and filed in any manner required.

And when your Delta system has helped your business grow, it's ready to grow right along with you—every Delta System is completely expandable and configurable.

You have spent five minutes reading this advertisement, at a cost of $62.40 in potential sales. Have you calculated what a Delta system can save your company? (Hint: a Delta system can pay for itself in less than 24 hours of time saved.)

Call us today for the name of your nearest Delta distributor.

*(and save thousands later)
Listing 4: Program using the discussed techniques to allow a user to either copy a specified file into another file or transmit its contents to the printer.

CP/M DISK UTILITIES PROGRAM
WRITTEN BY JAMES K. LARSON

0100 ORG 0100H
0100 C38902
JMP BEGIN ; SKIP TO START OF MAIN PROGRAM

EQUATES AND DATA STORAGE AREA

0005 = NTRY EQU 0005H ; CPM ENTRY POINT
0002 = WFUNC EQU 2 ; WRITE TO CONSOLE FUNCTION
0005 = PFUNC EQU 5 ; LINEPRINTER FUNCTION
0009 = PSTR EQU 9 ; PRINT BUFFER FUNCTION
000E = LOGF EQU 14 ; LOGIN AND SELECT DISK
000F = OPENF EQU 15 ; OPEN DISK FILE
0010 = CLOSEF EQU 16 ; CLOSE DISK FILE
0013 = REMVF EQU 19 ; DELETE A DISK FILE
0014 = READF EQU 20 ; READ A DISK RECORD
0015 = WRITEF EQU 21 ; WRITE A DISK RECORD
0016 = MAKEF EQU 22 ; CREATE A DISK FILE
001A = SETF EQU 26 ; SET DMA ADDRESS FOR NEXT READ/WRITE
0080 = TBUFF EQU 0080H ; DEFAULT TEXT BUFFER
005C = TFCB EQU 005CH ; DEFAULT FILE CONTROL BLOCK
0080 = RECLEN EQU 128 ; LENGTH OF ONE DISK RECORD
0060 = CR EQU 13 ; CARRIAGE RETURN
000A = LF EQU 10 ; LINE FEED
002A = HOME EQU 42 ; HOME CURSOR AND CLEAR SCREEN
0103 4445 DWEH: DW 'DE'
0105 4000000000 DB 'M',0,0,0,0
010A 5245 RES: DW 'RE'
010C 5300000000 DB 'S',0,0,0,0
0111 505249E54DNMSG: DW 'PR','IN','TI','NG','C','OM','PL','ET','E$
0123 50524F4345DNPRI: DW 'PR','OC','ES','SI','NG','C','OM','PL','ET','E$
0137 434F4D41ERRMSG: DW 'CO','MM','AN','D','OR','F','IL','ER','RO','R$
014D 5F504E4200UPERR: DW 'OP','EN','E','RR','OR','$'
0159 5752495452ERR: DW 'WR','IT','E','ER','RO','R$
0165 RCRDS: DS 1 ; STORAGE FOR NUMBER OF RECORDS READ
0166 OLDSTK: DS 2 ; STORAGE FOR ORIGINAL STACK ADDRESS
0168 00 FLAG: DB 00 ; INITIALIZE FLAG BITS STORAGE
0169 TFCB1: DS 33 ; SECOND FILE CONTROL BLOCK

SUBROUTINE WCHAR -- WRITES A SINGLE CHARACTER TO THE CONSOLE
CHARACTER IN THE A REGISTER - PRESERVES REGISTERS

018A E5 PRINT: PUSH H ; PRESERVE REGISTERS
018B D5 PUSH D
018C C5 PUSH B
018D F5 PUSH PSW
018E 0E09 MVIC PSTR ; FUNCTION IN C REGISTER
0190 CD0500 CALL NTRY ; DO IT
0193 F1 POP PSW ; RESTORE REGISTERS
0194 C1 POP B
0195 D1 POP D
0196 E1 POP H
017 C9 RET

Listing 4 continued on page 286
We all know that bilge pumps suck. And by now, we've found out—the hard way—that a lot of software seems to work the same way.

So I got pretty excited when I ran across dBASE II, an assembly-language relational Database Management System for CP/M. It works! And even a rank beginner like myself got it up and running the first time I sat down with it.

If you're looking for software to deal with your data, too, here are some tips that will help:

**Tip #1: Database Management vs. File Handling:**
Any list or collection of data is, loosely, a data base, but most of those "data base management" articles in the buzzbooks are really about file handling programs for specific applications. A real Database Management System gives you data and program independence (no repogramming when data changes), eliminates data duplication and makes it easy to turn data into information.

**Tip #2: Assembly Language vs. BASIC:**
This one's easy: if you're setting up a DBMS, you're going to be doing a lot of sorting, and Basic sorts are s-l-o-w. Run a benchmark on a Basic system like S*-IV against a relational DBMS like dBASE II and you'll see what I mean. (But watch it: I've also seen one extremely slow assembly-language file management system.)

**Tip #3: Relational vs. Hierarchal & Network DBMS.**
CODASYL-like hierarchal and network systems, around since the 1960's, are being phased out on the big machines so why get stuck with an old-fashioned system for your micro? A relational DBMS like dBASE II eliminates the pre-defined sets, pointers and complex data structures of a CODASYL-type DBMS. And you don't need to be a programmer to use it.

dBASE II vs. everything else.
dBASE II really impressed me. Written in assembly language (with no need for a host language), it handles up to 65,000 records (up to 32 fields and 1000 bytes each), stores numeric data as packed strings so there are no roundoff errors, has a super-fast multiple-key sort, and supports ISAM based on B* trees.
You can use it interactively with English-like commands (DISPLAY 10 PRODUCTS), or program it (so when you've set up the formats, your secretary can do the work). Its report generator and user-definable full screen operations mean that you can even use your existing forms.

And if all this makes your mouth water, but you've already got all your data on a disk, that's okay: dBASE II reads your ASCII files and adds the data to its own database.

Right now, I'm using dBASE II with my word processor for budgeting, scheduling and preparing reports for my clients.

Next come job costing, time billing and accounting.

An Unheard-of Money-Back Guarantee.
dBASE II is the first software I've seen with a full money-back guarantee.
To check it out, just send $700 (plus tax in California) to Ashton-Tate, 3600 Wilshire Blvd., Suite 1510, Los Angeles, CA 90010. (213) 666-4409. Test dBASE II doing your jobs on your computer for 30 days. If, for some strange reason, you don't want to keep it, send it back and they'll refund your money.
No questions asked.
They know you don't need your bilge pumped.
Listing 4 continued:

;*******************************************************************
0198 E5
0199 D5
019A C5
019B F5
019C 5F
019D 0E02
019F CD0500
01A2 F1
01A3 C1
01A4 D1
01A5 E1
01A6 C9

0198 DB
0199 DD
019A CB
019B FB
019C 5E
019D 0E02
019F CD0500
01A2 F1
01A3 C1
01A4 D1
01A5 E1
01A6 C9

;*******************************************************************
SUBROUTINE PCHAR -- PRINTS A SINGLE CHARACTER ON THE PRINTER
CHARACTER IN THE A REGISTER — PRESERVES REGISTERS
;*******************************************************************
01A7 E5
01A8 D5
01A9 C5
01AA F5
01AB 5F
01AC 0E05
01AE CD0500
01B1 F1
01B2 C1
01B3 D1
01B4 E1
01B5 C9

01A7 E5
01A8 D5
01A9 C5
01AA F5
01AB 5F
01AC 0E05
01AE CD0500
01B1 F1
01B2 C1
01B3 D1
01B4 E1
01B5 C9

;*******************************************************************
SUBROUTINE CLEAR -- CLEARS SCREEN AND HOME CURSOR ON
A SOROC IQ-120 TERMINAL -- PRESERVES REGISTERS
;*******************************************************************
01B6 F5
01B7 3E1B
01B9 CD9801
01BC 3E2A
01BE CD9801
01C1 F1
01C2 C9

01B6 F5
01B7 3E1B
01B9 CD9801
01BC 3E2A
01BE CD9801
01C1 F1
01C2 C9

;*******************************************************************
SUBROUTINE CRLF -- SENDS CRLF TO CONSOLE
;*******************************************************************
01C3 F5
01C4 3E0D
01C6 CD9801
01C9 3E0A
01CB CD9801
01CE F1
01CF C9

01C3 F5
01C4 3E0D
01C6 CD9801
01C9 3E0A
01CB CD9801
01CE F1
01CF C9

;*******************************************************************
SUBROUTINE SAVSTK -- SAVES THE OLD STACK POINTER AND SETS
A NEW STACK AT CBASE (BASE OF THE CONSOLE COMMAND PROCESSOR).
CBASE IS BOTH BELOW FBASE (BASE OF THE DISK OPERATING SYSTEM).
FBASE MAY BE READ AT NTRY+1.
;*******************************************************************

Listing 4 continued on page 288
The System/48 is the outstanding office automation computing system for the 80's... it's so productive we call it MAGIC®. Look at these features:

- Data management system
- Report generator
- Query processor
- Screen format generator
- Automatic interface code generator
- From one to eight interactive users per node
- Over half a million bytes of user memory available
- Winchester-technology hard disk with 18-million bytes (formatted capacity)
- 15-minute mean-time-to-repair
- Built-in protection from line-voltage spikes, noise, and brownouts

And, it features MAGIC®, the Operating System that gets things done faster than you can say abracadabra because of its multi-keyed Indexed-Sequential Access Method and flexible file-organization. MAGIC® also offers high security, with password protection. MAGIC® supports global or local printers for as many users as desired.

Circle 359 on inquiry card.

MAGIC® also includes DataMagic II® — TEI's red-hot database manager. DataMagic II® has even more tricks up its sleeve — like automatic or manual record-lock protection and automatic transaction backout to protect the database and it runs application software written for CP/M 2.X.

Take a MAGIC® leap into the future!
Arrange to attend one of our regularly scheduled System/48 workshops (RSVP).

OEM and Dealer Inquiries Invited

5075 S. LOOP EAST, HOUSTON, TX. 77033
(713)738-2300  TWX. 910-881-3639
Listing 4 continued:

01D0 C1  SAVSTK: POP B  SET RETURN ADDRESS
01D1 210000 LXI H+00 ICLEAR HL
01D4 39 DAD SP GET STACK POINTER
01D5 226601 SHLD OLDSSTK SAVE HIM
01D8 2A6000 LHLD NTRY+1 GET FBASE
01DB 7C MOV A+H
01DC 16408 SUI 0BH SUBTRACT CBASE OFFSET
01DE 67 MOV H+A
01DF F9 SPHL SET NEW STACK POINTER
01E0 C5 PUSH B SET RETURN ADDRESS
01E1 C9 RET

*********************************************************************

; SUBROUTINE GETSTK -- GETS OLD STACK POINTER AND RETURNS TO CPM
;*********************************************************************

01E2 2A6601 GETSTK: LHLD OLDSSTK GET OLD STACK POINTER
01E5 F9 SPHL PLUG HIM IN
01E6 C9 RET THIS WILL RETURN TO CPM

*********************************************************************

; SUBROUTINE PRT -- PRINTS THE NUMBER OF CHARACTERS IN THE B REG
; ON THE LINE PRINTER, ADDRESS OF FIRST CHARACTER TO PRINT
; IS IN HL.
;*********************************************************************

01E7 7E PRT: MOV A+H GET CHAR
01E8 CDA701 CALL PCHAR PRINT HIM
01EB 23 INX H NEXT, PLEASE
01EC 05 DCR B DONE?
01ED C2E701 JNZ PRT NOPE, KEEP PRINTING
01F0 C9 RET DONE, GO HOME

*********************************************************************

; SUBROUTINE MOVCHR -- MOVES CHARACTERS BEGINNING AT LOCATION
; IN HL TO LOCATION BEGINNING IN DE FOR A COUNT IN REG C.
;*********************************************************************

01F1 7E MOVCHR: MOV A+H
01F2 12 STAX D
01F3 23 INX H
01F4 13 INX D
01F5 0D DCR C
01F6 C2F101 JNZ MOVCHR GO TILL DONE
01F9 C9 RET

*********************************************************************

; SUBROUTINE LOGDSK -- LOGS IN A DISK AS ACTIVE FOR I/O, REG E
; CONTAINS 0 FOR DRIVE A AND 1 FOR DRIVE B.
;*********************************************************************

01FA E5 LOGDSK: PUSH H
01FB E5 PUSH D PRESERVE
01FC C5 PUSH B
01FD F5 PUSH PSW
01FE OE0E MVI C+LOGF
0200 CD0500 CALL NTRY
0203 F1 POP PSW
0204 C1 POP B RESTORE
0205 D1 POP D
0206 E1 POP H
0207 C9 RET

Listing 4 continued on page 290
The Text Solution for APPLE II®

Now APPLE II® Owners Can Solve Text Problems
With VIDEOTERM 80 Column by 24 Line Video Display
Utilizing 7 X 9 Dot Character Matrix

Perhaps the most annoying shortcoming of the Apple II® is its limitation of displaying only 40 columns by 24 lines of text, all in uppercase. At last, Apple II® owners have a reliable, trouble-free answer to their text display problem. VIDEOTERM generates a full 80 columns by 24 lines of text, in upper and lower case. Twice the number of characters as the standard Apple II® display. And by utilizing a 7 by 9 character matrix, lower case letters have true descenders. But this is only the start.

VIDEOTERM

VIDEOTERM lists BASIC programs, both Integer and AppleSoft, using the entire 80 columns. Without splitting keywords. Full editing capabilities are offered using the ESCape key sequences for cursor movement. With provision for stop/start text scrolling utilizing the standard Control-Sentry. And simultaneous on-screen display of text being printed.

Pascal

Installation of VIDEOTERM in slot 3 provides Pascal immediate control of the display since Pascal recognizes the board as a standard video display terminal and treats it as such. No changes are needed to Pascal’s MISC.INF or GOTOXY files, although customization directions are provided. All cursor control characters are identical to standard Pascal defaults.

Options

The entire display may be altered to inverse video, displaying black characters on a white field. PROMs containing alternate character sets and graphic symbols are available from Videx. A switchblade option allows you to use the same video monitor for either the VIDEOTERM or the standard Apple II® display, instantly changing displays by flipping a single toggle switch. The switchblade assembly inserts into one of the rear cut-outs in the Apple II® case so that the toggle switch is readily accessible. And the Videx KEYBOARD ENHANCER can be installed, allowing upper and lower case character entry directly from your Apple II® keyboard.

Firmware

1K of on-board ROM firmware controls all operation of the VIDEOTERM. No machine language patches are needed for normal VIDEOTERM use.

Want to know more? Contact your local Apple dealer today for a demonstration. VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon. Or send for the VIDEOTERM Owners Reference Manual and deduct the amount if you decide to purchase. Upgrade your Apple II® to full terminal capabilities for half the cost of a terminal. VIDEOTERM. At last.

APPLE II® OWNERS!

Introducing the KEYBOARD & DISPLAY ENHANCER

*PUT THE SHIFT AND SHIFT LOCK BACK WHERE IT BELONGS*
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Circle 380 on Inquiry card.
Listing 4 continued:

```assembly
; SUBROUTINE OPEN -- OPENS FILE WHOSE FCB ADDRESS IS IN DE.
; RETURNS 255 IN REG A IF NO SUCH FILE.
;*******************************************************************************
0208 E5  OPEN:  PUSH  H  ;PRESERVE
0209 B5  PUS H  D
020A C5  PUS H  B
020B 0E0F  MVI  C,OPENF
020C C0500  CALL  NTRY
020D C1  POP  B
020E D1  POP  D
020F E1  POP  H
0210 C9  RET
;*******************************************************************************
; SUBROUTINE CLOSE -- CLOSES FILE WHOSE FCB ADDRESS IS IN DE.
; RETURNS 255 IN A IF NO SUCH FILE.
;*******************************************************************************
0214 E5  CLOSE:  PUSH  H
0215 B5  PUS H  D
0216 C5  PUS H  B
0217 0E10  MVI  C,CLOSEF
0218 C0500  CALL  NTRY
0219 C1  POP  B
021A D1  POP  D
021B E1  POP  H
021C C9  RET
;*******************************************************************************
; SUBROUTINE DELETE -- DELETES THE FILE WHOSE FCB IS IN DE.
;*******************************************************************************
0220 E5  DELETE:  PUSH  H
0221 B5  PUS H  D
0222 C5  PUS H  B
0223 F5  PUS H  PSW
0224 0E13  MVI  C,REMVF
0225 C0500  CALL  NTRY
0226 F1  POP  PSW
0227 C1  POP  B
0228 D1  POP  D
0229 E1  POP  H
022A C9  RET
;*******************************************************************************
; SUBROUTINE CREATE -- CREATES THE FILE WHOSE FILENAME AND TYPE
; ARE IN THE FCB ADDRESSED BY DE. RETURNS 255 IN A IF NO
; DIRECTORY SPACE.
;*******************************************************************************
022E E5  CREATE:  PUSH  H
022F B5  PUS H  D
0230 C5  PUS H  B
0231 0E16  MVI  C,MAKEF
0232 C0500  CALL  NTRY
0233 C1  POP  B
0234 D1  POP  D
0235 E1  POP  H
0236 C9  RET
;*******************************************************************************
; SUBROUTINE SETDMA -- SETS THE DMA ADDRESS FOR THE NEXT DISK I/O
; TO THAT IN HL. INCREMENTS HL BY 128 (READY FOR NEXT TIME).
;*******************************************************************************
```

Listing 4 continued on page 292
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Listing 4 continued:

```assembly
;************************************************************************
F.C.O.B.T SETDMF: PUSH FSW
023A F5
023B C5
023C D5
023D E5
023E EB
023F 0E1A
0241 CD0500
0244 E1
0245 01B000
0248 09
0249 D1
024A C1
024B F1
024C C9

;************************************************************************
SUBROUTINE RDREC -- READS ONE RECORD FROM FILE WHOSE FCB IS IN
DE TO THE CURRENT DMA ADDRESS, RETURNS A 1 OR 2 IN REG A
IF EOF IS ENCOUNTERED. A ZERO IN REG A MEANS SUCCESSFUL READ.

024D E5
024E D5
024F C5
0250 0E14
0252 CD0500
0255 C1
0256 D1
0257 E1
0258 C9

;************************************************************************
SUBROUTINE WRREC -- WRITES ONE RECORD TO FILE WHOSE FCB IS IN
DE FROM THE CURRENT DMA ADDRESS. RETURNS 0 IF A SUCCESSFUL
WRITE.

0259 E5
025A D5
025B C5
025C 0E15
025E CD0500
0261 C1
0262 D1
0263 E1
0264 C9

;************************************************************************
SUBROUTINE WRDSK -- WRITES TO DISK FROM MEMORY BEGINNING AT
ADDRESS IN HL. WRITES FILE WHOSE FCB IS IN DE. WRITES NUMBER
OF RECORDS IN REG B. ANY ERRORS RETURNED FROM WRREC ARE
REPORTED AND THE WRITE IS ABORTED.

0265 CD3A02
0268 CD4002
026A A7
026C CD5502
026E C9

;************************************************************************
SUBROUTINE RDDBK -- READS FILE WHOSE FCB ADDRESS IS IN DE TO
MEMORY BEGINNING AT ADDRESS IN HL. ASSUMES FILE WILL FIT INTO
MEMORY. ENTIRE FILE IS READ IN.

0265 CD3A02
0268 CD4002
026A A7
026C CD5502
026E C9

;************************************************************************
SUBROUTINE WRDSK -- WRITES TO DISK FROM MEMORY BEGINNING AT
ADDRESS IN HL. WRITES FILE WHOSE FCB IS IN DE. WRITES NUMBER
OF RECORDS IN REG B. ANY ERRORS RETURNED FROM WRREC ARE
REPORTED AND THE WRITE IS ABORTED.

Listing 4 continued on page 294

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Circle 386 on Inquiry card.
Listing 4 continued:

;**********************************************************************
; MAIN PROGRAM -- READS A DISK DRIVE, FILE NAME, AND OPTIONS FROM
; THE DEFAULT BUFFER. OPTIONS ALLOW THE NAMED FILE TO BE
; PRINTED OR REWRITTEN TO A NEW FILE. ASSUMES FILE TYPE .DEM
; FOR INPUT FILE AND ASSIGNS TYPE .RES TO OUTPUT FILE.
;**********************************************************************

0289 CDB001 BEGIN: CALL SAVSTK $SAVE OLD STACK POINTER
028C CDB801 CALL CLEAR
028F 21B000 LXI H+TBUFF $COMMAND LINE IS HERE
0292 3E00 MVI A+0
0294 BE CMP M
0295 CAA303 JZ ERR $ERROR IF NO VALID CHARACTERS
0298 46 MOV B+M $GET NUMBER OF VALID CHARACTERS
0299 3E3A MVI A+':' $DISK SPECIFIED?
029B 23 INX H
029C 23 INX H $COLON IS HERE IF A LABEL IS SPECIFIED
029D 23 INX H
029E BE CMP M
029F CAA802 JZ TARG $TARGET IS END OF FILE NAME
02A2 28 DCX H
02A3 28 DCX H
02A4 05 DCR B $ASSUME FIRST CHARACTER BLANK
02A5 C3BF02 JMP TARG $SKIP IF NOT NEEDED
02A8 05 LDISK: DCR B $THUMP COUNTER
02AA 05 DCR B
02AB 3E42 MVI A+ ,'B' $DRIVE B?
02AC 28 DCX H $BACK UP ONE
02AE BE CMP M
02AF C8B602 JZ DRB $DRIVE B IT IS
02B2 23 INX H $ASSUME DRIVE A
02B3 C3BF02 JMP TARG
02B6 3A6801 DRB: LDA FLAG $FLAG DRIVE B
02B7 F604 ORI 00000100B
02BB 326801 STA FLAG
02BE 23 INX H
02BF 3E2E TARG: MVI A+',' $TARGET IS END OF FILE NAME
02C1 23 NCHAR: INX H $NEXT CHAR
02C2 05 DCR B $THUMP COUNTER
02C3 CAA303 JZ ERR $ERROR IF NO COMMANDS
02C4 BE CMP M
02C7 C2C002 JNZ NCHAR $KEEP LOOKING
02CA 23 INX H
02CB 3E50 INSTR: MVI A+,'P' $PRINT HIM?
02C0 BE CMP M
02CE C2DC02 JNZ DTST $CREATE NEW DISK FILE?
02D1 3A6801 LDA FLAG $SET PRINT FLAG
02D4 FA01 ORI 0000001B
02D6 326801 STA FLAG
02D9 C3EA02 JMP NXTINS
02DC 3E44 DTST: MVI A+,'D' $CREATE NEW DISK FILE?
02DE BE CMP M
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Listing 4 continued:

020E 3A6B01  LDA  FLAG  ;SET FILE FLAG
020F E602  ORI  00000010B
0210 326B01  STA  FLAG
0211 23  NXTINS:  INX  H
0212 05  DCR  B
0213 C2B02  JNZ  INSTR  ;KEEP READING INSTRUCTIONS
     ;LOG PROPER DRIVE
0214 EF 1E00  MVI  E',00  ;SET DEFAULT DRIVE A
0215 F1 3A6B01  LDA  FLAG
0216 E604  ANI  00000100B  ;WHICH DRIVE?
0217 F6 CAFB02  JZ  LOG  ;LOG DRIVE A
0218 F9 1E01  MVI  E',01  ;LOG DRIVE B
0219 FB CDFA01  LOG:  CALL  LOGDISK
021A 210301  ;SET FILE TYPE .DEM
     ;READ IN FILE
021B 01 115C00  LXI  H,DEM
021C 04 0D0802  CALL  OPEN
021D 3C 114B01  INR  A  ;ERROR TEST - A CONTAINS 255 IF ERROR
021E 22303  JNZ  RDSK  ;OK - GO ON
021F 14 114B01  LXI  D,OPERR  ;PRINT OPEN ERROR
0220 DA01  CALL  PRINT
0221 C0301  CALL  CRLF
0222 39703  JMP  DONE
0223 21AF03  RDSK:  LXI  H,FINIS  ;LOCATION OF FIRST OPEN MEMORY LOCATION
     ;DE ALREADY CONTAINS THE FCB ADDRESS
0224 D502  CD600  CALL  RDSK  ;READ HIM IN
0225 46800  326B01  STA  RCRDS  ;NUMBER OF RECORDS TO PRINT
0226 CD1402  STA  FCB+15  ;FCB IS STILL IN DE
0227 128  JNZ  D,NMSG  ;PRINT COMPLETION MESSAGE
0228 0D01  LDA  FLAG
0229 6A08 3A6B01  MVI  0000001B
022A 5501  LDA  RCRDS  ;NUMBER OF RECORDS TO PRINT
022B 04 6F01  MOV  C,A
022C 30 0D02  DCR  C
022D 05 1A03  LXI  H,FINIS  ;FIRST CHARACTER
022E 118000  LXI  D,120  ;INCREMENT
022F 6B02  PRTHOR:  MOV  B,RELEN  ;SET RECORD LENGTH
0230 7F91  DE701  CALL  PRT  ;PRINT ONE RECORD
0231 19  DAD  D  ;INCREMENT CHAR COUNT
0232 48 0D02  DCR  C
0233 4C 2503  JNZ  D,PRTHOR  ;PRINT MORE
0234 F1 11101  LXI  D,PRNMSG  ;PRINT COMPLETION MESSAGE
0235 0801  CD301  CALL  PRINT
0236 C301  CALL  CRLF
     ;IF FILE FLAG SET, CREATE NEW FILE
0237 3A6B01  LDA  FLAG
0238 E602  ANI  0000001B
0239 0A6903  JZ  DONE
     ;IF FILE .RES EXISTS, DELETE IT - THEN CREATE IT
023A 6A08 3A6B01  MVI  0000001B
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Listing 4 continued:

0360  21SC00  LXI  H,TFCB  ;MOVE FILE NAME
0363  116901  LXI  D,TFCB1
0366  0E09  MVI  C,9
0368  CDF101  CALL  MOVCBH
036B  210601  LXI  H,RES  ;FILE TYPE .RES
036E  117201  LXI  D,TFCB1+9
0371  0E07  MVI  C,7  ;SET TYPE AND ZERO REST OF FCB
0372  CDF101  CALL  MOVCBH
0376  AF  XRA  A  ;CLEAR A
0377  328901  STA  TFCB1+32  ;ZERO NEXT RECORD
037A  116901  LXI  D,TFCB1  ;DESTINATION FILE
037D  CD0802  CALL  OPEN
0380  3C  INR  A  ;DOES FILE EXIST?
0381  C28703  JNZ  MAKE  ;NOPE, LET'S CREATE
0384  CD2002  CALL  DELETE  ;YUP, LET'S DELETE
0387  CD2602  MAKE:  CALL  CREATE  ;FCB IS STILL IN DE
0388  CD6501  LDA  RCRD  ;NUMBER OF RECORDS TO WRITE
038B  47  MOV  B,A
038E  21AF03  LXI  H,FINISH  ;LOCATION OF FIRST CHARACTER TO WRITE
0391  CD7002  CALL  WRDSK  ;WRITE HIM
0394  CD1A02  CALL  CLOS
0397  112301  DONE:  LXI  D,DPNPC  ;PRINT COMPLETION MESSAGE
039A  CD8A01  CALL  PRINT
039D  CD3C01  CALL  CR LF
03A0  C1E201  CALL  GETSTK  ;RETURN TO CPN
03A3  C13701  ERR:  LXI  H,ERRMSG
03A6  CD8A01  CALL  PRINT
03A9  CD3C01  CALL  CR LF
03AC  C39703  JMP  DONE
03AF  FINISH:  END  100H

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One other important consideration in actually reading and writing to a disk file is the need to set the DMA (direct memory access) address. This is the beginning memory address for the next disk access. The 128-byte record read from (or written to) the disk is placed into (or taken from) memory beginning at this location. When the disk system is initialized, using functions 13 or 14, the DMA address is set to hexadecimal 0080, the default buffer. It is possible to read one record to this buffer and then transfer the data to where it is needed; however, there is a simpler way illustrated in listing 4. Set the DMA address to the desired destination address and read a record. Put this function in a loop to read an entire file. Files may also be written in a similar manner (see listing 4).

Possibilities

In the course of experimenting with CP/M—trying to discover the hidden meaning in commands not thoroughly explained in the manuals—I discovered a few interesting features. These features often have no explanation in the manual. First, the directory of any disk can be read by placing ???????? and ?? in the file-name and file-type bytes of an FCB, then doing a SEARCH and SEARCH NEXT (functions 17 and 18). These two functions write directory information into the default buffer at hexadecimal location 0080, where it may be accessed for printout.

The OPEN function first finds a file name/file type match, then copies the disk map into the FCB. If a disk map is supplied with an extent, record count, and next record, the READ or WRITE functions will work without first using OPEN. The CLOSE statement merely matches the file name/file type and writes the FCB disk map to the directory.

These last two items should suggest some interesting but dangerous possibilities. The fact that CP/M marks a file as deleted by placing the hexadecimal character E5 in the entry-type field suggests a possible way to protect a file simply by making it disappear. The FCB still appears in the directory, but no longer matches any search string. This one needs more experimentation, since writing to a disk with files erased in this manner can result in destroying files only meant to be hidden.

Conclusion

This article has presented the use of the CP/M-utility routines, typical calling sequences, applications subroutines, sent and returned values, and examples of their uses. Although written specifically for CP/M, it illustrates the general method of using utility routines supplied with an operating system. In addition, some possibilities for further experimentation with CP/M have been suggested. It is not meant to supplant the Digital Research manuals, but to supplement and clarify a portion of them. You should refer to the manuals for additional information.
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The Printer People


Circle 249 on Inquiry card.

BYTE June 1981 301
The first part of this article presented basic floppy-disk technology and a description of a simple controller design with its circuit details. This controller provides a great deal of function and flexibility when combined with some simple software.

Software

The software shown in listing 1 provides disk-formatting, reading, writing, and error-recovery functions. The software can be reassembled to allow relocation of program or page zero variables. Various entry points are shown in table 4.

Before using the FD1771 to read and write data within the sectors on the floppy disk, the disk must be formatted to conform to a certain structure. A program (entry point FORMAT) is supplied that formats all 77 tracks of a standard 8-inch disk in a standard IBM-compatible 128-bytes-per-sector arrangement (each track contains 26 sectors).

The program, when called, initializes all 6520 and 1771 electronic interfaces before writing the standard track. The initialization process guarantees that the head is positioned over the outermost track. Each track is written from a standard pattern contained in programmable memory. A 40 ms delay is generated following a step-in function to move the head to the next track. This guarantees the proper head-settling time required by the floppy-disk drive. This process continues until all tracks have been formatted.

Sector sizes other than 128 bytes can be selected by initializing the 1771 differently. (A sector size other than 128 can lead to incompatibilities with other floppy-disk systems.) For sector lengths greater than 128, the FORMAT program must be rewritten to use an entire track image in memory. This is required because of an indexing limit of 256 using the 6502 microprocessor. Our system, using sixteen 256-byte sectors per track, has proven to be a convenient alternative.

When a disk is properly formatted, the basic I/O (input/output) program (entry point FDENT) can be used. If the system has just been turned on, entry point FDENT should be called first to initialize all interface and drive electronics. To perform disk operations, certain variables must be set up before calling FDENT. They include the desired command, track number, and sector number, as well as the address in memory used for data transfer (see table 5).

The program begins by analyzing the command to determine which segment of the program must be used in response. There are three basic command types:

- head movement
- read/write sectors
- read/write raw tracks

In the case of read/write commands, the program ascertains if the head is positioned properly and, if necessary, provides the seek command to move it.

Following execution of the command by the 1771, completion

<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORMAT</td>
<td>Write proper track format on all 77 tracks</td>
</tr>
<tr>
<td>FDENT</td>
<td>Perform basic floppy-disk operations using established variables</td>
</tr>
<tr>
<td>FDIO</td>
<td>Uses FDENT, followed by error checking and retry</td>
</tr>
</tbody>
</table>

Table 4: Entry points for various floppy-disk controller operations.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVCODE</td>
<td>1</td>
<td>Device-selection byte 00 = DVC 0, 80 = DVC 1</td>
</tr>
<tr>
<td>ERRCODE</td>
<td>1</td>
<td>FF = Error, 00 = Normal Set by FDIO</td>
</tr>
<tr>
<td>COMMAND</td>
<td>1</td>
<td>1771 Command byte</td>
</tr>
<tr>
<td>STATUS</td>
<td>1</td>
<td>1771 Completion status</td>
</tr>
<tr>
<td>TRACK</td>
<td>1</td>
<td>Desired track value</td>
</tr>
<tr>
<td>SECTOR</td>
<td>1</td>
<td>Desired sector value</td>
</tr>
<tr>
<td>FDBUF</td>
<td>2</td>
<td>Address of data buffer</td>
</tr>
</tbody>
</table>

Table 5: Variables used to perform floppy-disk operations. All values are listed in hexadecimal.
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Character Set: 96 character ASCII (upper and lower case)
Character Size: 10 characters per inch (80 columns per line) plus expanded printing
Paper: Friction feed (synchronous), accepts single sheet and roll paper up to 9 1/2 inches maximum width. Prints original plus 3 copies.

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analysis is performed to read back and store the status, track number, and sector number from the 1771. 

The status can then be examined by the user program to determine if the operation was successful. No registers are saved by any of the routines previously discussed.

Although the hardware design has proven to be very reliable, an error occasionally occurs. Since it would be a great burden for each application to concern itself with error recovery, another program has been provided. Using entry point FDIO, a user program can add the error-recovery function to that provided by FDENT.

After storing all the registers, FDIO calls FDENT to perform the requested operation. Following completion, FDIO examines the status to determine if an error occurred, and, if so, the operation may be retried. Generally, read/write operations will be retried up to five times before assuming a “hard” (ie: nontransient) error.

A nonrecoverable error is indicated with hexadecimal FF in the ERRCDE variable (see listing 2). This condition generally causes the application program to terminate so the error can be researched. The STATUS variable provides details about the specific problem.

Certain nonrecoverable conditions will not be retried. For example, a busy or device not ready condition causes an error condition without retry. The program can be altered to increase the sophistication to any level desired. Errors can be cataloged and recorded on another floppy disk to provide a history of all abnormal conditions.

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>TRACK</th>
<th>SECTOR</th>
<th>BUFADR</th>
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<td>1A</td>
<td>20</td>
<td></td>
<td></td>
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<td>16</td>
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<td>SEEK</td>
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<td>8C</td>
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<td>01</td>
<td>00</td>
<td>10</td>
<td>VERIFY</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>READ</td>
</tr>
</tbody>
</table>

Table 6: Values to be set in variables for testing the controller (with the routine in listing 3). All values are listed in hexadecimal.

Testing

After completing construction of the controller circuit and verifying the proper timing of the 74123 components, some simple tests can be performed to verify proper operation. These tests can be conducted with the aid of a simple program (listing 3) and table (table 6). Set your monitor to begin execution at INIT. When the break occurs, set the variables as shown for each specific test and allow program execution to continue. This procedure requires you to load the software previously discussed. Initial testing requires a preformatted IBM-compatible disk. Examination of the status byte following each test helps diagnose any existing problems.

The restore-drive procedure should generate stepping pulses that move the head to the track 0 position. The head-drive lead screw can be moved manually off the track 0 position to verify proper operation.

Directing the head to seek to a specific track requires the desired track value to be set in the data register of the 1771. This test also loads the head but does not attempt to perform a track verification. This test can be repeated several times with different track values to determine if the 1771 properly seeks in both directions.

If the controller moves the head correctly, the third test performs a track verification. Following the seek movement, the head is loaded, and the 1771 reads the address information recorded on the track to verify that it has located the proper track.

The fourth test attempts to read a specific sector. The data is stored beginning at location hexadecimal variable (see listing 2). This condition generally causes the application program to terminate so the error can be researched. The STATUS variable provides details about the specific problem. Certain nonrecoverable conditions will not be retried. For example, a busy or device not ready condition causes an error condition without retry. The program can be altered to increase the sophistication to any level desired. Errors can be cataloged and recorded on another floppy disk to provide a history of all abnormal conditions.

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Listing 1: Software to provide fundamental high-level operations for the disk controller (written for the 6502 microprocessor).

FD400/FD1771B FLOPPY DISK CONTROL

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<th>CODE</th>
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</tbody>
</table>

Listing 1 continued on page 308.
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Listing 1 continued:

65 0000 ; BASIC FUNCTION:
66 0000 ; 1. WRITE COMMAND TO THE FD1771B.
67 0000 ; 2. WAIT FOR COMPLETION(INTRQ).
68 0000 ; 3. COMPLETION ANALYSIS(READ STATUS, TRACK, AND SECTOR)
69 0000 ; 4. EXIT
70 0000 ;
71 0000 ; SEEK FUNCTION:
72 0000 ; 1. WRITE NEW TRACK TO DATA REGISTER.
73 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
74 0000 ; 3. GO TO BASIC FUNCTION.
75 0000 ;
76 0000 ; READ FUNCTION:
77 0000 ; 1. SEEK TO PROPER TRACK IF NECESSARY
78 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
79 0000 ; 3. WRITE COMMAND TO FD1771B.
80 0000 ; 4. WAIT & LOOP FOR DRQ/INTRQ READING DATA ON DRQ.
81 0000 ; 5. ON INTRQ DO COMPLETION ANALYSIS(BASIC FCTN, STEP 3)
82 0000 ;
83 0000 ; WRITE FUNCTION:
84 0000 ; 1. SEEK TO PROPER TRACK IF NECESSARY
85 0000 ; 2. WRITE SECTOR TO SECTOR REGISTER.
86 0000 ; 3. WRITE COMMAND TO FD1771B.
87 0000 ; 4. WAIT & LOOP FOR DRQ/INTRQ WRITING DATA ON DRQ.
88 0000 ; 5. ON INTRQ DO COMPLETION ANALYSIS(BASIC FCTN, STEP 3)
89 0000 ;

FD400/FD1771B FLOPPY DISK CONTROL

CARD # LOC CODE CARD 10 20 30 40 50 60 70
91 0000 ;
92 0000 ;
93 0000 ;
94 0000 ; SADD $CCOD 6520 PIA A DATA DIRECTION
95 0000 ; SAD $CCOD 6520 PIA A DATA REGISTER
96 0000 ; SDA $CCOD 6520 PIA A CONTROL REGISTER
97 0000 ; SBDD $CCDE 6520 PIA B DATA DIRECTION
98 0000 ; SBD $CCOE 6520 PIA B DATA REGISTER
99 0000 ; CRB $CCOF 6520 PIA B CONTROL REGISTER
100 0000 ;
101 0000 ;
102 0000 ;
103 0000 ; CA1 <-- UNUSED
104 0000 ; CA2 --> PULSEC(-RE CLR1)
105 0000 ; PA7 <-- DAL7
106 0000 ; PA6 <-- DAL6
107 0000 ; PA5 <-- DAL5
108 0000 ; PA4 <-- DAL4
109 0000 ; PA3 <-- DAL3
110 0000 ; PA2 <-- DAL2
111 0000 ; PA1 <-- DAL1
112 0000 ; PA0 <-- DAL0
113 0000 ;
114 0000 ; PB7 <-- INTRQ
115 0000 ; PB6 <-- DRQ
116 0000 ; PB5 <-- READ
117 0000 ; PB4 <-- WRITE
118 0000 ; PB3 <-- MIR
119 0000 ; PB2 <-- A1
120 0000 ; PB1 <-- A0
121 0000 ; PB0 <-- ENABLE R/W
122 0000 ; CB1 <-- UNUSED
123 0000 ; CB2 --> DEVICE SELECT
124 0000 ;
125 0000 ;
126 0000 ;
127 0000 ; FDRST =002 RESTORE
128 0000 ; FDSK =012 SEEK
129 0000 ; FDSI =022 STEP
130 0000 ; FDST =042 STEP IN
131 0000 ; FDSTO =062 STEP OUT
132 0000 ; FDRD =080 READ SECTOR
133 0000 ; FDWT =0A0 WRITE SECTOR

Listing 1 continued on page 310
To the average manager, electronic mail means bells, whistles and fans. It means expensive special phone lines. It means a fussy, exotic mainframe that only data processing zealots understand, and only committees of senior corporate vice presidents authorize for acquisition. To top it off, the system is useless for communications outside your own company.

But now there's Micro-Courier. A system that gives you all the electronic mail you'll ever need without draining the corporate treasury, or entangling you in corporate red tape.

All it takes is a trip to your local Apple computer dealer, who can install low-cost Micro-Courier software on any Apple II desktop computer.

The rest of the equipment you already have. Your own phone line. Micro-Courier communicates over standard telephone lines, and it's designed to let you take advantage of late-night transmission rates. While you're home in bed, your Micro-Courier system will send 1,000 words of text in a minute for less than a quarter. A comparable TWX message costs $4.32.

But text is only the beginning. Because Micro-Courier will electronically mail much more. Charts, graphs, VisiCalc reports and complete programs. Built-in error checking (the kind found on big computers) ensures accurate transmission.

What's more, the system is menu-driven, so it asks for your commands in plain English. It maintains phone lists and sorts messages by individual user. Its documentation is clear and non-technical. And the scope of your network is virtually limitless, because Micro-Courier will exchange information with time-sharing systems and larger computers.

Call our toll-free number today.

Microcom, Inc., 89 State Street, Boston, MA 02109. (617) 367-6362

Apple and Apple II are trademarks of Apple Computer, Inc. VisiCalc is a trademark of Personal Software, Inc. TWX is a trademark of Western Union, Inc.
LISTING 1 CONTINUED:

134 DODD
135 DODD
136 DODD
137 DODD
138 DODD
139 DODD
140 DODD
141 DODD
142 DODD
143 DODD
144 DODD
145 DODD

FD400/FD1771B FLOPPY DISK CONTROL

CARD # LOC CODE CARD 10 20 30 40 50 60 70
146 DODD 05 =601 NOT SYNC TO AM
147 DODD 01 =601 NR TO R TRANS.
148 DODD 02 =602 INDEX PULSE
149 DODD 04 =604 EACH 10 MS.
150 DODD 01 =601 ENABLE HLD + HLT DELAY
151 DODD 00 =600 FB DATA MARK
152 DODD 01 =601 FA DATA MARK
153 DODD 01 =601 F9 DATA MARK
154 DODD 01 =601 F8 DATA MARK

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VISA / MC / CHECK
MULTI-USER OASIS
HAS THE FEATURES PROS DEMAND.
READ WHY.

(THEN COMPOSE.)

Without this control, unauthorized users could access your programs and data and do what they like. A frightening prospect isn't it? And multi-users can multiply the problem. But with the Logon, Password and Privilege Level features of Multi-User OASIS, a system manager can specify for each user which programs and files may be accessed — and for what purpose. Security is further enhanced by User Accounting - a feature that lets you keep a history of which user has been logged on, when and for how long. Pros insist on these security features. OASIS has them.

DATA INTEGRITY: FILE & AUTOMATIC RECORD LOCKING

The biggest challenge for any multi-user system is co-ordinating requests from several users to change the same record at the same time.

Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems.

For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

Pros demand file & automatic record locking. OASIS has it.

SYSTEM SECURITY: LOGON, PASSWORD & USER ACCOUNTING

Controlling who gets on your system and what they do once they're on it is the essence of system security.

Multi-User OASIS supports as many as 16 terminals and can run in as little as 56K memory. Or, with bank switching, as much as 784K.

Multi-Tasking lets each user run more than one job at the same time.

And there's our BASIC—a compiler, interpreter and debugger all in one. An OASIS exclusive.

Still more: Editor; Hard & Floppy Disk Support; Keyed (ISAM), Direct & Sequential Files; Mail-Box Scheduler; Spooler; all from OASIS.

Our documentation is recognized as some of the best, most extensive, in the industry. And, of course, there's plenty of application software.

Put it all together and it's easy to see why the real pros like OASIS. Join them. Send your order today.

OASIS IS AVAILABLE FOR
SYSTEMS: Altos, Compaq, Cromemco, Delta Products; Digital Group; Digital Microsystems; Dynabex; Godbout; IBC; Index; Intersystems, North Star, Cynx; SD Systems, TRS 80 Mod II, Vector Graphix; Vortexex.

CONTROLLERS, Bell Controls, Cameo; Covus, Korean, Micromation, Monta; Tarbell; Teleplex, Thinkeryx, X Comp

Write for complete Application Software Directory.

PLEASE SEND ME:

<table>
<thead>
<tr>
<th>Product</th>
<th>Price with Manual</th>
<th>Manual Only</th>
</tr>
</thead>
</table>
| OPERATING SYSTEM (Includes:
EXEC Language; File Management; User Accounting; Device Drivers; Point Spooler; General Text Editor; etc.) | $300 | $12.50 |
| BASIC COMPILER/INTERPRETER/DEBUGGER | $200 | $10.00 |
| RE-ENTRANT BASIC COMPILER, INTERPRETER/DEBUGGER | $150 | $15.00 |
| DEVELOPMENT PACKAGE (Macro Assembler; Linkage Editor; Debugger) | $150 | $25.00 |
| TEXT EDITOR & SCRIPT PROCESSOR | $150 | $25.00 |
| DIAGNOSTIC & CONVERSION UTILITIES (Memory Test; Assembler Language; Converters, File Recovery, File Copy from other OS, etc.) | $100 | $15.00 |
| COMMUNICATIONS PACKAGE (Terminal Emulator; Pos Send & Receive) | $100 | $15.00 |
| PACKAGE PRICE (All of Above) | $150 | $15.00 |
| SINGLE-USER | $500 | $60.00 |
| MULTI-USER | $850 | $60.00 |
| FILE SORT | $100 | $10.00 |
| COBOL-ANSI '74 | $750 | $35.00 |

Order OASIS from:
Phase One Systems, Inc.
7700 Edgewater Drive, Suite 830 Oaklad, CA 94621
Telephone (415) 562-8085
TWX 910-366-7139

NAME
STREET (NO BOX =)
CITY, STATE, ZIP

AMOUNT$ (Attach system description; add $5 for shipping; California residents add sales tax)

Check enclosed VISA
C.O.D. Mastercharge

Card Number
Expiration Date
Signature
Listing 1 continued:

```
164 0000 QAF9 =6F9  F9 DATA MARK
165 0000 QAF8 =6F8  F8 DATA MARK
166 0000
167 0000 ; ******* PIA CONTROL COMMANDS(-MR ON)
168 0000
169 0000 READ =$29  READ FD1771B
170 0000 WRITE =$19  WRITE FD1771B
171 0000 STAT =$00  A1=0,A0=0 STATUS REGISTER
172 0000 TRK =$02  A1=0,A0=1 TRACK REGISTER
173 0000 SECT =$04  A1=1,A0=0 SECTOR REGISTER
174 0000 DATA =$06  A1=1,A0=1 DATA REGISTER
175 0000 CMD =$00  A1=0,A0=0 COMMAND REGISTER
176 0000
177 0000 ; ******* PAGE ZERO VARIABLES/EQUATES
178 0000
179 0000 TIME1 =**+1
180 0001 TIME2 =**+1
181 0002 **=6EO
182 00EO DVCODE =**+1  DVC/FILE CODE
183 00E1 ERRCODE =**+1  ERROR CODE
184 00E2 COMAND =**+1  FD1771B COMMAND
185 00E3 STATUS =**+1  STATUS REGISTER
186 00E4 TRACK =**+1  TRACK REGISTER
187 00E5 SECTOR =**+1  SECTOR REGISTER
188 00E6 FDBUF =**+2  BUFFER PTR
189 00E8
190 00E8 **=6200

FD400/FD1771B FLOPPY DISK CONTROL

CARD #  LOC CODE CARD 10  20  30  40  50  60  70
192 0200
193 0200 ; ******* TYPE 1 COMMANDS
194 0200
195 0200 A5  E2 TYPE1 LDA COMAND IF NOT SEEK
196 0202 C9  20 CMP  #$20  ASSUME
197 0205 B0  3A BCS  BASIC BASIC
198 0206 C9  10 CMP  #$10  IF RESTORE
199 0208 90  36 BCC  BASIC ASSUME BASIC
200 020A A9  1F LDA  #WRITE+DATA PIA CTL CMD
201 020C 20  DE 02 JSR  SETUP SET-UP PIA
202 020F A5  E4 LDA  TRACK TRACK ADDR
203 0211 C9  4D CMP  #$0D  IF PAST END
204 0213 B0  33 BCS  CMPANL RETURN
205 0215 20  CD 02 JSR  PULSE WRITE TRACK
206 0218 A9  1D LDA  #WRITE+SECT PIA CTL CMD
207 021A 20  DE 02 JSR  SETUP SET-UP PIA
208 021D A5  E5 LDA  SECTOR SECTOR ADDR
209 021F 20  CD 02 JSR  PULSE WRITE SECTOR
210 0222 4C  40 02 JMP  BASIC CONTINUE
211 0225
212 0225 ; ******* COMMAND ENTRY ANALYSIS
213 0225
214 0225 A9  29 FDENT LDA  #READ+STAT PIA CTL CMD ** ENTRY **
215 0227 20  DE 02 JSR  SETUP SET-UP PIA
216 022A 20  CD 02 JSR  PULSE READ STATUS
217 022D 6A ROR  A IF DEVICE BUSY
218 022E B0  18 BCS  CMPANL DO COMPLETION
219 0230
220 0230 ; ******* DETERMINE COMMAND TYPE
221 0230
222 0230 A9  10 LDA  #$10  CMD MASK
223 0232 24  E2 BIT  COMAND CHECK FOR
224 0234 10  C9 BPL  TYPE1 TYPE 1
225 0236 0C  46 BVC  TYPE2 TYPE 2
226 0238 F0  4A BEQ  RDATA TYPE 3 READ
227 023A A9  20 LDA  #$20  SEPERATE
228 023C 24  E2 BIT  COMAND FORCE INTRQ FROM
229 023E D0  63 BNE  WDATA TYPE 3 WRITE
230 0240
231 0240 ; ******* BASIC COMMAND PROCESS
232 0240
233 0240 20  C2 02 BASIC JSR  WRTCMD WRITE CMD TO FD1771B
234 0243 2C  0E CC BIT  SBD WAIT FOR

Listing 1 continued on page 314
```
Computers Designed for the Professional

Billings Computer Division designs and supports a complete line of computer systems for the professional user which includes an impressive library of professional applications software.

**WORD/FORMS PROCESSOR PACK** is a screen oriented context editor featuring word underlining, variable line spacing, right margin justification, proportional pitch, block moves, search and replace, column alignment, super- and subscripting, plus many others.

**BOOKKEEPER SERIES ACCOUNTING PACK** includes Payroll, Accounts Payable, Accounts Receivable, and General Ledger. Easily tailored reports make this a very versatile package designed to meet the needs of a wide variety of businesses.

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**SCREEN ASIST PACK** is a program development tool which simplifies the formatting of information on the CRT screen. A special editor allows the creation of a template with protected and unprotected fields.

**FORTRAN PACK** includes all of the normal features plus special subroutines to allow enhanced file access and manipulation, sorting, use of screen ASIST, and many others. Overlay capability allows development of many programs normally too large for a small computer.

**BASIC PACK** has both EBasic for fast Basic applications and BBasic for applications requiring capabilities not normally available to Basic users, such as indexed files, structured "if-then-else" statements, Trace debug feature, formatted input and output, and others.

**COBOL PACK** is an ANSI 1974 version with many level two features plus the same enhancements as the FORTRAN PACK.

---

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**COBOL PACK** is an ANSI 1974 version with many level two features plus the same enhancements as the FORTRAN PACK.

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**Company:**

**Title:** ____________ ____________ **Phone:** ( ) ____________

**Address:**

**City:** ____________ **State:** ____________ **Zip:** ____________

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Circle 36 on inquiry card.
Listing 1 continued:

235 0246 10 FB  BPL *-3  INTRQ
236 0248  ;  ******** COMPLETION ANALYSIS
237 0248  
238 0248  ;
239 0248  A0 02  CMPANL LDY #2  LOOP CNT + INDEX
240 024A 98  CPLP TYA  USE INDEX TO
241 024B 0A  ASL A  SET AI.AD
242 024C 09 29  ORA #READ SET READ
243 024D 20 DE 02  JSR SETUP SET-UP PIA
244 0251 20 CD 02  JSR PULSE READ REGISTER
245 0254 99 E3 00  STA STATUS,Y STORE DATA
246 0257 88 DEY DECR INDEX

FD400/FD1771B FLOPPY DISK CONTROL

CARD # LOC CODE CARD 10 20 30 40 50 60 70
247 0258 10 F0  BPL CPLP CONTINUE
248 025A 60  RTS RETURN
249 025B  ;  ******** TYPE 2 VERIFY TRACK
250 025B  
251 025B  
252 025B  A9 2B  TYPE2  LDA #READ+TRK PIA CTL CMD
253 025D 20 DE 02  JSR SETUP SET-UP PIA
254 025E 20 CD 02  JSR PULSE READ TRACK
255 0260 C5 E4  CMP TRACK IF NOT EQUAL
256 0265 FO OD  BEQ TYPE2A SEEK TO TRACK
257 0267 9A E2  LDA COMAND SAVE COMMAND
258 0269 48  PHA FOR LATER
259 026A 9B 12  LDA #FDSK SEEK COMMAND
260 026C 85 E2  STA COMAND SET IT
261 026D 20 25 02  JSR FDENT DO SEEK
262 026F 68  PLA RESTORE
263 0271 85 E2  STA COMAND COMMAND
264 0272  ;  ******** TYPE 2 COMMANDS
265 0274  
266 0274  
267 0274  A9 1D  TYPE2A  LDA #WRITE+SECT PIA CTL CMD
268 0276 20 DE 02  JSR SETUP SET-UP PIA
269 0279 20 CD 02  JSR SECTOR SECTOR ADDR
270 027B 20 CD 02  JSR PULSE WRITE SECTOR
271 027D 9A 20  LDA #$20 SEPERATE
272 027E 2E E2  BIT COMMAND READ
273 027F 2D 1F  BNE WD ATA FROM WRITE
274 027F  ;  ******** READ DATA
275 0284  
276 0284  
277 0284  2C 02  RD ATA JSR WRTCMD WRITE COMMAND
278 0287  A0 00  LDY #0 BUFFER INDEX
279 0289  A9 2F  LDA #READ+DATA PIA CTL CMD
280 028B 20 DE 02  JSR SETUP SET-UP PIA
281 028D 2C 0E  CC  RDL BIT SBD WAIT FOR 4
282 028F 30 B5  BMI CMPANL INTRQ OR 2
283 0291 50 F9  BVC RDL DRG 2
284 0293  AD 0C CC  LDA SAD GET DATA BYTE 4 25 CYCLES
285 0295 49 FF  EOR #$FF INVERT DATA 2
286 0297 91 E6  STA (FDBUF),Y SAVE BYTE 6
287 0299 C8  INY INCR BUFFER PTR 2
288 029B DD EE  BNE RDL IF ZERO 2
289 029D 6E 7E  INC FDBUF+1 INCR BASE AND 5 + 9 CYCLES
290 02A1 6E 0B  BNE RDL CONTINUE 3
291 02A3  ;  ******** WRITE DATA
292 02A3  
293 02A3  
294 02A3 2C 0E  CC  WDATA JSR WRTCMD WRITE COMMAND
295 02A5 A0 00  LDY #0 BUFFER INDEX
296 02A7  A9 1F  LDA #WRITE+DATA PIA CTL CMD
297 02A9 20 DE 02  JSR SETUP SET-UP PIA
298 02AA 61 E6  WTL LDA (FDBUF),Y GET DATA BYTE 6
299 02AF 49 FF  EOR #$FF INVERT DATA 2
300 02B1 6D 0C CC  STA SAD WRITE IT 4
301 02B4 2C 0E  CC  WTL1 BIT SBD WAIT FOR 4 25 CYCLES

Listing 1 continued on page 317
Why Not the Best?
From The Dynamic RAM Company.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>2MHz</th>
<th>4MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>16K</td>
<td>$249</td>
<td>$259</td>
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<tr>
<td>32K</td>
<td>$375</td>
<td>$395</td>
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<tr>
<td>48K</td>
<td>$500</td>
<td>$530</td>
</tr>
<tr>
<td>64K</td>
<td>$625</td>
<td>$665</td>
</tr>
</tbody>
</table>

We have now been shipping our 2MHz dynamic RAM boards for over two years. Hundreds of 4MHz boards have been going out every month since early 1979. Our reliability is proven in the thousands of systems which contain our board. Many quality-minded systems houses across the country and overseas are using our boards for their equipment.

Our prices still beat all. Despite rising 16K memory chip prices (at least from reputable suppliers), Central Data continues to give you the best buy in memory today. Nobody offers a board with a capacity of 64K, assembled, tested, and guaranteed for a full year at the price we do.

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Central Data Corporation, 713 Edgebrook Drive, PO Box 2530, Station A, Champaign, IL 61820. (217) 359-8010

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| A2-3D/A Saturn Navigator  | $24.95 on disk (48K and A2-3D1 required) |

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subLOGIC
Communications Corp.
Box V, Savoy, IL 61874
(217) 359-8482
Telex: 206955
Circle 345 on inquiry card.
Listing 1 continued:

FD400/FD1771B FLOPPY DISK CONTROL

<table>
<thead>
<tr>
<th>CARD</th>
<th>LOC</th>
<th>CODE</th>
<th>CARD 10</th>
<th>20</th>
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<td>302</td>
<td>02B7</td>
<td>30</td>
<td>8F</td>
<td>BMI</td>
<td>CMPANL</td>
<td>INTRQ OR</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>02B9</td>
<td>50</td>
<td>F9</td>
<td>BVC</td>
<td>WTL1</td>
<td>DRQ</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>304</td>
<td>02B8</td>
<td>C8</td>
<td>INY</td>
<td>WTL</td>
<td>INCR BUFFER PTR</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>305</td>
<td>02BC</td>
<td>D0</td>
<td>EF</td>
<td>BNE</td>
<td>WTL</td>
<td>IF ZERO</td>
<td>3</td>
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<td></td>
</tr>
<tr>
<td>306</td>
<td>02BF</td>
<td>E6</td>
<td>E7</td>
<td>INC</td>
<td>FDBUF+1</td>
<td>INCR BASE AND</td>
<td>5</td>
<td>+ 9 CYCLES</td>
<td></td>
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<tr>
<td>307</td>
<td>02CC</td>
<td>D0</td>
<td>EB</td>
<td>BNE</td>
<td>WTL</td>
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<td>02C2</td>
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<td></td>
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<tr>
<td>312</td>
<td>02C2</td>
<td>A9</td>
<td>19</td>
<td>WRTCMD</td>
<td>LDA</td>
<td>WRITE+CMD PIA CTL CMD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>313</td>
<td>02C4</td>
<td>20</td>
<td>DE</td>
<td>02</td>
<td>JSR</td>
<td>SETUP</td>
<td>SET-UP PIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>314</td>
<td>02C7</td>
<td>A5</td>
<td>E2</td>
<td>LDA</td>
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<td>GET COMMAND</td>
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<td></td>
</tr>
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<td>02CD</td>
<td>20</td>
<td>CD</td>
<td>02</td>
<td>JSR</td>
<td>PULSE</td>
<td>AND WRITE IT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>316</td>
<td>02CC</td>
<td>60</td>
<td>RTS</td>
<td>RETURN</td>
<td></td>
<td></td>
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Listing 1 continued on page 318

Microengine Power
Plug in PASCAL-100™ new CPU Boardset for S-100 computers. Go with the power of the Pascal Microengine™ Run UCSD Pascal up to 10 times faster than typical implementations—with twice the memory capacity. You've got the best hardware for the best software around.

On-board Z80
PASCAL-100 includes a Z80® processor, so you can run your current software—including CP/M—without modification. Ready to convert an application to Pascal? Do it anytime, with no disruptive hardware changes.

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PASCAL-100 is designed for the versatile, flexible S-100 bus. Fully compatible with the new IEEE-696 standard, yet works with most pre-standardized boards.

OEM’s/DEALERS
Be sure to specify our PASCAL-100 OEM/Dealer Information Package

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<td>A5 E5</td>
<td>LDA</td>
<td>SECTOR</td>
<td>SAVE SECTOR</td>
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<td>408</td>
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<td>48</td>
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<tr>
<td>409</td>
<td>0340</td>
<td>20 25 02</td>
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<td>FDENT</td>
<td>EXEC CMD</td>
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</tbody>
</table>

Listing 1 continued on page 320
If you can’t find the right program in our new catalog, it probably hasn’t been written.

As the world’s largest publisher of professional software for microcomputers, Lifeboat Associates offers the largest selection of state-of-the-art programs. And our new catalog has more to offer than ever: We also add the crucial dimension of after-sales service and full support to everything we sell. Order your free catalog today.

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Listing 1 continued:

410 0343 38 SEC ASSUME ERROR
411 0344 ****** CHECK FOR BUSY/NOT READY
412 0344
413 0344
414 0344 A9 01 LDA #401 CHECK
415 0346 24 E3 BIT STATUS FOR
416 0348 D0 3F BNE ERI BUSY OR
417 034A 30 3D BMI ERI NOT READY
418 034C ****** DETERMINE CMD TYPE
419 034C
420 034C
421 034C A9 10 LDA #0 CMD MASK
422 034E 24 E2 BIT COMAND SPLIT INTO
423 0350 10 19 BPL TYP1 TYPE 1

FLOPPY DISK I/O & ERROR RECOVERY

CARD # LOC CODE CARD 10 20 30 40 50 60 70
424 0352 50 29 BVC TYP2 TYPE 2
425 0354 50 29 BEQ RDT TYPE 3 READ
426 0356 A9 20 LDA #920 SEPERATE
427 0358 24 E2 BIJ CMDAND FORCE INTRQ FROM
428 035A D0 27 BNE WRT TYPE 3 WRITE
429 035C ****** RETURN
430 035C
431 035C
432 035C 18 RTN1 CLC NO ERROR
433 035D A9 00 LDA #0 CLEAR
434 035F 85 E1 RTN2 STA ERRCODE ERROR CODE
435 0361 68 PLA CLEAR STACK
436 0362 85 E5 STA SECTOR OF SECTOR
437 0364 68 PLA AND ADDR HIGH
438 0365 68 RTN3 PLA RESTORE X
439 0366 AA TAX REGISTER
440 0367 68 PLA RESTORE Y
441 0368 A6 TAY REGISTER
442 0369 68 PLA RESTORE ACC
443 036A 60 RTS RETURN
444 036B
445 036B ****** TYPE 1 RECOVERY
446 036B
447 036B A9 18 TYP1 LDA #18 CHECK FOR
448 036D 25 E3 AND STATUS BOTH CRC AND
449 036F 00 EB BEQ RTN1
450 0371 09 18 CMP #18 NOT FOUND
451 0373 01 18 BEQ ERI ERRORS
452 0375 A9 30 LDA #30 STOP IF
453 0377 24 E2 BIT COMAND STEP IN
454 0379 D0 0E BNE ERI OR STEP OUT
455 037B F0 26 BEQ RDT1 RETRY SEEK AND RESTORE
456 037D
457 037D ****** TYPE 2 SEPERATION
458 037D

Listing 1 continued on page 322
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MAILMERGE 100
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OTHERS CALL
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CIRCLE 32 ON INQUIRY CARD.
Listing 1 continued:

459 037D A9 20 TYP2 LDA #$20 SEPERATE
460 037F 24 E2 BIT COMAND READ
461 0381 F0 0A BEQ RDT FROM WRITE
462 0383 ; ******** WRITE RECOVERY
463 0383
464 0383
465 0383 A9 60 WRT LDA #$60 ERROR MASK
466 0385 24 E3 BIT STATUS STOP IF WRITE
467 0387 F0 04 BEQ RDT PROTECT/FAULT
468 0389 A9 FF ER: LDA #$FF SET ERROR CODE
469 038B D0 D2 BNE RTN2 RETURN
470 038D ; ******** COMMON RECOVERY
471 038D
472 038D
473 038D A9 OC RDT LDA #$0C ERROR MASK
474 038F 24 E3 BIT STATUS IF ERROR
475 0391 D0 10 BNE RTD1 RETRY
476 0393 A9 10 LDA #$10 CHECK FOR
477 0395 24 E3 BIT STATUS NOT FND
478 0397 F0 C3 BEQ RTN1 NONE RETURN

FLOPPY DISK I/O & ERROR RECOVERY PAGE 11

CARD # LOC CODE CARD 10 20 30 40 50 60 70
479 0399 ; IF MULTIPLE
480 0399 24 E2 BIT COMAND SECTOR OPERATION
481 039B F0 06 BEQ RTD1 CHECK
482 039D A9 1B LDA #$1B FOR END OF
483 039F C5 E5 CMP SECTOR TRACK
484 03A1 F0 B9 BEQ RTN1 CALL IT NORMAL
485 03A3 ; CHECK ERROR COUNT
486 03A3
487 03A3
488 03A3 C6 E1 RTD1 DEC ERRCD E DEC ERROR CNT
489 03A5 10 05 BPL RTD2 RETURN
490 03A7 68 PLA WITH
491 03A8 68 PLA ERROR
492 03A9 4C 65 03 JMP RTN3 CONDITION
493 03AC ; RETRY OPERATION
494 03AC
495 03AC
496 03AC 68 RTD2 PLA RESTORE
497 03AD 65 E5 STA SECTOR SECTOR
498 03AF 66 PLA RESTORE
499 03B0 85 E7 STA FDBUF+1 ADDR HIGH
500 03B2 4C 3A 03 JMP RETRY RETRY

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Listing 1 continued:

FD400/FD1771B FLOPPY DISK FORMAT  PAGE  12

CARD # LOC  CODE  CARD  10  20  30  40  50  60  70
502  03B5  | THIS SEGMENT FORMATS AN ENTIRE FLOPPY DISKETTE IN IBM COMPATIBLE
503  03B5  | SOFT SECTORING WITH 128 BYTE SECTORS. EACH SECTOR CONTAINS 80
504  03B5  | BYTES OF ASCII BLANK('20') FOLLOWED BY HEX ZEROS FOR THE
505  03B5  | REMAINDER OF THE SECTOR.
506  03B5  |
507  03B5  |
508  03B5  |
509  03B5  |
510  03B5  |
511  03B5  | ****** INITIALIZE
512  03B5  |
513  03B5  20 F6 02 FORMAT JSR FDINT INIT SYSTEM  ** ENTRY **
514  03B8 A2 00 LD1 #0 A SIDE
515  03BA 8E 0D CC STX CRA DIRECTION
516  03BD CA DEX SET TO
517  03BE 8E 0C CC STX SADD OUTPUT
518  03C1 A2 2C LD1 #2C A SIDE
519  03C3 8E 0D CC STX CRA DATA
520  03C6  |
521  03C6  | ****** SET UP RECORD
522  03C6  |
523  03C6 A9 4C LDA #4C SET
524  03C8 BD 00 05 STA REND TRACK COUNT
525  03CB A9 FF LDA #FF SET TRK
526  03CD BD 03 BD 05 STA RTN TO ZERO
527  03D0 A9 FE GO LDA #FE SET SECTOR
528  03D2 BD 01 05 STA RSN TO ONE
529  03D5 A2 1A LD1 #1A SECTOR CNT
530  03D7 A0 FD LDY #RSTRT-REND WRITE LENGTH
531  03D9  |
532  03D9  | ****** ISSUE WRITE TRACK
533  03D9  |
534  03D9 A9 0B LDA #255-FDWTT STOR FD1771B
535  03DB BD 0C CC STA SAD COMMAND
536  03DE A9 19 LDA #WRITE+CMD STORE PIA
537  03EB CE 0E CC STA SBD COMMAND
538  03EE CE 0E CC DEC SBD ENABLE
539  03F1 EE 0E CC INC SBD READ/WRITE
540  03F3 A9 1F LDA #WRITE+DATASTORE PIA
541  03F6 BD 0C CC STA SBD COMMAND
542  03F8 EE FE 05 WDT INC RSTRT+1 DELAY 6 CYCLES
543  03F9 BF 00 05 LDA REND,Y STORE A
544  03FA BD 0C CC STA SAD DATA BYTE
545  03FB BD 0E CC WLP BIT SB D WAIT FOR
546  03FC 30 12 BMI NEXT INTRO
547  03FD 50 0F BVC WLP OR DRQ
548  03FE 8E DEY DEC INDEX
549  03F9 D0 ED BNE WDT CONTINUE
550  03FA CE 01 05 DEC RSN DEC SBD INDEX
551  03FB A0 0A LDA #RSTRT-REND INDEX VALUE
552  03FC BD 0E CC STA SBD COMMAND
553  03FD 00 08 BNE WDT+3 CONTINUE

FD400/FD1771B FLOPPY DISK FORMAT  PAGE  13

CARD # LOC  CODE  CARD  10  20  30  40  50  60  70
554  03EE EE FE 05 WDT INC RSTRT+1 DELAY 6 CYCLES
555  03F1 B9 00 05 LDA REND,Y STORE A
556  03F2 BF 00 05 LDA REND,Y STORE A
557  03F3 BD 0C CC STA SAD DATA BYTE
558  03F4 BD 0E CC WLP BIT SB D WAIT FOR
559  03F5 30 12 BMI NEXT INTRO
560  03F6 50 0F BVC WLP OR DRQ
561  03F7 8E DEY DEC INDEX
562  03F8 D0 ED BNE WDT CONTINUE
563  03F9 CE 01 05 DEC RSN DEC SBD INDEX
564  03FB A0 0A LDA #RSTRT-REND INDEX VALUE
565  03FC BD 0E CC STA SBD COMMAND
566  03FD 00 08 BNE WDT+3 CONTINUE

Listing 1 continued on page 326

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<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>LSI 11/23 CPU with 256KB Memory</td>
<td>$4175</td>
</tr>
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<td>10 Megabyte Cartridge Disk System</td>
<td>$4995</td>
</tr>
<tr>
<td>1 Megabyte RX02 Floppy Disk System</td>
<td>$2950</td>
</tr>
<tr>
<td>RT11 V4 Operating System</td>
<td>$1085</td>
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<tr>
<td>RSX11M Operating System</td>
<td>$3250</td>
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<tr>
<td>CI 1103LK — LSI 11/2 CPU, 64KB Memory, Power supply, KEV 11 in 16 slot rack mountable chassis.</td>
<td>$2450</td>
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<tr>
<td>PDP 1103SE — LSI 11/2 CPU, 64KB Memory, power supply, KEV 11 in 8 slot rack mountable chassis.</td>
<td>$2695</td>
</tr>
<tr>
<td>CI-11/23 AC — LSI 11/23 CPU, MMU, 256KB Memory, power supply, in 16 slot rack mountable chassis.</td>
<td>$5175</td>
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</tbody>
</table>

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Listing 1 continued:

569 0418 8D 0E CC STA SBD COMMAND
570 0418 CE 0E CC DEC SBD ENABLE
571 041E EE 0E CC INC SBD READ/WRITE
572 0421 2C 0E CC SLP BIT SBD WAIT FOR
573 0424 10 FB JSR DELAY DELAY 40 MS.
574 0426 20 35 04 DEC RTN INCR TRACK
575 0429 CE B3 05 DEC REND DEC TRK CNT
576 042C CE 00 05 DEL SBD ENABLE
577 042F 10 9F BPL GO CONTINUE
578 0431 20 F6 02 JSR FDINT RESTORE DRIVE
579 0434 60 RTS STOP
580 0435
581 0435
582 0435
583 0435 A9 40 DELAY LOA #$40 MAJOR LOOP VALUE
584 0437 85 DO STA TIME1 MAJOR LOOP CNT
585 0439 4A DL2 LOA #$4A MINOR LOOP VALUE
586 043B 85 01 STA TIME2 MINOR LOOP CNT
587 043D C6 01 DL1 DEC TIME2 DECR MINOR CNT
588 043F D0 FC BNE DL1 CONTINUE
589 0441 C6 00 DEC TIME2 DECR MAJOR CNT
590 0443 D0 F4 BNE DL2 CONTINUE
591 0445 60 RTS RETURN

FD400/FD1771B FLOPPY DISK FORMAT

<table>
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<tr>
<th>CARD #</th>
<th>LOC</th>
<th>CODE</th>
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<th>60</th>
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<tr>
<td>593</td>
<td>0446</td>
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<td></td>
<td>**<em>+255/256</em>256</td>
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<td>594</td>
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<td>595</td>
<td>0500</td>
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<td></td>
<td>;</td>
<td>***+RECORD FORMAT</td>
<td>(REVERSED AND INVERTED)</td>
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<td>596</td>
<td>0500</td>
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<td>;</td>
<td>REND .BYTE $00</td>
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<td>597</td>
<td>0500</td>
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<td>.BYTE $00,$00,$00,$00,$00,$00,$00,$00</td>
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<td>598</td>
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<td>00</td>
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<td>.BYTE $00,$00,$00,$00,$00,$00,$00,$00</td>
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<td>.BYTE $00,$00,$00,$00,$00,$00,$00,$00</td>
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FD400/FD1771B FLOPPY DISK FORMAT

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Listing 1 continued on page 334
Does timesharing on a small system make sense?

It does with OS-9™ Level One!

Now two (or more) acts can share your microcomputer stage. You will no longer have to walk away from your computer while it is busy running a long program. Because OS-9 is a multitasking operating system, you can be running a BASIC program while editing a PASCAL program, for example. This lets you make more efficient use of your time and your system, even if you only use one terminal. If your application requires multiple, independent terminals, one OS-9 system can do the work of several single-user systems.

The convenience of an advanced operating system

Sophistication does not require complexity. Many OS-9 users say that it is actually easier to use than the older 6800-type operating systems. Consider how easy it is to run multiple programs: to run a program you just type its name and hit 'return.' To run a program as a separate job, you type its name, an ' & ' character, then hit return. The program runs as usual, but OS-9 comes back immediately and is ready for your next command. Simple commands let you see each program's status, set its priority, or abort it.

The file management system has fast, byte-addressable random-and sequential-access files. The tree-structured multiple directory system lets you create separate disk directories for each user, project, or application. Command line I/O file redirection means you specify what device and/or files a program will use when you run it, not when you write it.

Efficiency and hardware versatility

No other operating system can run on such a broad range of hardware: the overall RAM requirement for Level One is 32K to 56K RAM. Memory utilization is superlative because OS-9 lets multiple tasks "share" the same reentrant program. For example, if two users run BASIC99, only one "copy" is actually loaded into memory. The Level Two version of OS-9 can utilize up to a megabyte of memory on systems having memory management hardware (both versions come with complete timesharing support).

OS-9's device independent I/O system can handle almost any number and combination of I/O devices: five or eight inch diskettes, Winchester disks, disk cartridges, serial and parallel ports, memory-mapped video displays, and more.

Microware® offers a large selection of "stock" device interface software modules, or you can create your own: all the information you need is in the manuals.

Excellent support and documentation

Each OS-9 package comes with a User's Manual and a System Programmer's Manual that cover every aspect of OS-9. If you have special requirements, you can even purchase the Source Code for most of OS-9 and related software. At Microware® we take pride in offering the best customer support in the business. Technical advice and assistance by phone, mail or telex is available during all business hours.

Superb software tools

In addition to BASIC99, Microware® offers: an Interactive Assembler, Macro Text Editor, Stylograph Word Processor, Interactive Debugger, and coming soon, COBOL, PASCAL and C language compilers.

Microware® software is available for most popular 6809 computer systems. Source listings and yearly maintenance update service are sold separately for most programs.

Please call or write for our free catalog. We accept phone orders and MasterCard and VISA orders.
Listing 1 continued:

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FD400/FD1771B FLOPPY DISK FORMAT

CARD # LOC CODE CARD 10 20 30 40 50 60 70
334 June 1981 © BYTE Publications Inc

Listing 1 continued on page 336
It's not hard to win . . .

with fast, reliable, mass storage

- The Cameo cartridge disk subsystem provides 40 to 100 times the storage capacity of floppy disks. Data transfer rates and reliability are correspondingly faster.
- Our cartridge feature lets you ... COPY ... BACK UP ... EXTEND ... or REMOVE your data base easily by just removing the disk pack as you now remove your floppy.
- The densely packed cartridges, although storing five million characters each, are byte-for-byte less expensive than floppy diskettes!
- Available on most 8-bit microprocessors (Apple, Heath, S-100, TRS-80 and others*) with most major operating systems (CPM, APPLE DOS, TRS DOS, OASIS, PASCAL, MPM, SCREEN EDIT and others*).

CALL OR WRITE FOR MORE INFORMATION

CAMEO ELECTRONICS INC.
1626 CLEMENTINE • ANAHEIM, CA 92802 • (714) 535-1682

*REGISTERED TRADE MARKS
Listing 1 continued:

END OF MOS/TECHNOLOGY 650X ASSEMBLY VERSION 5
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<td>0029</td>
<td>169 214 242 252 279</td>
<td></td>
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IF YOU CAN
WAIT A MINUTE,
WE CAN SAVE
YOU $1,000.

With the Starwriter™ Daisy Wheel 25 cps printer from C. Itoh.
A business letter, written on a 45 cps word-processing printer, might take about two minutes to print.
With the Starwriter, it might take closer to three.
The typical 45 cps printer retails for about $3,000.
But the Starwriter 25 retails for about $1,895—thus saving you about $1,000.
And therein lies the biggest difference between the Starwriter 25 and the more expensive, daisy wheel printers.
The Starwriter 25 comes complete and ready-to-use, requiring no changes in hardware or software. It uses industry-standard ribbon cartridges, and it’s “plug-in” compatible to interface with a wide variety of systems, to help lower system-integration costs.
Using a 96-character wheel, it produces excellent letter-quality printing on three sharp copies with up to 163 columns, and offers the most precise character-placement available, for outstanding print performance.

C. Itoh’s warranty:
3 months on parts and labor, supported by one of the best service organizations in the industry.

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I’d like to know more about the Starwriter, and how spending a minute can save me a grand.
Please send me the name of my nearest dealer.
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Title ___________________________ 
Company __________________________
Address __________________________
City ____________________________ 
State ____________________________ 
Zip ____________________________ 
Phone: Area Code __________ 
Number __________________________

LEADING EDGE.
Leading Edge Products, Inc., 225 Turnpike Street, Canton, Massachusetts 02021
Dealers: For immediate delivery from the Leading Edge Inventory Bank™ call toll free 1-800-343-6833
In Massachusetts, call collect (617) 828-8150. Telex 951-624

Circle 191 on inquiry card.
Listing 1 continued:

REN D 0500 597 524 546 576 530 554
RETRY 033A 405 500
RNORM 058A 630 554
RSL 0580 624 ***
RSN 0581 625 528 553
RSTRT 05FD 641 530 545
RTN 0583 627 526 575
RTN1 035C 432 449 478 484
RTN2 035F 434 469
RTN3 0365 438 492
SAD 0C0C 95 284 300 322 325 348 535 547 567
SADD 0C0C 1 94 339 517
SBD 0C0E 98 334 261 301 323 324 332 333 537 538 539
SBD D 0C0E 97 357
SECT 0004 173 206 267
SECTOR 00E5 187 208 269 407 436 483 497
SETDVC 0337 404 402
SETUP 02DE 331 201 207 215 243 253 268 280 297 313
SET1 02E8 337 335 347
SLP 0421 527 573
STAT 0000 171 214
STATUS 00E3 185 245 415 448 466 474 477
TIME1 0000 179 584 589
TIME2 0001 180 586 587
TRACK 00E4 186 202 255
TRK 0002 172 252
TRKEND 0409 560 561
TYPE1 0200 195 224
TYPE2 025B 252 225
TYPE2A 0274 267 256
TYP1 036B 447 423
TYP2 037D 459 424
WDATA 02A3 294 229 273
WDT 03EE 545 552 555
WLP 03F7 546 550
WRITE 0019 170 200 206 267 296 312 536 540 568
WRT 0383 465 428
WR TCMD 02C2 312 233 277 294
WT L 02AD 298 305 307
WTL1 02B4 301 303

INSTRUCTION COUNT

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Listing 1 continued on page 340
Hayden Games and Gameware

**REVERSAL** (Spracklens) Winner of the software division of the First International Man-Machine OTHERLO™ Tournament, this version of the 200 year old game Reversi, features 27 levels of play and high-resolution color graphics and sound. Special "Kibitz" option gives you hints in playing. Written by the authors of SARGON II, the first great computer chess program! 07004, Apple II tape, $29.95; 07009, Apple II disk, $34.95.

* BLACKJACK MASTER: A Simulator/Tutor/Game (Wazaney) A serious game that performs complex simulations and evaluations of playing and betting strategies. 05303, TRS-80 Level II tape, $24.95; 05308, TRS-80 Level II Disk, $29.95.

**SARGON II** (Spracklens) The first great computer chess program! "... an excellent program which will provide a true challenge for many players. ... Give your money and buy SARGON II. ..." 80 Software Critique. 03403, TRS-80 Level II; 03404, Apple II; 03410, OSI C1P; 03440, OSI C4P, each tape $29.95. 03408, TRS-80 Level II Disk; 03409, Apple II Disk; 03418, PSI C1P Disk; 03444, OSI C4P Disk; 03484, C5P Disk; each $34.95.

**MICROSAIL** (Johnson) A true test of your nautical skills as you race against wind, tides, and time. 04401, PET tape, $11.95.

**GRIDIRON** A Microfoot Ball Game (Micrflair Associates) Be both offensive and defensive quarterbacks. Includes time-outs, penalties, and the two-point conversion option used in college football. 03003, TRS-80 Level II tape, $12.95.

**MAYDAY** (Wazaney) Out of fuel? Try to avoid crashing with this challenging airplane flight simulation. 02601, PET tape, $19.95.

**STARCLASH** (Wazaney) An exciting game of galactic strategy for one or two players. 05903, TRS-80 Level II tape, $16.95.

**ROYAL FLUSH** Competitive Poker Solitaire (Wazaney) A game you can play alone or with any number of players. High score wins in this poker based, fun-filled card game. Choose from possible game variations. 07010, PET; 07013, TRS-80 Level II, each tape, $14.95.

ORDER NOW!
Hayden Book Co., Inc.
50 Essex St., Rochelle Park, NJ 07662
Send the software checked below. A check or money order is enclosed. I understand that Hayden pays shipping and handling costs and that I can return any disk or tape within 10 days if it is defective or I am dissatisfied with it for any reason. Residents of NJ and CA must add sales tax. Offer good in US only. Name of individual ordering must be filled in.

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**BACKGAMMON** (Wazaney) A classic game of skill and luck played against a preprogrammed opponent. 02501, PET; 02503, TRS-80 Level II; each tape, $10.95.

**BATTER UP!!** A Microbaseball Game (Savon) Action packed baseball with 3 levels of play. 02801, PET; 02803, TRS-80 Level II; each tape, $10.95.

New from Hayden

**HISTO-GRAPH** (Boyd) A calendar-based histogram or bar-graph production system. Allows the user to enter numeric data that relates to a date, and reproduces that data as a high-resolution histogram. 09009, Apple II Disk, $29.95.

**OP-AMP DESIGN** (Gabrielson) Provides the necessary values for your design and will suggest appropriate op-amp types. Includes a choice of six op-amps, and the program will then determine if your selection of an op-amp will be acceptable within your chosen parameters. Can be updated to accommodate future op-amps. 07040, Apple II tape, $16.95.

**DOUBLE PRECISION FLOATING-POINT FOR APPELLEOOFTTM** (S-C Software) Extends the accuracy of the arithmetic on the Apple from nine digits to a full 21 digit precision on all functions in Apple-compatible format. 09400, Apple II Disk, $49.95.

**DATA-GRA PH** (Boyd) Aids in the preparation of graphs and charts. Numeric data can be entered into Data-Graph and used to create colorful one-, two-, or four-quadrant graphs. 09109, Apple II Disk, $49.95.

More from Hayden

**FINPLAN** A Financial Planning Program for Small Businesses (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about the future growth of business, and to have the computer project results for up to a five year period based on those assumptions. And if you change any data, the program revises all resulting data automatically. The disk version can be used only with TRS/DOS Vers 2.3. 05103, TRS-80 Level II tape, $69.95; 05108, TRS-80 Level II Disk Version, $74.95.

**DATA MANAGER** A Data Base Management System and Mailing List (Lutus) Store information on a floppy disk and retrieve it quickly and easily. Use specific names, or by category. 04909, Apple II Disk Version, $49.95.

**PROGRAMMING IN APPELTME INTEGER BASIC** Self-Teaching Software (Banks & Coen) Teach yourself Apple Integer BASIC and control your own progress at all times with this interactive programmed instruction format. 05004, Apple II tape, $29.95; 05009, Apple II Disk Version, $39.95.

**APPLETM ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM** An Assembler/Editor/Formatter (Lutus) Write and modify your machine code. 04609, Apple II Disk Version, $39.95.

Apple is a trademark of the Apple Computer Co., Inc. and is not affiliated with Hayden Book Co., Inc.

Available at your local computer store!

Hayden Book Company, Inc.
50 Essex Street, Rochelle Park, NJ 07662

Circle 158 on inquiry card.

BYTE June 1981
Listing 1 continued:

LSR 0
NOP 0
ORA 2
PHA 6
PHP 0
PLA 10
PLP 0
ROL 0
ROR 1
RTI 0
RTS 7
SBC 0
SEC 1
SED 0
SEI 0
STA 27
STX 10
STY 1
TAX 1
TAY 1
TSX 0
TXS 0
TYA 2

* SYMBOLS = 101 (LIMIT = 800)  * BYTES = 837 (LIMIT = 8192)

* LINES = 853 (LIMIT = 3000)  * XREFS = 257 (LIMIT = 1600)

Listing 2: Example of a routine that reads disk track 3 into memory, starting at location hexadecimal 1000. This routine also illustrates the use of the ERRCDE variable.

```
JSR FDINT Initialize
LDA #$9C Read multiple
STA COMMAND sector command
LDA #$03 Request track
STA TRACK number 3
LOA #0 Set buffer
STA FDBUF address
LDA #$10 at hexadecimal 1000
JSR FDIO Do I/O
BNE ERROR check for error
```

Text continued from page 304:

The status byte indicates if the read operation was successful. If the read test appears good, various other commands should be attempted to increase your familiarity with the 1771 and drive operation.

Extensions

With the addition of an external multiplexing circuit to switch the floppy-disk control lines, multiple drives can be controlled. Multiple drives, however, add a new software-control problem. Since the 1771 retains the current head location, it is necessary to update the track register when switching between drives. A memory variable to contain the head location of each drive can be used to adjust the 1771's register.

A simplified version of the floppy-disk controller can be used to operate 5-inch disk drives in either single- or dual-density. In addition, this disk design is extensible to a more elaborate controller that uses a dedicated 6502 to communicate over a parallel or serial interface to a host computer.

Listing 3: Simple testing program for a disk controller/6502 microprocessor combination. When the BRK (break) occurs, the variables listed in table 6 can be set to test the various controller functions.

```
INIT JSR FDINT
BRK
BRK
GO JSR FDENT
BRK
BRK
JMP GO
```

Conclusion

Floppy-disk drives provide sufficient capacity and performance to meet the needs of most microcomputer users. By combining hardware and software, a floppy-disk system can be constructed economically without sacrificing any function or performance. The 6502 microprocessor, with a few hundred bytes of program, can control head movement and data transfer by utilizing the 1771 controller. The software provides a flexible, yet economic, solution to mass-storage problems.
THREE COMPUTERS IN ONE!
THE DIGIAC MAPS® CT-80 SYSTEM
Multi-User, Multi-Tasking, Cost Effective.

- 3 business systems can run concurrently - that's 3 times the overall system productivity! • Time share word processing, accounting, order processing, inventory, forms processing, billing & more! • 3 workstations can share data base - preparations can be done by several operators concurrently! • All workstations can share common peripherals. • Uses DIGIAC MAPS-80 operating system. (Digital Research MP/M) • High level language processors including Fortran - Basic - Pascal - Cobol. • Complete Turn-key system for ease of operation & learning!

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MAPS, Commercial Products Division of:
DIGIAC CORPORATION
175 Engineers Road, Smithtown, N.Y. 11787
Phone: (516) 273-8600

IEEE - S100 BUS 64K DYNAMIC RAM

Don't buy an outdated RAM board, buy the LOMAS DATA PRODUCTS 64K RAM board. The LDP 64K RAM is the only board that you can buy today and upgrade to a full 256K bytes on one board. The LDP 64K RAM offers the following advanced features:

- 6202 Dynamic RAM controller
- No waitstates with a 5 MHz 8080 or 8086
- 24 address lines for IEEE 696 compatibility
- Parity for ERROR control in large memory configurations
- 256K upgrade kit available in August
- Meets all IEEE 696 specifications

Introductory price of $695 until June 15. After June 15 $795.

LDP72 ADVANCED FLOPPY DISK CONTROLLER

- Meets all IEEE 696 specifications
- Advanced Intel 8272 LSI controller
- Digital data recovery circuit requires no adjustments for reliable operations
- Supports up to 4 drives
- May mix 5" and 8" drives on the same board

HAZITALL

New from LOMAS DATA PRODUCTS, the HAZITALL. The HAZITALL is the perfect companion for your other LDP boards. The board has the following features:

- 2 RS232 Serial Ports, one capable of synchronous data transfer
- 2 8 bit parallel ports
- An 8/15/4 Winchester Controller port
- A real time interrupt
- A socket for an 8231/9511 or 8232 math processor (math processor optional)
- Meets all IEEE 696 specifications

All these features are available for only $325 (assembled and tested).

LDP88 CPU BOARD

The LDP88 CPU board offers the 16 bit processor of the future while maintaining compatibility with your present 8 bit boards. The LDP88 offers the following features:

- Meets all IEEE 696 specifications
- 8088 CPU
- RS232 Serial Port

LDPI 8088 MAINFRAME

Why settle for an 8 bit system of the past when you can invest in the 16 bit system of the future. The LDPI includes the LDP88, LDP72, and the LDP 64K Dynamic RAM board. Options include: a second 8" floppy drive, 2 serial ports, 2 parallel ports, an 8" Winchester drive (Sept. '81).

PRICES

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<tr>
<td>LDP88</td>
<td>$349.95</td>
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<tr>
<td>LDP72</td>
<td>$219.95</td>
</tr>
<tr>
<td>8/100 prototype board</td>
<td>$29.95</td>
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<td>86-DOS</td>
<td>195.00</td>
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<tr>
<td>CP/M-86</td>
<td>250.00</td>
</tr>
<tr>
<td>Micro Soft Basic 86</td>
<td>500.00 (86-DOS required)</td>
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<tr>
<td>PASCAL/M</td>
<td>350.00 (with LDP1 and 86-DOS)</td>
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<tr>
<td>LDP1 with CP/M-86 or 86-DOS</td>
<td>$329.00</td>
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PASCAL/M is a trademark of Sonoma CP/M is a trademark of Digital Research
86-DOS is a trademark of Seattle Computer Products

LOMAS DATA PRODUCTS

11 Cross Street
Westborough, MA 01581
Telephone (617) 366-4335
Easy Data Entry?

Dear Steve,

I enjoyed your article “Build a Low-Cost, Remote Data-Entry Terminal.” (See the September 1980 BYTE, page 26.) Your idea is close to the type of device I need: a simple data-entry terminal that has a ten-character display and can be used to record data, ten characters at a time, using an audio-cassette recorder. Is there an easy way to use your device for this?

Roy Pittman
Stillwater OK

The remote data-entry terminal described in that article will do some of the things you want, but not everything. It cannot support more than an 8-bit display without circuit modification. It can, however, easily store and send up to fourteen characters entered sequentially on the keypad (refer to the last paragraph, on page 32 of the article).

Although it is a little involved and requires some extra button pushes to load the characters, the data-entry terminal could be used as you suggested. To do it, you first press the Control-Escape to enter the storage mode (the remote terminal sends a hexadecimal FA output to the recorder). Decoding the FA code will allow automatic turn-on of the recorder. The next one to fourteen keys pressed will be stored. They are automatically sent as a single message when a Control-semicolon is typed.

As designed, the data rate is 1200 bps (bits per second). To lower the data rate to something more manageable, say 300 bps, you simply lower the crystal frequency proportionately. To remotely switch a tape recorder on and off, you can use the keyboard function decoder that I described in a previous article. (See “Build a Keyboard Function Decoder,” July 1978 BYTE, page 98.) ... Steve

Backup Supplies

Dear Steve,

Allow me to add another request for backup power supplies. I want to use a computer for Bible translating for tribal people, but our electric power not only blackouts out for a few minutes to several days, but when the local welder starts work, the lights dim each time he strikes an arc.

My son had a computer damaged when a copying machine was turned on, so I wonder about the welder. I had decided on a solution similar to the ideas you have mentioned, but I felt that I couldn’t design a sine-wave inverter and that a computer probably wouldn’t accept the square wave from a Heathkit inverter. How about the motor/generator rigs used by the military for B+ power supplies? A 1974 McMaster-Carr catalog shows that they were available in 24, 28, 32, 63, and 110 VDC input and 250 to 2000 W output at 115 V 60 Hz. Prices ranged from $200 to $600.

Of course, this wouldn’t be as efficient as a solid-state inverter, and would need maintenance (since the rigs have brushes) but it might be easier and cheaper to buy equipment on the surplus market. Also, who publishes Digital Design?

Russell Reed
Pinamalayan, Oriental Mindoro, Philippines

Motor/generator combinations are definitely a reasonable backup power system. That was all there was before solid-state converters. I cannot speak for the condition of a World War II surplus unit, but if it operates, it can be an economical solution to your problem. In fact, many computer manufacturers (such as Control Data) frequently use motor/generators in their installations. Be careful to monitor the output frequency as well as voltage when you first start it. The years may have taken their toll on the regulator section.

Digital Design is published by Benwill Publishing Corporation, 1050 Commonwealth Ave, Boston MA 02215. The issue covering uninterruptible power supplies was February 1980 (Volume 10, Number 2). ... Steve

Bank Switching

Dear Steve,

With the recent price reduction of dynamic memory circuits, a 64 K-byte memory system can be built with 32 devices (at $96) or 128 devices (for $64). I read BYTE and other fine publications and I keep coming across an interesting concept called bank switching. What exactly is bank switching? Also, an idea I have is to latch the data at a port bus to provide a
Circle 37 on inquiry card.

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- Atari 800 with 40K ........... $870
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- Atari 826 Printer ........... $650
- Atari 826 Printer with 10K Interface Module ... $299

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Ask BYTE

total address bus of 24 bits. Can I do this?
Simon Chapman
Petaluma CA

Memory is indeed becoming inexpensive these days. Many personal computers will soon contain more than 64 K bytes of memory. To use the extra memory, they must, of course, use bank switching.

A bank of memory is some portion of memory that can be directly addressed by the processor. If you had an Apple II computer with 48 K bytes of memory, all 64 K bytes (including read-only memory) would be in the same bank of memory. Addressing the 64 K requires 16 address bits. If you were to add another 64 K of directly addressable memory, 17 bits would be required. Since the 6502 microprocessor (and the Z80 for that matter) has only 16 address bits, the additional bit must be created under program control.

The typical method is to dedicate a latched output port to this function. To access this second bank of memory, a program in the first bank sets the port output high, simulating the seventeenth address bit. The computer then works exclusively in the second bank. To return to the first bank, a program in the second bank resets the port to a low level.

As you can see, it can get complicated switching back and forth. Mirror images of the operating-system software would have to be resident in both banks. The solution to this problem is to bank-switch memory in 32 K-byte increments rather than 64 K bytes. The typical system would have the first 32 K-byte bank contain the operating system and switch up to eight individual 32 K banks occupying the second 32 K range. Activation of one of the eight boards is handled by setting a bit on an output port (each bit is a separate memory-bank enable) through the always resident operating system. In most cases, the bank-switching is transparent to the user and takes only a few instructions.

Perhaps as soon as I get some of the new 64 K-byte integrated circuits, I’ll discuss this topic in greater depth in an article. . . . Steve

Computer Stores

Dear Steve,

I have a degree in electronics and my fiancée has a degree in business management. We live in a small town and would like to open a computer store, for small businesses, homes, and industry. Where can I get some help and ideas on getting started? There are no computer-related jobs around here, and I feel like I’m being left out.

Bill Bass
Bristol TN

Starting a computer store is a costly and tough job. When you first open a computer store, most personal-computer manufacturers will only ship cash-on-delivery, and many items must be in stock for you to sell them. When hobbyists walk into a computer store, rather than ask if you sell it, most will ask if you have it in stock. Your advantage is not price—mail-order houses are generally much cheaper—so it must be demonstration and availability that sells your products.

Turnover of stock is the key to success. Make sure there is a large enough market in your area before committing to this endeavor, and only believe about a quarter of the people who say they will buy something from you if you open a store.

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Computer store is to visit one in another town (make sure it's not close enough to be a competitor) and ask the owner the questions you are posing to me. This is a new field and, unfortunately, there are as many failures as there are successes. Be careful, but don't hesitate to strike out on your own. ... Steve

Double Characters

Dear Steve,

I would like to acquire a home terminal, since terminal time at school is sometimes difficult to get. Is it possible to build a circuit to connect between the output of a TRS-80 Color Computer or a Videotex and my television or monitor that would double the number of characters per line that these machines display?

The Videotex seemed like the answer to my problems, but I need more than 32 characters to log on to the system I use.

Eric Lutz
Columbia PA

When you buy a computer, you get what you pay for. The hardware to produce 32 characters is cheaper than that to produce 64. While it's quite possible that some hobbyist will design a circuit to do the conversion you suggest, it hasn't happened yet. Also, I wouldn't buy equipment on the presumption that you can easily redesign it.

As for logging onto a computer, the number of characters displayed on the screen is usually immaterial. The software-terminal program used with the computer should "wrap around" at the end of 32 characters onto the next line (even though you haven't hit the carriage-return key yet). The length of the line you send is entirely determined by when you type a carriage return (after 50, 75, or any number characters).

I wouldn't be especially concerned about a 32-character display given the price/performance ratio of the machine. ... Steve

Comparing Frequency

Dear Steve,

I am looking for a circuit that compares two input signals and detects which has the greater frequency. The project I am building has a +5 V supply, so it would be handy to use TTL (transistor-transistor logic). Are there single integrated circuits to perform this function?

Marvin Green
Tualatin OR

There are various ways to compare frequencies. The comparison can be either analog or digital. One analog method is to use frequency-to-voltage converters and simple "window" comparators. (This technique is reliable only at lower frequencies.)

Since you mentioned +5 V, you're probably more interested in a digital-frequency comparator. Generally this is accomplished by comparing the phases of the two signals. An integrated circuit specifically designed for this purpose is the Motorola MC4044 Phase Comparator. (Determining A>B or B>A requires additional circuitry.)

If you know the ranges of the frequencies that you wish to compare, often it is easier to compare one unknown to some preset limits. (See figure 1.) Two retriggerable one-shots have their periods set for the upper limit (F1) and lower limit (F2) of the capture range. When the unknown frequency (F0) is applied, it is gated through the remaining circuitry to provide logic outputs such as F0>F1, F0>F2, F0<F1, or F0<F2. ...Steve

---

Figure 1

<table>
<thead>
<tr>
<th>IC Number</th>
<th>Type</th>
<th>+5</th>
<th>GND</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1</td>
<td>74LS123</td>
<td>16</td>
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</tr>
<tr>
<td>IC3</td>
<td>74LS08</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>
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Software Received

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Apple
- Address Book, name and address file and telephone dialer for the Apple II. Floppy disk, $49.95. Muse Software Company, 300 N Charles St, Baltimore MD 21201.
- Data Fixer, disk software-repair utility for the Apple II. Floppy disk, $29.95. Image Computer Products, 615 Academy Dr, Northbrook IL 60062.
- Data Plot, on-screen data-grafting program for the Apple II. Floppy disk, $59.95. Muse Software Company, (see above).

Atari

Commodore
- Addition, educational program for the Commodore PET. Cassette, $20. Teaching Tools, POB 12679, Research Triangle Park NC 27709.
- Subtraction, educational program for the Commodore PET. Cassette, $20. Teaching Tools (see above).

Exidy

Sword, word processor for the Exidy Sorcerer. Cassette, $34.95. North American Software (see above).


Radio Shack
- Aviation, aviation-calculation package for the TRS-80 Pocket Computer. Cassette, $24.95. Radio Shack, 1 Tandy Ctr, Fort Worth TX 76102.
- Income Property Analysis System, business-analysis program for the TRS-80 Model I or III. Floppy disk, $225. Advanced Business Microsystems, 8016 1 Martin D Love Fwy, #103, Dallas TX 75237.
- LDOS, disk operating system for the TRS-80 Model I. Floppy disk, $149. Galactic Software Ltd, 11520 N Fort Washington Rd, Mequon WI 53092.
- SECS, full-screen editor for the TRS-80 Color Computer. Cassette, $29.95. Datasoft Inc, 16600 Schoenborn St, Sepulveda CA 91343.
- SIGMON, machine-language monitor for the TRS-80 Color Computer. Cassette, $29.95. Datasoft Inc (see above).
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Circle 243 on Inquiry card.

Circle 215 on inquiry card.
Books Received


BYTE's Bits

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Some partially sighted individuals can now work with computer terminals thanks to Mr Simkovitz, a partially sighted Wayne State University researcher in electrical engineering. The device, called the Low Vision Terminal System (LVTS), allows people with poor vision to see and read computer output.

The LVTS is a microprocessor-based system that enlarges letters and characters to more than three inches in height. The size of the letters and characters and the speed of their movement are controlled by the user. The display can move horizontally one line at a time or scroll vertically through the text. Other possible beneficiaries of the LVTS could be secretaries, data acquisition personnel, or anyone accustomed to working with terminals for long periods. By adjusting the height and speed of the characters, eye strain can possibly be reduced.

Dr Edward R Fisher, associate dean for research and graduate programs at the College of Engineering, assisted Mr Simkovitz with the patent process. A US patent is pending in Wayne State University's name. The two are now searching for a manufacturer that will help develop and market the LVTS. For more information, contact Dr Fisher, (313) 577-3861, or Dan Simkovitz, (313) 577-3902, at Wayne State University, Detroit MI 48202.
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INNOVATIVE PRODUCTS

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Startrek 4.0 and Startrek 3.5

Startrek 3.5 is the descendant of Lance Micklus's Startrek 3.0. It has been revised five times and is thoroughly debugged. It is the most widely distributed Startrek game. At first I thought it was unfair to compare Startrek 4.0 by Jeff Hamilton with Startrek 3.5, but after playing version 4.0, I found features in it that I liked, and many that BYTE readers might prefer.

Startrek 3.5 is a menu-driven program. After each sequence of events, you are returned to a list that has eleven command numbers and one invisible command. From this list, you pick and choose commands as if it were a menu. Commands include control of phasers, photon torpedoes, impulse and warp drives, long-and short-range sensor scans, and alert status. You can display the ship’s current status, call up damage control to see what is or isn't functioning, call for repairs, or have the science computer tell you what objects are in your quadrant. The ship’s computer command takes you into a subsystem that scans its data base for data on Klingon warships, starbases, class F stars, planets, unexplored areas, etc. The computer obtains this information each

<table>
<thead>
<tr>
<th>At a Glance</th>
<th>Name</th>
<th>Startrek 4.0</th>
<th>Name</th>
<th>Startrek 3.5</th>
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<tr>
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<td>Lance Micklus</td>
<td>Author</td>
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<tr>
<td>Documentation</td>
<td>Two pages, 11.5 by 18 cm (4½ by 7 inches)</td>
<td>Thirteen-page pamphlet, 6 by 15.5 cm (2½ by 6 inches)</td>
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<td>Thirteen-page pamphlet, 6 by 15.5 cm (2½ by 6 inches)</td>
</tr>
<tr>
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<td>Very good</td>
<td>Excellent</td>
<td>Challenge</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
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time you request a sensor scan. The invisible command saves the game on disk or cassette.

Startrek 4.0 is not a menu-driven game; instead it runs in real time. To compare the two, let’s say you were battling a Klingon warship and you fired your photon torpedoes and missed. The Klingon fired back and knocked out your science computer. At this point, 3.5 returns to the menu and waits for you to enter your next move. On the other hand, in version 4.0, you must think and act quickly because situations occur as in real-time events. For example, a Klingon can wander into your quadrant, spot and fire at you, and leave you dangling in space while you slipped out for a snack. Ship repairs also go on in real time. In general, Jeff Hamilton’s Startrek 4.0 has the same commands as Startrek 3.5, but they are displayed in a small window on your control console as you enter them.

Startrek 3.5 has extensive and reasonably quick graphics. Sounds have been added to the game, but they are kept simple so as not to become tiring after many hours of play. Startrek 4.0 doesn’t have sound and uses rather simple graphics. The screen accurately demonstrates what is happening, and it shakes wildly when you are hit.

The objective of 4.0 is to destroy all the Klingons within thirty-two stardates, while stopping at a starbase only twice. The objective of 3.5 is to destroy twenty Klingons by a certain stardate, but the game does not end there. You must also explore and collect as much data as you can about an entire region, and you must locate and orbit all class M planets. As you’re doing that, you must cope with pulsars, black holes, and, of course, the crafty Klingons. When you have destroyed twenty Klingons and feel you have collected enough data, you dock at a starbase, where Starfleet Command rates your performance on a scale of 1 to 100%.

Startrek 3.5 has a three-dimensional universe (8 by 8 by 3) with 192 quadrants; a quadrant has 64 (8 by 8) sectors. Startrek 4.0 has a two-dimensional universe (8 by 8) with 64 quadrants. Again, each quadrant has 64 (8 by 8) sectors.

In Startrek 4.0, the computer can be used to help you figure out the exact coordinates to fire photon torpedoes or to navigate the ship. This helps your accuracy when you first start playing the game. Klingon warships using a cloaking device that makes them seem invisible are an extra problem in version 4.0, because they are immune to the photon torpedoes when in this state. In 4.0, but not in 3.5, if a star is in your path, you must navigate around it. In version 3.5, you must be true to your Starfleet orders, and never destroy a planet, star, or starbase, or the game ends immediately. The Klingons can maneuver out of the way of photon torpedoes and phaser fire.

Conclusions

While Startrek 3.5 is my personal favorite, Startrek 4.0 has an interesting angle to it. To some, the real-time aspect of 4.0 may make all the difference, but, all in all, both games are smooth-running and well debugged.
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Software Review

The BDS C Compiler

Christopher Kern, 201 1 St SW, Apt 839
Washington DC 20024

The ubiquitous Pascal compiler has joined the ubiquitous BASIC interpreter as a staple of the microcomputer programming environment, bringing with it the concepts of hierarchical program design, orderly program development, and legibility that generally fall together under the heading "structured programming."

But for those who are not ideologically committed to the proposition that Pascal is the most congenial programming language—and who have access to an 8080-based computer and the CP/M operating system—I would like to suggest an alternative: a language created at Bell Laboratories, named, with characteristic concision, C. C provides the same structured programming approach as Pascal, but it has a cleaner and crisper syntax, one that is both closer to the ultimate machine language of the computer and, paradoxically, somewhat easier to become familiar with than Pascal.

My recommendation is largely a product of my experience with one of the best and least expensive programming language packages I have come across: the C compiler developed by BD Software (by Leor Zolman of Cambridge, Massachusetts). I have been using the BDS C compiler for over a year, and I think many hobbyists who aren't already using a modern, high-level language could easily switch to C from their BASIC interpreter. C, like BASIC, can be learned quickly, but it has resources that BASIC, even in its ingeniously extended forms, can't match. And while the BDS C compiler does not provide as convenient a programming environment as BASIC—no compiled language really can—it comes about as close as possible to eliminating the worst annoyance of many compilers running on microcomputer systems: the long wait between idea and execution as the compiler cranks out an assembly-language file that must itself be compiled (run through an assembler) before the object program can be tested.

The operation of the compiler is relatively straightforward and quite fast. The command "CC1 filename.C" reads in the source program (which has been prepared using the host system's editing facilities and saved as a file on disk), parses it, and leaves the resultant intermediate file in memory. As CC1 goes out of business, it calls in another program, CC2, as an overlay (ie: it takes the place of the previous program). CC2 is the code generator: it saves the C machine-code program on disk in a special relocatable format. The relocatable machine-code program is turned into executable, absolute machine code by the linker, CLINK, which also merges the user's program with previously compiled program files (such as the standard C function library) if necessary. The entire source file is read into memory before compilation begins, but because it is possible to link separately compiled modules together, the available memory space of the computer does not limit source-program size. If the source code is too long to fit into the available memory at

---

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>BDS C compiler</th>
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<tr>
<td>Type</td>
<td>8080 compiler</td>
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<tr>
<td>Distributor</td>
<td>Lifeboat Associates</td>
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<tr>
<td></td>
<td>1651 Third Ave</td>
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<tr>
<td></td>
<td>New York NY 10028</td>
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<tr>
<td>Price</td>
<td>Complete package, $145; documentation only, $25</td>
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<tr>
<td>Format</td>
<td>Available for all CP/M systems</td>
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<tr>
<td>Computer</td>
<td>Any 8080-based computer running Digital Research's CP/M operating system (programs compiled by the BDS C compiler can be tailored to run on any 8080-family computer)</td>
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<tr>
<td>Documentation</td>
<td>70 pages; 22 by 28 cm (8½ by 11 inches)</td>
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<tr>
<td>Audience</td>
<td>Application programmers and system programmers who require a C compiler running in an 8080 environment</td>
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A Comparison of C and Pascal

C programs and Pascal programs look quite a bit alike. They should—the two languages have a lot in common, including sets of similar primitive operations that make direct Pascal-to-C or C-to-Pascal translation feasible. Yet enough differences exist to give the two languages a distinctly different "feel."

The most visible difference is block structure; C programs do not have the true block structure found in Pascal programs. A C program is a collection of separate functions; thus one function cannot be nested within another and called as a separate entity. Functions may contain blocks of code that are either executed completely or not at all, but they are not named as functions themselves, and they must be included in-line as part of the normal program flow within the function.

C uses only functions, where Pascal distinguishes between functions and procedures. In practice, the only real difference is that any C function can return a value to its calling routine. This is but one example of C's relaxed programming philosophy. Other examples include the ability to assign freely between integers and characters, and between pointers and unsigned integers, the latter providing virtually unlimited opportunity to perform address arithmetic within the host system's available memory space. There are times when this flexibility is very convenient, but there is a price: the compiler won't prevent a foolish move if the programmer insists on it. Whereas Pascal takes a very rigid, protective, and rather mathematical attitude toward program construction, C allows the programmer a certain amount of freedom. This makes sense: Pascal was designed as a teaching language, and C is a production programming language that allows the programmer to do things that he may want to do, at the expense of some conceptual niceties.

Both C and Pascal allow parameters to be passed to subroutines by value and by reference. This means that the called subroutine can receive either its own local copy of a parameter (which it can alter at will without changing the value of the variable as far as the calling routine is concerned), or a reference to the calling routine's variable (which can be subsequently altered by the subroutine that has been called).

Each language also provides pointers—variables that point to memory locations, such as the beginnings of arrays. In Pascal, pointers tend to be used sparingly, while in C they are much more common. Here again, C is unwilling to protect the programmer from itself. Pointers are risky. If they are misused, they can point somewhere entirely unexpected and clobber an innocent piece of unrelated code with predictably disastrous results. They can, however, make for extremely efficient programs, and C encourages their use.

C has been described as a relatively low-level language. It generally operates on the same primitive data objects as the computer itself, and it does not provide certain composite operations. For example, a string in C is a series of characters beginning at a given memory location, not a discrete entity that can be passed or assigned as a unit. Explicit functions are used to provide more sophisticated facilities for manipulating data objects, as well as for input and output. The more common primitive operations are provided in the C standard function library. Others must be written by the programmer.

One of C's most distinctive features is its unusual—and unusually concise—set of operators. C has multiple assignment operators that lead to expressions of the form x =+ 1 or y >> 4. These mean, respectively, "let x equal x plus one" and "let y equal logically shifted right 4 bits." Another unique C concision is the ? : (if, ... then) operator. It is used in expressions of the form if x is greater than 0 let y=; otherwise, let y=0.

BASIC exists in thousands of dialects. The same diffusion seems to be taking place—to a lesser extent, fortunately—with Pascal. Thus far, not many compilers operate on variations of C, so true portability between computers still exists. I know of three microcomputer C compilers: the BDS compiler (which implements a very complete subset of the language); one for a considerably more restricted (and slightly archaic) subset of C that was published, in C source code, in the May 1980 issue of Dr. Dobbs Journal of Computer Calisthenics and Orthodontia; and one for DEC LSI-11 systems (Whitesmiths Ltd., POB 1132, Ansonia Sta, New York NY 10023). An excellent C-like interpreter is available from tiny-c associates, POB 269, Holmdel NJ 07733 (see my review of tiny-c: "A User's Look at tiny-c," December 1979 BYTE, page 196). A tiny-c compiler is also available.
same disk-access speed, and (3) are of dubious value when used to compare different programming languages because it is unlikely that the benchmark programs will be of equivalent efficiency in all languages.

Having said all that, I will venture the opinion (acknowledging that it may be even more misleading than a benchmark program) that programs compiled on the BDS compiler run very fast indeed. Not as fast as those coded in assembler, obviously, but much faster than any BASIC interpreter, considerably faster than any pseudocode Pascal system (a technique that amounts to semi-compilation, with object code being generated for a "pseudo-machine" that is emulated by the host computer), and about as fast as those created by any microcomputer compiler I have seen. I have used BDS C to compile a rudimentary LISP interpreter, and while it's no match for a machine-coded LISP, the project demonstrated to my satisfaction that the BDS compiler is suitable for system-programming purposes.

BDS C is a true subset of the standard C language. Very little is left out. The most serious omissions are the lack of static variables and initializers. Several library functions are supplied to remedy the latter, although initialization remains somewhat more awkward than in standard C. Also absent are floating-point real numbers and long (32-bit) integers. A series of subroutines to perform floating-point conversions and arithmetic is supplied with the package, but this is not as convenient a way to provide real numbers as building them into the language the compiler accepts directly.

A considerable amount of work has been done to relieve the programmer of some of the more tedious aspects of the CP/M operating system. Library functions permit the use of the standard CP/M carriage-return/line-feed sequence to terminate a line or, at the user's option, the single newline character that is standard in other C programming environments. Buffered file routines are supplied as part of the standard library, which permits the programmer to write data to disk a character at a time instead of in blocks of 128 characters, as required by CP/M. Dynamic storage allocation and deallocation are also provided, so the user can create and dismantle complex data structures at run-time, and therefore reuse the memory area allocated to them (even though CP/M itself contains no allocation mechanism).

It's a shame the BDS compiler doesn't go one step further and provide redirected input and output; this would have permitted the user to write a program using a single I/O stream and then specify at run-time whether the program was to communicate with the console, a modem, a disk file, etc. Some high-level language compilers provide a debugging option that allows the user to trace program execution and print out variable values. Alas, BDS C is not one of them. Short of that, the best debugging tool I
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have found comes right out of the C standard library. It is the function "printf", which allows various data objects to be printed in appropriate formats and number bases while the program is being run.

The compiler accepts a number of optional directives that allow the user to:

- Place the generated code in any memory location (including read-only memory, as long as some programmable memory will be available somewhere in the target system)
- Optimize the object code for speed (which increases the amount of code generated) or for size (which slows the object program down a bit), and to control the way the compiler allocates space
- Save an intermediate file on disk between the two compiler phases
- Display the source text on the user's console during compilation

The linker also supports a number of useful options, including several that permit the programmer to create overlay segments that use the same data elements. This feature is not commonly available in microcomputer compilers for high-level languages.

The assembly-language source code for the run-time package is also supplied (the run-time routines contain the interface to the CP/M operating system). This permits the user to create a customized run-time package that allows BDS C programs to run under other 8080 operating systems. Those who sell application programs will, no doubt, be happy to learn that there are no royalty requirements for programs that include the run-time package in either its original or customized form.

In addition to the compiler and the linker, the BDS C package contains a librarian program, CLIB (used to manipulate compiled function libraries), the C standard library along with some useful extensions for the microcomputer (and specifically the CP/M environment), and a collection of sample programs that is of more than passing interest.

The precise sample programs that are delivered with any package may vary, but the copy of BDS C Version 1.4 that I received from Lifeboat Associates in New York contained a fairly sophisticated telecommunications program for connecting a microcomputer system through a modem to another microcomputer (or a time-sharing system), several impressive games (some requiring a cursor-addressable video terminal), and several utility programs, including two that permit the compiler to be used from terminals that generate uppercase characters only. The package also includes a lucidly written manual for the compiler and a copy of the outstanding C language manual, *The C Programming Language*, by Brian W Kernighan and Dennis M Ritchie.
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—Lancaster, California

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Musical Applications of Microprocessors
by Hal Chamberlin
Hayden Book Company, Inc
Rochelle Park, NJ
1980, 661 pages, hardcover $24.95

Reviewed by
Dick Moberg
404 S Quince St
Philadelphia PA 19147

This book is the culmination of many years of experimentation by one of the leaders in the field of computer music for small systems. Its depth of coverage and usefulness are unsurpassed by any other single publication.

A review cannot start without first looking at the book's author. Hal Chamberlin has been involved with microcomputers since their origin. His newsletter, The Computer Hobbyist, pioneered construction articles on tape, disk, and graphic interfaces long before there were any books or major publications on the subject. Combining his music and computer talents eventually led him to form a company, Micro Technology Unlimited, and to receive an award for his contributions at the 1979 Personal Computer Arts Festival. He is an avid writer for personal-computer magazines. His clear and often humorous style is prevalent throughout his book.

Before we look at the contents, let's discuss the book's intended audience. Being a long-time computer hobbyist with several years of childhood music lessons, I would target this book for the computer tinkerer or the musician with some syn-
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**BOOK REVIEW**

The musician will find the introductory parts on waveforms and music theory sufficient for understanding the rest of the book. The musician with no background in computing or electronics should have available some of the excellent paperback volumes now available on op (operational) amps, TTL (transistor-transistor logic) circuits, and microcomputers. But, even for the computer-musician novice, this is a book that is readily understandable.

Musical Applications of Microprocessors is divided into three sections: "Background," "Computer-Controlled Analog Synthesis," and "Digital Synthesis and Sound Modification."

Section 1 covers background material in music synthesis and microprocessors. The first chapter, "Music Synthesis Principles," starts with a discussion on the goals of music making, comparing conventional instruments with electronic-synthesis techniques. It emphasizes that with electronic synthesis, a musician is limited only by his imagination as to the accuracy, complexity, and variety of sounds that can be achieved with this medium. Next, the author discusses the relationship of the physical parameters of waveforms—frequency, amplitude, and harmonics—to the musical concepts of pitch, loudness, and timbre. The chapter ends with a history of electronic sound synthesis from the teleharmonium to the microprocessor.

Chapter 2 presents the terminology and techniques of sound modification. It starts with a section on tape-recording techniques (rearranging tape splices, speed transposition, etc) and then compares these to their electronic counterparts. Other electronic techniques such as...
filtering, spectrum shifting, reverberation, and chorus synthesis are discussed. The chapter concludes with a discussion on analyzing natural sounds for subsequent modification.

The next chapter, on voltage-control methods, explains the conventional techniques of using voltage to control frequency, amplitude, and harmonics. Each of these techniques is later explained in regard to its implementation with analog and digital circuits or by using software programming. The modular nature of conventional synthesizers is also discussed.

Chapter 4 addresses waveform synthesis by the computer by digital-to-analog conversion and looks at the advantages and limitations of using this method. Music-programming systems and languages, including MUSIC V and Hal’s NOTRAN (NOte TRANslat-ion language), are briefly described.

The background section concludes with a chapter on microprocessors. There is an interesting comparison between the 8080, LSI-11, and 6502 microprocessors showing where each (and similar processors) should be used in the grand scheme of a music-synthesis system. The author claims that the 8-bit 8080/Z80 family are the optimal microprocessors for synthesizer control, the 16-bit LSI-11 for direct microprocessor synthesis of music, and the 8-bit 6502 for replacing dedicated logic. Although the choice of processor will vary from one designer to the next, this section gives the design criteria and the desired microprocessor parameters for each area of application.

The remaining two sections of the book offer technical how-to information regarding microcomputers in music synthesis. There’s a discussion on the use of a
microcomputer as a controller of standard or custom analog sound-synthesizing equipment, and how a computer can simulate the analog module's functions in software to provide direct music synthesis.

The first chapter of the computer-controller section explains circuit details of the three voltage-controlled synthesizer modules—voltage-controlled oscillator, voltage-controlled amplifier, and voltage-controlled filter. Component values are provided along with construction tips for building those modules.

The next chapter, on data-conversion techniques, starts with a tutorial on the terminology regarding the use of D/A (digital-to-analog) and A/D (analog-to-digital) converters. All circuits for the various conversion techniques are given, along with component values and available devices. One impressive circuit shows how to make a 128-channel microcomputer-controlled D/A converter for less than $50.

The remaining four chapters in this section deal with the "systems" aspects of a computer-controlled synthesizer. A chapter on signal routing shows how the computer and various switching devices can replace the ever-confusing patch cords on conventional analog synthesizers. Two chapters on input devices follow: one entirely on keyboard-input methods and one on other devices such as ribbon controllers, joysticks, and digitizers. The last chapter describes the role of computer-graphics displays as aids in computer music composition.

The last section of the book, on direct computer synthesis of music, gives details on digital sound generation and filtering techniques, and includes the techniques that the author...
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**Atari Users Group**

The Bay Area Atari Users Group meets on the first Monday and on the third Tuesday of each month at 7 PM. The Monday-night meeting takes place at Foothill College, and the Tuesday-night meeting is at Interim Electronics, 447 S Bascom Ave, San Jose, California. The group publishes a newsletter. The dues for the group are $12 per year. The club currently has eight disks of public-domain software for sale at $5 per disk. The monthly meetings feature speakers discussing microcomputer uses and the Atari. Write to the Bay Area Atari Users Group, c/o Foothill College, 12345 El Monte Rd, Los Altos Hills CA 94022.

**OSI Group in Northern California**

The Ohio Scientific Users Group of Northern California has been formed. For details, write to Rod Freeland, c/o Public Interest Computer Services, POB 1061, Berkeley CA 94701; or call (415) 654-9880 after 1 PM.

**68XX Users Group**

This is a group for those hobbyists who have a strong interest in Motorola 68XX microprocessors. The group meets on the second Tuesday of each month in Santa Clara at American Microsystems Inc. Contact the 68XX Users Group at POB 18081, San Jose CA 95158.

**Behavioral Sciences AIM-65 Users Group**

Workers in the behavioral and biological sciences who are currently using or are interested in using the Rockwell AIM-65 are invited to participate in this group. Areas of study include hardware and software for experimental control, data acquisition, statistical analyses, and other applications. If you are interested, please write, outlining areas of interest and current or planned projects, to Dr J W Moore Jr, POB 539, Middle Tennessee State University, Murfreesboro TN 37132.

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Atlanta Small Computer Show, Atlanta Hilton, Atlanta GA. Producers of small computers, peripheral equipment, supplies, and services will be exhibiting at this show. Business owners, corporate and government executives, data processing managers, doctors, lawyers, and other professionals, are expected to attend. Obtain additional information from The Atlanta Small Computer Show, 4060 Janice Dr, Suite C-1, East Point GA 30344, (404) 767-9798.

**June 7-9**
Understanding and Using Computer Graphics, Chicago IL. This seminar will cover the latest technology on graphic systems. It will be headed by Carl Machover. Contact Bob Sanzo, Frost & Sullivan Inc, 106 Fulton St, New York NY 10038, (212) 233-1080.

**June 9-11**

**June 14-18**
NEPCON East '81, New York Coliseum, New York NY. This exposition is aimed at engineers, prototype developers, production specialists and testing personnel. Technical programs will be presented. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

**June 17-19**
National Educational Computing Conference, North Texas State University, Den- ton TX. This conference will provide a forum for discussion between individuals, and institutions with interests in educational computing. Computer literacy, computer education for teachers, and computers in education are some of the topics to be covered. Contact Dr Jim Poirot, NECC-81, General Chairman, Computer Sciences Department, North Texas State University, Denton TX 76203.

**June 21-26**
Computer Workshops for Educators, Northeast Louisiana University (NLU), Monroe LA. This program will cover a wide variety of topics. Room, board, and tuition is $135. Contact Dr Paul Ohme, Department of Mathematics, NLU, Monroe LA 71209, (318) 342-2186.

**June 22-27**
Digital Electronics for Automation and Instrumentation and Microcomputer Design Interfacing, Programming, and Application Using the Z80, 8080, and 8085, Virginia Polytechnic Institute and State University, Blacksburg VA. These two workshops allow participants to design and test concepts with the actual hardware. For more information, contact Dr Linda Leffel, CEC, Virginia Tech, Blacksburg VA 24061, (703) 961-5241.

**July 1981**

**July 9-10 and July 20-21**
Software Engineering, Denver CO and Seattle WA. Designed for systems analysts, designers, programmers, and managers, this seminar examines the latest developments in software engineer-
ing. For more information, contact Battelle, Seminar and Studies Program, 4000 NE 41st St, POB C-5395, Seattle WA 98105, (206) 525-3130.

July 29-31
The 1981 Microcomputer Show, Wembley Conference Centre, London, England. Seminars on microcomputer applications in business, production, and in education will be presented. Topics for conference sessions include hardware availability, software packages and development. For more information, contact Battelle, Seminar and Studies Program, 4000 NE 41st St, POB C-5395, Seattle WA 98105, (206) 525-3130.

August 26-28
The Seventh International Joint Conference on Artificial Intelligence, University of British Columbia, Vancouver, British Columbia, Canada. This conference examines computer applications of medical diagnosis, computer-aided design, robotics, programmable automation, speech understanding, vision, and other related topics. Tutorial programs and artificial-intelligence exhibits will be presented. For more information, contact Louis G Robinson, American Association for Artificial Intelligence, Stanford University, POB 3036, Stanford CA 94305, (415) 495-8825.

August 25-28
Vector and Parallel Processors in Computational Science, Chester, England. This conference will concentrate on hardware, software, algorithms, applications, and case studies concerning vector and parallel processors. For information, contact Mrs S A Lowndes, Science Research Council, Daresbury Laboratory, Daresbury, Warrington, WA4 4AD, England.

August 26-29
The Fifth Annual National Small Computer Show, New York Coliseum, New York NY. There will be daily lectures, and a five-hour seminar will be presented daily for executives who need an introduction to the understanding, acquisition, and use of computers in business. The registration fee for the show is $10 per day. The seminar for executives is $200, which includes all materials and show registration. For information, contact the National Small Computer Show, 110 Charlotte Pl, Englewood Cliffs NJ 07632, (201) 569-8542.

August 28-30
Personal Computer Arts Festival '81 (PCAF '81), Philadelphia Civic Center, Philadelphia PA. This show will include technical sessions, demonstrations, and exhibits, as well as the annual computer-music concert and computer graphics film and video show. PCAF '81 is being held in conjunction with the Personal Computing '81 show. For complete details, contact the address below.

The PCAF '81 Committee invites persons interested in microcomputer-music and digital-sound synthesis, computer composition tools, signal processing, computer-generated visual art, and other computer-based creations, to talk, demonstrate, display, or perform at PCAF '81. To participate, send a half-page description of a topic or performance (include tapes, prints, or slides, if possible) before July 1 to PCAF '81, POB 1954, Philadelphia PA 19105.

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August 24-27
Software Design, Reliability, and Testing, Sheraton Motor Inn, Lexington MA. This four-day seminar is for engineers, programmers, and technical managers. It examines concepts and techniques for developing and testing reliable, cost-effective software. It also addresses management concerns and recommended policies. Tuition is $600, which includes course notes, luncheon, refreshments, and an evening reception. Contact the Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

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Normally, program
manuals are not very in-
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unfortunately, most people
are not yet using TEX or
METAFONT. However, if
you are interested in how a
design for a computer scien-
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writing, and documenting his

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TEX and METAFONT is
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and how to use mathematics in the design of good-looking type fonts. It contains very brief introductions to both TEX and METAFONT, but, more interestingly, Dr Knuth describes some of the history of typesetting and typefont design and some of the history of his investigations into mathematical typesetting and font design, including some of the decisions he made while designing the two programs. His prose is comfortable and enjoyable. If you find it necessary to skip the more technical mathematics, you're skipping only about one page of Dr Knuth's lecture.

Judged by its manual, TEX is unlike any other textformatting program. The care and thought that went into its design set a standard for programs of this kind, and programs in general, that few can meet. It uses a novel algorithm for splitting text into equal-length lines which considers the appearance of the entire paragraph in which the line appears, not just the line itself. It has extensive facilities for handling mathematical formulas in a manner that is easy for the typist but yields professional-looking output. (Naturally it supports proportionally spaced type fonts, multiple-column page formats, footnote references, and other features which are essential for full typesetting capability.) The manual is easy to read, and while it certainly makes you wish you had a copy of TEX to run on your own computer, you don't need it to enjoy reading the manual. (Dr Knuth says that he intends to publish the programs in a book, putting them in the public domain.)

As far as I know, METAFONT, the typeface-design program, is unique. It allows you to write programs, in a special METAFONT language, that specify the shapes of a family of characters—that is, it allows you to design your own type fonts. Currently though, only high-density raster-scan

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**BYTE’s Bugs**

**Correction**

The name of the manufacturer of the wire-wrap prototyping board mentioned in “What's Inside Radio Shack's Color Computer?” (March 1981, BYTE, page 90) should have been Vector Electronic Company. We apologize for any confusion this may have caused.

**Book Review**

Printers can print the new fonts, and these devices are still extremely expensive. Consequently, the microcomputer applications for a font-design program are limited. However, like the TEX manual, the METAFONT manual is both interesting and informative. It reads as though the author were standing at times in front of you lecturing and, at other times, behind you looking over your shoulder, helping. Even if you are just interested in the design of type fonts by Dr. Knuth’s analytic method, you will find this book useful. (The manual includes many exercises. While they are interesting to read, if you’re not actually trying to learn to use TEX or METAFONT you may well want to skip them; I did.)

I used to think that only a hard-core, lost soul computer hacker could enjoy reading a manual for a program he might never use. This book has made me reconsider.

**Notice of Omission**

Due to a processing error the Washington Computer Service ad which appeared on page 27 of the May Byte had no Reader Service Number.

For more information regarding their “no problem trial offer” circle 475 on the inquiry card in this issue.
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Papers must be no more than twenty typewritten pages in length, double-spaced and referenced. Four copies must be submitted. Only original works that have never been published should be submitted. Authors must be enrolled in an undergraduate curriculum at the time of composition. All copies become the property of Cryptologia and the magazine assumes publication rights on all entries.

The papers will be judged by the editors of the magazine, and the winner will be announced on April 1, 1982, with publication of the winning paper in the July 1982 issue of Cryptologia. For information, contact Cryptologia, Albion College, Albion MI 49224.

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With the addition of an analog-to-digital converter and some simple sensors, a microcomputer can monitor analog voltages, read light levels, sense temperatures, or read the analog output from laboratory instruments. The six-channel A/D converter that I will describe reads positive voltages from 0 to 3 V, with either 8 or 10 bits of accuracy. It interfaces to the computer through an 8-bit bidirectional peripheral port whose I/O (input/output) lines are individually programmable and latched when used as outputs.

Once started, the converter operates asynchronously with respect to the computer and requires a minimum of code in the user's program. Conversion times are voltage-dependent, with an approximate range of 1 to 2 ms (milliseconds). A sample program segment and sub-routine written in 6502 assembly language are included to illustrate the use of the converter.

Major components of the A/D converter unit, shown as a schematic diagram in figure 1, are a Fairchild Semiconductor µA9708 analog-to-digital-converter integrated circuit, a clock, a 12-bit counter, and a 16-bit multiplexer. The µA9708 features an analog input multiplexer, controlled by address lines A0 thru A2, that selects one of eight input sources. Address 0 selects the internal zero voltage, and address 7 selects the internal reference voltage. Addresses 1 thru 6 select user inputs 11 thru 16, as shown in figure 1. Although the manufacturer rates the µA9708 at 8 bits of accuracy, it performs well at 10 bits of accuracy. A series of voltage readings taken at 0.1 V intervals from 0 to 3 V compared favorably with readings taken with a Fluke Model 8000A Digital Multimeter. Voltage differences ranged from 2 to 11 mV (millivolts). The greatest relative error, defined as the absolute value of the voltage difference divided by the multimeter reading, was less than 2%.

In order to read one of the analog channels, the channel address is placed on the address lines, and the ramp-start input (pin 3) is set low. The ramp-stop output (pin 7) goes high at this time. With the address lines stable for a signal-acquisition time of about 1 ms, the ramp capacitor, C1, charges to the voltage...
Figure 1: Schematic diagram of the A/D converter. Inputs 11 thru 16 of IC1 are the user's analog-input channels. The input voltage is converted to a binary number in the counter (IC4 and IC5), where it is retained until needed. The binary output is read in bit-serial fashion by the output multiplexer, IC6. Interface to the computer is through an 8-bit I/O port.

Easy selection of 8 or 10 bits of accuracy is accomplished by installing the clock timing components (C6, C7, R8, and R9) on a DIP header (see figure 2).
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Figure 2: Wiring of the DIP header (top view). This optional feature may be installed for easy selection of 8 or 10 bits of accuracy. The clock timing components are mounted on the header in such a way that when it is reversed in its socket, the time constants of IC3 (a 74LS221 monostable multivibrator) are appropriately changed.

Listing 1: A program segment, written for the 6502 microprocessor, that illustrates use of the A/D converter. Hexadecimal 10 is added to the channel address, and this value is then written to the interfacing I/O port to start the conversion. Data from the counter is read when needed.

<table>
<thead>
<tr>
<th>Address</th>
<th>Object Code</th>
<th>Label</th>
<th>Mnemonics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0250</td>
<td>A9 10</td>
<td>LDA H#10</td>
<td>CHANNEL 0 ADDRESS</td>
<td></td>
</tr>
<tr>
<td>0252</td>
<td>8D 01 A8</td>
<td>STA DRA</td>
<td>INITIATE A/D CONVERSION</td>
<td></td>
</tr>
<tr>
<td>0255</td>
<td>20 30 03</td>
<td>ISR RDADC</td>
<td>READ CHANNEL 0 COUNT</td>
<td></td>
</tr>
<tr>
<td>0258</td>
<td>85 D0</td>
<td>STA D0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>025A</td>
<td>86 D1</td>
<td>STX D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>025C</td>
<td>A9 17</td>
<td>LDA H#17</td>
<td>CHANNEL 7 ADDRESS</td>
<td></td>
</tr>
<tr>
<td>025E</td>
<td>8D 01 A8</td>
<td>STA DRA</td>
<td>INITIATE A/D CONVERSION</td>
<td></td>
</tr>
<tr>
<td>0260</td>
<td>20 30 03</td>
<td>ISR RDADC</td>
<td>READ CHANNEL 7 COUNT</td>
<td></td>
</tr>
<tr>
<td>0264</td>
<td>85 C0</td>
<td>STA C0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0266</td>
<td>86 C1</td>
<td>STX C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0268</td>
<td>A9 11</td>
<td>LDA H#11</td>
<td>CHANNEL 1 ADDRESS</td>
<td></td>
</tr>
<tr>
<td>026A</td>
<td>8D 01 A8</td>
<td>STA DRA</td>
<td>INITIATE A/D CONVERSION</td>
<td></td>
</tr>
<tr>
<td>026D</td>
<td>A9 02</td>
<td>ISR SUBM</td>
<td>COUNT(REF) - COUNT(O)</td>
<td></td>
</tr>
<tr>
<td>026F</td>
<td>20 7C 05</td>
<td>LDA C0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>027A</td>
<td>A5 C0</td>
<td>LDX C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0274</td>
<td>A6 C1</td>
<td>STA A0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0276</td>
<td>85 A0</td>
<td>STX A1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0278</td>
<td>86 A1</td>
<td>ISR RDADC</td>
<td>READ CORRECTED REF COUNT</td>
<td></td>
</tr>
<tr>
<td>027A</td>
<td>20 30 03</td>
<td>STA C0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>027D</td>
<td>85 C0</td>
<td>STX C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>027F</td>
<td>86 C1</td>
<td>LDA H#02</td>
<td>COUNT(1) &lt; COUNT(0)?</td>
<td></td>
</tr>
<tr>
<td>0281</td>
<td>A9 02</td>
<td>ISR CMPM</td>
<td>SET COUNT(1)</td>
<td></td>
</tr>
<tr>
<td>0283</td>
<td>20 89 05</td>
<td>BPL SKIP</td>
<td>TO</td>
<td></td>
</tr>
<tr>
<td>0286</td>
<td>10 08</td>
<td>LDA D0</td>
<td>COUNT(0).</td>
<td></td>
</tr>
<tr>
<td>0288</td>
<td>A5 D0</td>
<td>STA C0</td>
<td>COUNT(0).</td>
<td></td>
</tr>
<tr>
<td>028A</td>
<td>85 C0</td>
<td>LDA D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>028C</td>
<td>A5 C1</td>
<td>STA C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>028E</td>
<td>85 C1</td>
<td>STA C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0290</td>
<td>A9 02</td>
<td>LDA H#02</td>
<td>COUNT(1) - COUNT(0)</td>
<td></td>
</tr>
<tr>
<td>0292</td>
<td>20 7C 05</td>
<td>ISR SUBM</td>
<td>COUNT(1) - COUNT(0)</td>
<td></td>
</tr>
</tbody>
</table>
at the selected input. The ramp-start input is then set high. This disconnects the input voltage from the ramp capacitor, which now discharges linearly at a controlled rate through resistors R1 and R2. When the ramp capacitor is discharged, the ramp-stop output goes low. Since the capacitor’s discharge time is directly proportional to the input voltage, a counter running during the interval from the conditions ramp-start-high to ramp-stop-low will, at the end, contain a count that is proportional to input voltage.

In this circuit, a low-to-high transition of peripheral-port bit 4 triggers IC2, a 74LS221 monostable multivibrator. Its Q output goes high to clear the counter, while the Q output holds the ramp-start line low, allowing the µA9708 (IC1) to acquire the voltage from the selected channel. Upon timing out, IC2’s outputs change states, raising the ramp-start line to a high logic level and turning on the counter. When the ramp-stop line goes low, the counting stops, and peripheral-port bit 6 goes high to signal the computer that the conversion is complete. The counter value is the useful output of the converter, and is retained until it has been read and the next conversion cycle has begun.

The clock, IC3, is a multivibrator whose frequency is set to about 1 MHz by the 100 pF capacitors, C6 and C7, and 6.8 k-ohm resistors, R8 and R9, for a 10-bit count. An 8-bit count is selected by replacing R8 and R9 with 27 k-ohm resistors. If the frequency-determining components are installed symmetrically on a header, as shown in figure 2, the 8- or 10-bit counts can be selected by simply unplugging the header and reversing it.

A ripple counter and a 16-bit output multiplexer, controlled by address lines A0 thru A3, complete the circuit.

Before the circuit is used, all unused analog inputs should be grounded and the reference voltage and ramp slope should be set. The 10 k-ohm potentiometer, R3, is first adjusted until the reference voltage at pin 8 of IC1 is exactly 3 V, as in-

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dicated by an accurate voltmeter. Then the converter connected to the computer is run in a loop, repeatedly addressing and reading the reference voltage at address 7. The 50 k-ohm potentiometer, R1, is adjusted until the count is just under hexadecimal FF for an 8-bit count, or hexadecimal 3FF for a 10-bit count.

In normal use, the program must first configure the peripheral-port bits 0 thru 4 as outputs and bits 5 thru 7 as inputs, and it must clear bit 4. Voltage readings are taken by writing the value of the channel address plus hexadecimal 10 to the peripheral port and then waiting until bit 6 goes high. The channel address should not be changed during this time. Reading of the counter data automatically clears peripheral port bit 4, enabling its low-to-high transition when the next address is written to the port. The counter is read a bit at a time by writing the address of the desired bit into the peripheral port, reading the port, and then left-shifting bit 7 (the counter data bit) into a register pair.

Listing 2: RDADC, a 6502 subroutine to read data from the counter in the converter. The 16-bit counter value is returned in the accumulator and X register. Status bits reflect the condition of the high-order byte.

```
       READ A/D CONVERTER

THIS SUBROUTINE READS THE COUNTER OF THE A/D CONVERTER.
IT RETURNS THE HIGH-ORDER BYTE IN THE ACCUMULATOR
AND THE LOW-ORDER BYTE IN THE X REGISTER.

SCRATCH LOCATIONS USED: F0,F1

0330 A9 40 RDADC: LDA H#40 ;LOAD MASK TO TEST BIT 6
0332 2C 01 A8 LP1: BIT DRA ;IS A/D CONVERSION COMPLETED?
0335 50 FB BVC LP1 ;IF NOT, LOOP UNTIL DONE
0337 A2 0F LDX H#0F ;LOAD INDEX REGISTER/COUNTER
0339 8E 01 A8 LP2: STX DRA ;BIT ADDRESS
033C AD 01 A8 LDA DRA ;READ BIT
033F 2A ROL A ;ROTATE ACCUMULATOR
0340 26 Fl ROL Fl ;ROTATE MEMORY LOCATION Fl
0342 26 FD ROL FD ;ROTATE MEMORY LOCATION FD
0344 CA DEX
0345 10 F2 BPL LP2 ;BRANCH IF POSITIVE
0347 A6 Fl LDX Fl ;LOAD LOW-ORDER BYTE
0349 AS FD LDA FD ;LOAD HIGH-ORDER BYTE
034B 60 RTS
```

Reference

Designation

IC1  9708, A/D converter
IC2,IC3  74LS221, monostable multivibrator
IC4,IC5  74LS393, dual 4-bit binary counter
IC6  74150, 1 of 16 data selectors
IC7  74LS02, quad 2-input NOR gate
IC8  74LS08, quad 2-input AND gate
C1  0.01 µF, polyester
C2  0.02 µF, ceramic
C3,C4,C5  0.1 µF, ceramic
C6,C7  100 pF, ceramic
R1  50 k-ohm, 10-turn potentiometer
R2  47 k-ohm, ¼ W, 5% tolerance
R3  10 k-ohm, 10-turn potentiometer
R4,R5  10 k-ohm, ¼ W, 10%
R6  15 k-ohm, ¼ W, 5%
R7  100 k-ohm, ¼ W, 10%
R8,R9  6.8 k-ohm or 27 k-ohm, ¼ W, 5%

Table 1: Parts list for circuit of figure 1. Capacitor C1 should be a low-leakage type. No precision tolerances are required.
or 2 bytes of memory that will contain the 16-bit count. The sequence is repeated for each bit, starting with the most-significant bit at hexadecimal address 0F and ending with the least-significant bit at address 00.

The most efficient operation will result when the analog-to-digital conversion is initiated at a point in the program that occurs a number of instructions before the voltage reading is required. The computer is then free to execute the intervening instructions before having to wait for completion of the conversion. The hand-assembled program segment, shown in listing 1, illustrates the use of the converter and the RDADC subroutine (see listing 2). Note the instructions inserted between the initiation of the conversion at hexadecimal address 026A and the reading of the output at address 027A.

A nonzero count is always obtained, even when reading 0 V. This count must be subtracted from the reference voltage and channel counts. Thus, the computation for a linearized and scaled voltage reading becomes:

\[
V(i) = \frac{\text{Count(Channel i) - Count(0)}}{\text{Count(7) - Count(0)}} \times V_{REF}
\]

where \( V_{REF} \) is the reference voltage.

Long-term drift effects are minimized by reading the zero and reference voltages each time a channel is sampled. When reading very small input voltages, the possibility exists that a channel count may be smaller than the zero count. The apparent instability resulting from this condition is avoided by simply setting the channel count equal to the zero count.

The uses for such a converter are many and diverse. For example, if you are an energy-conscious homeowner, you may wish to monitor temperatures throughout your home. Or, if you are an amateur horticulturist, you may wish to monitor light intensity and temperatures of air and soil to optimize growing conditions for plants or cuttings. Whatever the application, I hope that this converter, with its 8 bits of accuracy for table subscripts or 10 bits of accuracy for better resolution, will serve you well.
This vocabulary of 139 entries can be stored in as little as 770 bytes. The ASCII codes shown are for the TRS-80 voice synthesizer. Using Votrax symbology, however, this vocabulary is applicable to many other synthesizers, including the new SC01 phoneme speech chip.

[In February, Kathryn Fons and Tim Gargagliano coauthored an article entitled “Articulate Automata” (February 1981 BYTE, page 164), in which they presented an overview of the physiology of speech and a look at how Votrax voice synthesizers are programmed. Since that article contained only general guidelines for programming voice synthesizers, they decided to provide us with more specific information in the form of this list of common computer terms and how they would be programmed....SM]
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 U1</td>
<td>Votrax ASCII</td>
</tr>
<tr>
<td>F P</td>
<td>E1 AY Y</td>
</tr>
<tr>
<td>K Y</td>
<td>IU U1 U1</td>
</tr>
<tr>
<td>AH1</td>
<td>UH2 ER</td>
</tr>
<tr>
<td>EH1</td>
<td>EH3 S</td>
</tr>
<tr>
<td>T Y</td>
<td>E1 AY Y</td>
</tr>
<tr>
<td>Y U1</td>
<td>IU U1 U1</td>
</tr>
<tr>
<td>V E</td>
<td>E1 AY Y</td>
</tr>
<tr>
<td>D UH1</td>
<td>B UH3 L Y1 IU U1</td>
</tr>
<tr>
<td>X EH1</td>
<td>EH2 K</td>
</tr>
<tr>
<td>W AH1</td>
<td>EH3 I3 Y</td>
</tr>
<tr>
<td>Z E</td>
<td>E1 AY Y</td>
</tr>
<tr>
<td>ACCESS</td>
<td>AE1 EH3 K</td>
</tr>
<tr>
<td>ADDRESS</td>
<td>AE1 EH3 D</td>
</tr>
<tr>
<td>AND</td>
<td>AE1 EH3 N</td>
</tr>
<tr>
<td>AUTOMATIC</td>
<td>AH1 T UH2 M</td>
</tr>
<tr>
<td>BILLION</td>
<td>B I1 I3 L Y UH3 N</td>
</tr>
<tr>
<td>BLOCK</td>
<td>B L AH1 UH3 K</td>
</tr>
</tbody>
</table>

Vocabulary continued on page 386
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Vocabulary continued:

BREAK ........ E R A1 AY K Votrax
             E R @ K ASCII

BUS ............ E UH1 UH3 S Votrax
             E 6 8 S ASCII

CABLE ........... K A1 Y E UH3 L Votrax
              K @ & E 8 L ASCII

CHARACTER ... K EH1 R EH1 K T ER Votrax
              K 3 R 3 K T / ASCII

CLEAR ........... K L AY I3 R Votrax
              K L @ R ASCII

CLOSE ........... K L 01 U1 Z Votrax
              K L 0 U Z ASCII

CONTINUE ........ K UH1 N T I1 I3 N Y1 IU U1 Votrax
                K 6 N T I I N Y U ASCII

COSINE ........... K 01 U1 S AH1 EH3 Y N Votrax
                 K O U S S & N ASCII

DATA ............. D AE1 EH3 T UH2 UH3 Votrax
                 D 9 5 T 7 8 ASCII

DESK ............ D EH1 EH3 S K Votrax
                 D 3 5 S K ASCII

DEVICE ........... D EH1 EH3 V UH3 AH2 Y S Votrax
                 D 3 5 V 8 A & S ASCII

DISK .............. D II I3 S K Votrax
                 D I I S K ASCII

DISPLAY ........... D II S P L A1 I3 Y Votrax
                    D I S P L @ & ASCII

DRIVE ............ D R AH1 EH3 Y V Votrax
                   D R I S V ASCII

EDIT ............. .EH1 D I1 T Votrax
                    3 D I T ASCII

ELSE .............. .EH1 EH3 L S Votrax
                   3 5 L S ASCII

ENABLE ........... .EH1 N A1 Y B UH3 L Votrax
                    3 N B B L ASCII
END ....... .EH1 EH3 N D Votrax
3 5 N D ASCII
ENTER ....... .EH1 EH3 N T ER Votrax
3 5 N T / ASCII
ERASE ...... .AY I1 R A1 AY Y S Votrax
* I R @ * & S ASCII
ERROR ...... .EH1 ER 01 R Votrax
3 / 0 R ASCII
ESCAPE ...... .EH1 EH3 S K A1 Y P Votrax
3 5 S K @ & P ASCII
EXECUTE ...... .EH1 K PA0 S EH1 K Y1 IU U1 T Votrax
3 K 0 S 3 K Y ( U T ASCII
EXPONENT ...... .EH1 EH3 K PA0 S P 01 U1 N EH1 N T
3 5 K 0 S P 0 U N 3 N T
FEED ........ .F E1 Y D Votrax
F E & D ASCII
FIELD ........ .F E1 Y L D Votrax
F E & L D ASCII
FIX .......... .F I1 I3 K PA0 S Votrax
F I # K 0 S ASCII
FLOPPY ...... .F L AH1 UH3 P Y Votrax
F L & 8 P & ASCII
FOR .......... .F 02 02 R Votrax
F C E R ASCII
FORMAT ...... .F 02 02 R M AE1 EH3 T Votrax
F C E R M 9 5 T ASCII
FORWARD ...... .F 02 02 R W ER D Votrax
F C E R W / D ASCII
FRAME ........ .F R A1 AY Y M Votrax
F R @ * & M ASCII
FREE .......... .F R E1 Y Votrax
F R E & ASCII
GET .......... .G EH1 EH3 T Votrax
G 3 5 T ASCII
GLITCH....... .G L I1 I3 T CH Votrax
G L I # T C ASCII

Vocabulary continued on page 388
Technical Forum
Vocabulary continued:

GOSUB       . . . . . G 01 U1 S UH1 UH3 B Votrax
            G 0 U S 6 8 B B ASCII

GOTO        . . . . . G 01 U1 T IU U1 Votrax
            G 0 U T # U ASCII

HUNDRED     . . . . . H UH1 UH3 N D R EH3 D Votrax
            H 6 8 N D R 5 D ASCII

IF          . . . . . . I1 I3 F Votrax
            I * F ASCII

INKEY       . . . . . . I1 I3 N K AY Y Votrax
            I * N K * & ASCII

INPUT       . . . . . . I1 I3 N P 00 T Votrax
            I * N P $ T ASCII

INSTRING    . . . . . . I1 I3 N S T R I1 I3 NG Votrax
            I * N S T R I * + ASCII

INSTRUCTION . . . . . . I1 I3 N S T R UH1 K SH UH1 N Votrax
            I * N S T R 6 K > 6 N ASCII

KEYBOARD    . . . . . . K AY Y B 01 02 R D Votrax
            K * & B 0 1 R D ASCII

KILL        . . . . . . K I1 I3 L Votrax
            K I * L ASCII

LEFT        . . . . . . L EH1 EH3 F T Votrax
            L 3 5 F T ASCII

LEN          . . . . . . L EH1 EH3 N Votrax
            L 3 5 N ASCII

LENGTH       . . . . . . L EH1 EH3 N TH Votrax
            L 3 5 N = ASCII

LEVEL        . . . . . . L EH1 EH3 V UH3 L Votrax
            L 3 5 V B L ASCII

LINE        . . . . . . L AH1 Y N Votrax
            L ; & N ASCII

LIST         . . . . . . L I1 I3 S T Votrax
            L I * S T ASCII

LOAD        . . . . . . L 01 U1 D Votrax
            L 0 U D ASCII

LOCK        . . . . . . L AH1 UH3 K Votrax
            L ; 8 K ASCII
Vocabulary continued on page 390
Technical Forum
Vocabulary continued:

POINT . . . . . . P 01 I3 AY N T Votrax
                      P 0 x x N T ASCII

POKE . . . . . . . P 01 U1 K Votrax
                       P 0 U K ASCII

POSITION . . . . P UH1 UH3 Z I1 SH UH3 N Votrax
                           P 6 B Z I > 8 N ASCII

POWER . . . . . . . P AH1 UH3 W ER Votrax
                          P + B W / ASCII

PRINT . . . . . . . P R I1 I3 N T Votrax
                        P R I x x N T ASCII

PUT . . . . . . . . . P 001 001 T Votrax
                           P % % T ASCII

RANDOM . . . . . R AE1 EH3 N D UH1 M Votrax
                      R 9 S N D 6 M ASCII

READ . . . . . . . . R E1 Y D Votrax
                        R E E D ASCII

REMARK . . . . . . R E1 M AH1 R K Votrax
                      R E E M + R K ASCII

REPEAT . . . . . . . R E1 P E1 AY T Votrax
                       R E P E x T ASCII

RESET . . . . . . . R E1 S EH1 EH3 T Votrax
                       R E S 3 5 T ASCII

RESTORE . . . . . . R E1 S T 02 O2 R Votrax
                      R E S T 2 2 R ASCII

RESUME . . . . . . . R E1 Z IU U1 U1 M Votrax
                      R E Z ( U U M ASCII

RETURN . . . . . . . R E1 T ER R N Votrax
                       R E T / R N ASCII

REWIND . . . . . . . R E1 W AH1 AY Y N D Votrax
                       R E W x x N D ASCII

RIGHT . . . . . . . R UH3 AH2 Y T Votrax
                   R B A & T ASCII

SAVE . . . . . . . . S A1 AY Y V Votrax
                      S @ x & V ASCII

SELECT . . . . . . . S EH2 L EH1 K PA0 T Votrax
                        S 4 L 3 K 0 T ASCII
SET .......... S  EH1 EH3 T  Votrax
                   S  3  5  T  ASCII
SHIFT ............ SH  I1 I3 F  T  Votrax
                      >  I  $  F  T  ASCII
SINE ............. S  AH1 EH3 Y  N  Votrax
                    S  $  5 &  N  ASCII
STEP ............. S  T  EH1 EH3 P  Votrax
                    S  T  3  5  P  ASCII
STOP ............. S  T  AH1 UH3 P  Votrax
                    S  T  $  8  P  ASCII
STRING ............ S  T  R  I1 I3 NG  Votrax
                      S  T  R  I  $  +  ASCII
SUPPLY ........... S  UH1 P  L  AH1 EH3 Y  Votrax
                    S  6  P  L  $  5 &  ASCII
SYSTEM ............ S  I1 S  T  EH1 M  Votrax
                      S  I  S  T  3  M  ASCII
TAB ............. T  AE1 EH3 B  Votrax
                    T  9  5  B  ASCII
TANGENT .......... T  AE1 EH3 N  D  J  EH1 N  T  Votrax
                    T  9  5  N  D  J  3  N  T  ASCII
THEN .......... THV  EH1 EH3 N  Votrax
                  <  3  5  N  ASCII
TIME ............. T  AH1 EH3 Y  M  Votrax
                    T  $  5 &  M  ASCII
TRACE ............ T  R  A1 AY  Y  S  Votrax
                    T  R  @  * &  S  ASCII
THOUSAND .......... TH  AH1 UH3 U1 Z  EH3 N  D  Votrax
                    =  $  8  U  Z  5  N  D  ASCII
USER ............ Y1 IU U1 U1 Z  ER  Votrax
                    Y (  U  U  Z /  ASCII
USING ........... Y1 IU U1 U1 Z  I1 I3 NG  Votrax
                    Y (  U  U  Z  I  $  +  ASCII
VALUE ........... V  AE1 EH3 L  Y1 IU U1 Votrax
                    V  9  5  L  Y  (  U  ASCII
ZAPPED .......... Z  AE1 EH3 P  PA0 T  Votrax
                    Z  9  5  P  0  T  ASCII
The Impossible Dream: 
Computing $e$ to 116,000 Places with a 
Personal Computer

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10260 Bandley Dr
Cupertino CA 95014

The 1960s were a decade of unrest, turbulence, and accomplishment. Man walked on the moon, *Star Trek* was launched, and the first million digits of $\pi$ were determined by a computer. Today, as we face the early 1980s, Robert Truax, a backyard hobbyist, is constructing a private spacecraft, *Star Trek* has been revived as a movie, and personal computers are a reality. As a people, passion drives us to explore the unknown reaches of our universe. It is pleasing to note that this exploration is no longer the exclusive domain of governments and large institutions.

The purpose of this article is to share my experiences in computing the mathematical constant $e$ to 116,000 digits of precision on an Apple II computer. Although this computation has little intrinsic value or use, the experience was stimulating and educational. The problems I was forced to overcome gave me insights that greatly contributed to new floating-point routines. These routines were, in some cases, two to three times as fast as those currently implemented in some of our languages at Apple. Because I wanted to develop my own solutions to the problem, I did not research existing techniques for computing $e$ to great precision. Therefore, my approaches are quite possibly not state-of-the-art.

I first calculated $e$ to 47 K bytes of precision in January 1978. The program ran for 4.5 days, and the binary result was saved on cassette tape. Because I had no way of detecting lost-bit errors on the Apple (16 K-byte dynamic memory circuits were new items back then), a second result, matching the first, was required. Only then would I have enough confidence in the binary result to print it in decimal.

Before I could rerun the 4.5 day program successfully, other projects at Apple, principally the floppy-disk controller, forced me to deposit the project in the bottom drawer. This article, already begun, was postponed along with it. Two years later, in March 1980, I pulled the $e$ project out of the drawer and reran it, obtaining the same results. As usual (for some of us), writing the magazine article consumed more time than that spent meeting the technical challenges.

Little Things Add Up

To compute the value of $e$, a method or formula must be found or derived. The CRC Standard Mathematical Tables handbook (see references) provides the well-known formula:

$$e = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \cdots$$

We know that $e$ is approximately 2.71828. For the sake of simplicity, we will deal with the fractional part only (.71828, etc) and abbreviate it $efrac$.

$$efrac = \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \cdots$$

Because each term is less than one-half the prior term, this series converges with the property that the sum of all terms beyond a specified $n$th term is less than that $n$th term. Thus, if the series is truncated after $n$ terms, the maximum error in the computation is less than $(1/n!)$. This property relates the number of terms used, $n$, to the precision obtained in the computation. Because this series contains a factorial in the denominator of the terms, it is said to converge rapidly. This means that great precision can be obtained with relatively few terms. For example,
We begin by reversing the order of terms in \( \text{efrac} \):

\[
\text{efrac} = 1/2! + 1/3! + \ldots + 1/(n-1)! + 1/n! \quad (n \text{ terms})
\]

We then develop the following identity:

\[
\frac{1}{i!} + \frac{1}{(i-1)!} = \frac{1}{i(i-1)!} + \frac{1}{(i-1)!}
\]

\[
= \frac{1}{i} + 1/(i-1)!
\]

By repeatedly applying this identity to the formula, we get:

\[
\frac{1}{n} + 1/(n-1)!
\]

On inspection, the second series is equivalent to the first for \( n \) terms. A notable property of the new series is that the computation begins with the \( n \)th (greatest) divisor and ends with 2 (the smallest). The algorithm for computing \( e \) with this series is as follows:

1. Allocate all available memory to the \( E \) array (which stores the value of \( \text{efrac} \), the fractional part of \( e \)). Initialize it to zero.
2. Set the initial value of \( \text{DIVISOR} \) to \( n \), the precalculated maximum term (where \( n! \) is greater than the precision of the result to be computed).
3. Add 1 to \( E \) and divide by the current \( \text{DIVISOR} \). The addition may simply imply setting the carry before dividing.
4. Decrement the \( \text{DIVISOR} \).
5. Repeat steps 3 and 4 until the divisor equals 1.

We have rearranged the series for \( e \) to begin with the smallest divisor (2) and end with the greatest (\( n \)). This method utilizes only 50% of available memory, compared to 100% in the original algorithm.
An example of this algorithm for $n=5$ is given in table 1.

How Large Is It?

An associate of mine once discovered that integrated circuit layouts could be conveniently specified in nanos­

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the fraction array E is assumed to be E(0), and the low-order byte is E(n). Remember that the 2-byte divisor, NH and NL, represents a whole number, and that the dividend represents a binary fraction with the binary point directly to the left of the MSB (most significant bit) of E(0).

In the algorithm that follows, the A0 byte represents the current byte, E(i), of the dividend at step 2. By step 6, however, all the digits of the dividend have been shifted out to the left (to the A1, A2 combination), and the digits of the new quotient have been shifted into A0 from the right. A0 is actually doing the work of two 8-bit registers.

Of course, all computation should be done in binary for maximum precision and speed. While targeted for 8-bit machines, these techniques are applicable to machines of longer word lengths.

The “add 1 and divide by n” algorithm (see figure 2) is as follows:

1. Initialize the remainder (locations A2 and A1) to 1, effectively adding 1.0 to the fractional dividend prior to dividing. (A2 is the most significant byte of the remainder.) This accommodates the algorithm developed for calculating e. An unmodified divide operation would call for initializing the remainder to zero. Initialize the index, i, to zero.

2. Move the next dividend byte, E(i), to location A0 to divide it by n. Shift A0 left 1 bit, moving the MSB into the carry bit.

3. Rotate the 16-bit remainder (A2 and A1) to the left by 1 bit, and rotate the carry bit from A0 into the LSB (least significant bit) of A1. This corresponds to the “shift” portion of the subtract-and-shift algorithm for division. No overflow can occur from this shift because the residual remainder must be less than twice the divisor, which in turn is less than 32,768 ($2^{15}$).

4. Compare the remainder, A2 and A1, to the divisor locations NH and NL. If the remainder is greater, then replace it with the difference of the two and set the quotient bit to 1. Otherwise, clear the quotient bit.

5. Rotate the quotient bit into the LSB of A0, and rotate the MSB of A0 into the carry bit.

6. Perform steps 3, 4, and 5, a total of eight times. Then replace E(i) with the byte in A0 (which is now the quotient of the byte-wide division just finished). Increment the index, i, and continue at step 2 until the last byte, E(n), has been processed.

**Special Optimizations**

I drive a small car and have found that it is helpful to accelerate or decelerate slightly in advance of certain stretches of the road (especially hills and downgrades) to obtain an adequate performance. Similarly, it is
sometimes necessary to compensate for the inherent deficiencies of microprocessors (eg: their size) by carefully implementing specific optimizations. For example, the comparison performed in step 4 (discussed above) would normally be done by subtracting the low, and then high bytes, and possibly preserving the difference for replacement of the remainder. Within certain processors, it may be faster to first compare the high bytes, since they frequently dictate the comparison result (255 out of 256 times for arbitrary contents). Also, the critical steps 3, 4, and 5 can be coded eight times in-line to avoid the overhead time of a loop. And because the divisor changes infrequently, it can be coded as fast immediate-mode data. After each full divide, the code, which resides in programmable memory, can be modified for the next divisor.

The 6502 assembly-language program in listing 2 calculates \( e \) in 14 K bytes of memory. In order to keep the listing brief for this article, the program is not fully optimized. The major operation (add 1, divide) is not coded in-line eight times but is instead implemented as a loop. Because the Y register is used as a loop counter, it is not available as an index to the \( e \) array, and time-consuming increment instructions must be performed on the instructions at EREF1 and EREF2. Also, it is slightly faster not to move the current dividend byte of \( e \) into a separate fast location (A0 in the algorithm). The \( e \) array begins at hexadecimal location 800 (which is the most significant byte of the array). This secondary text-screen page of the Apple II allows you to view roughly the first 1 K bytes of \( e \) as they are calculated. Although the character representation is not readily useful, it is at least comforting to observe that the program is working on the correct section of memory. Do not execute this program until you read further and have a good idea of how long it runs before completion. Also, remember that although the result is in binary and somewhat meaningless, it will later be converted to decimal and printed.

**Tomorrow Is a Long Time**

The execution time of this program is proportional to the number of divisions performed (9719 for the above example), the number of bytes being divided (14 K bytes in this case), and the average divide time per byte. The average divide time per byte is calculated as follows. In listing 2, the numbers in parentheses are the cycle times of all significant instructions of the divide routine. Careful analysis shows that when the high-order dividend (remainder) byte is less than the high-order divisor byte, 23 cycles are used. When the former is greater than or equal to the latter, 39 cycles are used, with approximately 13.5 additional cycles (on the average) if the two are equal. Statistically, the remainder will be less than the divisor half of the time and greater than or equal to the divisor half of the time. Analysis reveals that the 2 bytes will be equal approximately one out of every \( 2H \) comparisons, where \( H \) is the high-order divisor.
byte contents. In the example, $H$ varies from 37 down to 0, so the average frequency of equality is 1 in 37. Using this “fudge factor,” the average cycle time per 1-bit partial division is computed as follows:

$$\text{cycles per bit} = \frac{23}{37} + \frac{39}{37} + \frac{13.5}{37}$$

$$= 31.3649 \text{ cycles}$$

Every byte divided includes eight of the above iterations plus an overhead of 21 cycles, giving the following average:

$$\text{cycles per byte} = (\text{cycles per bit} \times 8 \text{ bits per byte}) + 21$$

$$= 31.3649 \times 8 + 21$$

$$= 271.919 \text{ cycles}$$

The average time per cycle on the Apple II is a function of the crystal frequency (14.31818 MHz) and the frequency of equality, which is 1 in 37 in the example.

**Listing 2:** A 6502 machine-language program for calculating $e$ to 34,524 decimal digits. The result is in binary and must be converted to decimal by the programs shown in listings 3 and 4.

**SOURCE FILE: ECALC1**

```
0000: 1 LSTON
0000: 2 LSTON
0000: 3 * CALCULATION OF $e$ -- 14K
0000: 4 * ...
0000: 5 * Woz 20-APR-80
0000: 6 * ...
0000: 7 * \text{EXAMPLE PROGRAM}
0000: 8 *
0000: 9 *
0000: 10 * LOCATION $800-3FFF$ ARE USED
0000: 11 * FOR THE (BINARY) FRACTION OF $e$. LOCATION $800$ IS THE MOST
0000: 12 * SIGNIFICANT BYTE, $3FFF$ IS
0000: 13 * THE LEAST SIGNIFICANT. THIS
0000: 14 * CORRESPONDS TO APPROXIMATELY
0000: 15 * 34524 DIGITS.
0000: 16 *
0000: 17 * THE FIRST DIVISOR IS 9720
0000: 18 * AND THE LAST IS 2. 9720
0000: 19 * FACTORIAL IS GREATER THAN
0000: 20 * $10 \times 34524$.
0000: 21 *
0000: 22 * THE MAJOR OPERATION IS AN
0000: 23 * INCREMENT (+1) OF $e$ FOLLOWED
0000: 24 * BY A MULTI-PRECISION DIVIDE
0000: 25 * BY THE CURRENT DIVISOR.
0000: 26 * EACH SUCCESSIVELY LESS SIG-
0000: 27 * NIFICANT BYTE OF $e$, TOGETHER
0000: 28 * WITH THE RESIDUAL REMAINDER
0000: 29 * $A1$ AND $A2$, IS DIVIDED BY THE
0000: 30 * CURRENT 2-BYTE DIVISOR. THE
0000: 31 * 8-BIT QUOTIENT IS LEFT IN $e$
0000: 32 * AND THE RESIDUAL REMAINDER
0000: 33 * IN $A1$ AND $A2$ (ACC HOLDS $A2$).
0000: 34 *
0000: 35 * THE CURRENT BYTE OF $e$ IS $A0$, ACC IS $A2$
0000: 36 * PCOUNT EQU 1 COUNTS RAM PAGES OF $e$ ARRAY.
```

Listing 2 continued on page 398
Listing 2 continued:

0800: 45 E EQU $800  E, BINARY FRACTION, TO $3FFF.
0038: 46 NUMPAG EQU $38  14K IS 56 RAM PAGES.
25F8: 47 N EQU 9720  (N FACTORIAL IS > 34524 DIGITS)
25F8: 48 NL EQU N&$FF  LO BYTE OF N.
0025: 49 NH EQU N/256  HI BYTE OF N.

----- NEXT OBJECT FILE NAME IS ECALC1.OBJ

0240:  51 ORG $240
0240:A9 38  52 NXTDVSR LDA #NUMPAG  INIT RAM PAGE COUNTER
0242:B5 01  53 STA PCOUNT  FOR 56 PAGES.
0244:A9 01  54 LDA #1
0246:B5 00  55 STA A1
0248:A9 08  56 LDA #E/256
024A:BD 5C 02  57 STA EREF1+2  MODIFY CODE SO THAT REFS
024D:B7 02  58 STA EREF2+2  TO E POINT TO FIRST BYTE.
0250:BD A0  59 LDA #0
0252:BD 52 02  60 STA EREF1+1  (ACC IS ALSO A2 OF RESIDUAL REMAINDER)
0255:BD 77 02  61 STA EREF2+1
0258:AO 08  62 NXTBYTE LDY #8  (2) COUNTER--8 BITS PER BYTE.
025A:OE !1 00  63 EREF1 ASL E  (6) MSB OF DIVIDEND BYTE TO CARRY.
025D:26 00  64 NXTBIT ROL A1  (5) SHIFT 3-BYTE DIVIDEND.
025F:2A  65 A
0260:C9 25  66 NHREF1 CMP #NH  (2) IF HI BYTE LESS THAN DIVISOR
0262:90 12  67 BCC EREF2  (3/2) THEN QUOTIENT BIT IS 0.
0264:DO 06  68 BNE REPLACE  (3/2) (TAKEN IF GREATER)
0266:A6 00  69 LDX A1  (3) COMPARE LOW BYTES IF HI BYTES EQUAL.
0268:EO F8  70 NLREF1 CPX #NL  (2)
026C:90 0A  71 BCC EREF2  (3/2) IF LESS, QUOTIENT BIT IS 0.
026C:AA  72 REPLACE TAX  (2)
026D:A5 00  73 LDA A1  (3) REPLACE RESIDUAL REMAINDER A1 AND A2
026F:EF F8  74 NLREF2 SBC #NL  (2) WITH RESIDUAL REMAINDER
0271:85 00  75 STA A1  (3) MINUS CURRENT DIVISOR.
0273:8A  76 TXA  (2) (HI BYTE OF RESIDUAL REMAINDER)
0274:EE 25  77 NHREF2 SBC #NH  (2) (GUARANTEED TO SET CARRY)
0276:2E 00 08  78 EREF2 ROL E  (6) QUOTIENT BIT INTO AO LSB, MSB TO CARRY.
0279:88  79 DEY  (2) NEXT OF 8 BITS.
027A:DD E1  80 BNE NXTBIT  (3/2) LOOP--NOTE: CARRY = QUOTIENT BIT.
027C:EE 5B 02  81 INC EREF1+1  (5)
027F:EE 77 02  82 INC EREF2+1  (5) MODIFY CODE REFS TO E ARRAY.
0282:DD D4  83 BNE NXTBYTE  (3) (NO BYTE OVERFLOW)
0284:EE 5C 02  84 INC EREF1+2
0287:EE 78 02  85 INC EREF2+2  (MODIFY HI BYTE)
028A:C6 01  86 DEC PCOUNT
028C:DD CA  87 BNE NXTBYTE  LOOP UNTIL DONE 56 RAM PAGES.
028E:AD 69 02  88 LDA NLREF1+1
0291:DD 06  89 BNE NXTDVR2
0293:CE 61 02  90 DEC NHREF1+1  DECR IMMEDIATE REFS TO
0296:CE 75 02  91 DEC NHREF2+1  CURRENT DIVISOR.
0299:CE 69 02  92 NXTDVR2 DEC NLREF1+1
029C:CE 70 02  93 DEC NLREF2+1
029F:AD 69 02  94 LDA NLREF1+1
02A2:4A  95 A
02A3:DD 61 02  96 ORA NHREF1+1  LOOP IF DIVISOR > 1.
02A6:DD 98  97 BNE NXTDVSR
02A8:60  98 RTS  (DONE)

*** SUCCESSFUL ASSEMBLY: NO ERRORS
Text continued from page 397:

frequency-dividing circuitry that generates the microprocessor clock. Due to color-graphics considerations, a slight adjustment (to eliminate display jitter) is made, which introduces a constant multiplying the crystal period, and gives us the following time per machine cycle:

\[
\text{time per cycle} = \frac{912}{(65)(14.31818 \text{ MHz})} = 0.9799269 \mu s
\]

The division time per byte (in µs) and time per program execution can now be calculated:

\[
\begin{align*}
\text{time per byte} & = \text{cycles per byte} \times \text{time per cycle} \\
& = 271.919 \text{ cycles} \times 0.9799269 \mu s \\
& = 266.46 \mu s \\
\text{time per program} & = \text{time per byte} \times \text{number of bytes} \times \text{number of divisions} \\
& = 266.46 \mu s \times (14)(1024) \times 9719 \\
& = 37,126 \text{ seconds} \\
& = 10.3 \text{ hours}
\end{align*}
\]

Note that as you compute \( e \) to greater precision, both the number of divisors and the length of each division increase. Also, at some point, a 2-byte division no longer suffices and a 3-byte division must be used. This causes the execution time to vary with roughly the second power of the precision sought. For example, three times the precision takes ten times as long to calculate!

Running the Example Program

If you wish to try the example program before branching out on your own, a few suggestions should be heeded. First, it is a shame to run a program for 10 hours and then find out it contained a minor bug. By changing \( N \) (the maximum divisor) to 1000 and NUMPAG to 4 (for 1 K bytes of precision), a quick trial/practice version can be assembled. The practice run allows the user to get the obvious mistakes out of the way with minimum consequence and verify that the assembly is correct. The following commands will clear the memory locations used, run the program, and finish in about 4.5 minutes (273 seconds). Hexadecimal location 0800 should contain B7, and location 0BFF should contain 24 upon completion. As mentioned previously, you can watch the calculation proceed by displaying the secondary text screen on the Apple II. During the trial run, it should be constantly changing.

The following two lines (to be entered when the Apple II is in monitor mode) allow you to run the test program:

\[
\begin{align*}
& \ast 800:0 \text{ N801} < 800.BFEM \\
& \ast C055 240G C054
\end{align*}
\]

The first line clears the area of memory that will be used, and the second line switches the video display to text page 2 (which will contain the value of \( e \) being computed), runs the program of listing 2, then returns to text page 1 when the program is complete.

The real (10-hour) example program should be run twice, and the results compared to verify that the program does not contain a minor bug and that the constants were properly determined. As discussed below, it is not necessary to initialize memory before running the program if the constant \( n \) has been properly selected. Therefore, it is recommended that the program be run first with initialized memory and later with random (uninitialized) memory. These results, when compared, should be identical. Once you have confidence in the binary result, save it on tape or floppy disk for printing in decimal.

Go Forth and Multiply

The computed binary fraction must next be converted to decimal and printed. The general method of converting a binary fraction to a decimal fraction is to repeatedly multiply it by decimal 10 (in binary). The carry from each multiplication (integer portion of product) is the next decimal digit. Because the most significant digits are generated first, the result can be printed as it is generated.

A higher-level language such as BASIC should be used to format the output, but unless you are planning a short vacation, highly optimized machine language should be used for the base conversion. The 6502 programs in listing 3 accomplish the conversion. Subroutine INIT is called once to generate a 256-entry, multiply-by-100 lookup table. Subroutine MULT scans the \( e \) array, from the least toward the most significant bytes, multiplying each byte by 100 via a fast table lookup. It also handles carries. The resultant carry is a 2-digit number between 0 and 99 that is returned to BASIC for printing. Note that multiplying by 100, instead of 10, generates 2 digits per pass.

Seeing Is Believing

The BASIC formatting program in listing 4 should produce an attractive printout. No single program will suffice, due to the fact that printers and people are so varied. The considerations include page headers (title, date, page number), lines per page, spacing between lines, digits per line, digit groupings (eg: groups separated by a space or two), and margins. For example, the poor horizontal registration of a Centronics 779 printer is painfully obvious with single-spaced printouts but almost undetectable with double-spaced ones. A little trial and error will insure that your printout is a perfect “10.”

The program in listing 4 was used with an NEC (Nippon Electric Company) Spinwriter. It prints 60 digits per line (twelve groups of 5 digits, separated by single blanks) and 60 lines per page. The page heading is simply the letter \( e \) and the page number, carefully aligned with the left and right margins. The text “\( e = 2.7 \)” precedes the first digit of the printout. The program ends after printing 34,500 digits, despite the fact that an additional 24 digits are re-
Listing 3: A BASIC driver program to print e from binary to decimal form. The program uses the machine-language program EPRNT, shown in listing 4.

SOURCE FILE: EPRNT

0000: 1
0000: 2
0000: 3
0000: 4
0000: 5
0000: 6
0000: 7
0000: 8
0000: 9
0000: 10
0000: 11
0000: 12
0000: 13
0000: 14
0000: 15
0000: 16
0000: 17
0000: 18
0000: 19
0000: 20
0000: 21
0000: 22
0000: 23
0000: 24
0000: 25
0000: 26
0000: 27
0000: 28
0000: 29
0000: 30
0000: 31
0000: 32
0000: 33
0000: 34
0000: 35
0000: 36
0000: 37
0000: 38
0000: 39
0000: 40
0000: 41
0000: 42
0000: 43
0000: 44
0000: 45
0000: 46
0000: 47
0000: 48
0000: 49
0000: 50
0000: 51

E' PRINTOUT ROUTINES

14K VERSION

WOZ 20-APR-80

THESE SUBROUTINES PERFORM

THE CRITICAL OPERATIONS

FOR CONVERTING THE 14K

BINARY VERSION OF 'E'

TO DECIMAL FOR PRINTING.

THEY ARE INTENDED TO BE

CALLED FROM A BASIC PROGRAM

WHICH DOES THE ACTUAL

PRINTING.

THE BINARY REPRESENTATION

OF THE FRACTIONAL PART OF

E (OR ANY OTHER NUMBER

TO BE CONVERTED TO DECIMAL)

IS STORED IN LOCATIONS $800

(MOST SIGNIFICANT) TO $3FFF

(LEAST). THE SUBROUTINES

INIT AND MUL RESIDE IN THE

$4000 PAGE OF MEMORY AND

USE TABLES PRODLO AND

PRODHI IN THE $4100 AND

$4200 PAGES RESPECTIVELY.

LOMEM MUST BE SET TO $4300

(17,152 DECIMAL) OR GREATER

FROM BASIC.

SUBROUTINE INIT MUST BE

CALLED ONCE TO GENERATE

'MULTIPLY BY 100' TABLES

PRODLO AND PRODH. INIT

MUST BE CALLED BEFORE MUL.

SUBROUTINE MULT PERFORMS

A 'MULTIPLY BY 100' ON THE

NUMBER 'E'. IT RETURNS

THE NEXT TWO DIGITS OF THE

DECIMAL EQUIVALENT AS A
0000: 52 * NUMBER BETWEEN 0 AND 99 IN *
0000: 53 * LOCATION 1 (WHERE BASIC *
0000: 54 * CAN PEEK IT FOR PRINTING). *
0000: 55 *
0000: 56 ***************************************

0000: 58 XSAV EQU 0 X-REG SAVE LOCATION.
0001: 59 RESULT EQU 1 RESULT BYTE FROM MULTIPLY.
0002: 60 PCOUNT EQU 2 COUNTS NUMBER OF RAM PAGES OF E.
0100: 61 PRODLO EQU $4100 LOW BYTE TABLE (100 * IDX).
0200: 62 PRODHI EQU $4200 HI BYTE TABLE (100 * IDX).
0800: 63 E EQU $800 E, BINARY FRACTION, TO $3FFF.
003F: 64 NUMPAG EQU 56 56 PAGES IN 14K
0006: 65 LASTPAG EQU $3F LAST (LEAST SIGNIFICANT) PAGE OF E.
0006: 66 *
0006: 67 ***************************************

****** NEXT OBJECT FILE NAME IS EPRNT.OBJO

4000: 69 ORG $4000
4002: A9 00 70 INIT STX XSAV PRESERVE X-REG FOR INT BASIC.
4004: AA 72 TAX STARTING PRODUCT HI BYTE.
4005: A8 73 TAY STARTING INDEX TO PRODUCT TABLES.
4006: 99 00 41 74 PRODGEN STA PRODLO,Y STORE LOW BYTE OF 100 * Y.
4009: 4B 75 PHA PRESERVE A-REG
400A: 8A 76 TXA HI BYTE OF CURRENT PRODUCT.
400B: 99 00 42 77 STA PRODHI,Y STORE HI BYTE OF 100 * Y.
400E: 68 78 PLA RESTORE A-REG (PRODUCT LOW BYTE).
400F: 18 79 CLC
4010:64 80 ADC #100 ADD 100 FOR NEXT PRODUCT.
4012:90 01 81 BCC NXTPROD
4014: E8 82 INX
4015:C8 83 NXTPROD INY NEXT OF 256 PRODUCTS.
4016:DO EE 84 BNE PRODGEN
4018: A6 00 85 LDX XSAV RESTORE X-REG FOR INT BASIC.
401A: 60 86 RTS (RETURN

401B: 87 *
401B: 88 ***************************************

401B: A9 38 90 MULT LDA #NUMPAG
401D: B5 02 91 STA PCOUNT 56 PAGES IN 14K.
401F: A9 3F 92 LDA #LASTPAG
4021: 8D 32 40 93 STA MULTI+2 INIT E REFS FOR LEAST
4024: 8D 38 40 94 STA MULTI+2 SIGNIFICANT RAM PAGE.
4027: A0 00 95 LDY #0 INIT INDEX TO E (WILL DECR TO $FF FIRST TIME)
4029: A2 00 96 LDX #0 TRICK TO CLEAR RESIDUAL CARR.
402B: 18 97 CLC
402C: ED 00 42 98 MULBYT LDA PRODHI,X (4) HI PROD BYTE IS RESIDUAL CARRY.
402F: 88 99 DEY (2) NEXT MORE SIGNIFICANT BYTE OF E.
4030: BE 00 08 100 MULTI LDX E,Y (4) (GET IT)
4033: 7D 00 41 101 ADC PRODLO,X (4) TIMES 100, PLUS RESIDUAL CARRY.
4036: 99 00 08 102 MULTI STA E,Y (5) RESTORE PRODUCT BYTE.
4039: 98 103 TYA (2) LAST BYTE THIS PAGE?
403A: DO F0 104 BNE MULBYT (3/2) NO, CONTINUE.
403C: CE 32 40 105 DEC MULTI+2 (6)

Listing 3 continued on page 402
Listing 3 continued:

403F:CE 38 40 106 DEC MULT2+2 (6) NEXT MORE SIGNIFICANT PAGE.
4042:C6 02 107 DEC PCOUNT (5) DONE 56 PAGES?
4044:D0 E6 108 BNE MULBYT (3) NO, CONTINUE.
4046:7D 00 42 109 ADC PRODHI,X RETRIEVE FINAL CARRY.
4049:85 01 110 STA RESULT SAVE AS TWO-DIGIT RETURNED VALUE.
404B:A6 00 111 LDX XSAV RESTORE X-REG FOR INT BASIC.
404D:60 112 RTS (RETURN)

*** SUCCESSFUL ASSEMBLY: NO ERRORS

Listing 4: EPRNT, a machine-language program that converts a binary number for printing as a decimal number.

FORMATTER PROGRAM - APPLE INTEGER BASIC
FILE E1 IS 'E' FROM $800 TO $3FFF
FILE EPRNT.OBJO IS INIT AND MULT SUBRS

CAUTION: MUST SET LOMEM TO 17152!
10 D$="": PRINT D$;"NOMON C,I,O": PRINT D$;"BLOAD E1,A$800": PRINT D$;
   "BLOAD EPRNT.OBJO,A$4000": PRINT D$;"PR#2"
20 INIT=16384;MULT=16411: CALL INIT:ODDEVEN=0
30 FOR PAGE=1 TO 10: PRINT ; PRINT "E"; FOR I=1 TO 63: PRINT " "; NEXT I: PRINT "PAGE ";PAGE/10;PAGE MOD 10: PRINT
40 FOR LINE=1 TO 60: IF PAGE>1 OR LINE>1 THEN 50: PRINT "E=2."; GOTO 60
50 PRINT ";
60 FOR GROUP=1 TO 12
70 FOR DIG=1 TO 5: GOSUB 200: NEXT DIG
80 PRINT " "; NEXT GROUP
90 PRINT ; IF PAGE=10 AND LINE=35 THEN 110: NEXT LINE: REM QUIT AFTER 34500 DIGITS
100 PRINT PRINT PRINT NEXT PAGE
110 PRINT D$;"PR#0": END : REM TURN PRINTER OFF
190 REM
192 REM SUBROTINE 200 PRINTS NEXT DIG
194 REM
200 IF ODDEVEN=1 THEN 220: CALL MULT
210 PRINT PEEK (1)/10: GOTO 230
220 PRINT PEEK (1) MOD 10;
230 ODDEVEN=1-ODDEVEN: RETURN

Text continued from page 399:
quired in order to be correct. The final page and line number were precalculated to detect this stopping point. Lines 200 thru 230 make up a digit-printing subroutine that calls the assembly-language multiply-by-100 routine (MULT) every other digit.

Analysis of the Algorithm
The specified algorithm has the property that the contents of e at a given stage of computation will yet be divided by (i!), where i is the current divisor. The first implication of this property is that the allocated memory need not be initialized, since it will all be reduced to insignificance when divided by n! (because n, the starting divisor, was specifically chosen such that n! is greater than the significance corresponding to that much memory).

An interesting aspect of this implication is that the result is perfect to the last calculated bit, despite the fact that terms beyond the n-th have been omitted. Additional terms (before the n-th) would simply cause the allocated
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- Advises you on how to properly answer key questions necessary to loan application in order to help avoid having your application turned down—gives examples of what you would not do under any circumstances.
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memory to have different contents (i.e., be initialized arbitrarily) when the nth term is reached. Since division proceeds from high toward low significant bits, arbitrary data beyond a specified least significant byte can never affect the contents of that byte or any more significant byte. There can be no accumulated truncation errors such as those encountered with summation-of-terms approaches.

The second implication is that, at a given stage of calculation, only the most significant bytes of \( e \) (i.e., those that will not subsequently be divided to insignificance) need to be divided! The first divisions can be very short, only a few bytes or so, while the last ones must encompass all of \( e \). For a given divisor, \( d \), the number of (least significant) bytes of \( e \) which need not be divided is \( \log_{256}(d!) \), which may be calculated by the HP-41C program in listing 5. Note that it calls the previously written program FACTLOG, which calculates the number of digits of \( d! \). The algorithm used is:

\[
\text{number of bytes of } d! = \text{number of digits of } d!/\log_{10}(256)
\]

It is unfeasible to precalculate the number of bytes to leave undivided (or the number to divide) for each divisor and to save it in a table because the table would consume a great deal of memory. As an alternative, the divisors can be broken into blocks of, say, 1 K bytes each, and for each block a fixed number of bytes (of \( e \)) can be divided. The number of bytes to divide for a given block is calculated as the total number of bytes in the \( e \) array minus the number of insignificant bytes (calculated as above) corresponding to the minimum divisor of the block, plus a "guard" byte or two to cover slight calculation errors.

In a later program that calculated \( e \) to 116,000 digits, I used 47 K bytes (188 pages of 256 bytes each) of memory, and the maximum divisor was 28,800. The divisors were grouped into fifteen blocks of 2 K-byte divisors each, and the number of memory pages not to be divided were precalculated for each block (see table 3). This version of the program used a lookup table to determine how many pages to divide (188 minus the number not to divide) for each divisor. This technique proved extremely beneficial because it reduced the computation time from four days to two.

The 47 K-byte version used virtually all the memory in a 48 K-byte Apple. The \( e \) array occupied hexadecimal locations 400 thru BFFF. A starting divisor of 28,800

Listing 5: The FACTBYT program for the Hewlett-Packard HP-41C calculator. This program calculates the precision to which the multibyte division has to be carried out for a given divisor. See table 3 for details.

\[
\text{LBL ALPHA FACTBYT ALPHA XEQ ALPHA FACTLOG ALPHA 256 LOG / RTN}
\]
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Table 3: Table of truncated multibyte divisions that can be made during the second algorithm. Due to the nature of the second algorithm, most divisors need not carry the division out the entire length of the multibyte dividend. By grouping divisors and not calculating the bytes that are unimportant to that particular group, calculation time can be significantly decreased.

<table>
<thead>
<tr>
<th>Range of Divisors in Same Group</th>
<th>Number of Insignificant Bytes</th>
<th>Number of Pages That Can Be Left Uncalculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 2047</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2048 to 4905</td>
<td>2448</td>
<td>9.6</td>
</tr>
<tr>
<td>4096 to 8191</td>
<td>5406</td>
<td>21.1</td>
</tr>
<tr>
<td>8192 to 16383</td>
<td>6558</td>
<td>33.4</td>
</tr>
<tr>
<td>16384 to 32765</td>
<td>11836</td>
<td>46.2</td>
</tr>
<tr>
<td>32768 to 65535</td>
<td>15206</td>
<td>59.4</td>
</tr>
<tr>
<td>65536 to 13107</td>
<td>18662</td>
<td>72.7</td>
</tr>
<tr>
<td>13108 to 26214</td>
<td>22158</td>
<td>86.6</td>
</tr>
<tr>
<td>26216 to 52431</td>
<td>27518</td>
<td>100.5</td>
</tr>
<tr>
<td>52432 to 104861</td>
<td>32932</td>
<td>114.5</td>
</tr>
<tr>
<td>104862 to 20970</td>
<td>38672</td>
<td>128.8</td>
</tr>
<tr>
<td>20971 to 41943</td>
<td>44312</td>
<td>143.2</td>
</tr>
<tr>
<td>41944 to 83886</td>
<td>50952</td>
<td>157.7</td>
</tr>
<tr>
<td>83887 to 167771</td>
<td>57792</td>
<td>172.4</td>
</tr>
<tr>
<td>167771 to 335542</td>
<td>64832</td>
<td>187.1</td>
</tr>
</tbody>
</table>

resulted in 115,925 digits of precision. Because the result occupied screen memory, it had to be written to cassette tape by the calculation program before returning to the Apple II monitor. Because there was no memory available for a BASIC program, the output formatting program was coded in assembly language and reside in parts of pages 0 and 1. Pages 2 and 3 were used for the multiply-by-100 tables.

On the Horizon

As with any limitless search, there remains the challenge to compute \( e \) to even greater precision. Unfortunately, the computation time of the specified algorithm is exponentially related to the precision sought. Divide operations on high-speed computers (approximately 12 \( \mu \)s per 32 bits) are two orders of magnitude faster than the 6502 routines. The ultimate approach is to construct a custom “divide machine.” Current technologies and low programmable memory prices make it feasible to construct such a machine with a thousand-fold performance improvement over the 6502 microprocessor. With such a machine, \( e \) could be computed to 100,000,000 digits within a couple of years (one year constructing and testing, one year computing). Such a machine would require power supply backup and error-correcting memory. The memory should be purchased at the latest possible date due to decreasing prices.

Once a few simple concepts are understood, the computation that I have described is as easy as \( \pi \) (see listing 6). Why do people spend time computing these numbers to such absurd precision? Because they’re there, I suppose. Who knows what great discoveries will be made by personal computer owners in the coming years? Rest assured that a guaranteed place in the mathematics Hall of Fame awaits the discoverer of the next greatest prime number.
Listing 6: A partial printout of the value of e. The first line agrees with the fifty-place value for e that is given in the CRC Standard Mathematical Tables.
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A complete checkup for your Model I. THE FLOPPY DOCTOR completely checks every sector of 35- or 40-track disk drives. Tests motor speed, head positioning, controller functions, status bits and provides complete error logging. THE MEMORY DIAGNOSTIC checks for proper write/read, refresh, executability and exclusivity of all address locations. Includes both diagnostics and complete instruction manual.

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DEALER INQUIRIES

Circle 213 on inquiry card.
CCS Microcomputer Systems
A new line of S-100 Z80-based microcomputer systems from California Computer Systems provides real-time hardware-vector interrupt and interrupt-nesting capabilities. Multiprocessing with interleaved data-transfer rates of up to 2 megabytes per second can be achieved using direct memory access. The main board has two programmable real-time clocks, two 8-bit parallel interface channels, and two programmable RS-232C serial I/O (input/output) channels, one of which may be used for synchronous communication. The chassis contains a nineteen-slot motherboard and a power supply.

The CCS OASIS multitasking operating system features reentrant and relocatable program capabilities, and employs an ISAM (indexed-sequential access method) file structure. Task-to-task communication, file protection, timekeeping, spooling, overlay, and device-independent I/O are accomplished through software. The operating system is supported with debug, editing, relocatable-linkage, and file-sort utilities. CP/M and MP/M can be used with the system. A BASIC interpreter and compiler, FORTRAN, COBOL, and Pascal compilers are also available.

Optional boards include printer and terminal interfaces, 16 K-, 32 K-, and 64 K-byte memory boards, floppy-disk subsystems and expansions, and Winchester-type disk subsystems and expansions. Prices for the CCS systems range up to $9100. Contact California Computer Systems, Marketing Department, 250 Caribbean Dr., Sunnyvale CA 94086, (408) 734-5811.

Acom's 8088 Board
The P188 is an S-100 bus 8088 microprocessor board that will run as a stand-alone processor or as a slave. Jumpers allow configuring the card to run in different operating modes, as well as with static or dynamic memory. The 8088 microprocessor has 16-bit internal architecture, addresses 1 megabyte of memory, and features 8- and 16-bit signed and unsigned arithmetic in binary or decimal, including multiply and divide.

The P188 costs $345 assembled and tested, and $275 in kit form. For more information, contact Acom Electronics, 4151 Middlefield Rd, Palo Alto CA 94303, (415) 494-7499.

Circle 524 on inquiry card.

Single-Board 6800 Computer
The ACS 12-PRO requires a power supply and terminal to operate. The 6800-based system provides two programmable 16-bit timers, an RS-232C serial port, two 8-bit parallel ports with handshake control, and up to 4 K bytes of programmable memory and 6 K bytes of PROM (programmable read-only memory).

The ACS 12-PRO is supplied with Datricon's 4 K D-FORTH operating system. With 1 K bytes of programmable memory, D-FORTH, and a manual, the ACS 12-PRO sells for $495. For additional details, contact Datricon Corporation, 7911 NE 33rd Dr, Suite 200, Portland OR 97211, (503) 284-8277.

Circle 525 on inquiry card.

Where Do New Products Items Come From?
The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in-first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.
What's New?

PERIPHERALS

Apple IEEE-488 Interface

The A488 interface card permits the Apple II and the Apple II Plus to operate as IEEE-488 bus controllers. The A488 uses an MC68488 LSI 488-controller integrated circuit that decreases the number of circuits required. The board has 2 K bytes of firmware in EPROM (erasable programmable read-only memory). For special-purpose firmware development, the EPROM can be replaced by programmable memory. The A488 allows bus and system control with character-string instrument commands for set-up, measure, clear, local, trigger, serial-poll, and respond functions. Any equipment on the bus can be designated by a name of up to sixteen characters. Up to fifteen pieces of equipment can be connected to the A488 across a distance of up to 20 meters (66 feet) from the Apple. The card's driver firmware is linked to string routines within Applesoft; floating-point processing of numeric data is easily done. Error checking is included, and software timing loops are not needed.

The A488 is priced at $475 from SSM Microcomputer Products Inc, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400.

Circle 527 on inquiry card.

Printer for Under $1000

The Model 445 Paper Tiger printer features a seven-wire ballistic-type print head and tractor-feed motor drives. The 445 can print at speeds up to 198 cps (characters per second). Functions include bold text and the ability to print 80 columns at 10 pitch and 132 columns at 16.7 pitch. Other features include the 96-character upper- and lowercase ASCII (American Standard Code for Information Interchange) character set, six or eight lines-per-inch vertical spacing, multiline buffering, and RS-232C- and Centronics-compatible parallel interfaces. Transmission rates from 110 to 1200 bps (bits per second) are selectable. Variable form length, perforation skipping, and the ability to handle six-part forms and roll paper are other features.

Integral Data Systems' DotPlot graphics capability is offered as an option. DotPlot enables printing the full range of graphics characters. The Paper Tiger Model 445 costs $795 and the DotPlot package is $99. Contact Integral Data Systems Inc, Milford NH 03055, (603) 673-9100.

Circle 529 on inquiry card.

Extend the TRS-80 Color Computer Bus

The Color Connection is a device that extends the TRS-80 Color Computer system bus as a System-50 bus (SS-50). Using the Color Connection, floppy-disk drives and video terminals can be added, and the Color Computer's 16 K-byte internal memory can be expanded. The Color Connection sells for $99.95 from Percom Data Company, 211 N Kirby, Garland TX 75042, (800) 527-1592; in Texas, (214) 272-3421.

Circle 530 on inquiry card.

Turn IBM Typewriters Into RS-232Cs

California Micro Computer's 5060 and 5061 modules enable the IBM Model 50, 60, and 75 electronic typewriters to perform as RS-232C-compatible computer I/O (input/output) devices. The modules can be installed and removed easily without requiring modifications to the typewriter. The model 5061 is a print-only version, while the 5060 allows the typewriter to perform full terminal functions. Both units offer ASCII coding with full buffering. The 5061 costs $497 and the 5060 is $860.

For further information, contact California Micro Computer, 9323 Warbler Ave, Fountain Valley CA 92708, (714) 968-0890.

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Lifeboat Associates
Software with full support
Low-Cost Color-Graphics Terminal

RCA’s VP-3301 is a microprocessor-controlled terminal with color graphics, reverse video, programmable and resident character sets, selectable data rates and formats, a flexible-membrane keyboard, and audio feedback. The VP-3301 can be connected to modems for communication with most timesharing and data-base computer networks. The software-selectable character-display format can produce either 40 characters by 24 lines or 20 characters by 12 lines. Characters and background can be displayed in one of eight colors or gray scales. The communications interface is RS-232C or 20 mA current-loop. Configuration control includes line/local, uppercase only, full- and half-duplex, data-word formatting, plus two control-code options. The video output can be directly connected to monitors or, with an RF (radio frequency) modulator, to a television set. The suggested price for the VP-3301 is $369 from RCA Microcomputer Products, New Holland Ave, Lancaster PA 17604. (717) 397-7661.

Circle 531 on inquiry card.

8-Inch Floppy-Disk Drives

Matchless Systems, 18444 S Broadway, Gardena CA 90248, (213) 327-1010, has announced the MS-800 8-inch floppy-disk drive. The drive is compatible with the TRS-80 Models I and II, the Apple II, and S-100 systems. The MS-800 has a capacity of 256 K bytes of storage. The data transfer rate is 256 kbps (bits per second) and the track-to-track access time is 10 ms. The prices range from $995 to $1595, which includes all hardware (such as the controller), software, and documentation. Circle 532 on inquiry card.

S-100 I/O Board

The MFIO is an I/O (input/output) board designed for S-100 bus systems. It features four serial RS-232C ports with independent data rates of 50 to 19.2 kbps. It also includes 24 bits of parallel I/O configurable for four ports, five timer/counters, sixteen levels of vectored-interrupt control, and an optional battery-powered real-time clock/calendar. The MFIO costs $595. For more information, contact Digicomp Research, Terrace Hill, Ithaca NY 14850, (607) 273-5900.

Circle 533 on inquiry card.

Series 47-TR Plotter

The Series 47-TR Strip Chart/Plotter is a curve tracer with alphanumeric capabilities. Its plotting area is 25 cm (10 inches) wide. The plotter features an RS-232C- or IEEE-488-compatible port and bidirectional paper drive. It requires two 8-bit words formatted to provide analog pen position. Pen speed is 75 cm per second with a position accuracy of ±0.15%, full scale. Paper can be incremented up to 2 cm per second at 0.0127 cm per step. The 47-TR is priced at $945. For details, contact Pedersen Instruments, 2772 Camino Diablo, Walnut Creek CA 94596. (415) 937-3630.

Circle 534 on inquiry card.

Cash Register Scans Bar Code

The CE-1000 bar-code-scanning cash register can keep track of your entire inventory. It is designed for use with the Commodore CBM microcomputer and includes software, firmware, and hardware. The unit can read UPC (Universal Product Code) bar codes found on most products for point-of-sale operations, making it useful for convenience, liquor, food, record stores, and other small businesses.

The CE-1000 bar-code scanner costs $1350. For more information, contact Creative Equipment, 50 NW 68 Ave, Miami FL 33126, (305) 261-7866.

Circle 536 on inquiry card.

Graphics Terminal for the North Star

The Sigma 1042S high-resolution, memory-mapped graphics terminal is designed for the North Star microcomputer. The display provides a 640 by 800 dot matrix backed by a 64 K-byte display memory. The display memory is divided into sixteen 4 K-byte blocks, which are individually selectable for mapping onto a main-memory window of only 4 K bytes. The 1042S terminal can also be used as a word-processing work station. In this application mode, it includes variable spacing, multiple fonts, and scientific-character capabilities. Reverse video, blinking, and intensification are offered as hardware features. The terminal can be used as a system console under CP/M. The 1042S costs $4000.

For more information, contact Sigma Information Systems USA Inc, 556 Trapelo Rd, Belmont MA 02178. (617) 484-2063.

Circle 535 on inquiry card.

Low-Cost Color-Graphics Terminal

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The CE-1000 bar-code scanner costs $1350. For more information, contact Creative Equipment, 50 NW 68 Ave, Miami FL 33126, (305) 261-7866.

Circle 536 on inquiry card.
What's New?

PUBLICATIONS

The Sizzle Sheet
The Sizzle Sheet is a marketing-communications guide for those who market computers, communications and information products, systems, and services. Featured are reviews and reports, editorials on the news, business and trade press, plus special issues.
For details, contact The Sizzle Sheet, POB 801, 150 Speen St, Framingham MA 01701, (617) 875-0013.
Circle 537 on inquiry card.

Symbol Manipulation Using LISP
This is a manual for the LISP programming language. The book introduces the basics of LISP programming and demonstrates how it is used in practice. It also discusses how artificial intelligence systems are built. Case studies and problems in pattern matching, natural-language understanding, and problem solving are included. An appendix offers a sample terminal session, lists basic LISP functions, and explains differences between MACLISP and INTERLISP.
Symbol Manipulation Using LISP costs $13.95, and is published by Addison-Wesley, Reading MA 01867, (617) 944-3700.
Circle 538 on inquiry card.

Printronix Printers Described In Brochure
A color brochure describing Printronix dot-matrix printers is available from Printronix Inc. The brochure discusses the Printronix hammer-bank printing mechanism and includes examples of graphics, bar codes, labels, and alphanumeric forms. For your free copy, contact Printronix Inc, 17421 Derian Ave, POB 19559, Irvine CA 92713, (714) 549-7700.
Circle 539 on inquiry card.

Magazine for TI 99/4 Users
99'er Magazine is a bimonthly magazine with news about the TI 99/4 and other TMS9900-based personal-computer systems. It features tutorial articles, software, book and product reviews, opinions and news items, and a question-and-answer technical forum.
Each issue is divided into sections for education, games and simulations, home activities, and business, scientific, or professional applications. Regular features include columns on the Logo language, CAI [computer-aided instruction], speech-synthesis usage, interfacing with peripherals, computer chess. The Source and TEXNET, news from user groups, and lessons in programming techniques. Advertisements from suppliers of software, peripherals, and other related products and services are also included. A bulletin-board page for noncommercial messages is provided for its readers.
The subscription rate is $15 for one year. Contact 99'er Magazine, Emerald Valley Publishing Company, 2715 Terrace View Dr, Eugene OR 97405, (503) 485-8796.
Circle 540 on inquiry card.

GamesMaster Catalog
The GamesMaster Catalog has listings of board, computer, electronic, hand-held, fantasy, and other kinds of games. One section is exclusively devoted to Dungeons and Dragons-type games. Nearly 1000 games are described in full detail, including landscape sets and miniature pieces.
For a copy of the catalog, contact Boynton & Associates Inc, Clifton House, Clifton VA 22024, (703) 830-1000.
Circle 541 on inquiry card.

Computer Crimes Books
The Computer/Law Journal has published a two-volume set on computer crimes. This first volume contains an introduction by Senator Abraham Ribicoff, author of the Federal Computer Crimes Protection Act. There are articles by well-known scholars like Donn Parker, Susan Nycum, John Taber, Rob Kling, and Jay Becker.
Volume two has a history of the Stanley Mark Rifkin case and a compilation and analysis of all federal and state statutes and bills addressing computer crimes, as well as a case digest, bibliography, and book reviews. Both issues are available for $16 each, plus $1 per issue postage.
Contact the Center for Computer/Law, 530 W 6th St, 10th floor, Los Angeles CA 90014.
Circle 542 on inquiry card.

Computer Books from Entelek
This catalog of computer books from Entelek features books on programming languages, microcomputers, robots, calculators, and educational uses of computers. The catalog is free from Entelek, Ward-Whidden House/ The Hill, POB 1303, Portsmouth NH 03801.
Circle 543 on inquiry card.

1981 Computer-Science and Engineering Books
A catalog of MIT Press books in the computer-science and engineering fields is available. This catalog describes over fifty books. Most of the books are offered at a 20% discount through December 1981. Copies of the catalog can be obtained from The MIT Press, Promotion Department, 28 Carleton St, Cambridge MA 02142, (617) 253-5642.
Circle 544 on inquiry card.
What's New?

SOFTWARE

Merge Your 737 Printer and Scripsit

Until Apparat Inc introduced Flextext, TRS-80 Model I users could not use all of the features of the Centronics 737 printer (Radio Shack Line Printer IV) with Scripsit, Radio Shack's word-processing program. Flextext is a utility for Scripsit and the 737 printer that supports proportional or compressed character sets in normal and extended modes, right-justified formatting using the proportional or compressed character sets, underlining in any of the Scripsit-selectable formats and Flextext-selectable character sets, super- or subscripts, and the intermixing and combining of the 737's features anywhere in a document. Flextext requires at least one disk drive and a TRSDOS-type operating system. The program costs $29.95 from Apparat Inc, 4401 S Tamarac, Denver CO 80237.

Utilities for the TRS-80 Color Computer

Mint Software's utilities for the Color Computer require 16 K bytes of memory. There are three cassette-based programming utilities available: Renumber, which provides the capability to load a program, renumber and save it; Squeeze, which will compress BASIC code to utilize minimum memory, and Merge, which allows two separate programs on cassette to be merged and saved. Other aids for cross-referencing line numbers and variables are available. The programs cost $19.95. A 16 K-byte memory expansion is also available for $70. Contact Mint Software, 6422 Peggy St, Baton Rouge LA 70808, (504) 766-2318.

Electronics Designers Program

Wiremaster is for small electronics companies with printed-circuit layout and wrapped-wire prototyping production problems. Connection data is derived from the schematic diagram and fed to Wiremaster in a CP/M text file. Outputs include a network map showing all pins and wires, a wire list sorted by lengths and levels, a parts list, and checklists that detect all wiring errors. The resulting information can then be used for printed-circuit-board layout, error checking, wiring, component stuffing, and system debugging.

Wiremaster comes on a single-density 8-inch CP/M floppy disk with a manual for $150. It runs on Z80 and TRS-80 Model II CP/M systems with 48 K bytes of memory. Contact Afterthought Engineering, 7266 Courtney Dr, San Diego CA 92111, (714) 277-7863.

DMADOS for 8080/Z80 Systems

DMADOS is a single-user, CP/M-compatible 8080 and Z80 disk operating system. It maintains up to sixteen user-defined passwords, allows files to be declared write-protected or invisible to the directory, and can function as a batched console processor. Using DMADOS, up to six print files can be sent to a background print task for printing. User-oriented prompting and error messages are provided.

DMADOS offers support for floppy- and hard-disk files of up to 4.2 megabytes. It is supplied with several utilities and a manual. DMADOS is available on 8-inch floppy disks or North Star double/quad-density formats. For more information on this $200 operating system, contact John D Owens Associates Inc, 12 Schubert St, Staten Island NY 10305, (212) 448-6283.

Chinese Lessons Program

Chinese greetings, times, seasons, numbers, foods, and other commonly used terms are contained in eleven computer-instruction lessons. Color, graphics, and sound are used in each lesson. Memory aids, meanings, and pronunciations are presented with the Chinese characters. The proper stroke sequence for each character is shown and can be repeated at the user's pace.

The Chinese lesson program is available for $29.95 on a doublesided 5-inch floppy disk for the Apple II with 48 K bytes of programmable memory and a single disk drive. For details, contact Computer Translation Inc, Department BPI, POB 7004 University Sta, Provo UT 84602, (801) 224-1169.

Dragonquest

In a race against the sun, you search for Smaegor, Monarch of Dragonfolk, who has kidnapped the Princess of the Realm and holds her in an unknown place. You must search the land, seeking the tools needed for the ultimate battle. On the river Delta and in the Temple of Baaththesi, clues abound. But where is the Princess? This is the scenario of Dragonquest, an adventure game from The Programmer's Guild, POB 66, Peterborough NH 03458, (603) 924-6065. It runs on TRS-80 Model I microcomputers, and costs $15.95 on cassette or $21.95 on a floppy disk.

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Radio Shack® is a trademark of the Tandy Corp.
CP/M® is a trademark of Digital Research

Circle 382 on inquiry card.
Voice Recognition for Z80 Systems

The Cognivox Model VIO-232 voice peripheral is designed for microcomputers using the Z80 microprocessor with a minimum-size programmable memory of 16 K bytes. The VIO-232 can be programmed to recognize words or short phrases from up to 32 entries, and it can answer with up to 32 words or short phrases. The recognition and voice response vocabularies can be different, allowing a dialogue with the computer. Vocabularies larger than 32 words are possible. The Cognivox VIO-232 includes a microphone, power supply, amplifier, speaker, and manual. The price is $149 from Voicetek, POB 388, Goleta CA 93116.

Circle 551 on inquiry card.

RS-232C-to-Current-Loop Adapter

The ADA400 is a bidirectional RS-232C-to-current-loop adapter, ideal for use with KIM-1 microcomputers. It allows the utilization of an RS-232C-interface terminal instead of a current-loop-interface teletypewriter. The ADA400 does not alter the data-transfer rate. It uses standard power supplies with low current requirements. The adapter can be modified to become an RS-232C-to-TTL (transistor-transistor logic) and TTL-to-RS-232C adapter. The ADA400 retails for $24.50. More information can be obtained from Connecticut Microcomputer Inc., 34 Del Mar Dr., Brookfield CT 06804, (203) 775-4595.

Circle 552 on inquiry card.

Record-Retrieval System for PL/I-80

BT-80 is a single-user record-retrieval system based on the B-tree index-organization technique. BT-80 is useful in PL/I-80 applications where single- or multi-keyed access to data records is required. Its facilities can be accessed from PL/I-80 or assembly-language application programs. The system includes utilities that provide access to command-level functions.

BT-80 runs under the CP/M 2.0, MP/M, and CP/NET operating systems. To operate, BT-80 requires the PL/I-80 runtime library and LINK-80 linkage editor. For complete details, contact Digital Research, POB 579, 801 Lighthouse Ave, Pacific Grove CA 93950, (408) 649-3896. Circle 553 on inquiry card.

Battery Backup for the PET

Backpack is a battery backup system for the Commodore PET. It is designed for installation within the computer case. Backpack provides 6 to 10 minutes of full-power emergency backup to the computer (video display included) during power failures. The batteries are recharged from the computer's power supply. No special wiring is needed to install the device. Backpack comes assembled for $225.

For more information, contact ETC Corporation, POB G, Apex NC 27502, (919) 362-4200.

Circle 554 on inquiry card.

Datapro Rates Word-Processing Systems

Thirteen word-processing systems have been named to the 1980 Datapro Honor Roll. Selection of these systems was based on results of a mail survey, which is contained in a thirty-page report, Word Processing Systems User Ratings. This report also contains general information about word-processing systems. The report is available for $15 from Datapro Research Corporation, 1805 Underwood Blvd, Delran NJ 08075, (609) 764-0100.

Circle 555 on inquiry card.

Floppy-Disk Carrier Case

The En Route case carries up to fifty 8- and 5-inch floppy disks during travel. It is small enough to fit under an airplane seat. The case has a polyethylene inner lining to prevent dust buildup. A key lock is included. The En Route case costs $65 from Inmac, 2465 Augustine Dr, POB 4780, Santa Clara CA 95051, (408) 727-1970.

Circle 556 on inquiry card.
Finally, there is a magazine that speaks to the beginner.

onComputing is the new McGraw-Hill quarterly that tells what's ahead — without talking over your head — in the 1980's with personal computers. onComputing puts you on target with all the applications that go beyond your imagination.

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Universal Development System

The UDS-1000 universal development system is a floppy-disk-based system that uses the Z80 microprocessor. Various cross-assemblers for software development are supplied from a selection including the Texas Instruments TMS1000 and the TMS-1400 series; Rockwell R6500V/1, MM75, -76, -77, and -78 series; Motorola 6800; Mostek 3870; Intel 8748, 8048; RCA 1802; NSC COP 420; OKI OLMS42; and other microprocessors. In addition to the cross-assembler, a ROM (read-only memory) emulation board for prototype testing and an EPROM (erasable programmable ROM) programmer are included. The price of the system, including 64 K bytes of programmable memory, a 24-line by 80-character video terminal, an 80 cps (characters per second) printer, ROM emulation, and the EPROM programmer board, is $8750. For information, contact Multitech Electronics Inc. 10322A N Stelling Rd, Cupertino CA 95014. (408) 252-4212.

Circle 557 on inquiry card.

Spelling Error Detection/Correction Package

Proofit is a set of programs that scans the words in a text file and compares them with those in one or more dictionaries. Words that are not found are flagged as possible errors. Correctly spelled new words can be added automatically to the dictionary. Corrections can be directly substituted for incorrectly spelled words in the text file. A package including manual and software on a floppy disk with over 10,000 words in the dictionary is $125. Software on a 5-megabyte hard-disk pack with over 30,000 words in the dictionary is $100 more. The manual can be purchased separately for $10.

Proofit runs on Alpha Micro AM-100 computers with 32 K bytes of memory. For information, contact Datalab Inc. 617 E University, Suite 250, Ann Arbor MI 48104, (313) 995-0663.

Circle 559 on inquiry card.

Daisy-Wheel Printer

The Starwriter letter-quality daisy-wheel printer runs at 25 cps. The Starwriter comes with a Centronics-compatible parallel interface, and uses Diablo ribbons and print wheels. The Starwriter has graphics capabilities and is code-compatible with Qume and Diablo printers. The printer accommodates paper widths of up to 38 cm (15 inches), and can make three copies. The Starwriter is available for $1779 from Computer Textile Inc. 10960 Wilshire Blvd, Suite 1504, Los Angeles CA 90024, (213) 477-2196.

Circle 560 on inquiry card.
INSULATION DISPLACEMENT SOCKETS

RIGHT ANGLE HEADERS

CARD EDGE CONNECTORS

RIBBON CABLE

25 PIN “D” CONNECTORS

SOCKETS

20 PIN "D" CONNECTORS

CABLE PLUGS

WIRE WRAP WIRE

WIRE KITS

“NEW” WIRE WRAP SOCKETS

ORDERING INFORMATION:

- Orders under $25 include $2 handling
- All prepaid orders shipped UPS Ppd.
- Visa, MC & COD’s charged shipping.
- All prices good through cover date.
- Most orders shipped same day.
- Byte must be mentioned to get sale price.

Write or call for 1981 catalog

- IC Sockets
- Vector Board & Pins
- Bishop Drafting Aids
- OK Tools
- RN IDC Crimp Connectors

TOLL FREE ORDERING NUMBER 1-(800)-423-7144
Memory Board for the SBC 86/12A

The Cl-8089 memory board is designed for Intel's Intellec SBC 86/12A microcomputer. Available with 32 K to 512 K bytes on a single board (depending on what memory components are used), the module is compatible with 8- and 16-bit Multibus-based systems. The Cl-8089 generates and checks even parity with selectable interrupt on parity error. It features a 250 ns data-access time and a 375 ns cycle time. The memory is addressable in 16 K-byte increments up to a total of 16 megabytes of memory. Power consumption is under 8 W. The price is $1500 for the 128 K-byte board and $4700 for the 512 K-byte module. The Cl-8089 is available from Chrislin Industries Inc. 31352 Via Colinas, #102, Westlake Village CA 91361. (213) 991-2254. Circle 561 on inquiry card.

12-Bit CMOS Converters

The DAC1218 and the DAC1219 are 12-bit CMOS complementary metal-oxide semiconductor, 4-quadrant, multiplying, D/A [digital-to-analog] converters. The devices offer 12-bit monotonicity, maximum differential linearity error of ±0.5 LSB (least significant bit), and feature a design technique resulting in TTL (transistor-transistor logic) compatibility. Power-supply voltages can range from +5 to +15 V; typical power consumption is 20 mW. The DAC1218 has a maximum linearity error specification of 0.012%, and the DAC1219 is rated at 0.024%.

In OEM quantities of 100, the DAC1218 sells for $10.75 each, and the DAC1219 is priced at $9.75 each. For additional information, contact National Semiconductor Corporation, 2900 Semiconductor Dr. Santa Clara CA 95051, (408) 737-5000.

Circle 562 on inquiry card.

Expand Atari's Memory

The RAMCRAM memory modules can expand the Atari 400's memory to 32 K bytes and the Atari 800's to 48 K. RAMCRAM plugs into the Atari internal memory-module slot, replacing the Atari's module. Each RAMCRAM module contains 32 K bytes of programmable memory. The suggested retail price is $320.

An 8-slot bus-expansion board for the Atari and Apple microcomputers, with power supply, controller, and software, is available for further memory expansion. This memory-board bus can hold up to eight RAMCRAMs, offering 256 K bytes of programmable memory. Its suggested retail price is $850.

For further details on both of these devices, contact Axion Inc., 170 N Wolf Rd, Sunnyvale CA 94086, (408) 730-0216.

Circle 564 on inquiry card.
New Commodore VIC 20 Computer
Now Available

Introducing the first full-featured, expandable color computer priced under $300!

Now, a new computer — the VIC 20 — offers a full range of special features and expansion capabilities which rival the features of existing microcomputers selling for 4 or 5 times as much!

The new VIC (Video Interface Computer) connects to any television set or monitor and provides 5K bytes of memory.

Check these outstanding features:

- **Color**: 8 character colors, 8 border colors, 16 screen colors
- **Sound**: 4 internal amplifiers including 3 tone (music) generators and 1 sound (noise & sound effects) generator. Each amplifier has 3 octaves. Sound uses a television or monitor speaker.
- **Memory**: 5K RAM (Random Access Memory) expandable externally to 32K RAM
- **Keyboard**: Full typewriter keyboard with special screen editing keys & PET graphics
- **Graphics**: Full PET keystroke graphics
- **Language**: PETBASIC
- **Programmable Function Keys**: 4 programmable function keys (8 separate functions)

**Plug-In Program & Memory Expansion Cartridges**:
(programs plug directly into the back of the computer...each program can be up to 27K)

**Full Computer Accessories**:
disk drive, printer, tape cassette, game controls & more

**Connects to any TV set/monitor** (Built-in RF Modulator)

**A "User Friendly" Computer**
The new VIC computer is designed to be the most user friendly computer on the market...friendly in price, friendly in size, friendly to use and expand.

With the VIC, Commodore is providing a computer system which helps almost anyone get involved in computing quickly and easily...with enough built-in expansion features to let the system "grow" with the user as his knowledge and requirements become more sophisticated.

**Expansion Features & Peripherals**
The VIC 20 is designed so a first time user can begin using it immediately with plug-in program cartridges, and build his system gradually as his needs (or budget) allow.

VIC system peripherals will include a tape cassette unit, single floppy disk drive, printer — and a broad range of add-on accessories which tailor the system to a variety of applications.

**FREE** with purchase the VIC 20 Personal Computer Manual. This User Manual is very unique as it is the most comprehensive manual ever written for a personal computer. The key ingredient is that no previous knowledge of programming or even typewriting is required. The manual is designed for the first-time owner along with extensive appendices for both the more experienced computerists and the beginners.

VIc-20 Personal Computer $299.95
Tape Cassette/Recorder 74.95
Software Cassettes — 6-Pak 59.70
VIC Programming Reference Guide 15.00

Sub Total
Tax (6% Calif)
Shipping & Handling 5.00
TOTAL
Eight Amp Power Supply for OEMs

The CEI Model FD503 is an 8 A power supply that provides outputs of +5 VDC at 8 A, +12 VDC at 2.5 A, -5 VDC at 1 A, -12 VDC at 0.5 A, and +24 VDC at 1.5 A continuous, 4 A surge. Floppy-disk drives can plug into the output connectors of the supply. The FD503 regulates positive outputs to 0.1% and negative outputs to 1%. Options include 100, 115, or 230 VAC power use; AC step-down for 115 V Shugart motors; and interconnecting cables. The CEI FD503 is priced at $139 each in lots of 100. Contact CEI Corporation, POB 501, Grenier Industrial Park, Londonderry NH 03053, (603) 623-8888. Circle 565 on inquiry card.

Universal Floppy-Disk-Controller Circuit

The TMS9909 floppy-disk-controller integrated circuit can control any floppy-disk drive while interfacing with any 8- or 16-bit microprocessor. It can read from and write onto partial sectors, read from or write onto single or multiple sectors of hard- and soft-sectored disks, as well as simultaneously control 5- and 8-inch drives. The TMS9909 provides CRC (cyclic redundancy check); data transfer rates of 125, 250, and 500 k bytes per second with one crystal; hard and soft formatting for 5- and 8-inch disks; and side selection for double-sided disks. Users can program the device for all major track parameters and various track-stepping, settling, and head-loading times. The TMS9909 supports single- and double-density formats on up to four drives. The TMS9909 has a memory-mapped microprocessor interface that supports an external DMA (direct memory access) interface. This allows designers to build only one interface for all floppy-disk formats.

For further details, contact Texas Instruments, Inquiry Answering Service, POB 25012, MIS 308, Dallas TX 75265, attn: TMS9909. Circle 566 on inquiry card.
# Lowest Prices in the West, North, South & East

## Apple Hardware

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Apple III/96K Information Analyst Package 12&quot; B/W Monitor</td>
<td>$3850</td>
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<tr>
<td>Same as Option A Plus: Disk II for Apple III</td>
<td>$4350</td>
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<tr>
<td>Same as Option A Plus: Disk II for APPLE III</td>
<td>$4800</td>
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## Other Hardware

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<td>Parallel Printer Interface Card</td>
<td>$160</td>
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<td>Communications Card</td>
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<tr>
<td>High Speed Serial Interface</td>
<td>$375</td>
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<tr>
<td>Pascal Language System</td>
<td>$425</td>
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<tr>
<td>Centronics Printer Interface</td>
<td>$185</td>
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<td>AppleSoft Firmware Card</td>
<td>$160</td>
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<tr>
<td>Integer Firmware Card</td>
<td>$160</td>
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<tr>
<td>Disk I with Controller DOS 3.3</td>
<td>$529</td>
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<td>Disk I only</td>
<td>$450</td>
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<tr>
<td>Graphics Tablet</td>
<td>$825</td>
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## Printers

<table>
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<td>Apple Silentype with Interface</td>
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<tr>
<td>IDS 445 (Paper Tiger) with Graphics</td>
<td>$765</td>
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<tr>
<td>IDS 460 with Graphics</td>
<td>$1199</td>
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<td>IDS 560 with Graphics 10</td>
<td>$1695</td>
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<tr>
<td>Centronics 737</td>
<td>$995</td>
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<tr>
<td>NEC Spinwriter (RO, Serial)</td>
<td>$2650</td>
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## Software

<table>
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<td>The Controller</td>
<td>$525</td>
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<td>Apple Post (Mailing List Program)</td>
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<td>Easymaker Professional System</td>
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<td>Apple Pie 2.0</td>
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<td>DB Master Data Management</td>
<td>$150</td>
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<td>The Cashier</td>
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<td>Apple Writer</td>
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<td>Visicalc</td>
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<td>Full Screen Mapping for CCA OMS</td>
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<tr>
<td>Pascal Interactive Terminal Software (PITS)</td>
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<tr>
<td>Interative Terminal Software (BITS)</td>
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<td>Data Capture</td>
<td>$29</td>
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<td>Apple Plot</td>
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<td>Apple Pilot</td>
<td>$120</td>
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<tr>
<td>Magic Wand Word Processor (Needs Z-80 Softcard)</td>
<td>$345</td>
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<tr>
<td>Dow Jones Portfolio Evaluator</td>
<td>$45</td>
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<tr>
<td>Fortran</td>
<td>$140</td>
</tr>
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## Ordering Information

- Phone orders invited using VISA, MASTERCARD or bank wire transfers. VISA & MC credit card service charge of 2%. AE credit card service charge of 5%.
- Mail order may send charge card number (include expiration date), cashier’s check, money order or personal check (allow 10 business days to clear). Please include a telephone number with all orders. Foreign orders (excluding Military PO’s) add 10% for shipping. All funds must be in U.S. dollars (letters of credit permitted). Shipping, Handling and Insurance in U.S. add 3% (minimum $4.00). California residents add 6% sales tax. Our low margins prohibit us to send COD or on purchase orders or open account (please send for written quotation). All equipment is subject to price change and availability. Equipment is new and complete with the manufacturer’s warranty. We do not guarantee merchantability of products sold. All returned equipment is subject to a 15% restocking fee. We ship most orders within 2 days.
- We are a member of the Chamber of Commerce.
- Retail store prices may differ from mail order prices.

Please send orders to:

**COMPUTER STOP**, 2545 W. 237 St., TORRANCE, CA 90505

Circle 83 on inquiry card.
WE WILL NOT BE UNDERSOLD

**DISK DRIVES**

FOR TRS-80® Model I

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>CCI-100</td>
<td>$314</td>
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<td>CCI-280</td>
<td>$429</td>
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**ADD-ON DRIVES FOR ZENITH Z-89**

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<th>Model</th>
<th>Price</th>
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<td>CCI-189</td>
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<td>CCI-289</td>
<td>$499</td>
</tr>
<tr>
<td>Z-87</td>
<td>$999</td>
</tr>
</tbody>
</table>

External card edge and power supply included. 90 day warranty/one year on power supply.

**RAW DRIVES**

8" SHUGART 801R

5 1/4" TEAC or TANDON

$ CALL POWER SUPPLIES $ CALL

**DISKETTES**

<table>
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<tr>
<th>Size</th>
<th>Price</th>
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<tr>
<td>5 1/4&quot;</td>
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<td>8&quot;</td>
<td>$6.95</td>
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**DISHKETTES**

<table>
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<tr>
<td>5 1/4&quot;</td>
<td>$40</td>
</tr>
<tr>
<td>8&quot;</td>
<td>$35</td>
</tr>
</tbody>
</table>

**SYSTEM SPECIAL**

Apple II Plus 48K w/driver and controller. Epson MX-80 printer and interface. SUP-R Mod RF Modulator: List $2965 You Pay $2299

**PRINTERS**

NEC Spinwriter

Letter Quality High Speed Printer

R.O.

R.O. with tractor feed

KSR with tractor feed

$2395

$2595

$2895

C-JOT

Starwriter

$1695

$2195

$2895

STARWRITER II

$1895

$2595

$3695

**PAPER TIGER**

IDS 445

Graphics & 2K buffer

$699

IDS 460

Graphics & 2k buffer

$1050

IDS 560

Graphics

$1450

OKIDAX

ANADEX

DP-8000

$849

DP-9500/01

$1345

**CENTRONICS**

Microline 80

Friction & pin feed

$420

Microline 80

Friction, and pin & tractor feed

$520

Microline 82

Friction & pin feed feed

$620

Microline 83

120 cps, uses up to 15" paper

$849

**16K RAM KITS**

2 for $37

$19

**S-100 CALIFORNIA COMPUTER SYSTEMS**

**APPLE ACCESSORIES AND SOFTWARE**

**VISICALC**

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**DB MASTER**

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$259.00

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**16K CARD**

$169.00

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**CCS CARDS**

$ CALL

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**ASTEROIDS**

$19.75

**FLIGHT SIMULATOR**

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**WIZARD & PRINCESS**

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**SARGON 2**

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**HI-RES FOOTBALL**

$35.00

**MYSTERY HOUSE**

$21.00

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Circle 97 on inquiry card.
### California Computer Systems

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>32K RAM BOARD A&amp;T.</td>
<td>$579.95, 200 NSEC.</td>
<td>$629.95</td>
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<tr>
<td>450 NSEC</td>
<td>$629.95, 200 NSEC.</td>
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<td>16K RAM A&amp;T.</td>
<td>$549.95</td>
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<tr>
<td>450 NSEC</td>
<td>$549.95</td>
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<tr>
<td>64K DYNAMIC A&amp;T.</td>
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<td>200 NSEC</td>
<td>$339.95</td>
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<tr>
<td>Z80 PROCESSOR A&amp;T.</td>
<td>$259.90</td>
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<tr>
<td>DISC CONTROLLER</td>
<td>$342.80</td>
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</table>

### Apple Products

- **Apple IEEE Instrumentation Interface Kit 7400:** A & T $275.00
- **ARITHMETIC PROCESSOR FOR APPLE 7811:** A & T $259.00
- **DISC CONTROLLER:** A & T $339.95
- **APPLE SYNCHRONOUS SERIAL INTERFACE:** A & T $342.80
- **APPLE ASYNCHRONOUS SERIAL INTERFACE:** A & T $153.95
- **Vector Jump Parallel Port with status:** Kit $146.00, PCBD $31.95

### Other Products

- **CB-1A 8080 Processor Board:** $143.00
- **CB-2 Z80 CPU BOARD:** $199.95
- **CB-3 4MHZ:** $379.95
- **CB-4 270B & 2716 Programming Board:** $143.00
- **CB-5 64 x 16 Video Board:** $144.95

### WAMECO Products

- **FDC-1 FLOPPY CONTROLLER BOARD:** Will drive up to 8 drives, $36.95
- **MEM-1 BK x B RAM 2102:** $146.00, PCBD $31.95
- **MEM-2 8x8x RAM 2102:** $31.95
- **MEM-3 32K STATIC RAM 2114:** $36.95
- **PPA-1 2K of PROM with power boot up:** $14.00
- **PPB-1 Front Panel:** $28.95
- **PPC-1 Realtime clock board:** $28.95
- **PT-1 POWER SUPPLY AND TERMINATOR BOARD:** $28.95
- **FPE-1 with MIKOS:** $14.00
- **FPE-2 with MIKOS:** $14.00
- **FPE-3 with MIKOS:** $14.00
- **FPE-4 with MIKOS:** $14.00
- **FPE-5 with MIKOS:** $14.00
- **FPE-6 with MIKOS:** $14.00
- **FPE-7 with MIKOS:** $14.00
- **FPE-8 with MIKOS:** $14.00
- **FPE-9 with MIKOS:** $14.00
- **FPE-10 with MIKOS:** $14.00

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- **FPE-11 with MIKOS:** $14.00
- **FPE-12 with MIKOS:** $14.00
- **FPE-13 with MIKOS:** $14.00
- **FPE-14 with MIKOS:** $14.00

### Contact Information

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- **In N. Y. State call:** (516) 752-0600
- **FORDHAM:** 855 Conklin St. Farmingdale, N. Y. 11735

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16K MEMORY—$22.00
FOR APPLE - TRS-80 - EXIDY - S100

IMSAI COMPATIBLE PRODUCTS

I-8080 S-100 ENCLOSURE
Sheet Metal Kit
Just like THE ORIGINAL IMSAI: Mainframe with blue cover, cardguides and hardware spaced for PS-28D Power Supply, up to 22 slot motherboard.
Kit of all metal parts and hardware with documentation $115.00
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S-100 Connectors—each $ 3.50
8015 Blank jump-start panel w/3 switches $ 32.50
8015 Jump start panel for 2 SA-400 $ 78.50

PS-28D Power Supply
Parts Kit:
PIO 4-4
4 parallel inputs and outputs (6212) $160.00
SIO 2-2
2 serial I/O ports, good to 9600 baud $175.00
VIO-F
Improved memory mapped video I/O board, includes keyboard port, 256 character EPROM's, firmware, monitor $275.00
Assembled & Tested

COMPUTER SYSTEMS

I-8080 SYSTEM
The basic 8080 based S-100 system. Includes CPA front panel, 20 slot 10 MHz motherboard (with all 20 connectors), MPU-A 8080 CPU board, PS-28D power supply (+ 8V @ 28A, +/- 16V @ 3A), and chassis. COMPLETELY ASSEMBLED & TESTED.
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Without MPU-A $ 630.00

I-8015 Complete System
The complete 8085 system, includes MPU-B, RAM III, 10 slot terminated motherboard, PS-28D, and jump start front panel. A complete 64K system!
Assembled & Tested $1250.00
Includes I-8015 system and DS-8 Disk system
w/CPM 2.2 and disk controller board set.
Assembled & Tested $2700.00

I-8035 Complete System
The complete 8085 system w/2 each TANDON TM-100 5½" disk drives, DIO-D, MPU-B, RAM III, chassis, 10 slot motherboard and power supply. Includes CPM® 2.2.
Assembled & Tested $2295.00

IOD-C/D
2 board disk controller for 6" or 5½" $350.00
CPM® 2.2
For DIO including documentation $175.00
CPA
Improved IMSAI style front panel works with Z80, etc. $225.00
MPU-A
8080 processor board—requires CPA $100.00
MPU-Y
8085 3MHz processor SBC w/serial plus parallel port, monitor $250.00
RAM III 64K
MEMORY
64K byte dynamic RAM board—Utilizes the Intel 3242 refresh controller and a single delay line for totally internal refresh. Uses time proven 4116 RAMS. Memory mapped I/O boards are allowed to coexist by the use of phantom. Board select via A16 thru A20 extended address lines.

IKB-1
Intelligent keyboard uses 8035 $350.00
MDX
Dual SA400 drive enclosure $ 75.00
DE 8
Dual 800R/801R horizontal style enclosure w/power supply and fan $240.00
Case Only $100.00
VIO-X
New port mapped video I/O board w/8085 processor, 8275 CRT controller, keyboard port, firmware. Assembled & Tested $235.00

IEEE 488 +3P
New IEEE-488 I/O interface with 3 parallel ports.

TERMS: (1) PREPAID Send check or M.O. for merchandise amount only—we pay the shipping within U.S. only.
(2) UPS COD or Bankcard orders by phone or mail—shipping charges added.
California Residents add 6.5% Sales Tax.

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San Jose, California 95112
(408) 295-7171

component supply, inc.

BYTE June 1981 427
SUNNY LOW LOW COST POWER SUPPLIES FOR S-100, FLOPPY DISKS.

**S-100 POWER SUPPLY KITS** (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PRIMARY SOURCE</th>
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<th>SECONDARY #2</th>
<th>SECONDARY #3</th>
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<td>4A</td>
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<td>3A</td>
<td>4A</td>
<td>25.95</td>
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<tr>
<td>T5</td>
<td>Z-BOA CTC</td>
<td>2A</td>
<td>2A</td>
<td>4A</td>
<td>14.60</td>
</tr>
</tbody>
</table>

**DISK DRIVE POWER SUPPLY “R3”** REGULATED, OPEN FRAME, ASSY. & TESTED 6.75

SPECs: +5V @ 5A QPV, -5V @ 1A, +24V @ 5A SHORTS PROTECT. 7 SIZES AVAILABLE: 1) 9" (W) x 6" (D) x 4" (H); 2) 9" (W) x 5.5" (D) x 5" (H)

**DISK SYSTEM PWR SUPPLY “S3”** OPEN FRAME, ASSY. & TESTED, COMPACT SIZE; 10" (W) x 6" (D) x 5" (H) 9.25

**POWER TRANSFORMERS** (WITH MOUNTING BRACKETS)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PRIMARY SOURCE</th>
<th>SECONDARY #1</th>
<th>SECONDARY #2</th>
<th>SECONDARY #3</th>
<th>PRICE</th>
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<tr>
<td>T1</td>
<td>Z-BOA CTC</td>
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<td>Z-BOA CTC</td>
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<td>1A</td>
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<td>T4</td>
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<td>Z-BOA CTC</td>
<td>2A</td>
<td>2A</td>
<td>4A</td>
<td>14.60</td>
</tr>
</tbody>
</table>

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(213) 328-2425 MON-SAT 9-6

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- 1024 BYTES RAM
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- 1024 BASES RAM
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- LATCHED I/O WITH HANDSHAKING LOGIC
- TTL AND CMOS COMPATIBLE

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<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Qume</td>
<td>DT-8</td>
<td>$599</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2/$1150</td>
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<tr>
<td>Mitsubishi</td>
<td>DT-8</td>
<td>$499</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2/$990</td>
</tr>
<tr>
<td>Shugart</td>
<td>851R</td>
<td>$649</td>
</tr>
<tr>
<td></td>
<td>Double sided/double density</td>
<td></td>
</tr>
<tr>
<td>Shugart</td>
<td>800/801R</td>
<td>$475</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2/$900</td>
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<tr>
<td>Siemens</td>
<td>FDD100-BDS395</td>
<td>$350</td>
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<tr>
<td></td>
<td>-</td>
<td>2/$600</td>
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**CONTROLLERS**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Price</th>
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<tbody>
<tr>
<td>Tarbell single density kit</td>
<td>$210</td>
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<tr>
<td>Tarbell single density A &amp; T</td>
<td>$290</td>
</tr>
<tr>
<td>MDA LSI-11 floppy controller</td>
<td>$375</td>
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**SPECIALS**

<table>
<thead>
<tr>
<th>Special</th>
<th>Price</th>
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<tbody>
<tr>
<td>CCS 2422A floppy disk controller with CP/M version 2.2</td>
<td>$375</td>
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**FLOPPY POWER KITS**

<table>
<thead>
<tr>
<th>Kit Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>Two units with the greatest of ease</td>
<td>$109</td>
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**DISKETTES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tr>
<td>Single sided</td>
<td>$39/10</td>
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<tr>
<td>Double sided</td>
<td>$59/10</td>
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**SPECIAL SPECIALS**

<table>
<thead>
<tr>
<th>Special</th>
<th>Price</th>
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<tbody>
<tr>
<td>SBC 80/30 CPU card (used)</td>
<td>$475.00</td>
</tr>
<tr>
<td>SBC 604</td>
<td>$150.00</td>
</tr>
<tr>
<td>SBC 614</td>
<td>$150.00</td>
</tr>
<tr>
<td>UDS 103J modem card (used)</td>
<td>$100.00</td>
</tr>
<tr>
<td>UDS 801A dialer card (used)</td>
<td>$100.00</td>
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**CONNECTORS**

<table>
<thead>
<tr>
<th>Connector Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>Apple, TRS-80, S-100 Based Computers</td>
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**CRYSATLS**

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<tr>
<th>Crystal Value</th>
<th>Price</th>
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<tbody>
<tr>
<td>3.57954 MHz</td>
<td>$0.99/ea</td>
</tr>
<tr>
<td>-</td>
<td>100/$0.80</td>
</tr>
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</table>

**CONNECTORS**

<table>
<thead>
<tr>
<th>Connector Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>Apple, TRS-80, S-100 Based Computers</td>
<td></td>
</tr>
</tbody>
</table>

Terms of sale: cash or checks, purchase orders from qualified firms and institutions. Minimum order $25. CA residents add 6% tax. Prices subject to change without notice. All goods subject to prior sale. Minimum shipping/handling charge $4.00.

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<table>
<thead>
<tr>
<th>Model No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4101C</td>
<td>SA400 in cabinet wipower</td>
<td>$359</td>
</tr>
<tr>
<td>5101C</td>
<td>SA800 in cabinet wipower</td>
<td>$909</td>
</tr>
<tr>
<td>8102C</td>
<td>Two SA300 in cabinet wipower</td>
<td>$1449</td>
</tr>
<tr>
<td>8202C</td>
<td>Two SA850 in cabinet wipower</td>
<td>$1759</td>
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**S-100 BASED COMPUTERS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>3101C</td>
<td>SA400 in cabinet wipower</td>
<td>$359</td>
</tr>
<tr>
<td>5212C</td>
<td>Two SA850 in cabinet wipower</td>
<td>$1759</td>
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**GENERAL**

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<th>Model No.</th>
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<tr>
<td>8022C</td>
<td>Two SA801 in cabinet wipower</td>
<td>$1329</td>
</tr>
<tr>
<td>8023C</td>
<td>Two SA851 in cabinet wipower</td>
<td>$1799</td>
</tr>
</tbody>
</table>

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"Control Talker II" can control stepping motors (up to eight), relays, counters, etc. and support a variety of uses including robotics, telephone dialing, security systems, numerical control, measuring—virtually countless applications. Also has added speech output to advise of status, etc.
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  - 32 input lines (TTL)
  - 32 output lines (50V)
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  - 8K PROM—user supplied, 1K RAM
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- uses Texas Instrument TMS 5200 V.S.P.
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- 32 word sample vocabulary included
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  - 8066 9K - 90 Column CRT $1295 230
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- **NEC Spindler** $2500
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**RESISTORS .02 ea!**

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<td>.61</td>
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<table>
<thead>
<tr>
<th>PART#</th>
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<td>40DP</td>
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<th>Capac</th>
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<td>4,700</td>
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<td>3.50</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th>Disk Type</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRIAM-SHiGArT-CENTURY-MICROPOLIS</td>
<td>+5V @ 8A - 5V @ 8A - 24V @ 7A</td>
<td>US-384 $89.00</td>
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<td>SHUGAR - SIEMANS - MPI 5%</td>
<td>+5V @ 8A - 12V @ 8A</td>
<td>US-340 $33.50</td>
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<td>SHUGART - SIEMANS - CDC 8&quot;</td>
<td>+5V @ 8A - 5V @ 8A - 24V @ 8A</td>
<td>US-205 $57.25</td>
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<tr>
<td>920C- 720.00 Cabinets</td>
<td>+5V @ 2A - 5V @ 2A</td>
<td>US-162 $68.00</td>
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<td>912C- 665.00 Cabinets</td>
<td>+5V @ 2A - 5V @ 2A</td>
<td>US-323 $66.50</td>
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<tr>
<td>920C- 720.00 Cabinets</td>
<td>+5V @ 2A - 5V @ 2A</td>
<td>US-205 $57.25</td>
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</tbody>
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16k memory (8) 4116's

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<table>
<thead>
<tr>
<th>TR-1000 16K</th>
<th>TR-20 16K</th>
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Lead Siegler ADMS VOT-L45 $1350

Soroc IQ 130 VOT-Q130 $675

Soroc IQ 139 NEW VOT-Q139 $850

Soroc IQ 150 detachable keyboard VOT-Q150 $1150

Television 521C VOT-T521 $655

Television 925C VOT-T925 $745

Television 950C detachable keyboard

Zenith 2-10 VOT-Z10 $735

CENTRONICS

730 $595

737 $750

JEFFERSON VALLEY, ASSOCIATES

S-100 BOARDS

Assembled. Tested. Burned-in

Rotron Muffin Fan $14.77

115 vac. 7 Watts WPA21 Factory Fresh Muffin fan

NIC pull-out. EMP-4M

TOLL FREE ORDER LINE

800-421-5041

TECHNICAL & CALIFORNIA

213-679-9001

TWX 910-325-6212
## DIP JUMPERS

- Made with Standard IC
- Fully Assembled and Tested
- Insulated Molded-On Snap-On
- Live by Use/No-Return Policy

Jumpers are used for jumpering between IC sockets, providing a convenient way to connect and disconnect circuits.

### DISCRETE LEDS

<table>
<thead>
<tr>
<th>Type</th>
<th>Polarity</th>
<th>Ht Price</th>
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### DISPLAY LEDS

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<tr>
<td>DLMD 10</td>
<td>C.A.-green</td>
<td>CA-400</td>
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</table>

### SOCKETS

- **Zero Insertion Force**
  - Ns 52 Form G Plated Brass
  - G.P.P. Plastic Body
  - Footprint for leaded ICs

### RECEPTACLES

- **Test Socket**

### 1/4 WATT RESISTOR ASSORTMENTS - 5%

<table>
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<th>2W</th>
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### CAPACITOR CORNER

- **50V TYPICAL DRIVE CAPACITORS**
- **100V TYPICAL FILM CAPACITORS**
- **150V TYPICAL TANTALUMS**
- **500V TYPICAL ALUMINUM ELECTROLYTIC CAPACITORS**

**PHONE ORDER WELCOME**

**FREE 1981 JAMECO CATALOG**

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1355 SHOREWAY ROAD, BELMONT, CA 94002

PRICES SUBJECT TO CHANGE
Circle 185 on inquiry card.

**Microprocessor Components**

**MOSA/NORMA Support Devices**

<table>
<thead>
<tr>
<th>Description</th>
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<th>Price</th>
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<tbody>
<tr>
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<tr>
<td>Microprocessor Chips</td>
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**Electronic Toy Motors**

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<th>Model</th>
<th>Width</th>
<th>Price</th>
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<tbody>
<tr>
<td>MABUCHI RE280</td>
<td>0.39 each</td>
<td>108.75</td>
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</tbody>
</table>

**Designers' Series**

**Blank Desk-Top Enclosures**

**Construction:**

The "DTE" Blank Desk-Top Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an integral slot (all around) to accept both top and bottom panels. The panels are then fastened to the thick slip tabs inside the end pieces to provide simple and easy mounting. The molded bottom panel slides back on notched tracks while the rest of the enclosure remains in place. The standard panel width may be used while making your own panel configuration. The molded end pieces can also be painted to match any panel color scheme.

**Mail Order Electronics**

MAIL ORDER ELECTRONICS - WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002

PRICES SUBJECT TO CHANGE.

**MICROPROCESSOR COMPONENTS**

**MOSA/NORMA SUPPORT DEVICES**

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**Mail Order Electronics**

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**Bourns Potentiometer**

1/4 Watt Single Turn

Values: 500Ω, 1K, 2.5K, 5K, 10K, 25K, 50K, 100K, 250K, 500K

INDIVIDUAL PRICING:

1/4 watt 100K $1.65
1/4 watt 250K $2.55

To order: Specify Bourns 8325 - (Value desired)

**AC and DC Wall Transformers**

**Connectors**

**Experimentor SOCKETS**

**Quick Test Sockets & Bus Strips**

**Global Specialties**

**Jameco Electronics**

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PRICES SUBJECT TO CHANGE.

**Circle 185 on inquiry card**

**BYTE June 1981**

457
Printers

IOM-5200A  $139.95
PRM-270080  $189.95
PRM-27070  $239.95
PRM-27070 With Graftrax II  $299.95
Interface & Cable for Apple  $399.95

Accessories for Apple

Apple Sticker - Micromate  $49.95
Apple Stick with Pots for Apple II  $49.95

Disks

Apple Stick with Pots for Apple II  $49.95
Apple Stick with Pots for Apple II  $49.95

SPIRIT - NEC

65 sq. cm, bidirectional, letter quality printer with deluxe tractor mechanism, both parallel and serial interfaces on-board, 16K buffer, ribbon, print thimble, graphics, microspace justification, data cable, and self test/alignment ROM.

PRD-5511 - $229.95
PRD-5512 - $289.95

Accessories for TRS-80

8" Disk Drives for TRS-80  $239.95
2 double density drives with cabinet, power supply, & cables
END-000433  $375.00
END-000434  $425.00
WCA-5036A  $475.00
WCA-5036A (required)  $525.00

Special Purchase - Save $50.00
Novation Cat Modem  $119.95
300 baud, answer and originate
(We have only 260.265 available at this special price)

16K MEMORY UPGRADE

Add 16K RAM to your TRS-80, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper blocks, fool proof instructions, and our 1 year guarantee.

MEX-16100K  $29.00
MEX-16101K Apple Kit  $29.00
MEX-16102K Exidy Kit  $29.00

18K RAM Card - Microsoft
(This is life after 48K)
MEX-16300A A & T  $174.95
Z-80" Card for Apple
MEX-16400A A & T  $279.95

Atari 800  $799.95
Apple Clock - Cal Comp Sys  $29.95
Apple Stick - Micromate  $49.95

Visicalc - Personal Sftwr
The ultimate program for your Apple II
SFA-2410005  $139.95

Disk UPGRADE - Apple
Apple Stick with Pots for Apple II  $49.95

Disk Drive for Apple

6" disk drive with controller for your Apple
MEX-123101  $179.95
MEX-123102  $229.95

8" DRIVES for APPLE
Controller, 2H5, two 8" double density drives, cabinet, power supply, & cables
Special Package Price Kit  $139.95

Printer Interface - G.C.S.
Centronics type 1/0 card w/ software
IOI-2041A A & T  $99.95

AIO. ASIO, APIO - S.S.M.
Parallel & serial interface for your Apple (see Byte pp 11)
IOI-20505K Par & Ser Kit  $129.95
IOI-20505K Par & Ser A & T  $159.95
IOI-20532K Serial Kit  $89.95
IOI-20525A Serial A & T  $89.95
IOI-2054X Kit  $89.95
IOI-2054A Kit  $89.95

A488 - S.S.M.
IEEE 488 controller, uses simple basic commands includes firmware and cable, 1 year guarantee (see April Byte pp 11)
IOX-7488A A & T  $399.95

Diskette Drives

Diskette Drive for Apple

5.25" disk drive with controller for your Apple
MEX-123101  $129.95
MEX-123102  $179.95

Bare cabinet
MMD-511003  $64.95
MMD-5111003  $75.00
MMD-5112003  $85.95

Special Sale Price
MMD-511003  $64.95
MMD-5111003  $75.00
MMD-5112003  $85.95

Low Prices, Accessories for Apple

Dual 8" Sub-Assembly Cabinet
End-004221  $225.00
End-004220  $59.95

Single sided, double density disk drive sub-system
End-004223  $975.00
End-004224  $1195.00

Double sided, double density disk drive sub-system
End-004226  $1495.00
End-004227  $1695.00

8" Disk Drives
Highly reliable double density floppy disk drives
Shugart 80/1 single sided, double density
MSF-10801R SA-801R  $425.00
Special Sale Price  $279.95

Shugart 80/2 single sided, double density
MSF-10851R SA-851R  $550.00
Special Sale Price  $425.00

Siemons 8DIN00-1421 single sided, double density
MSF-201120  $350.00
Special Sale Price  $279.95

Qume Datastrak & double sided, double density
MSF-750800 SA-851R compatible  $599.95
Special Sale Price  $279.95

Jade Disk Package
Double density controller's two 8" density floppy disk drives, SPC/MD2 (configured for controller), hardware and software manuals, boot PROM, cabinet, power supply, fan, & cables
Special Package Price Kit  $1399.95

Video Monitors

13" Color Monitor - Zenith
The hi res color you've been promising yourself
VDC-620000  $149.95

12" Green Screen - NEC
20 MHz, P31 phosphor video monitor with audio, exceptionally high resolution - A fantastic monitor at a very reasonable price
VDM-651200  $259.95

Teclock / Amdek
Reasonably priced video monitors
VDM-801120 Video 100 12" B&W  $149.95
VDM-801230 Video 100 12" B&W  $189.95
VDM-801250 12" Green Phosphor  $189.95
VDC-801310 13" Color  $399.95

Jade's new dual disk sub-assemblies include:
Handsome metal cabinet with proportionally balanced air flow system, assembled & tested dual drive power supply, quiet whisper type cooling fan, power-cable kit, lighted power switch, approved fuse assembly, line cord, Newer-Mar rubber feet, and all necessary hardware to mount 2-8" disk drives - it's all American made, guaranteed for six months, and it's in stock!

Dual 8" Sub-Assembly Cabinet
End-000421  $225.00
End-000420  $59.95

Single sided, double density disk drive sub-system
End-000423  $975.00
End-000424  $1195.00

Double sided, double density disk drive sub-system
End-000426  $1495.00
End-000427  $1695.00

Video monitors

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VDM-801230 Video 100 12" B&W  $189.95
VDM-801250 12" Green Phosphor  $189.95
VDC-801310 13" Color  $399.95
### S-100 CPU

- **CB-2 Z-80 CPU - S.S.M.** 2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.
  - CPU-3000K Kit: $239.95
  - CPU-3000A & T: $299.95

### S-100 Memory

- **EXPANDORAM II - S D Systems** 4 MHz RAM board expandable from 16K to 64K.
  - MEM-16530K 16K kit: $275.95
  - MEM-32631K 32K kit: $325.95
  - MEM-64632K 64K kit: $335.95
  - Assembled & tested: $50.00

### S-100 Disk Controller

- **DOUBLE-D - Jade** Double density controller with the inside track, on-board Z-80A, printer port, IEEE S-100, can function on an interupt driven bus.
  - IOD-1200K Kit: $299.95
  - IOD-1200A 8" A & T: $339.95
  - IOD-1200A 5/4" A & T: $359.95
  - IOD-1200B Bare board: $65.00

### S-100 Video

- **VB-3 - S.S.M.** 80 characters x 24 lines expandable to 80 x 48 for full page of text, upper & lower case, 256 user defined symbols, 192 x 256 graphics matrix, memory mapped, has keyboard input.
  - IOD-1095K 4 MHz kit: $345.00
  - IOD-1095A 4 MHz A & T: $495.00
  - IOD-1095K 80 x 48 upgrade: $395.00

### S-100 PROM Boards

- **PB-1 - S.S.M.** 2708, 2716 EPROM board with built-in programmer.
  - MEM-99510K Kit: $139.95
  - MEM-99510A A & T: $199.95

### Mainframes

- **MAINFRAME - Cal Comp Sys** 12 slot S-100 mainframe with 20 amp power supply.
  - ENC-11210K A & T: $429.95
**MODEM SALE**

**TOLL FREE**

**ORDER TODAY**

**PRIORITY ONE ELECTRONICS**

**9161-B DEERING AVE. • CHATSWORTH, CA 91311**

Terms: U.S.: VISA, MC, BAC Check, Money Order, U.S. Funds Only. CA residents add 6% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $2.50 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs., freight collect. All prices subject to change without notice. We will do our best to maintain prices thru JUNE, 1981. SOCKET and CONNECTOR prices based on GOLD, not exceeding $1.95 per oz.

**SOLDER TAIL PRICE**

**WIRE WRAP PRICE**

**PRIORITY S-100 CONNECTORS**

**GOF-IBAR6**

144 expressio

**CCS2422A**

Floppy Disk Controller with 8 Mm Version

**SALE**

**ECONOROM 2708**

16k x 8 EPROM BOARD USING 2708

**ECONOROM 2708**

The ECONOROM 2708 EPROM board is the ideal memory board for the user who wishes to maintain his software reliably, low cost, and non-volatile 2708 EPROMs. With its on-board Power-On-Jump circuitry, the ECONOROM 2708 board is ideal for adding additional memory to any IEEE 696/5-100 system.

**MB6 1K/16K EPROM BOARD**

The MB6A provides sockets to support up to 16 2708 EPROMS in the microcomputer industry. The board disables in 16 increments by removing the EPROM. For example, with 8 EPROMs, it acts as an 1k board.

**MB6A**

1k/16k EPROM BOARD USING 2708

**SHU-SA801R**

As Shown in JUNE BYTE, PAGE 46

**ICED MOUTH**

SPEECH PROCESSOR

**Chromeys Circuit Cellar**

AS FEATURED IN JUNE BYTE, PAGE 46

**LIST PRICE**

**OUR PRICE**

**SHU-SA801R**

2 OR MORE

**$395.00 ea.**

**$700.00 per oz.**

**PRIORITY S-100 CONNECTORS**

**MACHINERY SALE**

**TOLL FREE**

**ORDER TODAY**

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I/O4 2 Parallel & 2 Serial I/O Board

Number of ports - Two serial ports with status - Two parallel inputs - Two parallel outputs - Serial interface - Current-loop by optical isolators - 2060 ms current-loop - EIA receivers and drivers - 55 to 9600 baud - 34.5 baud (optional) for running selectrics - UART output - 5V & -12V available at connector - Addressing - Dip switch addressing of parallel I/O to any two port boundary - Prototyping area - 2 x 16 pin spare terminals

List Price - Our Price
SSMIO4K Kit $290.00 $260.00
SSMIO4A A&T $290.00 $260.00

INTERFACE II 2 Serial

Our I/O board gives you unparalleled flexibility and operating convenience. We include such features as:

- 2 independently addressable serial ports (dip switch selectable address)
- Real LSI hardware UARTS for minimum CPU housekeeping
- RS232C current loop (20mA), & TTL signals on both ports
- Precision crystal-controlled baud rates up to 19.2K baud
- Transmit & receive interrupts on both channels, jumpable to any vectored interrupt line
- Industry standard RS232C level converters with RS232 handshaking lines on ports
- Optically isolated current loop with provisions for both on-board & external current loop sources
- UART parameters, interrupt enables, & RS 232 handshaking lines are software programmable with power-on default to customer specified hard-wired settings for maximum flexibility

List Price - OUR PRICE
GB133U UNKIT $239.00
GB133A UNKIT $239.00

INTERFACE II 3P/1S

- 1 independently addressable serial port
- RS232C, 20mA current loop, & TTL signals
- Precision crystal-controlled baud rate generator
- Up to 19.2K baud
- Transmit & receive interrupts, jumpable to vectored interrupt line
- Five RS232I handshaking lines
- Optically isolated current loop
- 3 pin power supply
- Utilizes LSTTL octal latches for latched I/O data with 24mA drive current
- Full duplex 80 char per line, up to 80 char lines, with selectable polarity
- Interrupts for each input port
- Separate 25 pin connector for power for each channel and a status port for interrupt mask & port status

List Price - OUR PRICE
GB135P UNKIT $219.00
GB135A A&T $219.00

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

This multi-purpose S-100 board provides your computer with the needed system support functions at less cost than buying numerous single function boards. Includes sockets for 4K of extended address EPROM or RAM (2716 type), 1 socket with battery backup, crystal controlled month/day/hour/minute/second clock with SODC controller, optional high speed math processor (9511 or 9512), full RS-232C serial port, three 16 bit timer/counter/processors with 16 bit counters, power fail indicator, provision to switch CMOS memory to EPROM or RAM (2716 type), 1K, 2K, 4K or 8K bytes of RAM memory corresponds with locations in the $8000-$FFFF area of extended address space. Includes a compatible driver routine.

Want to make your S-100 system more versatile? System Support 1 is the answer. Includes:

- 4K of EPROM or RAM (2716 type)
- 15 levels of vectored interrupts
- 2 independent 16 bit interval timers
- Real time clock/calendar with backup battery or internal battery
- Full RS-232C serial port with software selectable baud rate
- Optional high speed math processor (9511 or 9512)
- RAM or ROM can be enabled or disabled by PHANTOM
- RAM or ROM can respond to full IEEE extended address (24 bits)

List Price - OUR PRICE
GBT133U UNKIT $299.00
GBT133A UNKIT $299.00

V83 80 Character Video Board

VB3 is the perfect video interface for word processing and other applications requiring 80 characters per line. It provides a standard 80 x 24 display or as much as 80 x 49 for a full page of text. VB3 is also available in upper and lower case characters, up to 256 user defined symbols, and a 160 x 192 matrix for graphics.

VB3 is memory mapped, but occupies memory only when activated. So one or more VB3s can be located at the same address with a full 65K of memory available to the user. It generates both US and European TV rates and includes a keyboard input. Software includes a CP/M compatible driver routine.

SPECIFICATIONS:
- Display - 80 char. per line, up to 84 lines
- Graphics up to 160 x 192 matrix
- Upper & lower case characters
- Up to 256 user defined symbols or optional EPROMs
- Software controlled operations: Inverted video, character size, character size, underline, strike-through, blank-out, cursor.
- Keyboard: Interface board port with status, dip switch addressing of ports
- On-board RAM - 4096 bytes (912 bytes optional)
- 114L (250nsec or 450nsec) switch addressing, 6K interrupts, 8K bytes capacity
- On-board bank select of RAM
- Buffer: All lines buffered
- Software: CP/M compatible driver routine
- Power terminal simulator routine

List Price - OUR PRICE
SMM-VB3A 80x192 KIT $499.00 $450.00
SMM-VB3A48 80x192 KIT $499.00 $450.00
SMM-VB3K24 80x192 KIT $425.00 $359.00
SMM-VB3K4B 80x192 KIT $475.00 $425.00
SMM-VB3U 80x192 KIT $500.00

Video Interface Software
- CP/M Compatible B: Disk, containing
  - CP/M BIOS Driver
  - Super Intelligent Terminal Routines
  - Menu-Driven Initialization Routine
  - Misc. - User-Contributed Programs

List Price - OUR PRICE
SMM-VB3DF $349.00 $35.00

V181 Memory Mapped Video Board

One of the most popular S-100 video boards available, this V181 is software controlled and memory mapped. Memory Mapping means that locations in the 8K (1024) byte on-board RAM memory correspond in locations in the 64K 0x1000 character display.

The 1K memory can be addressed at any 1K increment via DIP switch.

The V181 features a 128 x 46 matrix for graphics upper and lower case, Greek letters, and is selectable for white on black or black on white. Software includes a driver routine for cursor control, scroll-up, and X-Y graphic control.

List Price - OUR PRICE
SMM-V181C KIT $242.00 $205.00
SMM-V181A A&T $295.00 $250.00

VBI I/O Mapped Video Board

The VBI is an I/O controlled video interface board. With a TV monitor, the VBI becomes a video terminal. Other I/O card is required for keyboard input and video display.

The VBI cursor, linefeed, carriage return, backspace, and clear-screen are hardware controlled. The display is 512 x 480 dot matrix, upper and lower case, Greek letters, black on white or white on black. Software includes a driver routine for cursor control, scroll-up, and X-Y graphic control.

List Price - OUR PRICE
SMM-VBIK KIT $195.00
SMM-VBIA A&T $225.00

VBI2 Color Video Interface Board

VBI2 is an I/O controlled video interface board with a TV monitor. The VBI2 becomes a video terminal. No other I/O card is required for keyboard input and video display.

The VBI2 cursor, linefeed, carriage return, backspace, and clear-screen are hardware controlled. The display is 512 x 480 dot matrix, upper and lower case, Greek letters, black on white or white on black. The board produces a clear, bright display, and features adjustable picture size and character width. Circuitry is provided to drive a speaker for a tone.

List Price - OUR PRICE
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SMM-VBIA A&T $225.00

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**List Price** $995.00

**SALE PRICE** $819.00

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- 1K PROM with built-in drive and I/O utility subroutines incorporated in memory-mapped I/O
- 2K 214·300 nano second access time RAM for disk data offering and general purposes use
- Starting address of memory space is 340000 (0000h) for compatibility with other popular ROM based systems
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- Compatible with all 2, 4, and 5 MHz systems which conform with the proposed IEEE standard for 100 bus.
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- Switch selectable baud-rates from 56 to 19.2 Kbits/second
- 864 addressable memory mapped I/O (as many floppy disk controller boot proms)
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- CSC and assembled/tested boards are designed to meet all specifications
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- Does DMA
- THAT’S 2 WATTS OF STATIC 64K RAM

**HIT-V152**

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**List Price** $75.00

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- High-sensitivity 1mV/div.
- 2 Year Warranty

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- High-sensitivity 1mV/div.
- 2 Year Warranty

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- CSC and assembled/tested boards are designed to meet all specifications
- Through bypassing of all supply lines

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<td>Only</td>
<td>$879</td>
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<td>1410 w/numeric keypad, List $900</td>
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<td>1510, List $1395</td>
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FOR SALE: MITS Altair 8800 floppy-disk drive and controller. Recently aligned and all ECOs installed. With all manuals and special program tapes. $1100 includes shipping. Keith Monlock. Rt # 5 Box 263. Columbus MS 39701. (601) 328-8880.

WANTED: Information where I can find the King James Version of the Bible in computer-readable format on disk or cassette. I will accept collect calls if you have this information. Steven Tilden. 4771 S Warren Ave. Tucson AZ 85714. (602) 746-0549.


FOR SALE: Floating point math board for RCA VP. With driver software, uses MM5709 UP, 538 LP. HP-55 programmable calculator with timer, includes 5 suites and manuals. Best offer or will consider trade for IBM Quick. Printer II. Frank Shinyei. 10545 129 St. Edmonton Alberta. T5N 1W9.

FOR SALE: Heathkit M-100 computer with 32 K bytes of mem­ory System includes serial I/O interface, cassette recorder/player, and H-9 video terminal. All manuals, documentation, and software included. Extra are disk covers and special program tapes. $1100 includes shipping. Keith Monlock. Rt #5 Box 263. Columbus MS 39701. (601) 328-8880.

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BOMB

BYTE’s Ongoing Monitor Box

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March BOMB Results

Gregg Williams and Franklin C. Crow tied for first place for their articles, “Structured Programming and Structured Flowcharts” and “Three-Dimensional Computer Graphics, Part I.” A check for $100 will be sent to Mr. Crow. (Being a BYTE employee, Gregg is not eligible for the prize money.) The second-place prize of $50 goes to Tim Ahrens, Jack Browne, and Hunter Scales for their article, “What’s Inside Radio Shack’s Color Computer?” The next two places went to Steve Clarcia’s “Build the Disk-80” and Jim Howard’s “What Is Good Documentation?”
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*is your direct line to the editor's desk.* Each month, the two top-rated authors receive bonuses based on your votes. To cast your vote, first look at the list of this month's articles and corresponding article numbers (located in the unclassified ads section on the page preceding the Reader Service list), then rate each article as **Excellent, Good, Fair, or Poor** by circling the appropriate number in each column below. Your feedback helps to produce the best possible magazine each month.

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