VOL. 1 No. 3 July 1984

COMPUTER DIGEST

NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

THE NEW SINCLAIR QL COMPUTER...

An in-depth look at this under-$500 computer that includes 128K of RAM, two tape drives, and high-res graphics.

ARE PRINTING BUFFERS FOR YOU???

Nifty devices that free up your computer for other tasks while documents are being printed out.

A GERNSBACK PUBLICATION

COMMUNICATIONS SOFTWARE....

A look at the software that lets your computer talk to other computers.

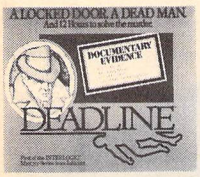
Radio-Electronics Software Store

New for our readers....A mailorder source of software for Atari 400, Atari 800, IBM P C, Commodore VIC-20, Apple II, and other personal computer systems.

IBM PC

☐ **FLIGHT SIMULATOR** by Microsoft ... List **$49.95.** Our price ... **$43.00.** Highly accurate simulation of flight in a single-engine aircraft. Working instruments. Out the window graphics. Real-time flight conditions. (IBM P C, 64k, color graphics, disc)

☐ **EASYWRITER II** by Information Unlimited ... List **$350.00.** Our price ... **$300.00.** Turns your computer into a word processor. You see everything on the screen. There are no imbedded commands. (IBM P C, disc)



☐ **DEADLINE** by Infocom ... List **$49.95.** Our price ... **$43.00.** A locked door. A dead man. You have 12 hours to solve the mystery. One false move, and the killer strikes again. (IBM P C, 48k, disc)

☐ **ALGEBRA,** Vol. 1 by Eduware ... List **$39.95.** Our price ... **$34.00.** A first year algebra tutorial covering definitions, number line operations, sets, etc. (IBM P C, 48k, color grpahics, disc)

☐ **MICRO/TERMINAL** by Microcom ... List **$94.95.** Our price ... **$83.00.** Allows access to remote mainframes and minis, information data banks, and other personal computers. (IBM P C, disc)

☐ **PC TUTOR** by Comprehensive Software ... List **$79.95.** Our price ... **$69.00.** Interactive program teaches you how to use your IBM Personal Computer, including hardware and software. (IBM P C, 64k, disc)

APPLE

☐ **PRISONER2** by Interactive Fantasies ... List **$32.95.** Our price ... **$28.00.** Escape is hardly possible. The island keeps you under surveillance. Just try and get out! (Apple II, 48k, disc)

☐ **PRISONER2** by Interactive Fantasies ... List **$39.95.** Our price ... **$34.00.** (Atari disc)

☐ **THE MASK OF THE SUN** by Ultrasoft Inc ... List **$39.95.** Our price ... **$34.00.** An animated adventure through a series of hi-res screens. An ultimate adventure challenge. (Apple II, 48k, disc)

☐ **MASTERTYPE** by Lighting Software ... List **$39.95.** Our price ... **$34.00.** A typing instruction system in an exciting hi-res game format. Learn to type while battling waves of attacking enemy words. (Apple II, 48k/64k, disc)

☐ **THE GRAPHICS MAGICIAN** by Penguin Software ... List **$59.95.** Our price ... **$53.00.** Make your own animated graphics. Handles up to 32 independent objects. Stores hundreds of color pictures. (Apple II, 48k, disc)

☐ **RENDEZVOUS** by Eduware ... List **$39.95.** Our price ... **$34.00.** In four phases, simulates an actual space-shuttle flight from Earth Liftoff through Orbital Rendezvous and Approach to Alignment Docking with a space station. Hi-rez graphics (Apple II, disc)

☐ **SAT WORD ATTACK SKILLS** by Eduware ... List **$49.00.** Our price ... **$43.00.** A tutorial for mastering vocabulary, deciphering new or unfamiliar words, and taking tests. (Apple II, disc)

COMMODORE VIC-20

☐ **PIPES** by Creative Software ... List **$39.95.** Our price ... **$34.00.** Connect a pipeline from the water supply tank to every house. Watch out for leaks. Use as little pipe as possible. 5 skill levels. (Commodore VIC-20 cartridge)

☐ **SHAMUS** by Human Engineered Software ... List **$39.94.** Our price ... **$34.00.** Only you can stop the Shadow's mad reign of terror. Two levels with 20 rooms each. A joystick challenge. (Commodore VIC-20 cartridge)

☐ **HOUSEHOLD FINANCE** by Creative Software ... List **$17.95.** Our price ... **$15.00.** Home utility program records and analyzes your monthly income, expenses and budget in 16 categories. (Commodore VIC-20 tape cassette)

☐ **HOME OFFICE** by Creative Software ... List **$29.95.** Our price ... **$25.00.** Combines VICPRO, a flexible and efficient word processor with VICDATA a powerful and sophisticated information storage and retrieval system. (Commodore VIC-20, cassette tape, 8k additional memory required)

ATARI

☐ **SUBMARINE COMMANDER** by Thorn EMI ... List **$49.95.** Our price ... **$43.00.** A submarine patrol simulator to hunt and destroy enemy ships. 9 skill levels. Plug-in cartridge. (Atari Cartridge 400/800)

APPLE

☐ **MINER 2049** by MicroLab ... List **$39.95.** Our price ... **$34.00.** Chase into a Uranium mine thru 10 levels of traps and capture Yukon Yohan. Scale ladders, jump from moving platforms, and win—if you can. (Apple II, 48k, disc)

Radio-Electronics Software Store

200 Park Avenue South

New York, NY 10003

Number of items ordered ☐

Total Price of Software ..... $_____

Sales Tax (NY State Residents Must Include) ..... _____

Shipping ($2.00 per item) ..... _____

TOTAL ENCLOSED (Sorry, No COD's) ..... $_____

Name _____

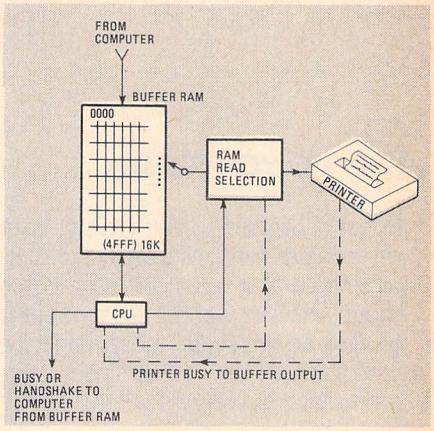
Address _____

City _____ State _____ ZIP _____

SORRY - NO CREDIT CARD OR COD ORDERS

CONTENTS

Vol. 1 No. 3 July 1984



Page 8

Page 11

ON THE COVER

Sinclair started many revolutions: He was first with pocket calculators and flat-screen TV's. But perhaps he'll be best remembered for the first under-$100 computer: the ZX81/Timex Sinclair 1000. He is trying to start a new revolution with the Sinclair QL—an office computer for less than $500. The QL comes equipped with 128K RAM, two micro-sized tape drives, and an RS-232 serial port. Integrated software—word-processing, spreadsheet, database, and graphics programs—is also included. ROM-resident SuperBASIC is standard as well. We'll take a look at the machine in detail, starting on page 5.

EDITORIAL

WHY DO YOU READ?

■Most of us read so that we can learn. When we find an article in a magazine that interests us, we read it in the hope that we'll pick up a bit of information that we didn't have before. Naturally, we have to be particular about what we want to learn about—we can't spend our entire lives reading. So we select those magazines that deal directly with our own specific fields of interest. Since we cannot read *everything*, it becomes important that we be selective about who our "teachers" are.

As we all know, there are a great many computer-oriented magazines available. Almost everybody that owns a computer gets a "great" idea for a new computer magazine, and thinks it's the best thing to come down the pike since the invention of sliced bread. Some of those ideas are indeed worthy. Some of the magazines that result will actually last. And some will soon fall by the wayside. How do you select which ones to read?

One of the tests that you can apply, is to look at what magazine editors call a "masthead." That's where they list the names of the people responsible for the publication you are reading. We're rather proud of our masthead, from the publisher right through all of the staff. Those people have been in electronics publishing almost since they learned to write, have worked their way, through the ranks, to the positions they now hold—accumulating years of experience in computers and electronics in the process.

The people who actually write our articles are also experts. (Many of the names, you'll notice, are not new.) They've been writing for many years, and most of our writers are employed in responsible positions at some of the top companies in the computer field. They know what they're talking about, and have learned how to communicate that information in the written word.

What I'm trying to tell you is that **ComputerDigest** is a professionally-developed publication; it's written, edited, and published by professionals for you. We want you to get the most out of it. All *you* have to do is read it! And by all means, let us know what you think.

BYRON G. WELS
EDITOR

COMPUTER DIGEST

Hugo Gernsback (1884-1967) founder
M. Harvey Gernsback, editor-in-chief
Larry Steckler, CET, publisher
Art Kleiman, editorial director
Byron G. Wels, editor
Brian C. Fenton, technical editor
Carl Laron, associate editor
Robert A. Young, assistant editor
Ruby M. Yee, production manager
Robert A. W. Lowndes, production associate
Dianne Osias, production assistant
Joan Roman, circulation director
Arline R. Fishman, advertising coordinator

Gernsback Publications, Inc.
200 Park Ave. South
New York, NY 10003
Chairman of the Board:
M. Harvey Gernsback
President: Larry Steckler

ADVERTISING SALES 212-777-6400
Larry Steckler
Publisher

EAST/SOUTHEAST
Stanley Levitan
Radio-Electronics
200 Park Ave. South
New York, NY 10003
212-777-6400

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Radio-Electronics
540 Frontage Road—Suite 325
Northfield, Illinois 60093
312-446-1444

PACIFIC COAST
Mountain States
Marvin Green
Radio-Electronics
15335 Morrison St., Suite 227,
Sherman Oaks, CA 91403
818-986-2001

The Sinclair QL

Sinclair started a revolution with his low-priced ZX80 and ZX81 computer. Will his new Sinclair QL have a similar effect on the business-computer market?

MARC STERN

■In the modern world of electronics and microcomputers there are a number of innovators and inventors who keep developing ideas that revolutionize the industry. One of those innovators, whose contributions will continue to be felt for years is Clive Sinclair. In the early 1970's, he took advantage of the four-bit microcomputer technology that was then coming to the fore and developed the first pocket calculator. If that were not enough, later in the 1970's, he was credited with developing the first miniature, flat-screen television set.

In 1981, Sinclair, ever the innovator, apparently looked at how far the cost of the microprocessor had fallen and decided the time was ripe for a low-cost personal computer. Thus, the *ZX80* was born—the first computer under $200. By using a membrane keyboard, plastic case, and a very compact operating system, the price of the computer could be kept down. Sinclair's next machine, the *ZX81* could be sold for even less—it was the first $100 computer. One of the reasons that it could be sold so cheaply was that it contained only four IC's—the Z80 microprocessor, a 2K RAM IC, the 8K operating system, and a custom IC that took the place of 14 TTL IC's that were in the *ZX80*.

Other companies soon realized the potential market for low-priced computers. Commodore Business Machines, Texas Instruments, Atari and a host of other companies all began to produce machines that eventually brought true computing power to home users at well below $200 in cost.

By the end of 1982 and into 1983, the battle in the home computer marketplace became so intense that most of the major manufacturers involved in the dog-fight fell by the wayside and pulled out of the business. Texas Instruments dropped out, as did Mattel Electronics, and Atari suffered major reverses. Even Timex (which had taken over the distribution of the *ZX81* in the U.S.) pulled out, leaving the field to Commodore and Radio Shack.

Despite that, Sinclair proved his point: He showed that microcomputers could be low-cost devices and provide average people with real computing power.

Sinclair does it again

Now that 1984 is half over, it looks as if Sinclair has done it again, but this time in a higher part of the computer spectrum, the desktop segment. Sinclair Research Ltd. (50 Staniford Street, Boston, MA 02114) has developed a home/business microcomputer—the Sinclair QL (Quantum Leap) shown in Fig. 1. The machine includes two breakthroughs in the less-than-$500 category.

The first breakthrough in this $499 small system is its microprocessor: a member of the powerful Motorola MC-68000 series with its 32-bit internal architecture. The second breakthrough in the less-than-$500 category is the use of integrated software. The QL is supplied with a word-processing a spreadsheet, database, and graphics programs. We'll look more closely at the software in a few minutes, but right now let's look at what's inside the QL.

FIG.1—THE NEW SINCLAIR QL: at just $499, a "quantum" leap in computing performance and designed for the serious home, business or educational user.

The MC-68008 microprocessor

After all the media attention given to the Apple *Macintosh* microcomputer, you've doubtless heard of the MC-68000 microprocessor. But you probably haven't heard about its variants, which include the 68008.

The 68008 is a 16-bit microprocessor with an 8-bit data bus. Why did Sinclair go with that device? Most likely because it is cost effective. It has the benefits of a 32-bit internal architecture. But because of its 8-bit data bus, you can use byte-wide memories and peripherals. Bus multiplexing is not necessary, as it is with some 16-bit microprocessors. All those factors help to reduce the cost of a system. The memory-addressing capacity of the 68008 is 1 megabyte.

The hardware

One of the most impressive features of the QL is its size. That a computer this powerful can fit in a 5⅜ by 1¾ by 18¾-inch unit that weighs about 3 pounds is amazing.

Sitting on the QL system board are four Sinclair-designed semi-custom ICs, as well as the microprocessor itself. The first IC, dual-sourced by

Plessey and Synertek, controls the display and memory; the second, dual-sourced by NCR and Synertek, controls other major system-level functions including the Sinclair Microdrive tape-storage units, local area network and RS-232C transmission, and the third and fourth, made by Ferranti, provide analog functions required by the Microdrives.

Standard in the QL is 128K of RAM, which is expandable externally to 640K via a plug-in cartridge available from Sinclair. As shown in Fig. 2, the cartridge plugs in at the left-hand side of the 65-key keyboard.

The keyboard features five special-function keys, as well as separate cursor-control keys. One drawback a user may find is the lack of a separate numeric keypad on the QL, you must use the number keys at the top of the keyboard. The *Microdrives* are found at the far right of the keyboard.

FIG.2—THE NEW SINCLAIR QL shown with a prototype of the forthcoming QL 0.5megabyte RAM pack, connected via the QL's internal expansion slot.

The QL provides two built-in Microdrive units for mass storage. Those tape drives are similar in concept to the tape storage units used in other systems such as the Coleco Adam. Each tiny tape that is inserted into the drive unit—as shown in Fig. 3—has a storage capacity of 100K. Those read-write drives have an access time of 3.5 seconds and a program-loading rate of up to 15 kilobytes-per-second. That's not nearly as fast as a disk drive, but it's a great improvement over cassette-tape storage.

The QL comes with a ROM-resident version of the BASIC programming language called Sinclair SuperBASIC, as well as the QDOS tape-operating system. It is all contained in 32K of ROM.

However, this isn't all that you will find in the QL system. The QL also uses a second processor—the Intel 8048—to handle keyboard I/O, sound, RS-232C reception and real-time clock functions. The inclusion of the second processor means that the 68008 doesn't have to handle housekeeping chores, as well as data-crunching and can thus devote its full capability to handling data.

The QL's video display capabilities are as good as many higher-cost microcomputers on the market. It features built-in high-resolution graphics capability—512 by 256 pixels in eight colors—and allows the user the flexibility of employing either a dedicated color or monochrome monitor or a home television set. Part of the QL's memory serves as dedicated video RAM: 32K

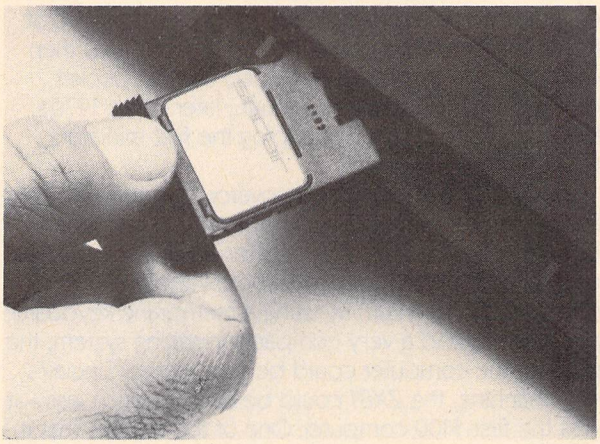


FIG.3—INSERTING THE MICRODRIVE cartridge in the Sinclair QL.

(about 8 pages) of memory, are dedicated to video memory locations. That means that each point on the screen is addressable and has a corresponding location in memory so it can be instantly updated or manipulated by an applications program. The QL normally displays the industry-standard 80 columns by 25 lines on a dedicated monitor and it offers you a choice of character sets. When it is used with a television set, its display is 40 to 60 columns, depending on the software used.

The preceding feature shows the impact the QL is likely to have on the computer market. Like its little relative, the *ZX81* that is still being offered by Sinclair, it will prove to computer users that a computer doesn't necessarily have to cost a bundle to be a "real" device and not a toy. The *ZX81* showed it in the low-end of the market, while the QL will show it in the desktop arena.

The QL also contains nine peripheral/expansion ports. They include one internal expansion port; one microdrive expansion port; a ROM cartridge port; two ports which can be equipped to handle serial interfaces; a local area network port, and two joystick ports. Also included is an RGB-output port and the RF (TV) output.

The software

As was noted earlier, the QL is aimed at the business or home user with sophisticated needs and comes with a standard set of integrated programs that were developed over a period of 18 months by Psion. The applications include comprehensive word-processing, planning, information handling, and graphics capability that are integrated in style, structure, design and in the sharing of information.

The applications—QL Quill; QL Abacus; QL Archive, and QL Easel—all run under the QDOS operating system that is built into the system's ROM. QDOS, developed by Sinclair, has a number of features that are

only available on a microprocessor as advanced as the 68000 series. For instance, because it is capable of handling a great deal of data very quickly—depending on the timing and system resource sharing requirements—it can have two or more applications resident at one time, although only one of them can be active at any moment (it's still a single-user system, after all). That allows you to have a degree of multitasking capability (handling two tasks at nearly the same time). For instance, let's say you were receiving a file upload from another QL user, while you were processing text. Because the system is so capable, you could halt the word-processing program, bring up the file transfer program, and begin the transfer. Then, you could go back to your text-processing program as the file was transferred in the background and you could continue working. Or, you could just leave the file-transfer program up in the background and another user could call you and leave the file while you were doing something else.

As in everything, though, there is a catch and that is the more you ask the system to do, the more RAM you need and thus it's quite likely, although the company doesn't indicate this, that you need the full complement of RAM for the QL (640K). That is because multitasking-even for a single-user is still a memory-hungry function. The resident programs and the data that might be manipulated, input or output, all require their fair share of RAM.

QDOS also contains a time-sliced priority job scheduler, as well as display handling for multiple screen windows (here's where the dedicated video RAM becomes especially important because you can manipulate it separately and it shouldn't detract from the overhead needed by other functions). Finally, because of the nature of the operating system and the QL, QDOS provides device-independent input and output.

Also contained within ROM is Sinclair SuperBASIC, a good implementation of the standard programming language. It features procedure structuring; extendability, including syntax; a clean machine-code interface; equal capability for strings and arrays; a full-screen editor, and full error-handling facilities. Since it is an interpreted, rather than a compiled language—the system must interpret the source code before it can be used—it tends to be slower than a compiled language, which is written directly to machine code through a compiler routine. However, interpretation speed is independent of the size of the program, so you have fairly fast program execution. Finally, as in other advanced implementations of BASIC, the operating-system facilities are accessible from BASIC.

As for the rest of the software available which operates under QDOS, the key tenet is usability. The software has been designed to make the word-processing, spreadsheet, database and graphics capabilities available and usable by people with no prior training.

That has been achieved by using several interesting concepts: pyramidal; "do-and-see," and "inform and decide." The pyramidal structure of the software takes you directly to the most commonly used facilities. It enables even the most inexperienced person to perform useful tasks immediately. And, as you become more experienced with the software, you can make the software do more things.

At all times, the software is "do-and-see." In other words, it takes a totally interactive approach and the visual effect is immediately displayed in the video device. For example, the screen always shows exactly what will be output to a printer or plotter. There are no special control characters needed to indicate various type fonts. Instead, the type font itself is shown. In other programs, the only indication of a change in typeface is a special screen symbol.

Finally, the software is self-documented.

Throughout the programs, comprehensive information on the current status and on available actions are displayed. Continuous prompting is directed at the current action being pursued. In addition, a comprehensive help function is available in all the packages at all times.

The integrated software package allows you full text-processing capability, as well as spreadsheet functionality. Further, it allows you to create and manipulate data in a database and it allows you to combine all of the data created into a graphics display.

What does that mean? Suppose you had a report you had to file that needed inputs from a text-processing program; as well as financial data, and other information contained in a database. With an integrated program, you can integrate the text with spreadsheet financial information and database data into a final report and you can also integrate the graphics you need to complete it. Then, if you decide to change something, the report is automatically updated. Isn't it a nice feature? That means you don't need filtration programs and programs that make one data file compatible with a second or third program and it makes your operation more efficient.

The key to this functionality is a common file structure that allows data created under one program to be used by another, which the QL software does.

The future

As you can see from the foregoing, the Sinclair QL is a powerful machine and it shows that you needn't pay a high price for a high performance machine. That is just what the *ZX81* did and it's quite likely that is what this new machine will mean.

The inexpensive pricetag shatters the mystique of the computer marketplace where a high price was equated with quality and functionality. The QL, with its advanced microprocessor, graphics capability and advanced software, has both quality and functionality, but in a price that is lower than $500. And, it offers users one feature that is a costly add-on in many systems, the ability to tie into a *Local Area Network* or LAN. The LAN has been touted as the gateway to information sharing in the electronic office of the future and it shows that Sinclair's thinking is on that office. He aims at giving people a quality alternative for a reasonable price.◀Φ▶

PRINTING BUFFERS

No, you don't have to sit there and glare balefully at your computer while you wait impatiently for the printer to play "catch-up."

HERB FRIEDMAN

■Pithy sayings and cliches are endemic to all aspects of life and we have our share of them in electronics. The radio amateurs have "If you can't hear 'em you can't work 'em." Generations of hi-fi enthusiasts have had "The system is only as good as the weakest link" drummed into their ears for years. Computerists have "A computer is only as fast as the slowest peripheral."

Among the very slowest of peripherals is the printer. While the computer is all set to zip through a monstrous database in seconds, the printer is putting it all on paper a letter at a time, tick, tick, tick.....tick. And during the time when the printer is doing its tick...tick,..tick, the computer sits idle, waiting for the printer to stop.

Depending on the printer's inherent speed, the idle time can be enormous. For example, consider a 3000-word document, which represents 12 pages of text, 25 lines-per-page, 60 characters-per-line—the defacto standard American business format. One of the modern competitively-priced matrix printers can zip along at about 80–120 characters-per-second. This sounds like *Superman* speed, but first, to create enhanced characters the speed is cut approximately in half, so at best we have 60 characters-per-second, which is 10 words, or one full line of print per second. Exclusive of paper feed or changes, 3000 words will take a minimum of 5 minutes to print. Not bad, you could most likely wait 5 minutes to use the computer.

But you don't want your letters to appear computerized by having matrix characters, so you use a letter-quality daisy wheel printer. A competitively priced daisy printer delivers about 12 characters-per-second. Now we have a whole new ballgame as they say. At 12 characters-per-second, not even allowing for changing the paper or the slower carriage returns and linefeeds it will take 25 minutes to print 3000 words, and that's a lot of time for a computer to be out of service just to print a document.

The spooler

One of the earliest schemes to free the computer from serving as a storage bin for the printer was something called a *spooler*, spooler being an acronym for "Simultaneous Peripheral Operation On-Line," which in plain language means that disk drives and printers can be operational while a program in memory is active with some other function. For example, the spooler might be printing your thesis on perpetual motion while you're composing a letter to the local utility complaining about an electric bill for $1000 during the month you were away on vacation.

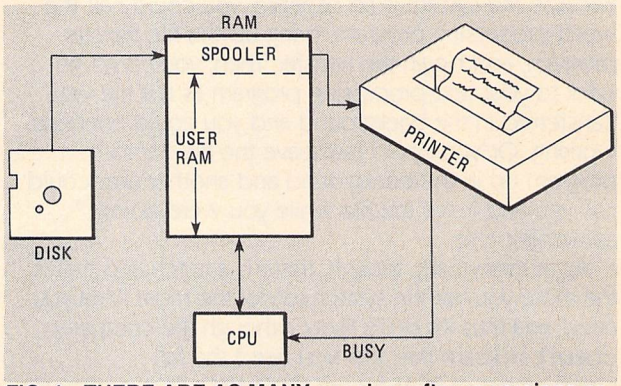


FIG. 1—THERE ARE AS MANY spooler software versions as there are word proccessors. Most of them work this way.

While there are probably as many versions of spooler software as there are word processors, they all more or less work as shown in Fig. 1. The spooler loads itself into high memory. When the computer "looks up" at the top of memory it sees not the actual top of RAM but the bottom of the spooler. Assuming the computer has 64K RAM, if the spooler requires 10K the computer has only 54K RAM available for the user and the computer "sees" 54K as being the top of RAM.

The spooler functions as a pass-thru for blocks of data from the disk to the printer. If the keyboard is activated it takes preference: the spooler holds off calling for a block of information and the computer functions normally; the user can then utilize user RAM for just about anything else.

Programs or functions in the user RAM are said to be in the *foreground*; the spooler function is said to be in he *background*. Only when the foreground is inactive is the background permitted to operate. Actually, because of the small buffer usually built into the printer, and a small buffer of perhaps less than 1K in the spooler (or even larger), the user rarely realizes it's all happening in fits and starts. With a well-written spooler it's almost impossible to detect any interruption in the printer's throughput even though activating the keyboard might delay the spooler by as much as three seconds.

Spooling is sometimes built into word processing software so the user doesn't have to twiddle his or her thumbs waiting for the printer to finish. With a software spooler the printer goes it's merry way—as slow as it wants—while the user powertypes through another document. The only thing the user cannot do is access the disk system while the spooler is active. That is not a problem if you're using the foreground to build a

spreadsheet for disk storage after the background spooling is finished, or if you plan to use only non-disk functions until the printing is finished. But, if your foreground task involves the disk system, something's got to give. If you're *boilerplating* a document and the pre-written paragraphs are going to come from disk, the foreground and background tasks are usually going to be mutually exclusive. The few spoolers that can time-share the disk system generally take up so much RAM there's little remaining for the foreground task. So there must always be a compromise of sorts as long as the spooling is done through software.

Hardware spoolers—the printer buffer

When there's no room for compromise, when you want to print and yet have full access to the disk system, you must totally divorce the printing function from the computer. That is done with a hardware spooler, an electronic device usually called a "printer buffer," or a "printer controller," or a "printer optimizer." To avoid confusion, we'll refer to all of the hardware devices as a *printer buffer* regardless of what it's called by the manufacturer.

The basic concept of a printer buffer is a 4-terminal *black box* full of RAM (memory) which is controlled by its own internal CPU (*C*entral *P*rocessing *U*nit). Two input wires connect to the output printer port of the computer, the remaining two output wires connect to

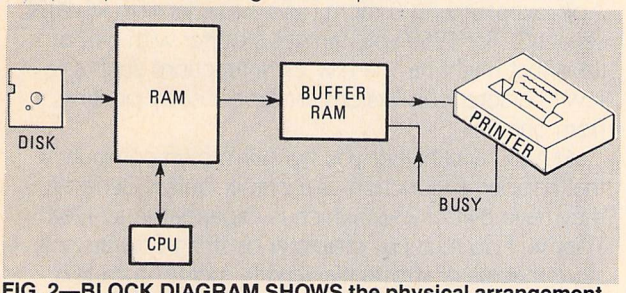


FIG. 2—BLOCK DIAGRAM SHOWS the physical arrangement and interconnections of the printer buffer.

the input of the printer. The physical arrangement is shown in Fig. 2. The internal structure of the buffer is such that, to the computer, it appears to be a printer, while to the printer the buffer appears to be the computer.

When the computer is given the command to PRINT, it dumps to the buffer, filling the buffer's RAM with a mirror image *of the signals intended for the printer.* Understand this point very clearly: The buffer does not receive a mirror image of the computer's RAM; rather, it receives what is intended for the printer. The data stored in the computer's RAM is what determines the signals sent to the printer, but it is not necessarily the same.

Generally, the buffer outputs immediately to the printer, which thinks it's getting data from the computer. In a matter of seconds—the precise time depending on the amount of data to be transferred from the computer to the buffer—the computer has completed its dump and is free for any other use. The printer chugs along doing its own thing at its own speed using the data from the buffer; it no longer has any effect on the computer.

Now it's entirely possible that the data in the computer exceeds the RAM available in the buffer; you could have a buffer with 16K RAM while your document takes up 18K in the computer. In this instance, the buffer busies-out the computer until there is free RAM available in the buffer.

It works this way: As shown in Fig. 3, when the buffer's RAM is full, the buffer sends a "busy" signal back to the computer through the handshake connection in exactly the same way as the printer would stop output from the computer. The memory in the buffer is arranged in an overwrite stack, that is, it fills from memory location 0000 and transmits to the printer from 0000. As data in RAM is sent to the printer, the RAM is considered empty and available for new data. After a predetermined block of RAM is free the busy signal to the computer is lifted and the free RAM is loaded with fresh data. As soon as the buffer's RAM is full the computer is busied-out until another block of free RAM is available for data storage. Meanwhile, the buffer's CPU is working its way through the stack. When it gets to address 16K it returns to 0000 and sends the new data, once again moving down the stack through the fresh data. Again, when a sufficiently large block of RAM is cleared, the busy is lifted and the computer fills the free RAM.

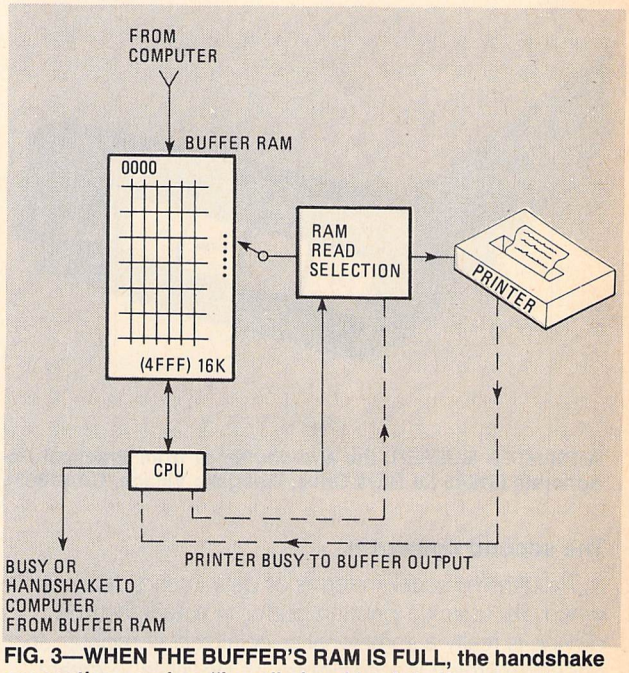
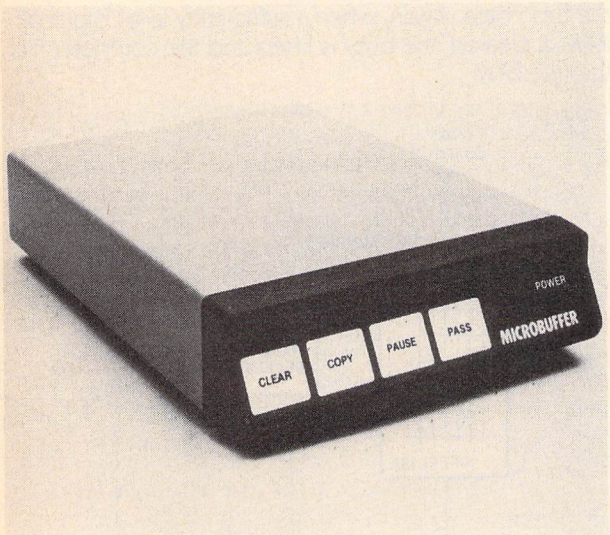


FIG. 3—WHEN THE BUFFER'S RAM IS FULL, the handshake connection sends a "busy" signal back to the computer.

When the computer dumps the remainder of its data, it is free for another purpose even though the buffer is still feeding the printer. So as you see, when the data in the computer's RAM exceeds the capacity of the buffer's RAM it might take somewhat longer than a few seconds to free the computer, but it won't be much longer. Using our previous illustration of 18K of computer data with a 16K buffer, we have 2K of data that cannot be be accommodated by the buffer in the initial "fill." The printer runs at, say, 60-bps (bytes per

second). It will take, therefore, an additional 33 seconds for the buffer to release the computer. Actually, 33 seconds is a "nominal value" because the printing commences the instant the buffer's RAM starts to fill, the printer doesn't wait for the RAM to fill. On the other hand, a buffer generally makes its free RAM available to the computer in blocks: it might well accept output from the computer when the first "page" of 256 bytes is free, or 512 bytes,or 1024 bytes, or whatever it's designed to accept as a block of data.

That is really a worst-case scenario because rarely does the computer's stored data exceed the buffer's RAM. In general, few documents exceed 12K bytes, the equivalent of 8 pages of double spaced text at 250 words-per-page. Those who consistently work with larger documents will not use a 16K buffer. More likely, they will use a 64K buffer, which exceeds the total user-available RAM of an 8-bit computer. (In this instance "user-available" means the RAM not used for the computer's operating system and the foreground program.) For example, one of the popular word processors for 64K computers leaves slightly less than 30K available for text storage, so the most the buffer will have to accommodate is 30K of data.



A PRINTER BUFFER, the *Microbuffer* is from Practical Peripherals (31245 La Baya Drive, Westlake Village, CA 91363).

The second computer.

Though we speak in terms of data in and data out when discussing a printing buffer, in actual fact the device is really a somewhat specialized computer, and once something is a computer it's possible to create many diverse functions. The simplest, least expensive buffers serve primarily as RAM storage devices—what flows in flows out unmodified in any way. But the same internal "computer" that handles the data flow can also do things like character and string conversions. For example, assume you are using a Radio Shack *Model 4* computer. This creates a beaut of a problem because Radio Shack's own software assumes a printer that does an automatic carriage return after a linefeed, so Radio Shack's software does not transmit a carriage return after a linefeed. On the other hand, most standard CP/M software that will run on the *Model 4* transmits a line feed after a carriage return. Because of the automatic linefeed of the printer you now have two linefeeds when you want just one. You could probably reprogram the internal switches of the printer each time you changed operating systems (usually requiring some disassembly of the printer), but an easier way is to simply program the buffer (through a keypad) to convert ASCII code 13 (CR) + 10 (LF) to just 13 (CR). The buffer will now straighten out the carriage returns and linefeeds. Each time it comes to a CR + LF command in its own RAM it will output only CR.

Some buffers can also memorize a string of characters, substituting them for a single symbol. For example, an intelligent buffer can be programmed so a single "#" character in a document causes a complete letterhead to print. In effect, # equals: SuperAtenna Repair Co., 12 Howling Wind Rd., Windy City, NH.

When you can't afford to keep your computer tied up just running the printer, or you need some oddball character and string conversions, the easiest way to do the job is most likely to be a printer buffer.

Printer buffers come in all sizes, shapes, and prices that range from about $200 to well over $500. The lowest cost models are esentially RAM storage devices of 16K intended for parallel Centronics-compatible input/output ports. Those models can generally be expanded to at least 64K, possibly even 128K or 256K. Approximately $100 more buys a model with RS-232C serial I/O. For $250 you can get a buffer with 64K of RAM that might have a few extra functions such as a few character conversions, or repeat copy printing from one fill.

At $500 and higher you get full-blown computers that happen to function as a printer buffer. Generally, they have 64K of RAM which is expandable to 128K. They will do multiple character or string conversions, store macros of substantial length, merge stock text with mailing address input, directly drive more than one printer, convert from serial to parallel I/O or vice versa, provide two or three printer outputs for a single input....the list of special functions is seemingly endless.

No buffer that we have seen, regardless of price, has all the functions of every other printing buffer. No matter how sophisticated a buffer might be, if it hasn't got the one single feature that's important to you it's not worth the money. If you work with large documents then you need at least 64K of RAM, that's important. If you have several printers with different printer codes maybe a buffer that does extensive conversions is what you need. If you do a lot of form letter mailing, a highlight feature for the printer buffer you need might be extensive (and long) macros or the ability to stack texts so they print one after the other in perfect sequence.

For personal computers, printer buffers are still in the introductory stage, so advertisements vie for your attention with endless lists of functions and features. A good rule of thumb to use when considering a printer buffer is: "If the function or feature isn't clearly listed—if it's implied or assumed—it probably doesn't have it."◀Φ▶

PC: "PERSONAL COMMUNICATIONS"

Your computer's window on the world

HERB FRIEDMAN

■The concept of "personal communications" as applied to personal computers changes so frequently that it's most difficult to keep up with "what's new" both in terms of services and the software needed to access the services.

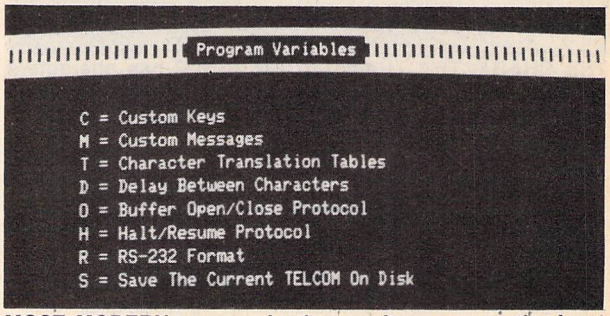
Often, what's new and exciting is not what's efficient and practical but what is fashionable. For example, many of the very same magazines that run "in depth" articles on how to join the revolution in on-line computer services get their author's articles on "hardcopy," *hardcopy* being *technese* for a typewritten sheets. Others, which claim to be computerized, actually request their authors supply the article on a disk specifically formatted for a particular computer that uses one particular kind of word processor, usually WordStar.

On the other hand, **Radio-Electronics**, which is a general electronics publication, has been truly computerized almost from the earliest days of personal computing. R-E gets its columns and features by computer to computer transfer; the hardcopy serves only as a reference backup. Better still, an author can dial-up R-E and dump the manuscript using any preferred word processing program, not just WordStar. Standard, generally-available communications software at R-E automatically modifies the author's upload for R-E's preferred word processor. For example, my files are created with TYPIT, which puts a carriage return after every line in the format that I use for ASCII text transfer. R-E's communications software strips off the linefeeds before they ever get to the storage disk.

Until very recently, that kind of data exchange represented typical personal computer communications: Hobbyists exchanged data and programs (let's be honest and call it "pirating" programs), businesses got information from field offices and salespersons, and college students did their computer work from their dormitories (in those schools with an enlightened administration). However, since personal computers became just another appliance found in many households there has been a dramatic shift in the type and kind of personal communications and the required software.

The communications package.

Today, the fashionable use for personal computer communications is to access the on-line information services, and much of the communications software—what is called the "communications package"—is specifically tailored to access these services.



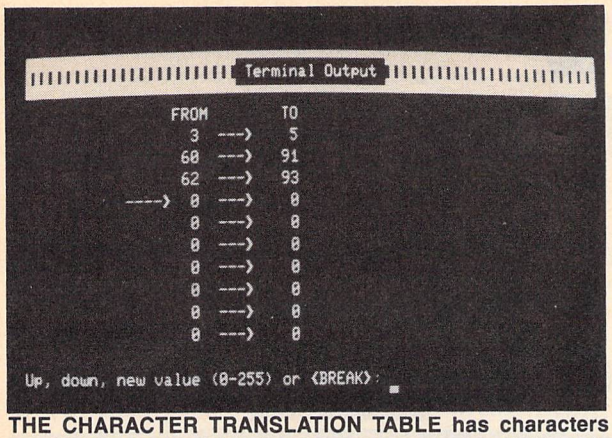
MOST MODERN communications software, even the least expensive, permits customization of program variables of *TELCOM2*, one of the most powerful but least expensive packages.

For those of you not familiar with the term *on-line*, it originally meant equipment and/or software ready for immediate use. By logical extension to personal computing, it means an information service or network which can be accessed by a personal computer through the dial-up telephone system. All that's needed for on-line access of an information service is a personal computer, a modem, and a software package that programs the computer to emulate a "smart terminal."

A smart terminal is one that can store (download) incoming data and transmit (upload) its own tape or disk files, or data stored in its memory. This contrasts with a "dumb terminal," which is only a keyboard and display, or a computer that emulates only a keyboard and a display.

While a dumb terminal can also access computers and on-line information services it cannot store incoming data, nor can it upload its data. As fast as the incoming information scrolls off the sreen it's gone unless fed to a printer. The dumb terminal is simply not adequate for modern on-line or personal communications use, so we will ignore it from here on; we limit our discussion to smart terminals—a full blown computer that also functions for communications.

Dial-up on-line information services—the Source and CompuServe being the best known—have been with us from the early days of personal computing. Today, we also have the Dow Jones News Service for the Wall Street gamblers, even more specialized services for farmers, information networks only for those with IBM computers, and....you name it. If someone thinks people will pay money for information of any kind they start up an on-line information service.



THE CHARACTER TRANSLATION TABLE has characters specified in decimal ASCII and converts outgoing CONTROL-C (3), < (60), and > (62) to CONTROL-E (5), (91), and (93).

Most communications software provide for easy access to the information services through extensive *macros*, a macro being a complete "message" transmitted by touching only a single key. For example, a macro will transmit the telephone number of an on-line information service (assuming use of an auto-dial modem) and wait to receive the required prompt. On receipt of the prompt, the computer then transmits the required response...and repeats this first-you-then-me exchange several times until the local computer is linked and signed into the information service.

If the software is to be used for several on-line services employing different operating codes (called *protocols*), many communications software packages also provide for automatic translation of transmitted or received ASCII characters. For example, assume that many of the on-line services you access require a CONTROL-C to "bail out," but one service requires a CONTROL-E, and you never can seem to remember the one which is not CONTROL-C. If you have a communications package such as TELCOM (Mumford Micro Systems, Box 400 Summerland, CA 93067) or OMNITERM (Lindbergh Systems, 49 Beechmont St., Worchester, MA 01609), you can create a special version that will automatically translate a CONTROL-C to a CONTROL-E. In this way you always use a standardized keyboard entry which the computer translates to the correct characters for the remote computer or information service.

Introducing E-mail.

In the past year or so there has been a considerable change in the use of personal computers for both on-line information services and what is called E-MAIL (*E*lectronic *M*ail). The use of those services is increasing at such a rapid rate that software is now being tailored more toward specific on-line/E-Mail use than for the kind of conventional data and program exchange of the early users of personal computers.

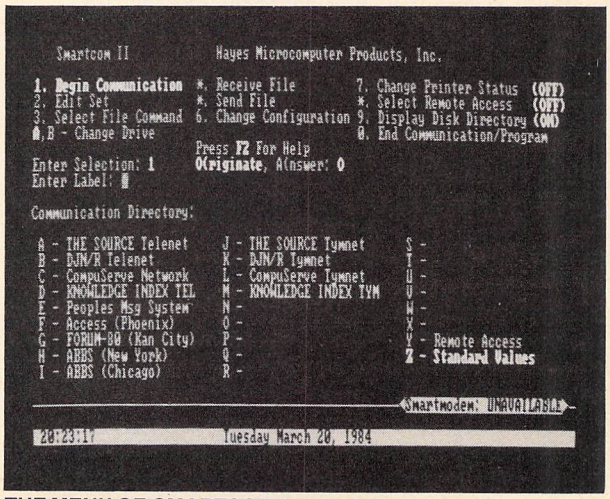
First, popular access to on-line services is no longer primarily for entertainment after prime time when on-line information service rates are lowest. Many on-line services cater to business users and access to the service must be at the touch of a button; no one has time to waste dialing, then punching in strings of access codes, and finally flipping through a menu. So the most modern communications software provides for extended macros; one key dials the service, handles the sign-on protocols, and goes directly to the desired information area of the host computer. True, many older programs had this feature, but the most recent software has macro sign on and automatic E-Mail.

E-Mail is so important a concept to those who can use it efficiently that some New York banks prominently feature E-Mail as one of the highpoints of electronic banking. (Problem is, the pitchman—or is it "pitchperson"—mumbles when they get to the part about how E-Mail can only be sent to other users in the same bank's network.)

One can see the importance of E-Mail by simply looking at the new software packages, such as IBM's "Personal Communications Manager" for the IBM PC/PCjr. Virtually the entire package is oriented towards E-Mail. Like much of the latest communications software, PCM gets involved in unusually sophisticated protocol transfers.

A *protocol transfer* is a method of data transmission that insures an error-free download, upload, or exchange. Until recently, most personal computer protocol transfers involved data and programs, not ASCII text. Instead of exchanging data using ASCII characters, the data is an exact representation of the binary information, and it is transmitted in blocks. Depending on the specific software, error checking is done through a CRC (*C*yclic *R*edundancy *C*heck) or a checksum. Both are means whereby each block of data is followed by a value derived from the data. If a bit gets glitched during transmission the CRC or checksum doesn't match the value of the received data and the host computer automatically requests another transmission. Only when the CRC or checksum matches the data value is the data stored in the computer's memory or written to mass storage.

As a general rule, communications software has some limit on the number of protocol "tries" before it quits and informs the operator there is a data loss.



THE MENU OF *SMARTCOM II* not only lists every function, but also the services programmed for automatic access through the Communications Directory.

Somewhere around 8 to 10 tries is standard before the computer quits and warns the operator that a reliable exchange isn't possible.

Some software entertains the operator with a running count of the number of blocks transmitted or received, the number of errors, the number of tries, etc. None of this information has any real value, but it beats staring at a blank screen.

The protocols must be compatible.

A protocol exchange requires that both computers recognize exactly the same set of control signals—the "protocol." If one computer uses, say, X-ON/X-OFF (CONTROL-Q/CONTROL-S) to start and stop transmission while the other recognizes only ETX/ACK (CONTROL-C/CONTROL-F), or if the computers use different means of calculating the checksum, they will never be able to do a protocol exchange because they will always be searching for control signals that never arrive.

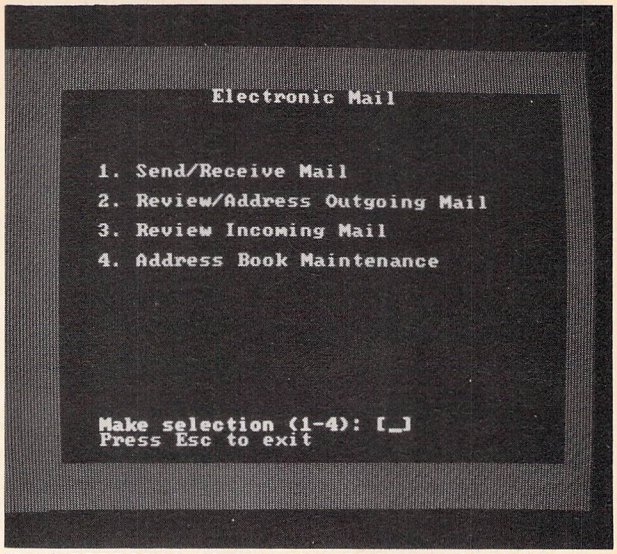
Unfortunately, manufacturers like to insure that people purchase their products, so few communications software packages employ protocols used by other communications software. TELCOM won't do protocol exchanges with CROSSTALK (Microstuff, Inc., 1845 The Exchange, Atlanta, GA 30339), and SOFTCOM (The Software Store, 706 Chippewa Square, Marquette, MI 49855) won't do protocol exchanges with UNITERM (BT Enterprises, 171 Hawkins Rd., Centereach, NY 11720), etc., etc, ad nauseum. About the only outfit that really gives the user a break is MITE (Mycroft Labs, Inc., Box 6045, Tallahassee, FL 32301), which recognizes the CLINK (Crosstalk), XMODEM (public domain), HAYES (Hayes Microcomputer Products, Inc., 5923 Peachtree Industrial Blvd., Norcross, GA 30092) and IBM PC protocols—which encompases the majority of the commonly-used CP/M-IBM personal communications software.

When only interactive text is involved there is usually no need for protocols because the data is exchanged on a character by character basis, not in blocks, and the exchange is continuously viewed. The operator can easily recognize a glitch and make an informed guestimate, or ask for a repeat transmission. The data exchange in this instance uses ASCII because the on-line services and hardware all recognize ASCII. If you access the Source, CompuServe, etc., your computer sends and receives ASCII-encoded characters.

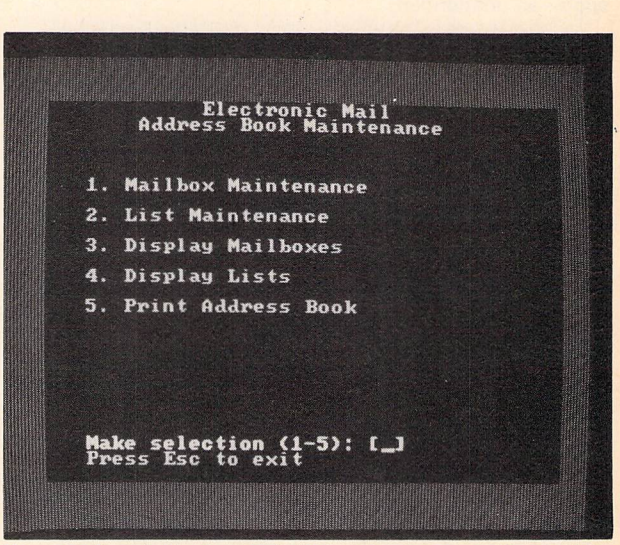
Some software does a checksum or CRC check of ASCII text but doesn't interfere with the exchange It just inforr s the user(s) there was an error.

Bu modern applications of the personal computer have strained the non-protocol ASCII exchange with which most users of personal computers are most familiar. E-Mail is the wave of the present for many business users, and so communications software must provide for error-free data exchange of text. Why error-free? Imagine sending a construction bid by E-Mail and it arrives as $125,000 instead of $12,500.

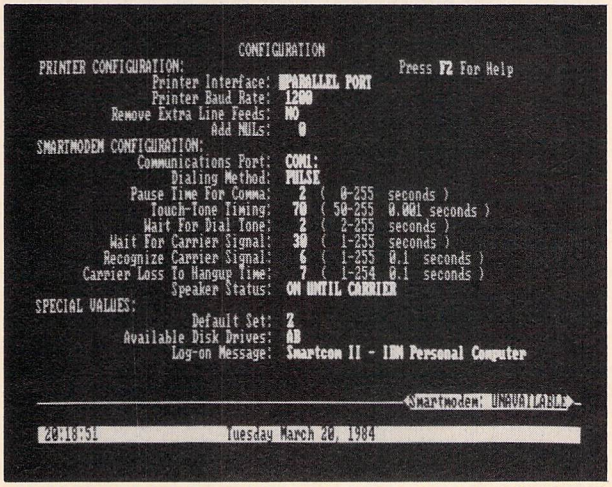
E-Mail oriented communications software is more or



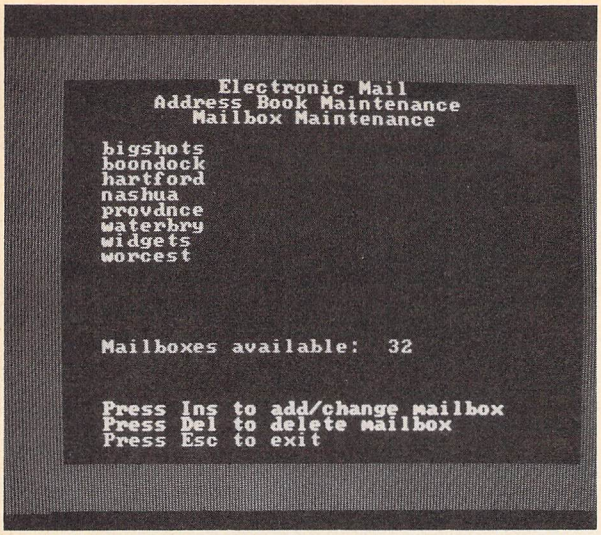
IBM'S *PERSONAL COMMUNICATIONS MANAGER* is big into E-mail. This sub-menu shows just some of the E-mail options.



If you select Address Book Maintenance, you will see this menu that gives you 5 more choices.



THINK OF ANY CONFIGURATION and *SMARTCOM II* will probably let you do it. (Smear of screen is caused by automatic highlighting.)



YOU NAME THE MAILBOXES in IBM's program. To deliver your mail, just enter the name of the mailbox and the computer will auto-dial the remote location and deliver your message—all unattended.

less the same as any other communications software, but it also includes protocol exchange and has many special features specifically intended for E-Mail. Most important, the E-Mail usually referred to is not the E-Mail of the on-line services whereby you leave a message for another subscriber in an "electronic mailbox" at the Source or CompuServe.

What *is* E-Mail?

E-Mail is a real document, a letter, data, memo or whatever you would normally put down on paper for exchange between two business offices (at least for the present). True E-Mail oriented communications software is clocked and dated; it will automatically transmit your document at a specific date and time. It will go to an internal Address Book, look up the telephone number of the office for which a message is intended, automatically dial the remote telephone and redial until a link is established, transmit the correct remote access codes, compare the return confirmation codes, then go to the data file, locate the desired file and transmit the document using an unusually precise protocol to virtually eliminate any possibility for transmission error, and finally sign off and disconnect.

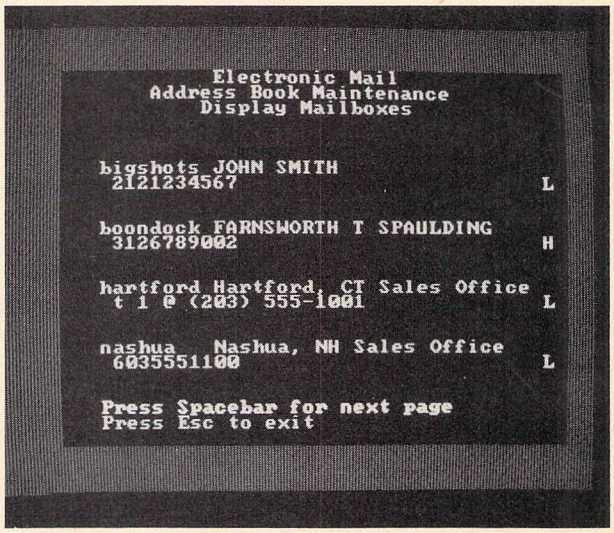
Similarly, true E-Mail software will automatically answer the phone, go on-line, test for protocols, receive and store incoming data using the same precise protocol, and then disconnect. The user can even program what time the computer should auto-answer the telephone line to prevent all callers from being greeted with an answer-tone.

Though many E-Mail features are found in conventional high performance communications software, the major differences are the protocols, internal Address Book access, and header-derived transmissions. As for the protocols, IBM's latest personal computer communications package for home and business, "Personal Communiations Manager," uses the Microcom Networking Protocol. It matters not whether this is the best or worst protocol because today, by popular demand, software must be IBM-compatible, hence, the Microcom Networking Protocol will most likely become the defacto E-Mail standard for home and business, just as the XMODEM protocols are the defacto standard for CP/M bulletin boards.

In a typical E-Mail system each office or location is considered to be a mailbox, identified in the Address Book by a specific codeword or identification. The mailbox file contains the identification, the telephone number and access protocols. For example, Super-Shlock Industries, manufacturers of gold-plated widgets, might be identified by the single word WIDGET, while your own home office might be identified as BIGSHOTS, with a field office identified as BOONDOCK.

You need a header.

Each time you selected a document for transmission you would assign a header to the outgoing log that selects the files to be transmitted. Documents to be transmitted after hours to the home office would have the header BIGSHOTS. Orders and requests for bids to Super-Shlock Industries might have the header



WANT TO SEE WHO PICKS UP THE MAIL at the mailbox? You can call up the list at the touch of a key. The character L or H at the right means low speed (300 baud) or high speed (1200 baud) modem—again automatically selected.

WIDGETS. Five inquiries to the field office asking for information on how many left-handed screwdrivers were in stock would have the header BOONDOCK.

To transmit your document(s) to the field office you would program the communications package to send files coded BOONDOCK at 1:30 AM. At 1:30 in the morning the computer would start up, locate the phone number identified as BOONDOCK in the Address Book, dial the listed telephone number, and after the communications link was established it would search out and upload all files logged as BOONDOCK.

Same thing with the other files. At 3:00 A.M. the computer might "come-up," find itself programmed to transmit WIDGET files, so it would access the telephone circuit associated with the WIDGET identifier

in the Address Book, and then upload all logged WIDGET files.

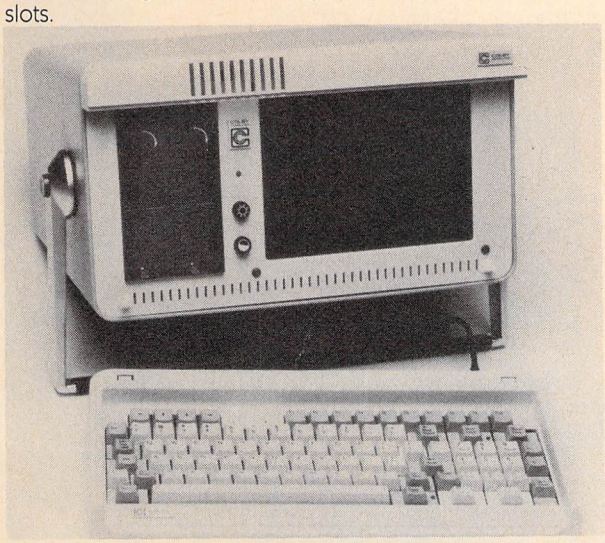
An important component of any business operation is "accountability," which is the business-administrator's way of pinning the blame for mistakes on someone else. While general purpose communications software can be used for E-Mail, true E-Mail software keeps a log of incoming and outgoing traffic. It records who sent what to whom at which telephone number at what time. If the Skyhook Antenna Company claims it never received your order for 25 direct broadcast satellite antennas all you need to do is consult the log, if you sent your order by E-Mail. The log will show the date and time the telephone number was dialed, the protocol identifier exchange (if recorded), the subject or name of the transmitted file (your order), and depending on the particular E-Mail software, the number of tries, failure or success of the protocol exchange, and possibly the disconnect time. It will be difficult for Skyhook Antenna Inc. to deny your order when you have virtually a confirmation in your log.

As with just about everything else in personal computing, new developments are often ready for the marketplace before you even get a chance to become familiar with the hardware and the software you recently purchased. In the field of personal computer communications, be prepared for some startling developments in personal and business E-Mail because it works so well and so easily, and can leave a rather detailed audit trail. Also look at it this way: The junk mail you get through E-Mail doesn't clutter your mailbox and doesn't have to be taken out for the garbage pickup. You get rid of it with the simple command ERASE.◀CD▶

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

IBM-PC COMPATIBLE COMPUTER, the Colby *PC-3,* is a standalone, tansportable computer that incorporates Colby's "high density" IBM-PC compatible motherboard with many functions on the motherboard that would ordinarily require additional plug-in boards, taking up space in the expansion slots.



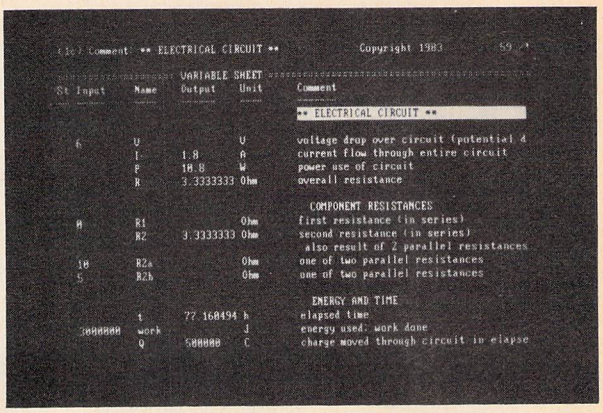
CIRCLE 121 ON FREE INFORMATION CARD

The unit weights 26 lbs., has a 9-inch amber screen and dual 360K double-sided, double-density floppy-disk drives. It measures 8½ × 16 × 16½ inches, has 3½ IBM-PC expansion slots, and a full-width carrying handle that doubles as a tilt stand. The computer can be stored under an airline seat.

The *PC-3* comes standard with 128K of RAM (but can be upgraded to have as much as one megabyte of RAM on the motherboard), a real-time clock, serial port, parallel port, SASI hard-disk interface, and an 80-column × 25-line display with IBM-fiPC compatible graphics capability. It is priced at $2795.00.—**Colby Computer,** 849 Independence Avenue, Mountain View, CA 94043.

EQUATION-PROCESSING SOFTWARE, *TK!Solver* is an equation-processing program that makes it easy to solve mathematical problems without programming. The user simply enters the model (one or more equations), types in the known values, and presses the action key. The program finds all of the unknown values.

All the tools needed for problem-solving are built into the program, including mathematical functions, facilities for converting units of measurement, and the ability to produce graphs and tables. With the program, the user can create his own mathematical functions and use them along with the built-in functions.



CIRCLE 122 ON FREE INFORMATION CARD

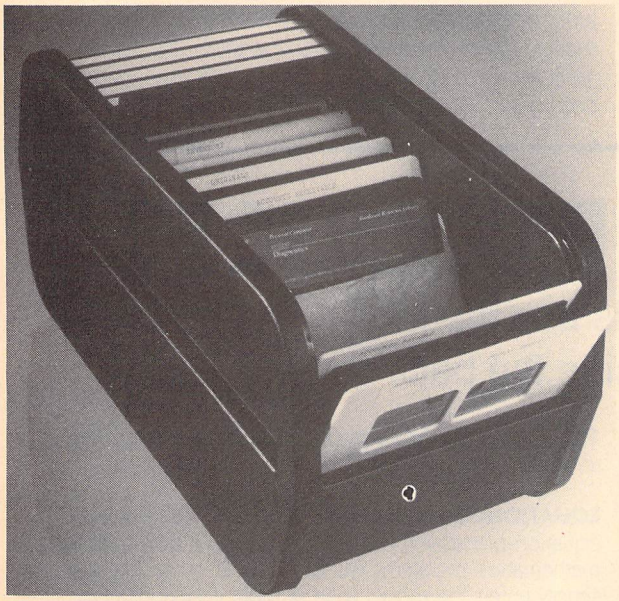
TK!SolverPack applications packages, designed for use with the *TK!Solver* program, solve problems in specific fields. They contain models, which in turn contain the necessary equations, values, and tables for solving a particular problem. The models provided in the applications package can be

modified by the user, if desired.

TK!SolverPacks are available for Introductory Science, Mechanical Engineering, Financial Management, and Building Design and Construction. Additional *SolverPacks* are promised in the future, including packages based on educational books published by McGraw-Hill Book Co.

TK!Solver has a suggested list price of $399. The *TK!SolverPack* applications packages are priced at $100. each—**Software Arts,** Borman/Williams, Inc., 156 Fifth Avenue, New York, NY 10010.

DISK FILE, the Rolltop *100,* known as the "Executive" features a silver rolltop enclosure and a textured black high-impact plastic body. It holds 120 diskettes and comes with 10



CIRCLE 123 ON FREE INFORMATION CARD

dividers and color-coded labels. The Executive Rolltop *100* Disk File is priced at $39.95 (model *RT100E*). A locking model for securing valuable programs or data (Model *RT100EL*) is priced at $49.95.—**Microcomputer Accessories, Inc.,** 6721 Buckingham Parkway, Culver City, CA 90230.

COLOR-GRAPHICS TERMINALS, *Graphos II* and *Graphos III* feature shiftable cell architecture and 16 independently

CIRCLE 124 ON FREE INFORMATION CARD

managed screen windows that can smooth-scroll in any direction, be used to compare images, and mix graphics and alphanumerics. The windows have individual color tables and are central to device-independent operation.

Both *Graphos II* and *Graphos III* are well suited for the OEM, systems integrator, and software developer. Each terminal communicates through an RS-232 connector with practically any host computer, and attaches to a variety of monitors. Those terminals can be rack-mounted or used on a desk.

The two terminals differ in memory, speed, and number of colors. *Graphos II* runs at 6.25 MHz and has 16 colors displayable on a TTL-input monitor. It is priced at $3,995.00 (without monitor). *Graphos III* is an enhanced version capable of generating 32,768 colors on an analog RGB monitor, has a speed of 12.5 MHz, and more memory (256K vs 128K graphics RAM; 224K vs 128K local storage RAM). It is priced at $5,485.00 (without monitor). Complete packages with 13" and 19" monitors are available.— **Ithaca InterSystems,** 1650 Hanshaw Road, Ithaca, New York 14850.

PRINTER STAND, *Printer Caddy* is a solid oak-wood container for your printer. The finish comes in light, medium, and dark wood, with the natural markings of the oak wood showing through. There is easy access to printer paper, with two doors front and back; there are also dual fans for cooling,

CIRCLE 125 ON FREE INFORMATION CARD

and an adjustable printer shelf that features ¾" sound-suppression material.

Overall dimensions are 32" × 27" × 44". The printer stand may be moved about easily on four over-size ball-bearing casters. The *"Printer Caddy"* is priced at $490.00.—**Daisy-Net International, Inc.,** PO Box 1152, Northbrook, IL 60062.