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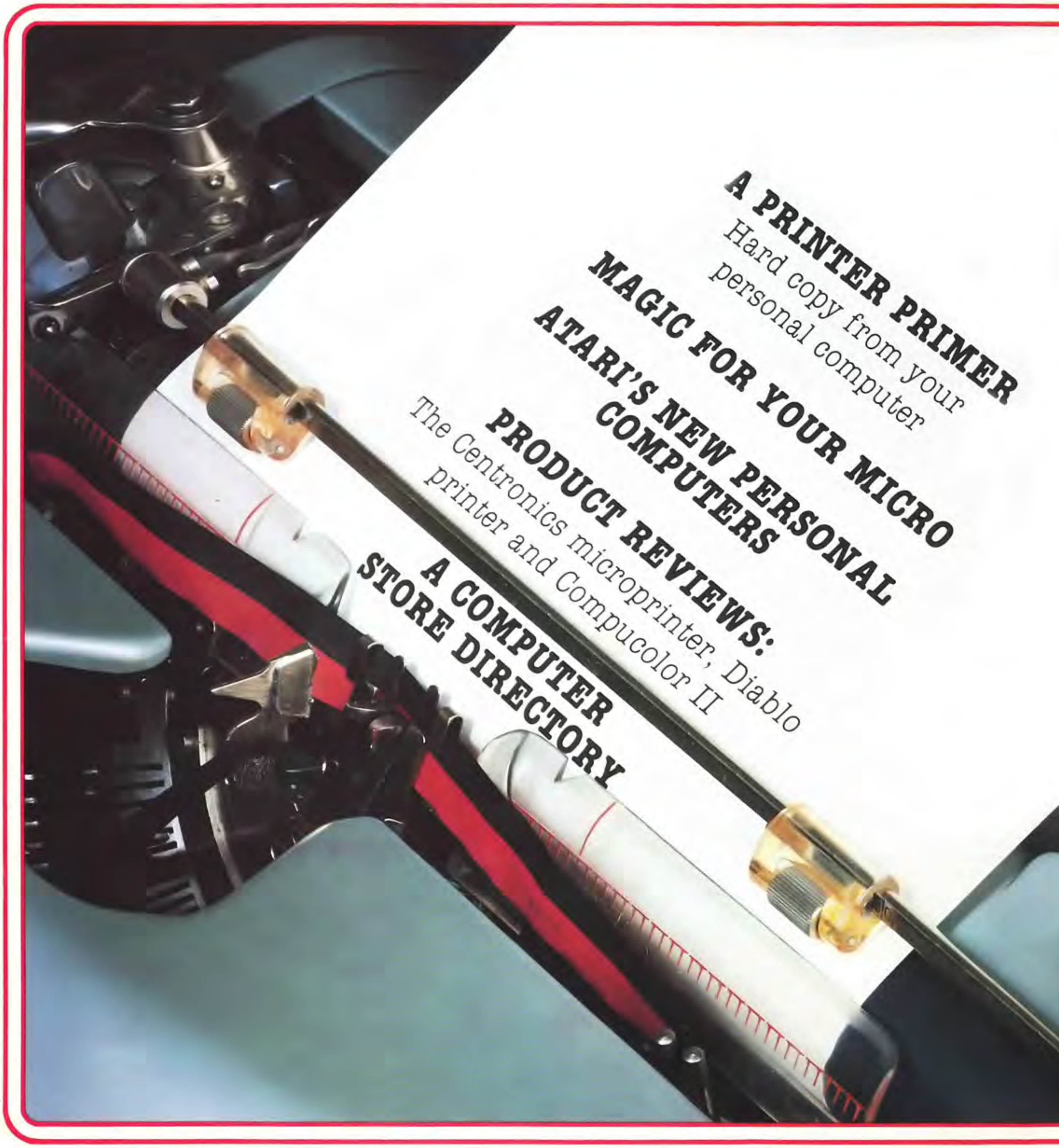

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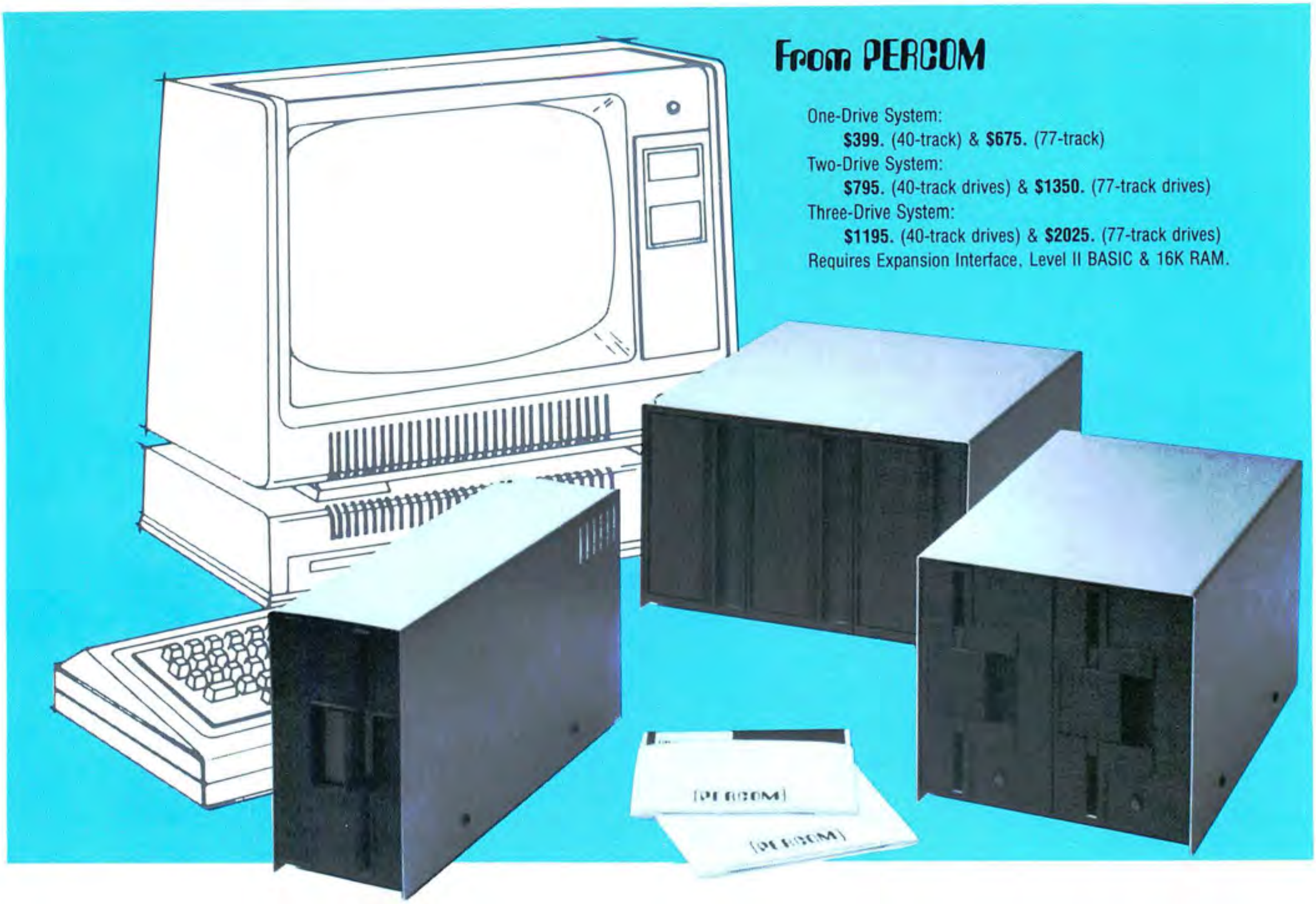

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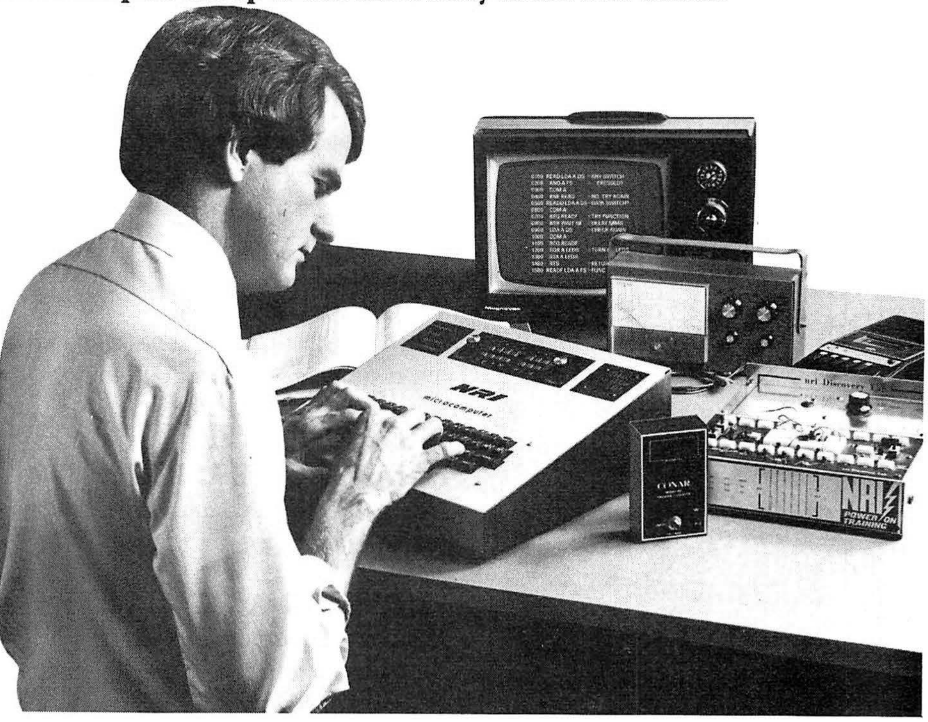

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Editorial onComputing

Hard Copy

Hard copy is a phrase familiar to computer users: it refers to a printed record of some kind, usually a listing of a computer program or the results obtained from running a program. To get hard copy you need a printing device, and the printer has become one of the hottest topics in the personal computer world.

Not many years ago the printer was a relatively uncommon sight in the typical personal computer system. The Teletype predominated as the most common way of obtaining a written record of one's work. The Teletype (which is still very much in evidence) is a relatively slow device, and can print only in upper case.

All that has changed. We're now in the midst of a printer boom. The emergence of inexpensive, fast, and reliable models has triggered an upsurge in sales. Centronics, one of the largest printer manufacturers, reports that fully 20% of their business is now directly related to personal computing, both for business and home use.

The problem then becomes, which printer should you buy? The number of choices is bewildering, both in terms of price and technology used. Can personal computer users hope to obtain high quality, letter quality printing for a reasonable price? Which is best, dot matrix, daisy wheel, Selectric ball, or some other type of printing mechanism? How about the type of paper used by some of the printers on the market—is that a limitation?

"A Printer Primer," our lead article by Elizabeth Hughes in this issue, should help you make a more intelligent choice. You'll read about the latest technology from IBM's laser printer to Sanders Technology's amazing refinement on the dot matrix printer, as well as the more down to earth models. And you'll find a table of printers that should fit your budget and your needs. Our review section also features some interesting printers for your inspection.

In short, we hope you'll benefit from a bit of the hard stuff!

• • •

P.S.: As promised in the last issue, I've "tipped my hat" in this issue and am revealing my top secret magic program, designed to fool your family and friends. Whatever you do, don't reveal the secret to anyone. ■

Chris Morgan

Editor-in-Chief

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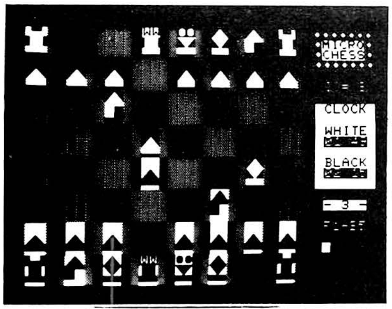

MICRO CHESS

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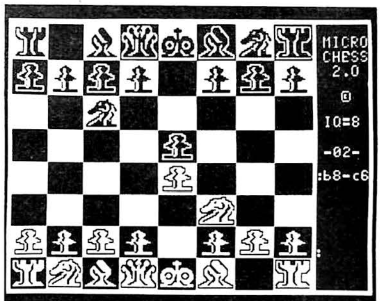

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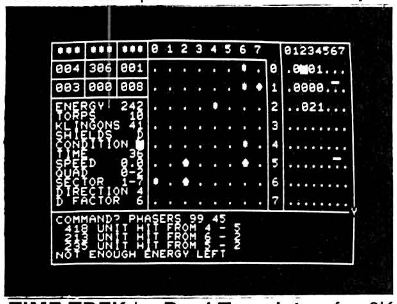

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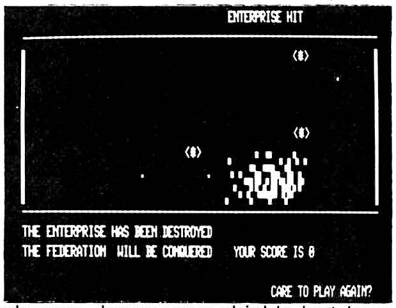

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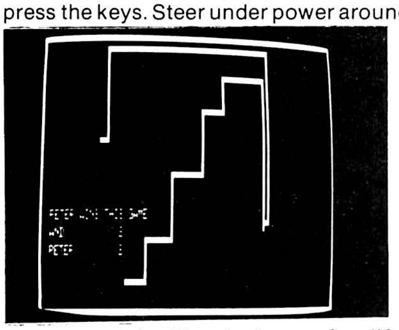

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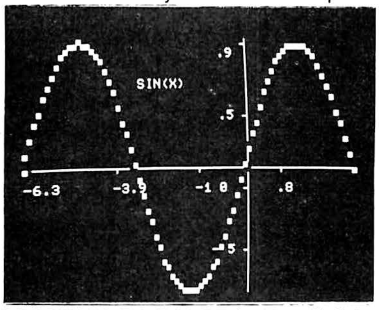

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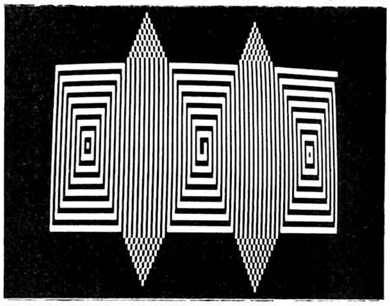

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CIRCLE 170 ON INQUIRY CARD

by Elizabeth M Hughes

As the personal computer market grows, so does the demand for printed output. People who formerly did all their programming in front of a video display are now feeling the need for a permanent written record of their work—a way to get their computerized thoughts down on paper. A new breed of inexpensive and reliable printers is coming to the rescue. The purpose of this article is to acquaint you with some of the jargon used to describe printers and to show you how they work. In addition, we will list some of the printers currently available and describe their features.

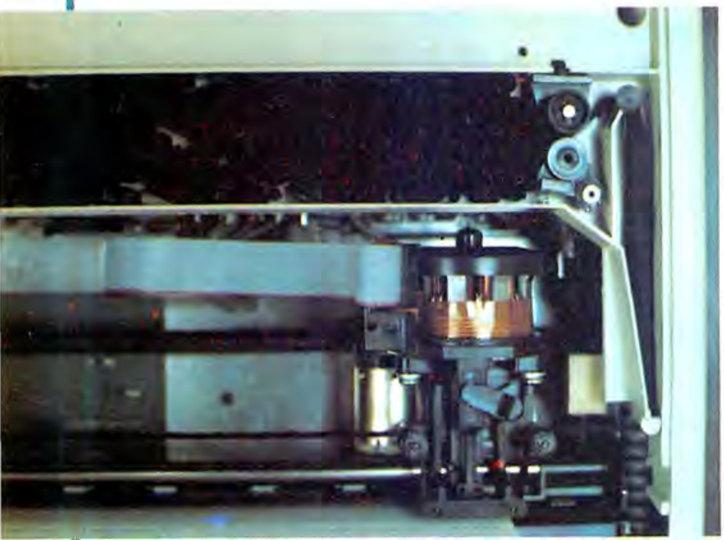
Photo by Chris Morgan

Classifying Printers

Printers can be classified by four characteristics: technique of printing (*impact* or *nonimpact*); method of forming characters (*dot matrix* or *shaped character*); fundamental printed unit (*line* or *character* printer); and speed. Speed is expressed in characters per second or lines per minute (the latter terms are often abbreviated as *cps* and *lpm*, respectively).

Elizabeth M Hughes came to computing from logic and philosophy, which she taught at college level before becoming a professional freelance writer.

Printers are available in a broad range of speeds, including *low speed* (10 characters per second), *medium speed* (up to 200 characters per second); *high speed* (300 to 2000 lines per minute), and *very high speed* (4000 to 18,000 lines per minute). The high speed and very high speed printers are currently represented by the more expensive line printers; most personal computer users do not need such high printing speeds. This article will concentrate on character printers rather than line printers, since character printers are more commonly found in today's personal computer market.

Line Printers

Line printers are the workhorses of the computer industry. The more sophisticated models are capable of printing up to 18,000 lines per minute; a more typical speed is 300 lines per minute. As the name implies, line printers print a line at a time. Actually, most line printers print a character at a time, but the speed of execution is such that the characters in each line appear to be produced simultaneously.

Line printers usually operate in a *parallel* mode by filling a *buffer* with an entire row of characters from the computer, then printing that line. (A buffer is a temporary memory storage area, in this case located inside the printer.)

Line printers are capable of printing on multipart forms, an asset for business applications where extra copies of data must be kept. This ability is also beginning to appear in certain personal computer character printers.

Impact Printers

The majority of printers in use today are *impact printers.* They print characters by striking an inked ribbon so that the parts of the ribbon required to form a character are forced into contact with the

A PRINTE

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paper, leaving the character's impression. A typewriter, for example, is an impact device. When a key is struck, only that part of the typewriter ribbon which is required to produce the character's shape is forced against the paper. If, like a typewriter, the printer strikes the character first (so it presses against the ribbon and the paper), it is called *front-striking*. If, on the other hand, it strikes the paper first, forcing it against the ribbon and the character, it is called *back-striking*.

One of the most common serial impact printers is the Teletype Model 33. Its impact head is cylindrical and has shaped characters arranged on its surface so that by rotating the head and moving it up or down, any individual character can be selected and impressed against the ribbon and paper. IBM's Selectric typewriter operates similarly, but utilizes a spherical impact head which is replaceable, permitting the use of different character fonts. Both, of course, are front-striking devices, but the Selectric, at 15 characters per second, is 50 percent faster than the Model 33 (10 character per second).

Higher speeds in front-striking devices have been achieved using hammer impact rather than character impact. Both the Qume and Xerox-Diablo companies make printers employing what is called a *daisy wheel*. The daisy wheel is a disk from which flexible arms extend. The characters are located at the ends of the arms. As the wheel spins, each character moves past the print position, where it can be struck by a hammer, pressing it against ribbon and paper and printing it. Since the wheel can turn constantly, these systems can attain print speeds of up to 55 characters per second.

Nearly as fast (to 30 characters per second) is Univac's back-striking printer, which utilizes a drum one character wide. The drum spins constantly, presenting each character in each print position as it moves horizontally across the print line. In each position, the hammer strikes the correct character as it moves past.

Halfway between the character printers and the line printers is the General Electric Terminet. It has characters mounted on a belt which forms a horizontal loop. As the belt moves, each character is presented to each print position. Hammers mounted behind (inside) the belt strike the proper character as it passes the print position, causing it to impact against the ribbon and paper. Since the print mechanism is stationary rather than moving through the print positions, this cannot truly be called a character printer, although on some versions of the Terminet the effect of a character printer is given by firing the hammers in groups from left to right across the print line. Speed tells its own tale, however: some versions of the Terminet can attain speeds of up to 340 lines per minute. Centronics also makes band printers.

Dot Matrix Impact Printers

All of the impact printers discussed so far have been *shaped character* printers—that is, the part of the mechanism which contacts the ribbon and leaves its impression on the paper is itself in the shape of a character. Another approach is to use a selection of dots from a dot matrix to compose the desired character; this is what *dot matrix* printers do. A dot matrix printer makes available to each print position a matrix of dots, usually 5 dots wide by 7 dots high (offering 35 dots) or 7 dots wide by 9 dots high (offering 63 dots). Which dots are printed (and which are not) determines which character is printed.

This approach allows a greater variety of characters in the *character set*, since many different alphabets can be represented using the same dot matrix if one has sufficient control over the selection of dots printed. The term character set refers to the total range of characters (letters, numbers and symbols) which the printer can print. The character set is stored in an electronic device called a *read only memory* located inside the printer. The read only memory maintains a permanent record of the shape of each character. When the computer wishes to print, say, a capital W, it sends this request to the

R PRIMER

Photo by Ed Crabtree

Front-striking printer: the character or dot to be printed is impressed first on the ribbon, then on the paper.

Photo by Ed Crabtree

Back-striking printer: a hammer strikes the paper, forcing it first against the ribbon, then against the character or dot to be printed. Shown are the reversed letter impressions used to create the printed copy.

Photo by Chris Morgan

printer, which then looks up the W entry in its read only memory and prints it. In some printer models, the read only memory can be easily changed to accommodate a new character set or typeface — an easier and less expensive task than replacing a belt of shaped characters, for example.

The print density offered by dot matrix printers is usually the same as that provided by shaped character printers (80 or 132 columns at 10 columns per inch), but Centronics, Texas Instruments, and a few other companies have recently introduced matrix printers which produce a print density of 15 characters per inch or 132 characters per line on 11 inch wide paper. Dot matrix printers can also be used for plotting, but so far only a few are available with the additional electronic controls and software required to implement this function.

The most common approach to impact dot matrix printing, used by Printronics, Okidata, and Tally, relies on a matrix of wire actuators. As these actuators move back and forth across the page, electronic impulses cause hammers to strike or not to strike in the location specified. Where a hammer strikes, a dot is printed.

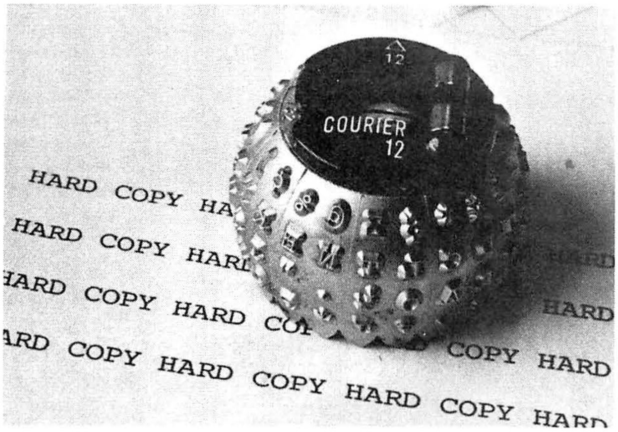
A different approach is used by Potter, a company

One would almost suspect that wherever two or three engineers are gathered together in the name of computing, a new technique of printing is being developed.

which makes a number of models, some of which print at speeds of up to 500 lines per minute. The Potter system utilizes a rotating print drum. On the drum are helical ridges carefully placed so that, as the drum turns, the ridge passes successively through each of the dot positions for a given print column. A hammer, one dot high, strikes the ribbon and paper when the ridge is properly positioned to produce a dot. Which dot positions are struck and which are not determine what character is printed.

Nonimpact Printers

Several approaches to nonimpact printing have been developed in recent years. They offer fewer moving parts to break down and print speeds ranging



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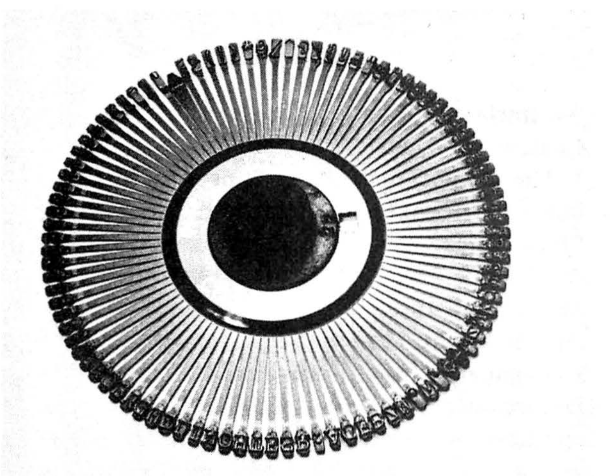


Photo by Ed Crabtree

Two types of front-striking print heads used for impact printing. At top is IBM Selectric ball; at bottom is daisy wheel element.

from 10 characters per second to 45,000 lines per minute in exchange for their inability to produce multiple copies. An impact printer, of course, only requires carbon paper or its equivalent if multiple copies are desired; nonimpact printers produce only an original.

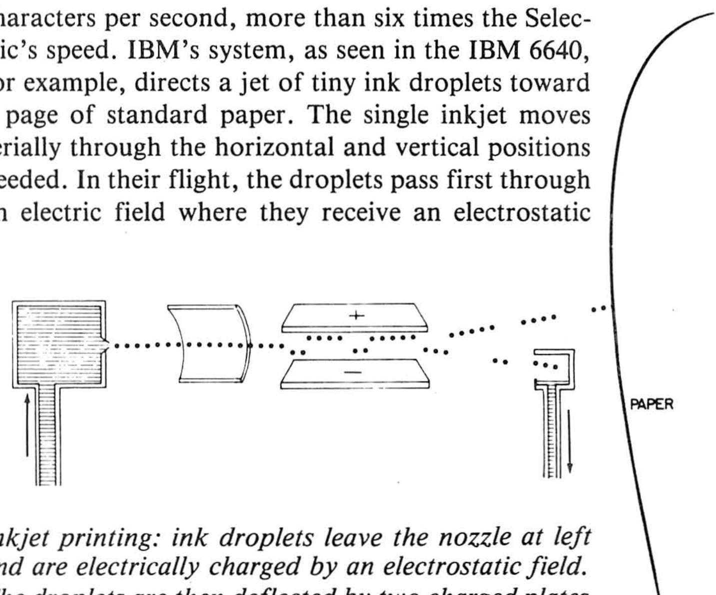
The easiest way to understand nonimpact printers is to divide them into those which require special paper and those which use ordinary paper. While there are many different approaches using special papers, only two nonimpact techniques are common using standard paper: inkjet and xerographic. Let's discuss them first.

In *xerographic* printing, characters are first *imaged* onto a printing surface; that is, an image of the characters in question is caused to appear by one of several means depending on the nature of the printing surface. The surface is then *toned*, which means that ink particles contact the surface, adhering to the places where characters are imaged, but not to any of the surface surrounding the characters. This is usually done by having the ink particles magnetized or electrically charged so that they will be repelled or attracted by like or unlike magnetic fields or electric charges on the surface. When the toning process is complete, the ink on the imaged characters can be transferred to ordinary paper simply by bringing the toned printing surface into contact with it. The ink is then *fused* to the paper, usually by heating it slightly.

Since a number of lines can be printed at once using this process (depending primarily on the paper size and the number of lines per sheet desired), this is a high speed process used for high volume jobs. Two basic variations of the process described above are available. The Xerox Model 1200 (1974) uses flashes of light to photographically image characters on a drum, while the IBM Model 3800 (1976) uses a laser beam character generator to image dot matix characters on the surface of a photoconductor. In both versions, the image is toned, then transferred and fused to the output paper. Both printers have a moneysaving optional feature called a *forms overlay* which permits the output of both the form layout and the information filling in the form simultaneously.

The speed of these xerographic printers is impressive. The Xerox 1200 can print 60 8½ by 11 inch sheets (13.3 characters per inch horizontally and eight lines per inch vertically) per minute, which works out to about 4000 lines per minute. The IBM 3800, while offering greater flexibility of character set, has a speed range of 8180 to 20,820 lines per minute — but costs more than twice as much. Due to the expense and sheer physical size of these devices, few personal computer enthusiasts are apt to encounter them.

The other technique for nonimpact printing on ordinary paper is *inkjet* printing. It is most commonly used for comparatively low speed word processing applications. At first glance unlikely, this newly developed process has been refined to the point where it can produce printing nearly equal in quality to the output of a Selectric typewriter—but at 92 characters per second, more than six times the Selectric's speed. IBM's system, as seen in the IBM 6640, for example, directs a jet of tiny ink droplets toward a page of standard paper. The single inkjet moves serially through the horizontal and vertical positions needed. In their flight, the droplets pass first through an electric field where they receive an electrostatic



Inkjet printing: ink droplets leave the nozzle at left and are electrically charged by an electrostatic field. The droplets are then deflected by two charged plates and hit the paper at the desired position. Some droplets are aimed at an ink gutter for recycling.

Each advance in the technology offers new possibilities, and the delays are few between the perception of these possibilities and the appearance of a printing device using them.

charge. They then pass by a deflection plate which electrically attracts or repels the charged droplets. In this way the drops can be directed to a position in the print column corresponding to a dot position in the 24 by 40 dots per character matrix which forms the printed character. If no dot is needed in a particular position, the droplet is directed into a gutter where it is recycled back to the jet.

In the container industry this process is in use in a form more analogous to a high speed printing press than to most computer output devices. The Mead Dijit printer, instead of using a single moving inkjet, has 100 jets per inch and one jet per droplet position. It is capable of printing at 45,000 lines (or about 600 feet) per minute.

Inkjet printing technology is improving so rapidly that inkjet character printers may begin to appear at prices affordable by personal computer users before too many years have passed.

Techniques Using Special Papers

Five different processes using special papers are currently in use. The most commonly found system employs *thermal* sensitive paper, which changes color when heated. Both Texas Instruments and NCR, the major suppliers of thermal printers for computer output, use a matrix of heated dot elements as a print head. The matrix, usually 5 by 7 dots, is stepped across the page, pausing at each print position. In the print position, the elements required to form the desired character contact the paper briefly, so that their heat changes the paper's color. This leaves the dots which are required for the character printed in that position.

Until recently, thermal printers were far less expensive than comparable impact dot matrix printers. This, coupled with their silence and speed (as high as 120 characters per second, although 30 characters per second is most common), made them popular for use on systems where limited hard copy needs would offset the extra expense of the special paper. Recently, however, both Digital Equipment Corporation and General Electric have introduced impact dot matrix printers at prices competitive with comparable thermal printers, so the picture may change. If it does, thermal printers may be available at good prices from surplus houses.

An Intriguing New Printer from Centronics: Model 730

The Model 730 is the latest product in a long line of printers from Centronics. For under $1000 the user gets a great deal of versatility — the 730 is a 7 by 7 matrix impact printer which can accept three types of ordinary paper: regular 8½ by 11 inch sheets, rolls of Teletype style paper, or multiform fanfold paper. This feature makes the unit useful for small business applications. Printing speed is 50 characters per second, and the paper handling mechanism can move paper by friction feed or by pin feed.

Unlike thermal paper, the special paper used in *electrostatic* printing undergoes no visible change. Instead, characters are imaged on its dielectrically coated surface by electrically conductive styli. Depending on the system and manufacturer, 100 to 200 styli per inch are used; when a character is to be printed, its image is formed by a pattern of electrically charged dots in the coating. The character's resolution and detail depend on the number of styli per inch used. After imaging, the paper is passed through a toner bath where electrically charged ink particles are attracted to the areas contacted by the conductive styli and repelled from all other parts of the paper. Since the output paper is itself imaged (unlike the xerographic systems which, in order to print on standard paper, use an intermediary printing surface) there is no need for an additional process to transfer and fuse the ink onto the output paper.

Electrostatic printers routinely operate at speeds of 300 to 3600 lines per minute, although one of Honeywell's electrostatic printers can print 18,000 lines per minute. The combination of speed, fine resolution, and a price competitive with that of the fastest impact printers has brought electrostatic

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Dot matrix — IBM Selectric — Diablo diasy wheel — High speed chain printer — Inkjet — Dot matrix electrostatic

printers into wide use in applications where both printing and relatively rapid plotting (at widths of up to 72 inches) are desired. Where no plotting application is foreseen, the paper cost of electrostatic printers can become prohibitive, but the relatively low initial equipment cost assures them continued popularity. Versatec is the main supplier of printer/plotters, although Gould and Varian each has a share of the market. Electrostatic printers without plotting capability are provided by Houston Instrument and, at extremely high speed (165,000 lines per minute), by Honeywell.

Electrolytic (wet process) and *electrographic* (dry process) printers are frequently lumped together, since there are similarities both in their techniques of printing and in their most frequent applications. Both processes use special papers which change color with the voltage on the print head or writing element. In the electrolytic process, a special paper is moistened, then drawn between electrodes whose current, passing through the parts of the paper to be printed, changes its color. In the electrographic process, the writing element burns away the light metallic surface of its special paper revealing the dark underlayer.

Two electrographic printers are currently available in the personal computing market. Offered by Axiom (the EX-800) and Centronics (the Microprinter), they employ eight styli to produce, using a 5 by 7 dot matrix, a standard 7 bit ASCII set of 96 characters (upper and lower case). *[The Centronics unit is reviewed by Steve Ciarcia elsewhere in this issue...ed.]* The eighth stylus is available to provide a software controlled underscore. Each printer can produce its character set in three sizes — 20, 40, or 80 characters per line — and Axiom has recently made available the EX-810 printer/plotter with plotting capability of up to 512 dots per line. The differences between the Axiom EX-800 and the Centronics Microprinter are slight: the Axiom takes slightly wider paper (5.5 inches wide as opposed to 4.75 inches wide on the Centronics), and the Centronics is slightly faster (150 lines per minute as opposed to 120 lines per minute on the Axiom). Improved electrographic papers, which reduce the tendency to pick up fingerprints, coupled with high speed and comparatively low cost ($600 and up), have put these new printers among the best choices for the personal computer user.

Electrolytic and electrographic printers are frequently found in facsimile systems, military communications equipment, and commercial terminal equipment. Univac's electrographic system, for example, employs a moving print head of nine styli which etch seven columns of dots per character. Although electrographic and electrolytic printers benefit from comparatively low prices and speeds of up to 2200 characters per second (on the recently introduced SCI Systems Series 1100 "oatmeal box" printer; but 300 characters per second is the usual top end), the appearance and expense of their special papers could be drawbacks. This factor, combined with their limited plotting ability, has prevented them from attaining more popularity in professional circles.

Perhaps the most unusual of the processes requiring special paper is the *indirect magnetic* process offered by Inforex. This system relies on a

Continued on page 86

THE COMPUCOLOR II

A User's Report

by Blaise W Liffick
Photos by Ed Crabtree

After using the Compucolor II for several weeks, I've only just begun to learn about all the capabilities of the machine. In the area of vector graphics, I've discovered all kinds of things that aren't described in the documentation, and there are areas I've had to leave virtually unexplored due to lack of time. Each feature of this machine would take several weeks of careful scrutiny in order to review it as thoroughly as I'd like, so I'll present what I've discovered so far.

Hardware

Photo 1 shows the Compucolor II Model 5 with deluxe keyboard as delivered, with all disks and documentation purchased with the system. It uses a TMS 8080A microprocessor and has 32 K bytes of programmable memory. It has vector graphic capabilities in eight colors on a direct video monitor which displays 32 lines of 64 characters of text, or a resolution of 128 by 128 in graphics mode. The character set includes the standard 64 character ASCII set plus 64 additional special graphics characters.

The most convenient feature is the single 5 inch floppy disk drive mounted in the right side of the display cabinet. Each formatted disk will hold 51.2 K bytes of data.

The unit I tested came with the deluxe keyboard (see photo 2). It has 117 keys, including 16 graphics function keys (labeled F0 through F15 at the top of the keyboard). It also has a numeric keypad at the right. The selection of colors is done via the keypad on the left.

The company literature describes the unit's input and output (I/O) ports, which include an RS-232C serial channel suitable for a printer or modem, and a 50 pin bus to be used for additional peripherals in the future.

Photo 3 shows the internals of the Compucolor II. Inside a standard television case is the power supply (bottom left of photo), main processor and memory board (bottom), video board (right), and floppy disk drive (upper left).

Photo 2: The deluxe keyboard, a $200 option with the Compucolor II. Its extra keys allow sophisticated interactive vector graphics and easy color selection.

Blaise Liffick is senior editor of BYTE Books.

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Photo 1: The Compucolor II Model 5 with deluxe keyboard.

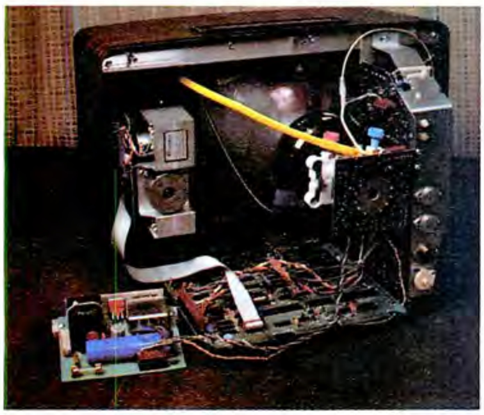

Photo 3: An inside view of the Compucolor II. The power supply for the entire unit is at the lower left of the photo.

The Compucolor II is quite portable, since its dimensions are those of a small color television, and the keyboard can be disconnected easily. I don't know the exact weight of the unit, but it appears to be approximately 45 pounds. The price of the unit as tested is $2200.

Software

Compucolor Corp has as complete a line of software as I've seen from any company. That goes for both system software and application programs. And it's obvious that their programmers enjoy using the powerful color commands available to them. Every program they provide seems to use color quite effectively.

BASIC is the native language of the Compucolor II. The dialect it speaks is summarized in table 1. It includes 30 keywords for program, editing, and command statements, 18 mathematical functions, 9 string functions, and 30 two-letter error messages. As nearly as I can determine, this is Compucolor's own version of BASIC, but it is essentially the same as the most well-known Microsoft versions. BASIC is contained in the machine's 16 K bytes of read only memory.

A disk operating system is provided in the form of a *file control system*, which is also in read only memory, and is accessed from BASIC by pressing the [(ESC)] and [D] keys, in that order. *(Note: in this article an item enclosed in brackets is one keystroke. For example, [CONTROL] indicates the control key.)* Table 2 summarizes the file handling commands. Once in the file control system, [(ESC)] [E] reenters BASIC without disturbing any programs. The file control system can also be entered under program control, making it possible to access data files, the disk directory, etc, from a program.

Photo 4 shows the character set of the Compucolor II in large size. A smaller character size (one half the size of the larger set) is also available. A line will hold 32 large or 64 small characters.

Also available are an 8080 assembler, text editor, and application programs including chess, Star Trek, Othello, and a math tutor.

STATEMENTS:

Input and Output	Control	Definition	Execution Control
READ	RUN	DIM	GOTO
DATA	CONT	REM	IF . . THEN
RESTORE	LIST	DEF FN	FOR . . . TO . . . STEP
PRINT		CLEAR	NEXT
INPUT			GOSUB
GET			RETURN
PUT			ON . . . GOTO
OUT			ON . . GOSUB
INP			CALL
			END

OPERATORS:

Arithmetic	Comparison	Logical
=	=	AND
+	< >	OR
−	> =	NOT
★	< =	
/	>	
∧	<	

UILT-IN FUNCTIONS;

Arithmetic	Transcen-dental	String	Miscellaneous
ABS	SIN	LEFT$	FRE
INT	COS	RIGHT$	POS
RND	TAN	MID$	
SGN	ATN	CHR$	
SQR	LOG	ASC	
	EXP	LEN	
		VAL	
		STR$	

OTHER FEATURES:

File Operations	Miscellaneous
SAVE	PEEK
LOAD	POKE
FILE "N"	PLOT
FILE "R"	WAIT
FILE "A"	
FILE "C"	
FILE "D"	
FILE "T"	
FILE "E"	

Table 1: A summary of Compucolor's BASIC commands. This version of BASIC is similar to that used by other manfacturers which was written by Microsoft. The notable differences are the CLEAR command, which is used to set up space for arrays and strings, the numerous FILE commands, the LIST command, which will either list an entire program or the program beginning at a specified line number to the end, and the PLOT command, used for the graphic mode.

Graphics

Without vector graphics, the Compucolor II might be just another computer. But the graphic capabilities make this machine quite versatile, and the brilliant colors can create exciting displays.

The graphic mode can be entered via either the BASIC PLOT command or through keyboard control. This allows the user to design graphics either automatically via BASIC or interactively in the graphic (CRT) mode, depending on the situation. To make this capability even nicer, an entire graphic display can be saved on disk using just a few BASIC commands. So you don't have to recreate a conplete display from scratch; rather, just load it in from the disk.

Photo 5 shows the range of the plotting capabilities of this machine. The display is 128 by 128 graphics blocks. Notice on the cross lines the resolution of the blocks used in this mode: somewhat coarser than is possible using the Apple II high resolution graphics, but much finer than, for instance, the TRS-80 graphic mode.

Color can be added to the display easily. Photo 6 shows an example of

COPY . . . TO
DELETE
DEVICE
DIRECTORY
DUPLICATE . . . TO
EXIT "FCS"
INITIALIZE
LOAD
READ
RENAME . . . TO
RUN
SAVE
WRITE

Table 2: The file control system (FCS) commands. The file control system is entered by hitting [(ESC)][D] while in BASIC, and [(ESC)][E] to reenter BASIC.

the range of possibilities of the Compucolor II, with listing 1a showing how this box was designed under BASIC control, and listing 1b showing how the same display would be made interactively under the graphic mode.

The deluxe keyboard makes designing interactive displays much easier through the use of the vector graphics keys F0 through F15 (see photo 2). This keyboard is a $200 option, but if you plan on using the Compucolor II to design colorful displays, it would be well worth the investment.

Impressions

I ran into several difficulties while learning about the Compucolor II, its operating system, and its deluxe keyboard. Some of my problems arose from an incomplete understanding of the system, but others can only be attributed to areas overlooked by Compucolor.

The seemingly universal problem with company documentation has not been spared Compucolor. Although they go to greater lengths than many manufacturers in providing both hardware and software documentation, the most notable lack of information is ironically in the area of vector graphics, the strong point of the Compucolor II. While the descriptions of the BASIC commands and the interfaces of the machine were detailed abundantly, Compucolor provides only sketchy documentaion of the graphic functions. Also curious is the fact that the documentation provided for the vector graphics assumes graphic control under BASIC, not graphic (CRT) mode. Thus, the steps shown in listing 1b took me many hours to discover. A table of the possible graphic characters, their ASCII values, and the location of each value as it is displayed on the screen is definitely needed. There should also be a table showing where each graphic character is located on the keyboard. The documentation leaves this as an exercise for the reader.

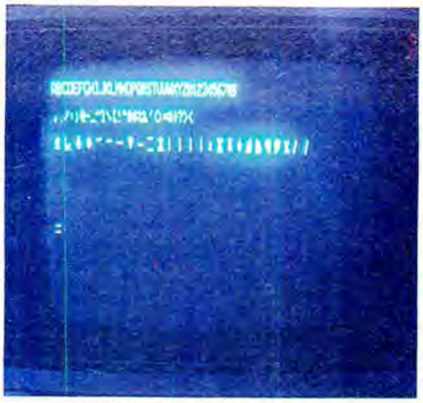

Photo 4: The character set of the Compucolor II. The characters were printed in large size. Note that there is a space between all graphic characters for clarity.

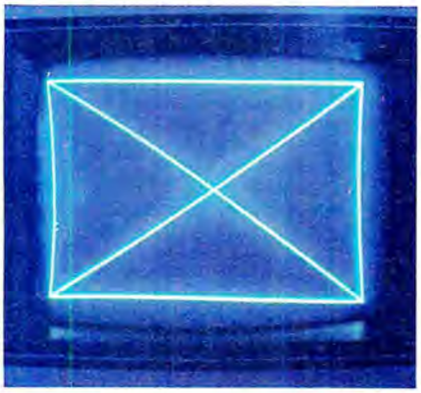

Photo 5: A demonstration of the range of the video display, 128 by 128 blocks. The resolution of the blocks is obvious from the cross line. Also note the slight aberration of the vertical sides of the square.

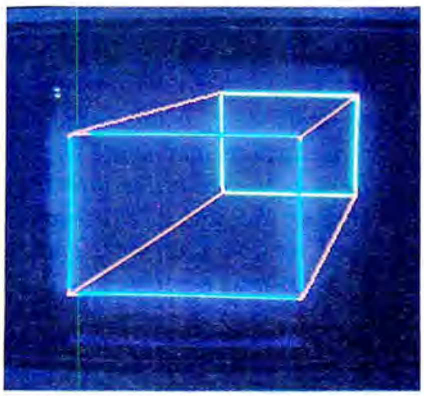

Photo 6: A demonstration of the added dimension that color and vector graphics give to a microcomputer. Listings 1a and 1b show the steps taken to produce this display.

In the area of software, I was also occasionally frustrated. In the application programs, the programmers could have been more careful to prevent the user from "bombing" the execution. Inputs inadequately screened and no keyboard lockout while the program was calculating were the two most common problems here.

In the area of systems programs, I ran into one major glitch. When the steps shown in listing 2 are followed, the system goes off into limbo and the only way to get it back is to reset. The problem becomes obvious when you become more familiar with the system, though. Listing 2 shows a BASIC program being loaded under the file control system. BASIC is subsequently reentered via the [(ESC)] [E] sequence. Now, the program just loaded, in this case MENU, can be listed, and you might even be allowed to execute it, but try to modify it and *boom*. . .limbo. What is wrong here is that the BASIC has its own load command for BASIC programs. Evidently the file control system should not be entered to load a BASIC program. I don't know if you are supposed to be able to load a BASIC program under the file control system, but apparently you can't. Again, this situation should have been caught by the programmer(s) who wrote the file control system.

From a hardware standpoint I found little I didn't like. The video display is clean and sharp; the machine is well laid out. However, the display does have a tendency to wave. This may be interference from the power supply. Whatever the cause, it is annoying, although eventually I learned to ignore it.

The only other problem I encountered with the video display was in Compucolor's choice of colors. I am slightly color blind and I had a particularly difficult time differentiating green from yellow and cyan (light blue) from white. But this appears to be not entirely due to my color deficiency, since others I know

```
5    REM DRAW BOX THE COLOR OF THE PRESENT FOREGROUND COLOR
10   PLOT 2,64,64,242,64,122
20   PLOT 242,122,122,122,64,64,64,255
30   PLOT 29,20: REM CHANGE COLOR TO BLUE
35   REM DRAW BLUE BOX
40   PLOT 2,97,97,242,97,4,4,4,4,97,97,97,255
50   PLOT 29,17: REM CHANGE COLOR TO RED
55   REM DRAW RED CONNECTING LINES
60   PLOT 2,4,97,242,64,122,253,4,4,242,64,64
70   PLOT 253,97,97,242,122,122,253,97,4,242,122,64,255
80   END

(the CAPS LOCK key is in the off position)
[CPU RESET]                   (enter CRT mode)
[CONTROL][B]                  (select interactive graphics mode)
[@][@]                        (plot the green box)
[F2]
[@][Z]
[Z][Z]
[Z][@]
[@][@]
[F15]                         (get out of vector graphics mode)
[CONTROL][FG ON/FLG ON]       (select new color)
[CONTROL][T]                  (for blue color)
[CONTROL][B]                  (reenter graphics mode)
[A][A]                        (plot blue box)
[F2]
[A][DELETE LINE]
[DELETE LINE][DELETE LINE]
[DELETE LINE][A]
[A][A]
[F15]                         (get out of graphics mode)
[CONTROL][FG ON/FLG ON]       (select new color)
[CONTROL][Q]                  (for red color)
[CONTROL][B]                  (reenter graphics mode)
[DELETE LINE][A]              (plot connecting lines)
[F2]
[@][Z]
[F13]
[DELETE LINE][DELETE LINE]
[F2]
[@][@]
[F13]
[A][A]
[F2]
[Z][Z]
[F13]
[A][DELETE LINE]
[F2]
[Z][@]
[F15]                         (done)
```

Listing 1: The listings shown here will display a 3 color box, as shown in photo 6. Listing 1a is a BASIC program which draws the display, and listing 1b is the keystroke sequence (with the [CAPS LOCK] key off) used in the interactive CRT mode which accomplishes the same thing as the BASIC program. In listing 1b, an item enclosed in brackets, [item], is one keystroke, and the [CONTROL] key is pressed simultaneously with the next key listed.

```
[(ESC)][D]                    (enter FCS)
>FCS: LOAD MENU               (load a BASIC program)
>FCS: [(ESC)][E]              (reenter BASIC)
10 REM CHANGING A LINE IN MENU CRASHES THE SYSTEM
```

Listing 2: The steps followed which totally "crash" the system. The point here is that the file control system should not be used to load a BASIC program, since BASIC has its own LOAD command.

who are not color blind also had difficulty telling these colors apart. I first noticed this problem while playing Compucolor's Star Trek game. On the long range scan of the galaxy, the number of stars in a quadrant shows up as yellow. If there is a star base in that quadrant, the number of stars is green instead. The first few dozen times I played the game I was soundly beaten because I couldn't find the star bases. A change to line 45 of the program to make the number of stars in a quadrant show up as blue and the star bases show as yellow fixed this problem quite easily, however.

I don't want to give the impression that I have only negative feelings about the Compucolor II. On the contrary, I found some incredible nuggets of unknown features by playing around with the keyboard. For instance, the [COMMAND] key can be used to print out a complete BASIC keyword. The sequence [COMMAND] [T], for example, prints the keyword LOAD, and [COMMAND] [TAB] prints RUN. Very handy, making it unnecessary to type out all those keywords when entering a program by hand. Unfortunately, this feature appears to be undocumented, so it's trial and error for a while until you get the hang of it. But this illustrates some of the unique planning that went into this machine.

Conclusions

As I said earlier, to discover and describe all the features of this machine would take months, so this is where I'll stop. The Compucolor II is an extremely versatile machine and deserves ranking with the big three off-the-shelf computers (Apple II, TRS-80 and PET). Don't overlook this machine when you get ready to buy. ■

A complete line of available software and documentation is available from the Compucolor Corp, POB 569, Norcross GA 30071.

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BOOK REVIEW

Getting Involved With Your Own Computer

by Leslie Solomon and
Stanley Veit
Ridley Enslow Publishers
Short Hills NJ, 1977
216 pages, paperback
$5.95
Reviewed by Bob Braisted

Getting Involved with Your Own Computer is a book intended to provide the essential information for the eager novice who is looking to invest in a personal computer. What was once an oversized monstrosity of unreliable components at exorbitant prices, has now been transformed into a compact, relatively dependable and inexpensive item called the personal computer.

This book is the consumer's advocate for the recently developed computer market. The text suggests that the *informed* buyer is more likely to find precisely what is needed at a reasonable price.

One section is dedicated to introducing the fundamentals of computer operation. This discussion includes a description of the functional parts of the small system. Another section is devoted to specifying the several sources of information available to assist the hobbyist in selecting a suitable system. These sources include magazines, catalogues, computer clubs, and seminars. A large portion of the book is designed to characterize the variety of systems available today. This entails a discussion of the various microprocessor chips that control each system. Most software is designed to be compatible with only 1 specific microprocessor, so software which works with one system may not work on another.

The text takes special care to consider the overall cost of buying a system. The author advises the purchase of a "training" system which will instruct the user in all the elementary skills involved in utilizing a computer. Having mastered those skills you can begin to acquire a complete system. When this book was written, the personal computer market was still in its initial stages, so the information is just a bit dated. The potential buyer must therefore be aware of the current trends in design so he can avoid buying obsolete equipment.

No critical comparison and contrast of all the systems is furnished in the book. Any unique features of the individual systems are noted as well as any probable disadvantages of the system organization. It is left to the reader to continue further research via the suggested channels of communication to make a final decision.

A word of caution is brought to the attention of the computer shopper. When consulting with experienced hobbyists, keep in mind that they will tend to support their own equipment. Seek a number of opinions and don't rely solely on any one person's word for there is no single best design. You must know what the requirements are for your intended applications and choose the system that thoroughly suits those applications. This book will be helpful in setting up initial guidelines for investment in your personal computer, and will point you in the right direction for a more detailed investigation of its potential. ■

Bob Braisted is a senior at the University of Connecticut majoring in electrial engineering.

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CIRCLE 80 ON INQUIRY CARD

MAGIC FOR YOUR MICRO

by Chris Morgan

Magic on your personal computer? Why not! People play games with their computers, balance their checkbooks, and figure compound interest, as well as scores of other applications. Now you can add programmed prestidigitation to that list.

Picture this: your unsuspecting victim is invited to pick a card out of a deck of ordinary playing cards and lay it face up on the table next to your computer, where both of you can see it. The MAGIC program is then initiated. The computer confirms that a card has been selected, and immediately guesses the color of the card! You type "YES" and the computer guesses the suit of the card. Once again you type "YES" and the computer states whether the card is high or low. This process continues until the computer has correctly guessed the value of the card. The amazing part is that the computer never makes an incorrect guess!

Bear in mind that there are no secret electronic circuits, that what you see is what you get, and that the program will run on any personal computer having a suitable BASIC language package. I wrote the program on an Apple II computer, but it should run equally well on a Radio Shack, Pet, or any other computer whose BASIC package can examine the length of character strings—more about that later. And for magicians, the final, delightful fact is that the *modus operandi* is in full view of the spectators at all times. To top it all off, the program has fooled every computer scientist and programmer I've shown it to!

How does it work?

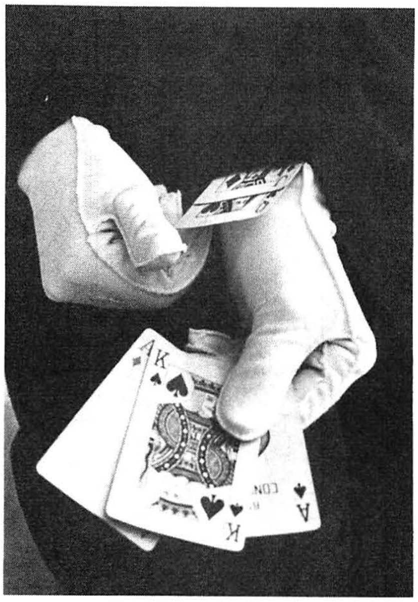
I'll keep you in suspense just a little bit longer. First I want to give you some background about the art of magic.

Misdirection

One of the fundamental concepts in magic is *misdirection*, the art of directing the audience's attention away from some secret manipulation that must go on during the course of the trick. Misdirection can be physical (ie: diverting the eyes of the audience) or mental (ie: causing the audience to think about some diversion rather than the real secret of the trick).

Another important concept in magic is *simplicity*: the secrets of some of the finest magic tricks are remarkably simple. Sometimes they are so simple that the public is often disappointed when a secret is revealed.

While I make no claims about the quality of my computerized trick, I can say with confidence that its secret is simplicity itself. But you'll still have to practice quite a bit in order to do the trick well.



Photos by Risa Swanson

The Secret

The secret lies in your apparently innocent replies to the computer's guesses. When the computer states that the chosen card is black, you type "YES" and hit the return key. However, you can also add a space with the space bar (ie: "YES ") before hitting return. This conveys one bit of information to the computer in the form of a binary (0 or 1) code. But how does the computer make its first guess about the color of the card? Ah, here's where the misdirection comes in! The computer begins by asking "HAVE YOU SELECTED A CARD?" You of course type YES, but you add a space after YES if the card is black, and leave it out if the card is red. The computer now knows the color of the card, and next states "YOUR CARD IS RED" (or black, as the case may be). You affirm the guess by typing YES again, but this time you send the computer information about the *suit* of the card with your binary code. In other words, you are staying *one ahead* of the computer. Following this, you send information about the value of the card (eg: is it 8 or less, or 9 or greater, and so on) until the value of the card is determined.

Simple? Yes—deceptively so. But in order to perform the trick you must first memorize the code used in figure 1. You also need time to think about your replies each time. To help do this, there is a built-in time delay at line 1000 of the trick's program which takes place after every entry you make. If you like, you can add some fancy graphics routines during this time delay to make it appear that the computer is thinking (assuming you know how to program in BASIC, that is). Or you can have the computer ask an occasional non sequitur question (such as, PLEASE ENTER YOUR SOCIAL SECURITY NUMBER, or PLEASE ENTER THE TIME) to throw people off the track.

About the Program

The basic technique used in this program is to examine the length of a *character string*. A character string is simply a sequence of letters, numbers, and symbols (in our case, "YES" and "YES "). For example, in listing 1, line 200 examines the length of character string A$ (ie: your typed-in reply). If the length is equal to 3, your reply was "YES". If equal to 4, it was "YES ". The entire program is actually a *binary tree*, that is, a way of ordering a set of things (in this case, 52 playing cards) into a tree-like structure. Each branch of the tree has a unique binary code, and a particular set of 1s and 0s from you causes the computer to home in on the desired card. See figure 1.

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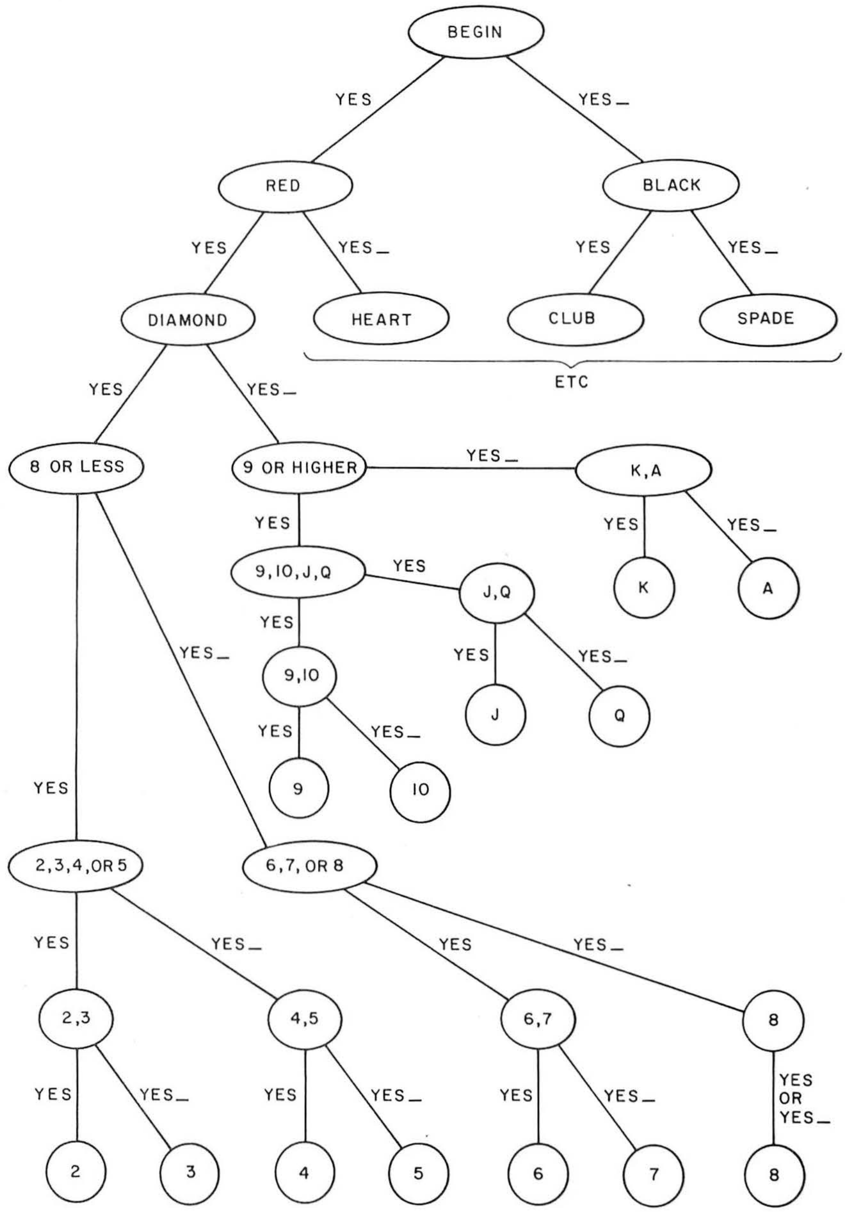

Figure 1: How the secret Magic program works: the diagram shows what is called a binary tree*—that is, a series of nodes, each branching in two directions. In order to use the program, type RUN. The computer will then ask if you have selected a card. Type either YES or YES __ , depending on whether the card is red or black. This step is shown immediately below the "BEGIN" node at the top of the tree. The computer then "guesses" the color of the card. (In actual fact, it already knows the color of the card from your input, but this way it can gain the next piece of information it needs to determine whether the card is a spade or a club—assuming it is a black card, of course.) Next the computer "guesses" the suit of the card. This time, your reply tells the computer whether the card is 8 or less, or 9 or greater. Continue to follow the path down the tree to the chosen card, and the computer will magically name it! Note that the underscore __ is used in the chart to indicate a space.*

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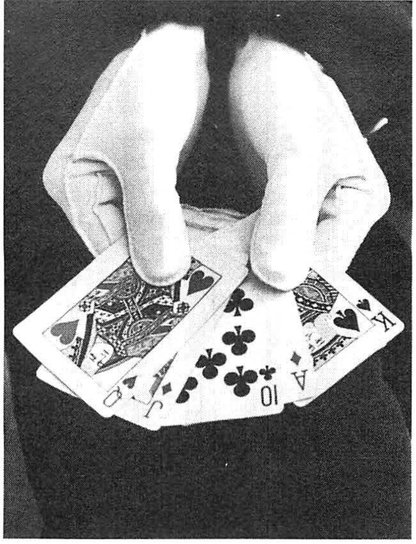
Note: lines 110 and 115 use the BASIC ASC statement to determine the ASCII code for the typed reply. If your computer doesn't accept this statement, try the following:

```
110  IF A$ = YES THEN 200
115  IF A$ = NO THEN 125
```

Misgivings

One misgiving I had when first performing the trick was that people might see that I was sometimes adding a space after the YES, and sometimes leaving it out. Well, so far, nobody has noticed this. The utter innocence of your actions, plus the fact that you appear only to be *replying* to the computer's amazing guesses, throws people off the track. I have found that pausing after typing "YES" or "YES " and before hitting return helps, since many people like to check their entries before committing them to the computer



anyway. The blinking cursor will not give you away, so do not rush when you type your replies. The key word here is *natural*. Be natural in your actions and your audience will be baffled.

Practice, Practice, Practice

The two rules of magic are:

1. Practice until the trick becomes second nature to you.
2. Never do a trick twice.

A trick will fool an audience the first time, but some sharp-eyed people might notice a bit of film-flam the second time. The code to be memorized is not excessively difficult. To start, it might help you to remember that the first coded reply conveys the color of the card, and that the character string "YES" stands for red. "YES" and "red" are both three characters long, to aid in memorization.

Final Thoughts

Several magicians I know have suggested that I keep this little trick a secret, but I was anxious to open up a new avenue for having fun with personal computers. If you decide to try the trick, please write to let me know about it. And remember, *practice*!

Listing 1: This is the Magic program written for the Apple II in integer BASIC. The search method used for finding the desired card is detailed in figure 1.

```
50   REM THIS PROGRAM IS DESIGNED TO PERFORM A
51   REM CARD TRICK ON YOUR COMPUTER.
90   DIM A$ (20)
100  PRINT "HAVE YOU SELECTED A CARD?"
104  PRINT "PLEASE TYPE YES OR NO"
105  INPUT A$
110  IF ASC (A$) = 217 THEN 200
115  IF ASC (A$) = 206 THEN 125
120  INPUT "ILLEGAL ENTRY, PLEASE TYPE YES OR NO", A$
125  PRINT "I WILL THINK FOR A WHILE"
126  PRINT "UNTIL YOU'RE READY"
127  GOSUB 1000
128  GOTO 100
150  REM THE FOLLOWING ROUTINE DETERMINES
151  REM THE SUIT OF THE CARD
200  IF LEN (A$) ≠ 3 THEN 300
205  GOSUB 1000
210  INPUT "YOUR CARD IS RED, CORRECT?", A$
211  IF LEN (A$) ≠ 3 THEN 250
215  S = 1
220  GOSUB 1000
225  INPUT "YOUR CARD IS A DIAMOND.", A$
230  GOTO 400
250  S = 2
255  GOSUB 1000
260  INPUT "YOUR CARD IS A HEART.", A$
265  GOTO 400
300  GOSUB 1000
305  INPUT "YOUR CARD IS BLACK.", A$
310  IF LEN (A$) ≠ 3 THEN 350
315  S = 3
320  GOSUB 1000
325  INPUT "YOUR CARD IS A CLUB.", A$
330  GOTO 400
350  GOSUB 1000
355  S =4
360  INPUT "YOUR CARD IS A SPADE.", A$
361  REM THE FOLLOWING ROUTINE DETERMINES
362  REM THE VALUE OF THE CARD
400  IF LEN (A$) ≠ 3 THEN 700
405  GOSUB 1000
406  INPUT "YOUR CARD IS 8 OR LESS.", A$
407  IF LEN (A$) ≠ 3 THEN 600
410  INPUT "YOUR CARD IS A 2, 3, 4, OR 5.", A$
415  IF LEN (A$) ≠ 3 THEN 500
420  GOSUB 1000
425  INPUT "YOUR CARD IS A 2 OR 3.", A$
430  IF LEN (A$) ≠ 3 THEN 475
435  V = 2
440  GOTO 1500
475  V = 3
480  GOTO 1500
500  INPUT "YOUR CARD IS A 4 OR 5.", A$
505  IF LEN (A$) ≠ 3 THEN 550
510  V = 4
515  GOTO 1500
550  V = 5
555  GOTO 1500
600  GOSUB 1000
605  INPUT "YOUR CARD IS A 6, 7 OR 8.", A$
606  GOSUB 1000
610  IF LEN (A$) ≠ 3 THEN 650
615  INPUT "YOUR CARD IS A 6 OR 7.", A$
```

Listing 1 continued on page 22

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Listing 1 continued from page 21:

```
620   IF LEN (A$) ≠ 3 THEN 635
625   V = 6
630   GOTO 1500
635   V = 7
640   GOTO 1500
650   GOSUB 1000
651   V = 8
652   GOTO 1500
700   GOSUB 1000
705   INPUT "YOUR CARD IS A 9 OR GREATER.", A$
710   IF LEN (A$) ≠ 3 THEN 950
715   GOSUB 1000
720   INPUT "YOUR CARD IS A 9, 10, J, OR Q.", A$
721   GOSUB 1000
725   IF LEN (A$) ≠ 3 THEN 800
730   INPUT "YOUR CARD IS A 9 OR 10.", A$
735   IF LEN (A$) ≠ 3 THEN 750
740   V = 9
745   GOTO 1500
750   V = 10
755   GOTO 1500
800   INPUT "YOUR CARD IS A J OR Q.", A$
805   IF LEN (A$) ≠ 3 THEN 900
810   V = 11
815   GOTO 1500
900   V = 12
905   GOTO 1500
950   INPUT "YOUR CARD IS A K OR A.", A$
951   IF LEN (A$) ≠ 3 THEN 975
952   V = 13
955   GOTO 1500
975   V = 14
976   GOTO 1500
1000  REM TIME DELAY ROUTINE
1010  FOR I = 1 TO 500
1020  X = 23 * 34/56 * 25/67
1030  NEXT I
1040  RETURN
1499  REM PRINTOUT ROUTINE FOLLOWS
1500  GOSUB 1000
1502  GOTO 1500 + V*5
1510  GOSUB 1600
1511  PRINT "TWO OF ";
1512  GOTO 1700
1515  GOSUB 1600
1516  PRINT "THREE OF ";
1517  GOTO 1700
1520  GOSUB 1600
1521  PRINT "FOUR OF ";
1522  GOTO 1700
1525  GOSUB 1600
1526  PRINT "FIVE OF ";
1527  GOTO 1700
1530  GOSUB 1600
1531  PRINT "SIX OF ";
1532  GOTO 1700
1535  GOSUB 1600
1536  PRINT "SEVEN OF ";
1537  GOTO 1700
1540  GOSUB 1600
1541  PRINT "EIGHT OF ";
1542  GOTO 1700
1545  GOSUB 1600
1546  PRINT "NINE OF ";
1547  GOTO 1700
1550  GOSUB 1600
1551  PRINT "TEN OF ";
1552  GOTO 1700
1555  GOSUB 1600
1556  PRINT "JACK OF ";
1557  GOTO 1700
1560  GOSUB 1600
1561  PRINT "QUEEN OF ";
1562  GOTO 1700
1565  GOSUB 1600
1566  PRINT "KING OF ";
1567  GOTO 1700
1570  GOSUB 1600
1571  PRINT "ACE OF ";
1572  GOTO 1700
1600  YOUR CARD IS THE ";
1601  RETURN
1700  GOTO 1700 + S * 5
1705  PRINT " DIAMONDS"
1706  GOTO 1800
1710  PRINT " HEARTS"
1711  GOTO 1800
1715  PRINT " CLUBS"
1716  GOTO 1800
1720  PRINT " SPADES"
1800  END ■
```


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The Computer Language BASIC

by Dr W D Maurer

In order to understand how to write programs for computers, you have to understand what a computer language is. There are over a hundred computer languages in the world today. They go by names such as FORTRAN, COBOL, ALGOL, SNOBOL, PL/1 (pronounced "P-L-one"), LISP, APL (the initials, not "apple"), and the like. BASIC is the computer language that is most commonly used by people who work with microcomputers, and therefore this is the language we shall work with.

The name of every computer language stands for something. Just as IBM stands for International Business Machines, so COBOL, for example, stands for COmmon Business-Oriented Language. (Yes, I know it should be CBOL, in that case, not COBOL. People who make up these computer mnemonics often cheat a little and use the first two—or more—letters of a word, such as CO in "COmmon." FORTRAN is the worst offender in this regard; it stands for FORmula TRANslator, or TRANslation.)

BASIC, however, is a case of the tail wagging the dog. The inventors of BASIC wanted to name their language BASIC because that's what it is—a *basic* computer language—but having done that, they had to make it stand for something. After much head-scratching they finally came up with Beginner's All-purpose Symbolic Instruction Code. That name is not particularly descriptive. It is for beginners, although PhDs in engineering use it all the time, too. It is in a sense all-purpose, but "symbolic," "instruction," and "code" are words that are today used to describe other kinds of computer languages more often than they are used to describe BASIC. Of course, the game of making up mnemonic names is always fun to play, whether the results look sensible or not (Batty About Such Intelligent Computers?).

A computer language is a language in which one writes computer programs. (You write stories or novels in English or French; you write programs in FORTRAN or BASIC.) A computer program is a series of steps, each of which specifies something for the computer to do, and some of which may tell it to go to another step (either forward or backward in the

A computer program is a series of steps, each of which specifies something for the computer to do...

BASIC BASIC BASIC BASIC BASIC

series of steps) and keep on going from there. In order to see what this means in practical cases, let's look at a typical program (*not* written in BASIC):

1. Set the value of X to be 1.
2. Print out, on a sheet of paper, the value of X and the value of the square root of X, to six decimal places.
3. Increase the value of X by 1 (make it 1 higher than it was before).
4. Now, if the value of X is less than 101, go back to step 2. Otherwise, *stop*.

What this program is supposed to do is to get the computer to print out a table of square roots like the one in figure 1. This *whole* table, let it be repeated, will be printed out on a piece of paper if the above program of four steps is presented to the computer. Before we go on to describe BASIC, let us see how this works:

1. The value of X is set to be 1.
2. Now we print out the value of X (which is 1) and the value of the square root of X (which is also 1, since $1 \times 1 = 1$), to six decimal places, which would be 1.000000.
3. The value of X is increased by 1, so the value of X is now 2.
4. Well, 2 is certainly less than 101, so the program tells us to go back to step 2. Now what happens?
5. We now have to do step 2, which says to print out (on the same sheet of paper) the value of X (which is 2) and the value of the square root of X, or the square root of 2, to six decimal places, which happens to be 1.414214.
6. Now, having done step 2, we go on. Step 3 is next. Increase the value of X by 1, it says; all right, X is now 3.
7. Is 3 less than 101? Certainly. Back we go to step 2 again.
8. This is getting monotonous. Print out, it says, the value of X, which is 3, and the value of the square root of 3...and on we go.

Needless to say, we're now going to do steps 2, 3, 4, 2, 3, 4, 2, 3, 4, and so on, over and over again, and each time we're going to print out one more line of our handy square-root table. Will we ever stop? Or will the square-root table keep printing out indefinitely until the end of time? (When the stars in their courses burn out, will there still be computers, endlessly churning out square-root tables?) Fortunately, in this case, the answer is no. The program will print out the last line of the square-root table, namely 100 and 10.000000, and then it will quietly stop. Let's see why.

When the computer prints out 100 and the square root of 100, at step 2, the value of X has to be 100. So let's start from there, and carry on:

1. The number 100, and the square root of 100, are printed out.
2. We increase the value of X by 1, making it equal to 101.
3. Now, the all-important question: Is X less than 101? This time—for the first time—the answer is no. X is not *less than* 101. X *is* 101. We cannot have a number which is less than itself. So what does step 4 say? It says, "Otherwise, stop." And that's what the computer does; it stops.

Now that we've seen what a computer program is, let's see what a computer language is. A typical microcomputer has a *keyboard*, like a typewriter keyboard, at which you can sit and type anything you want to, and a video display, like a TV screen, sometimes called a CRT (that stands for "cathode-ray tube," and *that* stands for—oh, never mind. Ask your favorite electronics freak). Such a computer can be set up in such a way that whatever you type on the keyboard comes out on the screen, and in this way you could type in, if you wanted to, the four steps of the program that we have illustrated just as they stand.

But that wouldn't work; it would not make the computer produce the square-root table. The reason is that this program isn't written in BASIC (or any

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1	1.000000
2	1.414214
3	1.732051
4	2.000000
5	2.236068
6	2.449490
7	2.645751
8	2.828427
9	3.000000
10	3.162278
11	3.316625
..	....
..	....
..	....
..	....
..	....
..	....
..	....
..	....
..	....
..	....
..	....
99	9.949874
100	10.000000

Figure 1: The table of square roots.

other computer language for that matter). A computer needs its programs written in a computer language, and a microcomputer, most of the time, needs its programs written in BASIC.

So how do we write the above program in BASIC? Well, just as with every other language, there are rules of grammar. If we wanted to write step 1 of the above program in BASIC, we might write

```
0010        LET X=1
```

The 0010 is called a *line number*. It doesn't have to be 0010; we chose that number just for convenience. If there are four steps in a program, we usually, for convenience, give them the line numbers 0010, 0020, 0030, and 0040. The only absolute requirement is that these numbers have to be in order. We couldn't use 5, 9, 7, and 2, in that order, for example, in order to number our four steps. (In the FORTRAN computer language, by the way, we could do exactly that. Computer languages are very different from each other, and it's best to learn only one at a time.)

The word LET is optional (on most versions of BASIC). Thus we could have written

```
0010        X=1
```

to make this step a bit shorter. But the other words we used when we described this step in the first place—"Set the value of," etc—have no place in BASIC. Every kind of statement has to be written according to the rules.

(There is one exception to this. Every so often, in a program, we would like to write a little note to ourselves, to remind ourselves what a particular statement was supposed to do. In BASIC, this is called a *remark*, and it starts with REM, right after the line number. Thus we could write another statement that wasn't in our original program:

```
0015        REM SET THE VALUE OF X TO BE 1
```

This won't set the value of X to be 1; it is just put in there to tell us what we were doing. Since the line number is 0015, this will go in between the line numbers 0010 and 0020, and the computer, when it is producing the square-root table, will just ignore it, because it is only a remark.)

Before we do the second statement, let's do the third statement in BASIC, because it's easier. The third statement of our program would be

```
0030        LET X=X+1
```

and again the LET is optional. Anybody who has had algebra, please don't worry about that statement. It doesn't mean that X and X+1 are equal; of course, they can't be equal. It is simply an instruction to the

Just as the English say "lorry" and Americans say "truck," so in BASIC there are dialects—different versions depending on which computer you're using.

BASIC BASIC BASIC BASIC BASIC

computer to let X be equal to whatever it was before, plus 1. So if X was 37, for example, this makes it 38. The line number is 0030 since this is the third statement (not counting the remark).

The fourth statement is easier than the second statement, also. The fourth statement would be

```
0040        IF X<101 THEN 0020
```

in some versions of BASIC, and

```
0040        IF X<101 GOTO 0020
```

in other versions. At this point we cannot be too specific about the rules of BASIC. Just as the English say "lorry" and Americans say "truck," so in BASIC there are dialects (and that's what they're called)—different versions depending on which computer you're using. In order to know whether to use THEN or GOTO, you have to consult the BASIC manual for whatever computer you happen to be using.

It should be added at this point that the test for X less than 101 is usually written in a different way—we usually say "If X is *less than or equal to 100*, then go back to step 2." This form is used because the number 100 that appears in the step is actually the last value of X that is printed. In BASIC, that would be

```
0040        IF X< =100 THEN 0020
```

(or possibly GOTO instead of THEN). Of course, the 0020 is the *line number* of the second statement, which is the one we want to go back to. Also, the "otherwise, stop" does not need to be specified; whenever a BASIC program runs past the last statement, it will stop automatically anyway.

Now, finally, let's do the second statement. The problem with the second statement is that not every version of BASIC has square roots in it. Assuming for the moment, however, that we have one that does, and that it's called SQR (this, also, is not standard from one version of BASIC to another), we would write

```
0020        PRINT X,SQR(X)
```

So the whole program would be like this in BASIC:

```
0010        LET X=1
0020        PRINT X,SQR(X)
0030        LET X=X+1
0040        IF X< =100 THEN 0020
0050        END
```

The only one of these statements that we haven't discussed yet is END. There is always one END statement in every BASIC program, and that statement is always the last statement of the program. It is there to tell the computer that this is all the statements there will be in this program.

The Rules of BASIC

Next we will discuss the "rules of grammar" of the computer language BASIC.

To start with, the program discussed above used a number called X. Everybody knows that X stands for an unknown number, or *variable* as it is sometimes called, even without remembering anything else about algebra. Actually, although computer programs written in BASIC look very much like formulas in algebra, there is very little that a person learns in an algebra class which is absolutely essential to learning how to program.

The quadratic formula does not come up in learning BASIC; neither does proving theorems, or, for that matter, even "solving for X" as this term is understood in algebra. You do have to be comfortable with using X (or Y, or Z, or P, or Q, or any other letter) to stand for a number; and, unlike algebra, you have to think of the value of X, for example, as possibly *changing* while a program is on the computer. For example, in the program discussed earlier, X was first equal to 1, then 2, then 3, and so on up to 100.

Besides the letters of the alphabet, BASIC will allow you to use A1, H4, Q7, and so on, as variables;

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that is, any letter followed by a digit. Note that X2, for example, is a variable, just like X, and that X2 does not mean "X squared." If we want X squared in a computer program, that is, X times X, we normally write X*X (where * means "times"). This is another respect in which BASIC is different from the rules of algebra; in your algebra class, you learned to write RT to mean R times T, but in BASIC, if you want R times T, you would have to write R*T instead.

Every step in a program is represented in the BASIC language by what is called a *statement*. There were four steps in our program above, and therefore four statements, plus the END statement. These were:

```
0010    LET X=1
0020    PRINT X,SQR(X)
0030    LET X=X+1
0040    IF X< =100 THEN 0020
0050    END
```

Every BASIC statement has a *statement type*, and learning BASIC is mainly a matter of learning the rules for the various statement types. Thus we have a LET statement, a PRINT statement, an IF statement, and an END statement, and these four statement types are used in the above program. The END statement is the easiest; it always says just END. The LET statement is of the general form LET variable=expression. Sometimes the expression is very simple; in the first statement above, X is the variable, and 1 is the expression. In the third statement above, X is again the variable, and X+1 is the expression. But whatever the expression is, the value of this expression becomes the new value of the given variable.

The PRINT statement has the word PRINT, followed by all the things we want to print. These things can be variables, constants, or more general expressions. We can write PRINT X, X+1, X+2 and, if X is 10, the computer will print out 10, 11, and 12. Finally, the IF statement has the word IF, followed by the condition we are testing for, followed (sometimes) by the word THEN, followed by what we are supposed to do if the condition we tested for were actually true. Usually (although not always) this is GOTO someplace, where "someplace" refers to a line number; and this means that the computer goes to the statement with that line number and continues from there. If the condition we tested for is *not* true, then the computer will simply go on to the next statement (the one right after the IF).

Another statement type is INPUT. One of the fascinating things we can do with microcomputers is to set them up (that is, program them) so that they will *ask us* for data and then do whatever strange things we want them to do with that data. As an example of this, let's look at another program in BASIC. (This time, we'll look at the whole program first, and then try to see what it means.)

```
0010    INPUT X
0020    Y=X*X*X
0030    PRINT "THE CUBE OF ",X," IS ",Y
0040    GOTO 0010
0050    END
```

If you were to write this program in BASIC for a microcomputer, and then run it, it would start out by producing a question mark (or some other message, such as READY) on the screen. This is your cue to type something. Let's say you type 23. (You also have to type the "return" key on the keyboard.) Then the computer would print out, on the screen,

```
THE CUBE OF     23 IS     12167
```

and produce *another* question mark (or READY, or whatever). Let's say that this time you type a 17 (again followed by a return). Then it would type out on the screen,

```
THE CUBE OF     17 IS     4913
```

and so on. In other words, what you now have, in your computer, is a primitive slave. All it can do is to calculate the cubes of numbers, but it will keep doing that for you, over and over, as long as you keep feeding it numbers. And if you get tired and want to

Actually, although computer programs written in BASIC look very much like formulas in algebra, there is very little that a person learns in an algebra class which is absolutely essential to learning how to program.

BASIC BASIC BASIC BASIC BASIC

go to sleep, your spouse can feed it numbers, then your children, and so on unto the third and fourth generations; your slave will dutifully calculate the cube of each number and tell you what it is, never flagging, asking only for a continuous supply of electricity from your local power company.

Of course, eventually this primitive slave becomes boring. At the least, it would be nice to have an intelligent slave. But before we see how to do that, let's look at the program above. It uses two new statement types, INPUT and GOTO. GOTO is obvious (and we can usually write either GO TO, two words, or GOTO, one word, but GOTO is preferred). All it does is to tell the computer to go to the line specified and continue from there.

INPUT is something like PRINT; that is, if you want to, you can INPUT several things instead of just X as we have done here. But everything you input must be a variable, like X, rather than an expression. The statement INPUT X means that the computer has to wait for whoever is sitting at the keyboard to type something and then press the "return" key. When the user has finished doing this, whatever has been typed then becomes the new value of X. Of course, it doesn't have to be X; it can be Z, or Q, or H7, or P9, or whatever variable name we specify in our program.

Now let's look at what this new program does:

1. First is INPUT X. The program waits until you have typed something, in this case 23, followed by the return key. When you have done this, 23 becomes the new value of X.
2. Now we are supposed to set Y equal to X times X times X (remember that * means "times"), or, in other words, 23 times 23 times 23. This is what the cube of 23 is, of course, and this is the new value of Y.
3. The PRINT statement tells us to print four things: the words "THE CUBE OF"; X, which is 23; the word "IS"; and Y, which is 12167 (or 23 times 23 times 23). This gives us the message THE CUBE OF 23 IS 12167, which comes out on the screen. The big spaces in the middle of the message are characteristic of BASIC; other, less basic computer languages (SNOBOL is one example) don't exhibit them.
4. Now we have GOTO 0010, so we dutifully go back to the statement with line number 0010.
5. At this point we have INPUT X again. By this time it should be clear what is going to happen. The computer will do the statements with line numbers 0010, 0020, 0030, 0040, and so on, over and over and over. Every time, a new number will come in on the keyboard, and that number and its cube will be part of the message that is printed on the screen.

How do we tell our primitive slave to stop? The program, this time, gives us no way that we can do this. One way would be to change the program so that the primitive slave can turn itself off, so to speak. For example, suppose that we take out the statement GOTO 0010 and substitute

```
0040        IF X <> 0 THEN 0010
```

The symbol < > in BASIC means "either less than, or greater than, but not equal to." So what we are asking here is that the number X—which was what we put in—is *not* equal to zero. We are assuming, in other words, that we would never want our primitive slave to calculate the cube of zero. We already know the cube of zero; zero times zero times zero is zero. If we asked our slave to calculate the cube of zero, it would do so, but then it would get to the above statement and it would check whether X is *not* equal to zero. Since this is *not* true, it would *not* go to 0010 (read that one back again and make sure you understand it); and so it would stop, because we are at the end of the program. But in any other case—that is, if X is not zero—the primitive slave would function just as before.

Fortunately, on most microcomputers, we don't have to do this. There is a special key called the "break" key (or sometimes the "escape" key, with ESC printed on it) that you can push at any time

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Every BASIC statement has a statement type, and learning BASIC is mainly a matter of learning the rules for the various statement types.

BASIC BASIC BASIC BASIC BASIC

while your program is running; and, when you do, it will stop.

Another statement type that is very useful is FOR. The FOR statement is always used together with another type of statement, namely the NEXT statement. Let us go back to our original program, which was typing out a table of square roots. There are a lot of programming situations like this, in which we would like the computer to do something over and over again *n* times (where *n* is 100 in this case); and in many of these we have a variable (X in this case) which takes the values 1, 2, 3, 4, and so on up to *n*, as we proceed. This type of situation is what the FOR and NEXT statements are there for. In fact, we could have written

```
0010    FOR X=1 TO 100
0020    PRINT X, SQR(X)
0030    NEXT X
0040    END
```

In other words, do the statement with line number 0020 for 100 values of X; and, each time, after we do this, go on to the next value of X. The rules for the FOR and NEXT statements are as follows:

1. The FOR statement has the word FOR, the name of some variable, an equals sign, the first value of that variable, the word TO, and the last value of that variable. (If we want to, we can follow this with the word BY and then something called a "step size." For example, FOR X=1 TO 100 BY 2 would specify the successive values of X to be 1, 3, 5, 7, 9, and so on; and the last one would be 99, rather than 100. The next value of X is always found by adding the step size, so in this case we would add 1+2=3, 3+2=5, and so on.)
2. The NEXT statement has the word NEXT, followed by the name of the same variable that was in the FOR statement.
3. There can be *one or more* statements between the FOR and the NEXT. If there is only one, then that one is done repeatedly; if there are several, then they are all done, then they are all done again, and so on.

Another fascinating capability that our slaves have, if we continue to think of computer programs as slaves, is that they can have slaves of their own. Suppose we have a computer system which does not have a square root function in it. In this case, if we wanted to produce our square root table, we would have to write another program to calculate square roots. Never mind how you would write this program. All we care about for the moment is that there is another such program, and that it starts at some line number of its own, say, 0060. It calculates the square root of X, and, once it has done so, sets (let us say) Z equal to the square root of X. Once it has done that, instead of ending, it does a RETURN, which is another statement type. (That means that the last statement of this second program would have a line number, followed simply by the word RETURN.)

This second program is called a *subroutine*. It corresponds to what the slave would do if it wanted to acquire another slave to do part of its job. In order for the first slave to acquire the second, let's take out the statement

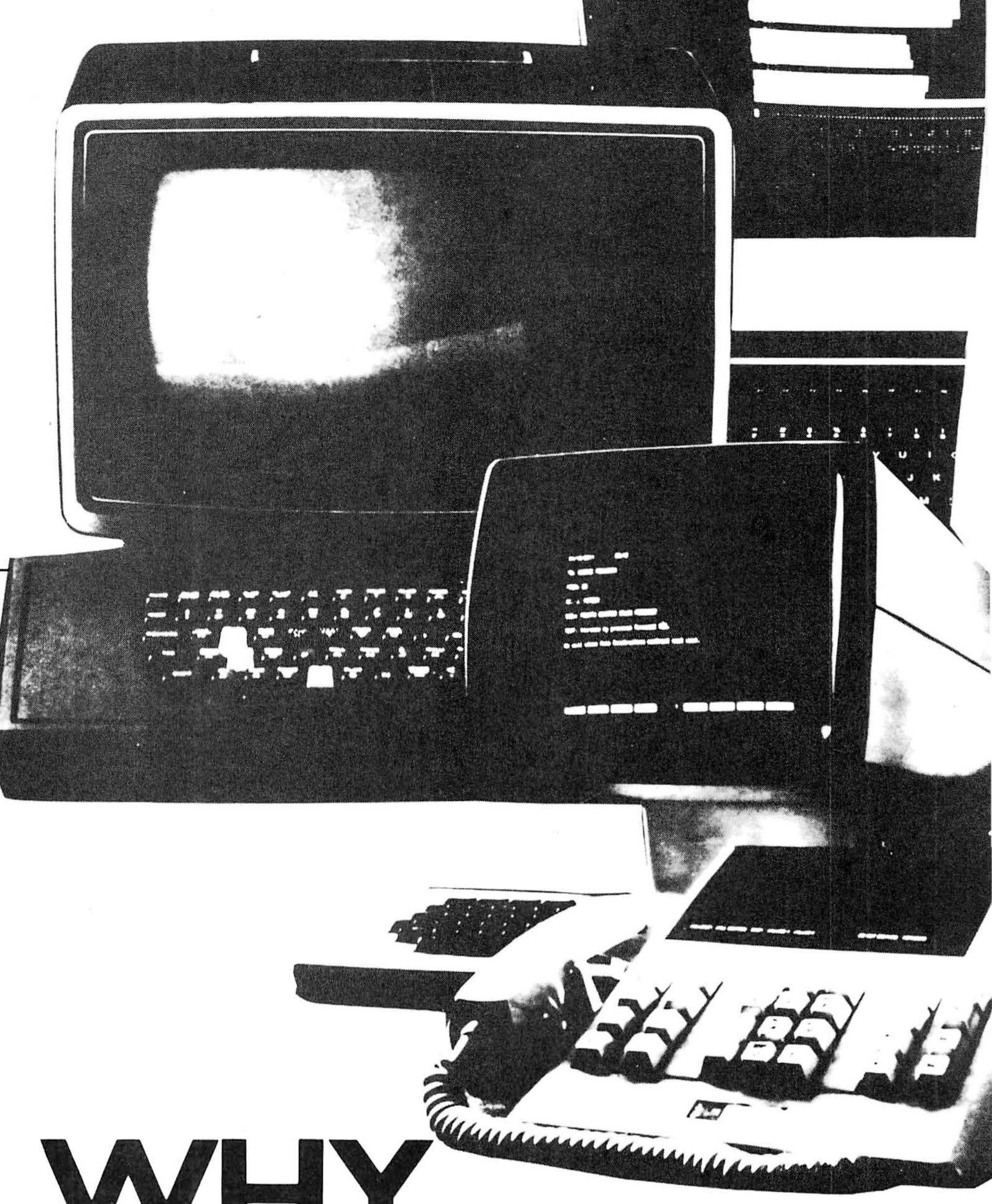
```
0020    PRINT X, SQR(X)
```

and write, instead,

```
0020    GOSUB 0060
0022    PRINT X, Z
```

Now what happens? GOSUB means "go to a subroutine." The computer will go to the subroutine that starts at line number 0060, which calculates the square root of X, and sets Z equal to that number. Then the subroutine will *return*—that is, it will go back to the point immediately after the GOSUB. But that is the new statement PRINT X, Z. So the result is that the computer will print X, followed by Z—which is the square root of X—instead of X and SQR(X), and the effect will be exactly the same as before.

Of course, your slave can have several other slaves, and these can have others, and so on as far as you wish. Pretty soon, you have a whole corporation of slaves working for you! ■



by Carl Helmers

WHY OWN A COMPUTER?

Just as the automobile liberates us from the need to use muscle power for transportation over long distances, the personal computer's fascination is that it amplifies our brain power and allows us to accomplish feats of mental acuity which are impossible to the unaided human brain.

The idea of personal computing no longer requires that an individual be familiar with electronics engineering and computer science in order to benefit from these mental amplifiers. Complete off-the-shelf systems are now sold at hundreds of computer retail stores from coast to coast. A certain familiarity with basic principles is required to recognize what a computer can do. But we all drive automobiles without being automotive engineers, so we all can use computers without necessarily being experts on the internal details of these wonderful machines. The present day world of small computers is a world of Apples, Commodore PETs, Radio Shack TRS-80s, Compucolors, Exidy Sorcerers, and other systems made by manufacturers large and small.

What is the thrill of personal computing? Why are we interested in acquiring such an intricate and delicate machine? I contend that the answer lies in the nature of the small computer as a thought amplifier. Just as the automobile liberates us from the need to use muscle power for transportation over long distances, the personal computer's fascination is that it amplifies our brain power and allows us to accomplish feats of mental acuity which are impossible to the unaided human brain. We have here the real world implementation of a science fiction con-

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cept, widely available and quite inexpensive. So let's take a tour through some of the ways in which real and practical amplifications of thought are possible on a personal computer.

I'll start with an irritating problem I had the other day, one which is familiar to nearly every adult in the United States: balancing a checkbook. My personal checking account is complicated by the fact that it is in one of the six New England states which for several years have had interest paying NOW accounts. Thus my bank pays me for the privilege of using a checking account, rather than the other way around. But being a lazy sort of person, I've had this particular account for two years or more, and had never reconciled the monthly statements. I use the simplifying assumption that if I never credit the interest payments in my checking account, the net effect of errors in arithmetic will be in the positive (ie: safe) direction. It was a considerable, but not unexpected, shock then, when I found that the bank said I had several hundred dollars less than I thought I had.

Now, without a personal computer, I would have had only the bank statements and my cancelled checks to go on, and a portable calculator as my only computational element. Everyone who has ever dealt with such a problem knows that the banks never make mistakes with their computer programs and it is only we mortals who make mistakes. So, I proceeded to hunt for my mistake, using my new personal computer as a tool in the process.

What could this computer do for me? It basically has one nice feature which all full function personal computers have: a filing system on random access floppy disk drives. This filing system and a way of editing files of data are the key to my use of this computer to hunt for a mistake in my checking account records. (As an aside, purchasing a personal computer without floppy disks can become inconvenient. Audio tape storage is fine when you start using a computer; however, when you start working with many programs and large amounts of data you will probably find that the capabilities of the floppy disk are desirable.)

A second nice feature of my own personal computer is that it has a printer. The printer enables me to get a copy of the data on my disk files, or to print the results of a program which uses the data on the disk files. The printed output is important of course if you have to show off the results of a computation to someone like the person at the bank to whom you complain about errors. The printed output can also be used effectively to provide a work sheet for verifying the data. Printed output is not absolutely essential for this purpose since the usual output on the television display of the computer can also be quite effective.

A full function computer with dual Shugart minifloppy disks, a reasonable amount of main memory, and printer costs around $3000 as of mid 1979 when this is written. This is the price one would end up paying for machines such as the Apple II or Radio Shack TRS-80 with 32,768 bytes of memory, inexpensive Centronics or Axiom electrostatic printers, and a full function BASIC interpreter built into the machine. All of the uses to which I put my computer with the exception of good looking full-size printed output could be accomplished on such a system.

My own machine is a more expensive one, the Northwest Microcomputer Systems 85/P which has dual full size Shugarts, a Diablo printer unit, and a software system called UCSD Pascal. But then I paid $8000 for the basic machine plus $3000 for the printer. Borrowing again from the automobile analogy, the differences between my system and the mass production systems like Apple or TRS-80 are like the differences between a Ford or Chevrolet car and a Jaguar or Lotus road machine. Both classes of cars accomplish the transportation function admirably, but with differences in detail.

So, I went to my computer, which sits in the living room of my home, and proceeded to use it in a very "brute force" manner to help in the verification of the checking account: I sat down on the evening before Thanksgiving and began typing in a single line of text for every transaction entry which the bank statements and cancelled checks indicated. These transactions are characterized by the date according to my check, some text briefly describing the nature of the transaction, and a dollar amount entered as positive if it was effectively a deposit, or negative if the transaction was some form of withdrawal. A typical line looked like this:

```
~~>D 02/10/78 trip reimbursement   80.00
```

or, this . . .

```
203 02/12/78 weekly cash           50.00
```

In the first case, I used an arbitrary 4 character code, ~~>D to indicate that a deposit took place. In the second case, the check number was used to correlate the entry back to my handwritten check record and the cashed check returned by the bank. The first stage of the bank account fixup activity was finished some three or four hours later when I had typed in all of the 300 or so transactions representing the 2 year history of the account. After typing in the details from the checkbook, I added records for all those miscellaneous negative and positive items found on the bank statements: monthly interest payments, charges for printing of checks, etc. The final result of all this was a file which theoretically had the whole history of the account as recorded in my checkbook, plus the minor adjustments which I never recorded before.

Then, I took the file and printed it, so that I could check off each transaction against the bank statements for the account in an effort to find the error. Some ten minutes after printing the file and commencing this checkoff I found the major error: I had made the unfortunate mistake of crediting my income tax refund twice in my records in the checkbook! Here was the source of most of the several hundred dollar discrepancy. In the course of checking off the entire file, I also found several other small errors, such as writing 180.00 when the actual transaction was 180.39.

This is a fine use of the computer as far as it goes, but just a starting point. Now that I had all these records of my checking account, there was no longer any need to use the hand calculator to do all the arithmetic. I then sat down to write a small program which reads every line of the file, totalling the current balance of the checking account as a result of that line's transaction. Then each line is printed along with the current balance. I figured that this little finesse would produce a neat utility program which I could run once a month to get an updated status of the account, which should then agree with the balances obtained from the bank.

I wrote that checkbook printing program in about an hour or so, using the Pascal language of my system. It was no trouble getting the program written and debugged — a process which took a bit longer than it might have since it *was one of the first Pascal* programs I have ever written. The result, all 70 or so lines, worked just fine, taking the data from my file "CTHCHK1178.TEXT" on disk and printing it with the current balances. The only problem was that the balances I got still did not agree with the bank! So, back to the checking off procedure, going through the bank statement and identifying each amount on both my file and the bank's record. I found the residual error, a pay check deposit which I had forgotten to record in the file of transactions, a transaction which accounted for some negative balances observed from time to time in the printout of the program. So I fixed the file and ran the program one final time resulting in a pretty printout and a balance that agreed with the bank.

And, here lies the true power of the personal computer. By using the facilities of computation and data editing in this machine, I was able to check and verify my bank account's history in a way which might have been much more difficult had I not had the computer and the small amount of programming skills needed to write the simple little program which I now use to balance my checks every month. I was able to use evidence gathered with my computer and printed out on a piece of paper to resolve a puzzling discrepancy; the task of finding the discrepancy without introducing further arithmetic errors would have been much more difficult without this personal computational tool.

Now, this episode with the checking account is perhaps one of the single applications most subject to hyperbole by promoters and detractors of the concept of the small individually owned computer. Every promoter of a computer system in the marketplace will create mounds of hyperbole about the wonderful checking account balancing program delivered with the system as a demonstration of its marvelous capabilities. And

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every detractor of the concept of a personal computer system will yawn with creative antipathy and say, "What's so great about balancing a checkbook?"

But both attitudes miss the point of the personal computer. It is not any one specific use of the personal computer which counts, but the total impact of all the particular applications which can be performed. Some applications of the facility require meticulous planning and care. Other applications can be achieved for the retail price of software cartridge or tape and the act of plugging in a program to run on the system. No one buys a computer just to do checking accounts, play games, compute the number π to 10,000,000 decimal places or keep track of recipes in the kitchen. A general purpose computer can do all of these — or none of these — depending on the desires of its owner.

What other uses have I found for my computer since I got it?

Using the system with a more sophisticated printer as a word processing device, I write articles such as this. Here, the personal computer is used for a very real business purpose, much as my parents' personal automobiles are used to call upon clients in their accounting practice. I can enter the text of an article with instant error correction, move portions of text without retyping, have the computer search for misspellings or particular terminology, and save the results on disk. Whenever I like, I can print the contents of a file of text, using a file transfer program which automatically counts pages and inserts headings, and a neat double spaced manuscript can be delivered to the production department. Many of our authors with personal computers deliver manuscripts prepared and typed on their own systems. (See Jerry Pournelle's article about writing science fiction with a personal computer, in the Summer 1979 issue of onComputing.)

Such professional purposes are hardly the only reasons for using my home system. The same word processing capability of my general purpose computer has numerous personal applications as well.

I use the system's editing and filing capability to keep track of my weight and blood pressure measured on a daily basis. This is perhaps one of the most personal applications of a general purpose computer possible in present technology. I measure blood pressure and pulse rate just after I awaken, then immediately following 30 minutes of aerobic exercise on an exercise bicycle. Recording this information is a task that could just as well be done in pencil on a piece of paper, to be sure. But recording the data in the floppy disk images of the system produces nice neat daily records for my doctor, as well as programs to compute moving averages of these factors which are important measures of individual health.

I also have recently begun experimenting with the fermentation of various sugar laden juices into wines and beers. This easily performed process was inspired by the annual apple cider pressings common to any apple growing region such as southern New Hampshire where I live. There is nothing at all quite like going out and picking your own apples, washing them and pressing them in an antique cider press of 1890s vintage. This process of pressing does nothing to turn off the natural yeasts on the surface of the apples, and with a little anaerobic conditioning using a water trap, a mild form of apple jack will result a couple of months later, just in time for use in the ski season after a day of cross country hiking.

Last year I bottled about a fifth of a gallon of such hard cider (which was stronger than usual due to an extra cup of sugar). Six months after bottling, with a used cork in a used wine bottle, I opened it to find a most excellent light sparkling white wine very reminiscent of champagne. After this successful accident I came across an excellent book by a retired physicist named Sanborn C Brown. The book is entitled *Wines & Beers of Old New England, a How-to-do-it History* (The University Press of New England, Hanover NH 1978). In it is a thoroughly enjoyable account of the economic, healthful and sociological importance of wines and beers to colonial American life; it contains numerous suggestions for adapting the old recipes using materials which are readily available from the supermarket.

Since reading this book I have prepared several batches using one gallon glass bottles. The use of the computer again is primarily as a scribe, recording the details of each batch. The recipe for the initial broth typically includes apple juice, varying amounts of maple syrup and honey, ginger, cranberries and spices, etc. The preparation of the initial mix often involves heating for various periods of time in a giant kettle. After cooling, the kind of yeast added and the history of the fermentation are of interest. The final entries in the text for a given batch might be the date when it is bottled in a used wine, Perrier water, beer or champagne bottle.

Then, when a guest has arrived and been suitably impressed by the results of this process, it becomes a simple matter to look up the file with the recipe and output it on the printer. As in all such text manipulation uses of the computer, a good portion of the activity could just as well have been done on paper, but the ability to manipulate and print results improves the activity and makes it in some sense more convenient. Employing the computer for this purpose is a natural result of the computer's availability in its living room setting.

There are other filing tasks which I accomplish which are probably shared by numerous persons. I have begun a project, for example, of recording on disk the

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I never type a letter any more. I compose the letter on the screen, then print it...

essential details (composer, performer, manufacturer, identification number) of each of the 500 or so albums in my phonograph record collection. At a steady rate of perhaps 25 or so entries a night, it will not be long before I can sort the file alphabetically and thus generate my own catalog to take with me to the record stores. Here is a function which is performed in a way which allows instant updating and sorting by various key data items which would not be nearly as easy to do by hand. The application of the computer to this area, however, does involve a bit of programming since the intent is to create formatted and sorted lists of the data for reference, and the field of commercial software for personal computers has not yet developed to the point where I can buy this particular function in a ready made package for $9.95.

Continuing in a word processing vein, I have quite a number of other uses of the facilities of my personal computer and printer combination. For one thing, I never type a letter any more. I compose the letter on the screen of the machine, then print it. If the letter is of no lasting significance, I scratch the file after printing it. But if it is a letter which I might want to repeat at a later date, or modify to direct to a different person, then I save it as a floppy disk file.

Thus far, I have hardly described any uses of this computer which employ my own programming. I am mostly using standard facilities supplied with the machine for personal purposes: entering and editing textual data which can be printed or displayed on the screen of the computer. To be sure, I wrote one small program to balance the checkbook, and a second equally simple program to list files from the disk while counting lines and producing page breaks. And, the record catalog project certainly will require some custom programming before it is complete.

Use of a computer without writing programs for it is certainly possible. Every "turnkey" system, such as my company's Compugraphic typesetting equipment and Xerox 9400 copier, has a computer inside it with all the programming locked into its manufacturing process. But one of the key attributes of the general purpose computer is that its owner can learn to create and use programs which are tailored to his or her specific purposes.

Similarly, any particular personal use of a computer for some definite purpose is likely to be similar in principle yet different in detail. If I want to sort records, I'll probably use any one of a small set of fairly general sorting algorithms selected according to the expected characteristics of the data I am sorting. If I want to print out a nice neat formatted report on my wine experiments, my record library or my checking account, the principles involved in writing such a program are quite universal and applicable to any computer. But the differences in detail require custom programming and skill acquired through practice.

Much of the power of the personal computer, then, lies in learning how to express one's thoughts in the form of programs to manipulate the data which is entered and edited using the standard software of the system. Text editing and word processing using standard software is a kind of static use of the computer somewhat akin to using a typewriter and a piece of paper; a much more dynamic use of the computer is to use a programming language to write programs which use this data

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The same computer which can be programmed by its owner to sort, format and print various files of information like the record library catalog can be used to prepare and compute a mathematical model of the owner's income tax situation or various investments in stocks, bonds or income properties.

Driving a car is a general and nonspecific capability which gets instantly customized when you decide upon a destination and a particular vehicle. And computing is just as general and nonspecific a capability which gets customized whenever a particular purpose is chosen within the capabilities of the machine. Just as one owns an automobile in order to drive, the reason for ownership of a personal computer is to be able to compute.■

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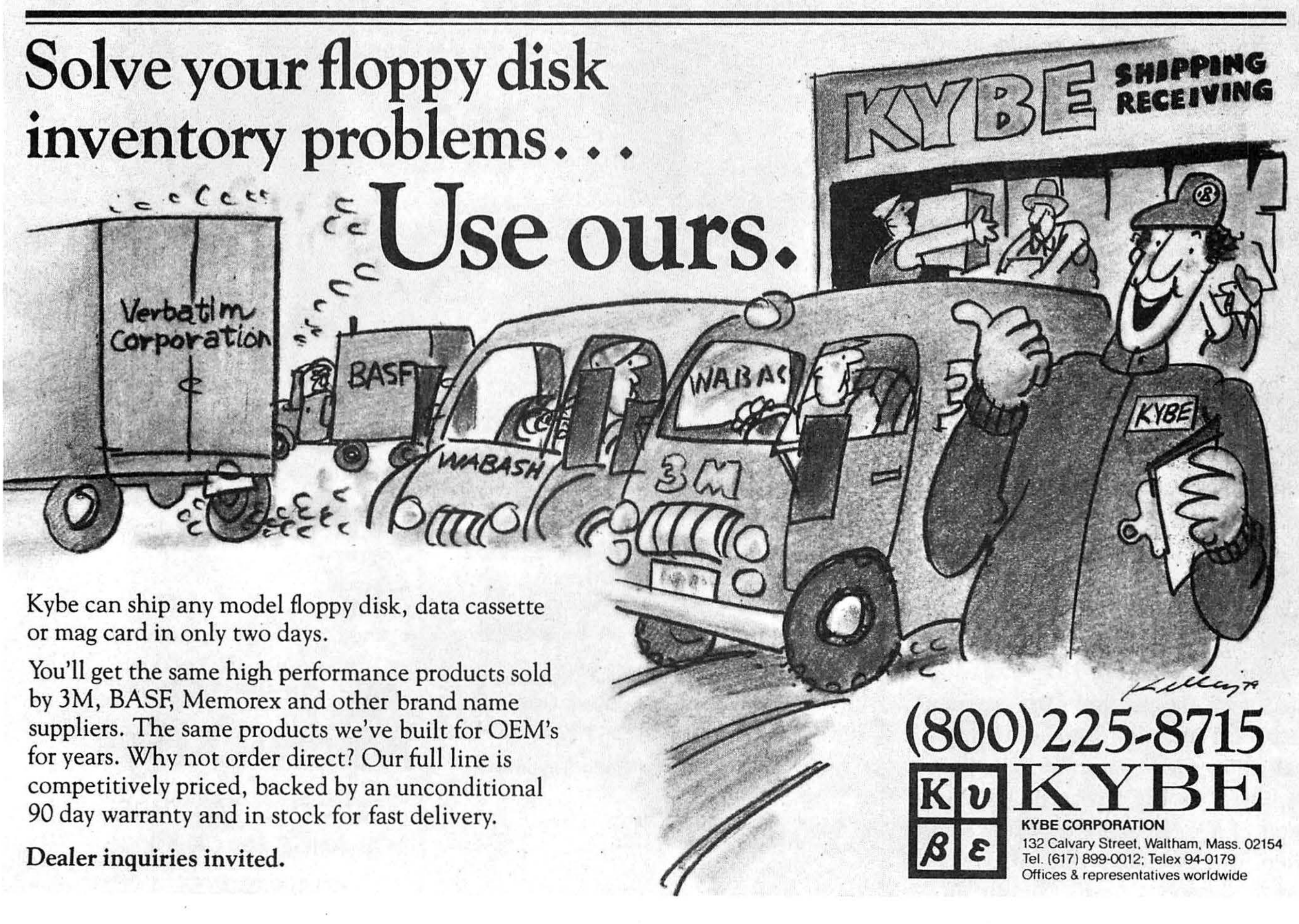

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THE SYSTEM

by

Dr Russell Reiss

There is a lot of talk these days about ten-dollar computers on a chip and five-hundred-dollar complete microcomputer systems being sold in retail stores. What has become of the popular image of a computer as a mammoth complex, full of boxes with blinking lights, rows of whirring tape drives, and mechanical nightmares, that swallows up stacks of cards and spits out reams of paper? What about the room full of programmers who sit all day in front of strange television screens with keyboards, and the systems people who endlessly pore over stacks of printouts that read like encyclopedias written by creatures from outer space? And how about that communications expert who's always worrying about the terminals all over the country that tie into that one big computer?

To many teachers, businessmen, and potential computer users the problem of separating fact from fiction is quite real. To understand what makes a computer tick perhaps we should start by asking what a computer really is.

Part of the confusion is due to the fact that a digital computer is a very general-purpose device. Besides being able to "compute," it can also access, manipulate, store and retrieve any kind of data. "What the computer is" is intimately related to its application, the type of information it is processing, and the devices which are interfaced to it. To compare a computer as it is used in one application to one used elswhere is analogous to comparing the design, control, operating philosophy, maintenance, and economics of a model aircraft to a supersonic transport. They both have wings, and fly; that's about all. I do not mean to imply that microcomputers are only toy replicas of larger computers. They are extremely powerful, fast, flexible devices which have been used in more applications than their larger counterparts.

A great deal of confusion stems from the imprecise and casual use of the prefixes maxi, midi, mini, and micro as applied to computers. I know people who thought for a long time that a programmable calculator was a minicomputer! The interchangeable use of the terms microcomputer and microprocessor further complicates the issue. Certainly, there are no hard and fast definitions which can be adhered to. In this field any attempt at a rigid definition only requires the passage of a few years before it looks foolish.

Obviously, maxicomputers are the big, expensive giants found in large computer centers. The computer, in this case, includes all its peripheral devices and even its special room with air conditioning, false floors, and water cooling system for the processor. The term really implies computer *system*, and some would go so far as to include the people and procedures required to make it run. Maxicomputers are so expensive that they usually can be justified only if the computer serves the needs of many people. One project, one task, or one person generally does not require a "maxi." For this reason maxicomputers are found in large corporations and governments which feel comfortable being able to point to a building and say, "There's our computer." More and more individual tasks are being taken off the large computers

Peripheral costs usually far exceed the cost of the raw processor, and software (programming) expenses typically equal or exceed the investment in hardware.

and being turned over to smaller, more dedicated systems. When these smaller systems are still shared by a number of users (and require a committee to authorize purchase) they are generally referred to as midicomputers. If they are even smaller then they must be minicomputers!

Minicomputers became popular in the late 1960s. By 1970 one could purchase a stipped down minicomputer for under $10,000. Such units were more powerful than the early giants, and much smaller. They could fit in the corner of a room in a small rack or console. The most common peripheral was a Teletype machine. At this price and size many university and industry laboratories found it convenient to use a separate computer for each project. Nearly everything imaginable was interfaced to these computers, from radio-telescopes to jet engines to laboratory animals. Most of these interfaces were special purpose, custom built units.

It became apparent that the applications for minicomputers in computation, measurement, data collection, manufacturing, control, and other areas were limitless. Companies sprang up to provide more minicomputers, more peripherals, and more interfaces. With improved technology and greater competition, prices continued to drop as performance increased. Wider use of minicomputers led to vast improvements in programming languages and support software. Today minicomputers cover the range from self-contained desktop units costing a few thousand dollars, to rooms full of equipment costing nearly a million dollars. In most cases the actual processing elements are quite similar; the big difference is in the amount of memory and number of peripheral devices required for the particular application. Peripheral costs usually far exceed the cost of the raw processor, and software (programming) expenses typically equal or exceed the investment in hardware.

With improved semiconductor technology steadily shrinking the size and cost of computer hardware, people began to speculate about the day when the entire processing element could fit on one integrated circuit. Around 1973 this became feasible and the era of microprocessors had begun. These early devices were hardly "computers on a chip." The elementary control and computational circuits were there, but no memory, and certainly none of the peripherals (or even their electronic controllers). These devices were at first called microcomputers; but the realization that they were far from complete computers quickly led them to be called microprocessors. Thus, the term microprocessor refers to the family of large scale integrated circuits which provide varying amounts of computer "intelligence."

These microprocessors have been built into a tremendous number of devices. They provide the manufacturers of these devices with a compact, inexpensive, convenient, and flexible replacement for complex electronics. The same type of microprocessor may be used in many different applications by simply changing its control program and its electrical interfaces. Users of products which contain microprocessors benefit too, since the units may be made easier to use, more compact, less expensive, and more reliable.

The modern personal computer is one of the products which contain a microprocessor. A microprocessor chip, packaged with sufficient memory in a box with the necessary lights, switches and power supplies, becomes a desktop computer, comparable to a minicomputer. By adding an inexpensive operator terminal (keyboard and video display) and a language such as BASIC, the essence of a small computer system emerges.

Since the technology used in fabricating microprocessors permits them to operate very fast, and since they are structured in an expandable way, these personal microcomputer systems can grow into rather full-blown computers if their owners can afford enough (relatively expensive) peripheral devices.

Now that we've looked at different classes of computers, you may be wondering what they have in common. We've implied that minicomputers are small maxicomputers, and that personal microcomputers can be made to perform comparably to minicomputers. So they must have a lot in common. If we take a close look at computers in general, we find that inside they are all very similar regardless of their size or what name they are given.

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Computers all possess five things: a central processing unit, memory, input and output mechanisms, peripheral devices, and programs.

Computers all possess five things: a central processing unit (sometimes abbreviated as CPU), memory, input and output mechanisms (I/O), peripheral devices, and programs (see figure 1). Although the exact form which each of these elements may take can vary tremendously from one computer to the next, they are, nevertheless, present.

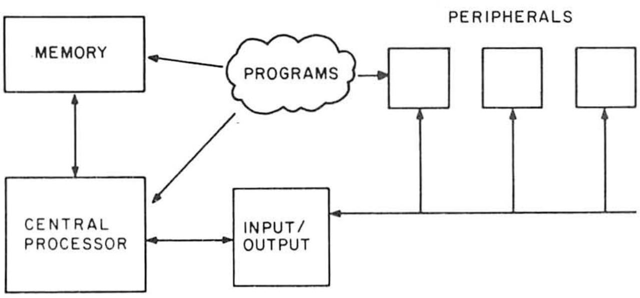

Figure 1: Common elements of all computers.

The unifying factor among all these elements is the program. At the hardware level the program we are speaking of is in a form called machine language. This is the actual sequence of binary instructions which tell the hardware what to do. This sequence may have been derived from a program written in a higher level language such as assembly language or a user-oriented language like BASIC, FORTRAN, or COBOL. The converter, or translator, which changes one language into another is either an assembler, compiler, or interpreter, and it must also exist in machine language form if it is to perform the translation automatically on the computer.

The machine language program being executed resides in memory. The processor first fetches an instruction from memory. Then, based on the operation code specified by this instruction, the processor executes the instruction by carrying out a specific sequence of activities. Many of these activities operate on data temporarily held in registers in the processor. Other activities require that the processor access, manipulate, or store data in memory. Still other activities control peripheral devices via the input/output (I/O) mechanism. Once the sequence of activities associated with one machine language instruction is complete, the processor fetches the next instruction and the cycle repeats. To do all this work the hardware contains various elements of timing, control, sequencing, logic, and arithmetic.

It may be argued that the central processor of many computers is not so "central" any more. Distributed systems are scattering the processing elements amongst input/output, peripherals, memory, and even geographical location to the point that processing is no longer central and, at times, difficult to pin down. As the processing functions get distributed, so do the memory elements, the programs, the input/output mechanisms and the peripherals. It is quite common today for "the computer" to actually be a number of interconnected small computers.

The term memory, as used above, deserves some discussion. It does not include bulk storage devices such as disks, tapes, cassettes, floppy disks, and the like. A better term is main memory, or memory which contains the currently executing program and working data. This is also a difficult element to identify in some bigger systems which are continually moving programs and data to and from disks. This is done in timeshare systems to give each user a time slice, during which his program may be worked on by the processor. It is also done in virtual memory systems where there is not enough main memory to actually hold a complete program. Only that portion of the program currently being executed resides in main memory. When another portion of the program is required it is fetched from disk. Things get even more involved when a cache memory is used. This is a small, very fast extension of main memory. A rather complex control mechanism continually tries to keep the cache full of the instructions which the processor needs next. About 75% of the time it is successful and the system does not have to be slowed down by accessing main memory. The other 25% of the time the wrong data is in the cache and a reference to main memory must be made. The net effect is a significant increase in computing speed (for a given memory speed) at the cost of a small amount of expensive cache memory. This technique does not work if the processor is only as fast as the main memory employed, which is usually the case with the smaller, personal computers.

The complexity and power of the input/output (I/O) mechanism vary greatly between small and large computers. The hardware designers of large

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computers are always trying to relieve the central processor of any tasks which are not directly related to its processing function. Therefore, they include powerful I/O processors which can communicate with memory directly, and handle the complete movement of data to and from peripherals. If memory is properly designed to permit overlapped accessing, the I/O processor and the central processor may do their jobs simultaneously without much interference. These I/O processors, and "front-end processors" in data communications, are actually minicomputers themselves, containing dedicated programs which direct the activities required to support a particular set of peripherals. Often, multiple I/O processors are operating concurrently. It is interesting to note that while hardware designers are striving to make the central processor faster and to relieve it of overhead activities, the systems software people keep finding new bookkeeping, monitoring, and data shuffling activities to keep the computer busy supporting the operating system.

In contrast, personal microcomputer systems generally employ extremely simple input/output (I/O) mechanisms. Since the speed of the system is considered to be secondary to its cost, every effort is made to eliminate extra hardware. The processor is used to directly support as much I/O activity as possible. There are even some microcomputers which speed nearly 50% of their time refreshing the information on the face of the video terminal (even if it is not changing). This is not always as wasteful as it may seem. In a dedicated or single user application, so long as all response-time requirements are met, who cares what the processor does with the remainder of its time? After all, the processor chip only cost $10 to begin with. For example, if a microcomputer user gets an answer from his 50% effective computer in ten seconds, how much is it worth to him to get it in five seconds from a 100% effective computer? In most cases his computer is faster, since it is working only for him, than if he were one out of a couple of hundred users on a multi-million-dollar computer. Relatively slow response time when interacting with humans is usually an annoyance rather than a catastrophe. Since the personal computer only has to deal with one human being at a time, compared to the larger timeshared computer's dealings with a multitude of people simultaneously, the result is the personal computer's responses are often faster.

Thus we see a range of present computer technology from the simple gates of combinatorial logic to the integration of various components into a single computer system or network of computer systems.

The technology is fundamentally similar in all computers. The modern personal computer simply provides us all with a way to use the same tools which were formerly confined to large and expensive projects or functions. ■

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How and Where to Get Bargains in Used Computer Peripherals

Text and Photos
by Sol Libes

Is used computer equipment worthwhile? If so, how and where do you find it? I have been in the personal computer hobby for about ten years. I have bought a considerable amount of used computer gear, and feel that I can offer some advice on the subject.

Once the computer is up and running, personal computer owners start hunting around for peripherals. They look for video terminals, printers, modems and the like. The major problem encountered is cost. Most of these items are electromechanical and often they cost several times what one might pay for the all electronic central processor. New video display terminals can cost $750 and up, while a high speed printer can be over $2000. It is not unusual to find a word processing terminal listing for over $3000 new.

What can a computer owner do to save money? One way is to buy used equipment. The question is: "Where and how do you find it?"

The big market in used computer equipment is due to many factors, one being that the state of the art is changing rapidly and as companies acquire the latest products their present working equipment often becomes available. The result is that there is a great deal of equipment becoming available that may not be up to the highest speed or have the latest features, but is fully operational. For example, you can buy a used video display terminal for less than $500, or one that requires minor modifications for under $200. Hard copy terminals range from $300, for an untested unit, to about $1000 for guaranteed units with extra features.

There are even minicomputers available at bargain prices. Digital Equipment Corp (DEC) PDP-8s, with 4 K words of core memory and serial

Trenton Computer Festival, the largest flea market for computer hobbyists, held annually, in late April, by the Amateur Computer Group of New Jersey. Last year over 5000 people attended this 2 day event.

interface, start at $750 and go up to $3000 for the newer models.

New dealers in used equipment are appearing all the time. The list that accompanies this report is not complete by any means, but it does include the larger dealers in the country and many of the smaller ones. Most used equipment dealers publish catalogs and maintain mailing lists. A simple postcard will usually get you their latest used equipment catalog and put you on their mailing list. Most of these companies are more than eager to deal with individuals.

Many dealers refurbish the used equipment they sell and restore it to manufacturer's specifications to the point where it is often indistinguishable from new equipment. For example, several dealers refurbish Teletypes to "as new" condition. This means a complete cleaning, replacement of defective or worn components, replacement of items such as plastic covers, repainting exposed metal enclosures, running the machine for at least five hours to insure its performance, and guaranteeing it for 90 days. A new Model ASR-33 Teletype, one of the most popular hard copy terminals used by home computer people, costs about $1200. An "as new" reconditioned unit typically sells for $700 while an "as is" nonreconditioned machine goes for under $500.

Particularly good buys can be obtained on equipment no longer being manufactured or from a manufacturer no longer in business. Prices are often considerably less than for equipment still being manufactured. But be careful here. If the manufacturer is no longer in business you may run into a problem getting documentation and replacement parts. Sometimes this even happens with manufacturers who are still in business but no longer manufacture the product. Usually the larger manufacturers will provide documentation and replacement parts for several years after production on the unit has ceased.

The largest and oldest used computer equipment dealer in the country is American Used Computer Corp, which was started in 1968. Second largest is Newman Computer Exchange, which was founded in 1972.

In addition to equipment dealers, used equipment is often advertised in publications such as *On-Line, Electronics News, Computerworld* and *Computer Hotline.* These should be consulted regularly for current buys and new companies in the market.

Another excellent source of used computer equipment is amateur radio flea markets. Ham

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Sol Libes is an enthusiastic microcomputer user, past president of the Amateur Computer Group of New Jersey, a teacher at Union County Technical Institute in New Jersey, and author of several books on digital logic and microcomputers.

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radio operators are big users of Teletypes and other printers, tape readers and punches, modems, etc. These flea markets are held locally and regionally. The largest is held in April in Dayton OH, and draws over 10,000 attendees with acres of flea marketeers in their booths. To find out when and where the ham flea markets are being held, consult the ham magazines such as *QST, CQ, Ham Radio* and *73*.

There are also two large computer hobbyist flea markets held each year. There is the Trenton Computer Festival (held in Trenton NJ) in late April and The Southern California Swap Meet held in Santa Barbara in July. Watch the magazines for announcements of these and other computer flea markets.

Specific Used Equipment Recommendations

Here are some recommendations on what to look for in used computer equipment.

Video Display Terminals: Keep in mind that a new video display terminal that sells for about $750 to $1500 has a display with 24 lines of 80 characters, has upper and lower case letters, operates at speeds up to 9600 bits per second (bps) and has extra features such as cursor control, reverse video, intensity control, etc.

Used video display terminals are usually older and generally lack many of these features. However, they can be purchased for $300 to $600, depending on features. For example, older terminals are mostly upper case only. This is fine for most applications, but if the intention is to do word processing, both upper and lower case letters are necessary. In addition some may have only 72 or 64 characters per line. I do not consider this a serious deficiency. However, some older terminals, such as the ITT Asciiscope, display only 12 lines on the screen and this can be a serious limitation during program development.

When looking at a used video display terminal check the following features:

1) Number of characters per line: 64 minimum, 80 desirable.
2) Number of lines per page: 16 minimum, 24 desirable.
3) Data rate: 110 to 9600 bps desirable.
4) Upper and lower case letters: necessary for word processing.
5) Interface: should be either 20 mA loop or RS-232.

Magnetic Tape Drives: These units, utilizing 9 track magnetic tape drives, are very suitable as backup for disk drive systems. Be sure there is a controller included which has transistor-transistor logic (TTL) input and output levels. Generally these units can be interfaced using a standard parallel

Used Computer Equipment Vendors	Equipment
ADM Communications 1322 Industrial Av Escondido CA 92925 (714) 747-0374 and 16782 Red Hill Av Irvine, CA 92714 (714) 957-2720	Teletypes, video terminals, modems
American Used Computer Corp POB 68 Kenmore Station Boston MA 02215 (617) 261-1100	Used minicomputers, printers, video terminals, modems, Teletypes
ASCI 1197 N Tustin Blvd Anaheim CA 92806 (714) 632-0220 (312) 924-3379	Teletypes, used minicomputers
Atlantic Surplus Sales 3730 Nautilus Av Brooklyn NY 11224 (212) 372-0349	Teletypes, parts, supplies
Business Resource Service POB 11293 Phoenix AR 85061 (602) 866-9123	Teletypes, video terminals, GE Terminet terminals
Computer Warehouse Store 584 Commonwealth Av Boston MA (617) 261-2701	(See American Used Computer Corp)
Crisis Computer Corp 2323 Owen St Santa Clara CA 95051 (408) 246-0402	Used minicomputer systems, terminals and peripherals
Data Access Systems 100 Rt 46 Mountain Lakes NJ 07046 (201) 335-3322	Teletypes, video terminals, modems, parts
Dol-Data Inc Suite 1400 1111 W Mockingbird La Dallas TX 75247 (214) 630-9711	Used Selectrics
Data-Lease 700 N Valley St #A Anaheim CA 92801	Used minicomputers, video terminals, Teletypes
Data Processing Design Inc 6980 Aragon Cir, Suite B Buena Park CA 90620 (714) 994-4971	Used minicomputers, video terminals
Electravalue Industrial POB 157 Morris Plains NJ 07950 (201) 267-1117	Teletypes, terminals, modems, keyboards, parts
Federal Communications Corp Suite 107 11105 Shady Trail Dallas TX 75229 (214) 620-0644	Teletypes, data phones and TWX units

Used Computer Equipment Vendors	Equipment
Herback & Rademan Inc 401 E Erie Av Philadelphia PA 19134 (215) 426-1700	Used computer gear, parts, terminals, keyboards, video displays
JM Associates 80 Emerald Av Westmont NJ 08108	Used computer peripherals and minicomputers
ICC Computer Corp 1115 Security Dr Dallas TX 75247 (214) 630-1401	Used Teletypes and TWX units
MiniComputer Exchange 154 San Lazaro Sunnyvale CA 94086 (408) 733-4400	Miniperipherals
National Teletypewriter Corp 207 Newtown Rd Plainview NY 11803 (516) 293-0444	Used Teletypes, parts and supplies
Newman Computer Exchange 3960 Varsity Dr Ann Arbor MI 48104 (313) 994-3200	Used minicomputers, peripherals and Teletypes
PMR Canada Ltd 94 Hyde Av Toronto, Ontario Canada M6M 1J4 (416) 653-4842	Used minicomputers, components and parts
RCA Service Company Bldg 204-2 Camden NJ 08101 (609) 779-4129	Used Teletypes
Rondure Company 1224 Security Dr Dallas TX 75247 (214) 630-4621	Used Selectrics, modems and parts
Teletypewriter Parts Company 13641 N 32nd Av Phoenix AR 85029 (602) 866-9123	Used Teletypes and parts
Streeter Associates 9 Poplar Pl Fanwood NJ 07023 (201) 889-2222	Used Diablo terminals and printers
Van't Slot Enterprises 550 Springfield Av Berkeley Heights NJ 07922 (201) 464-5310■	Used Teletypes, parts and supplies
Worldwide Electronics Inc 130 Northeastern Blvd Nashua NH 03060	Used Selectrics, printers and components

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interface with two ports (one for data and one for control). You will have to write some machine or assembly language software to control the unit, so the use of a tape drive is not recommended for the beginner. This is usually not difficult if you are generating and reading your own tapes. However, if you desire compatibility with the manufacturer's standard protocol, it often requires software for code conversion and data format handling that may be difficult to implement. Be sure to obtain the manufacturer's interfacing guide with the unit.

Disk Drives: Disk drives available on the used equipment market should generally be avoided unless you have considerable knowledge of the particular drive and controller combination. I have heard about too many problems with used floppy disk drives and frankly do not feel that the grief and time spent on these units is worth the dollar savings.

Teletypes: Teletypes are without a doubt one of the most popular hard copy machines used with personal computers. Over 500,000 of the popular Model 33 machines have been made and hence they are widely available on the used equipment market. Because its encoding and decoding is done mechanically, rather than electronically, it is slow (10 characters per second), heavy, and very noisy. It is also an upper case only machine. The major benefit to the computer user is that it is easy to maintain. You can purchase parts and excellent maintenance manuals from the manufacturer and numerous Teletype vendors across the country.

The Model 33 comes in several versions. The most popular version is the Model 33ASR (automatic send and receive) which includes a paper tape punch and reader and employs a 20 mA current loop input/output. This unit sells brand-new for about $1200 and used (refurbished) for $500 to $700 (as is). The Model 33KSR is the same as the ASR except it lacks the punch and reader and generally goes for $100 less. Finally, the Model 33RO (receive only) contains only the printer (no keyboard) and is generally available for $100 less than the KSR.

Selectrics: Terminals using IBM Selectric printing mechanisms are readily available on the used equipment market. Hundreds of them have come from airline ticket offices and similar installations. They have seen many years of hard use, but are very rugged and can be overhauled and interfaced to personal computers. Prices vary from less than $200 to over $1000. For $200 you can buy an "as is" Selectric mechanism with power supply and solenoids. However, be careful. Most of these units do not use standard ASCII code or interface. The likelihood is that these units can only be used as printers with an appropriate software driver program written to convert ASCII to the code used by the Selectric. This equipment should be purchased only by persons knowledgeable in hardware and software interfacing.

Very few used equipment vendors sell Selectrics with RS-232 interfaces that work with the ASCII code. These units generally cost $600 to $1000, and can be easily connected to most microcomputer systems. Even converted, these units are still utilized primarily as printers, since the Selectric keyboard lacks many of the standard ASCII key functions, such as "control" characters.

Finally, IBM will not repair machines that do not bear its name, but will sell the parts and maintenance manuals. These can be purchased at local IBM parts depots. The documentation on the nonIBM components in the terminal must come from the terminal manufacturer.

Diablo Terminals: Terminals and printer-only units using Diablo printer mechanisms are also available on the used equipment market. These units are very desirable for word processing. The current model is the Hytype-II and sells new for about $3000 in a printer-only version. The Hytype-I, the predecessor to the II, is also readily available. The printer-only version of the Hytype-I sells for $700 to $900. This unit requires the addition of a high capacity power supply, computer interface, and software driver program. Complete used Hytype-I terminals, with built-in power supply and RS-232 interface, generally sell for $1100 to $1500. This unit is very suitable for use in word processing since the print quality of any Diablo mechanism is comparable to an electric typewriter. The Hytype-II offers higher speed and some additional features, such as printer graphics; otherwise it is essentially the same as the Hytype-I.

In summary, the major items which personal computer users will find of interest on the surplus markets are printers and terminals. When such items are available with the Teletype style current loop interface or the Electronic Industries Association RS-232C interface, with the ASCII character set, they can be easily hooked up to standard ports available in many personal computers. The more elaborate and sophisticated pieces of equipment, such as used 9 track tape drives, used floppy disks, and used hard surface disk drives, should be avoided by novices. The requirement of some variant of the ASCII character set is due to the fact that nearly every personal computer product uses ASCII encoding of the keys of the typewriter style keyboard used to input programs and data. The computer store which sells you a computer is an invaluable source of the detail technical advice on how to connect an RS-232 or current loop printer or terminal to your machine.■

the Diablo Printer

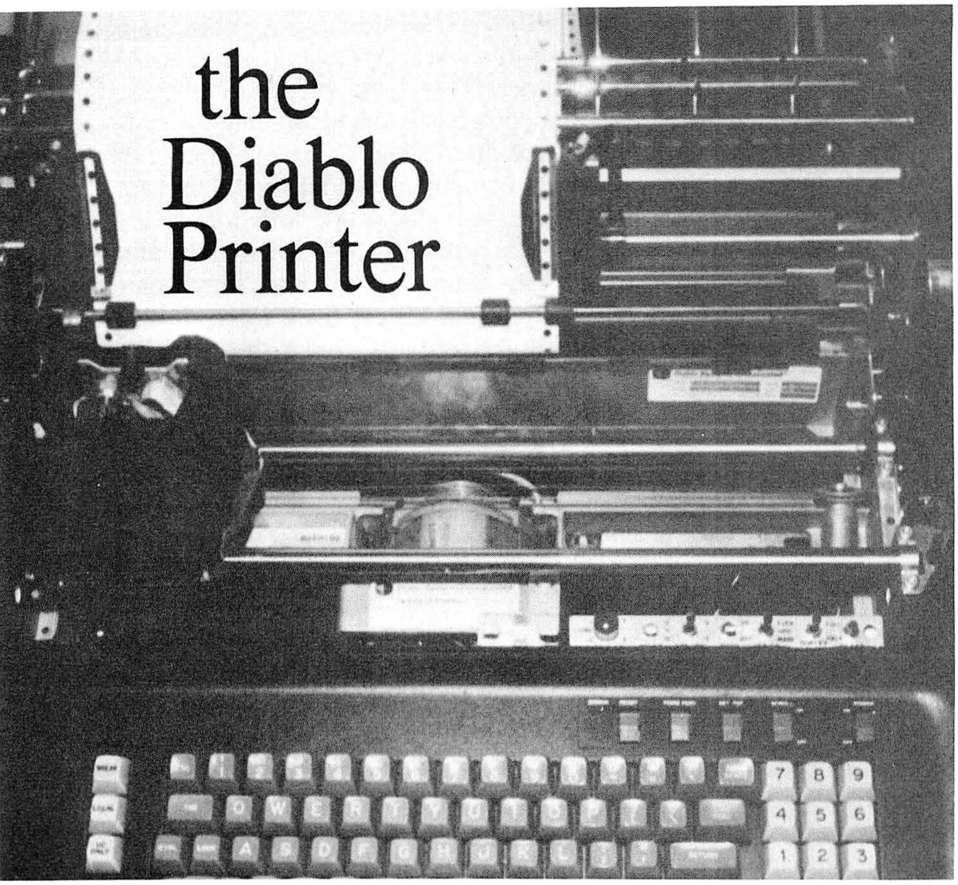

Photo by Ken Knecht

A USER REVIEW

by Ken Knecht

Several years ago I decided to make the big plunge and get a printer. I had a video terminal but now I wanted a printer to make future programming efforts easier.

My video terminal was very nice, but it has dot matrix letters, no graphics capability, and displays only upper case letters. This seemed perfectly adequate at the time of purchase but I since have wished I had graphics capability and lower case. Unfortunately the terminal I had chosen cannot be modified for these requirements. I resolved I wouldn't make the same mistake again. This time I'd look a little further than my present needs.

I wanted impact printing of typewriter style letters on regular paper, and both upper and lower case. Keeping my resolve in mind I added the following requirements — ability to change type fonts, graphics ability, a forms tractor to allow use of continuous feed computer paper, and a keyboard.

I looked at a lot of terminals and only one available at the time seemed to fill the bill: the Diablo 1620. The price was higher than I had expected to pay and I had to do terrible things to my savings account to purchase it, but I haven't regretted it for a minute.

The Diablo uses a daisy wheel so print fonts can be changed, can be used for graphics with a pin feed platen, has a forms tractor available, and a lot of other features I didn't know I needed until I needed them. So far it hasn't let me down when I come up with some new idea for the printer; and it has features I haven't used yet.

It has been very reliable with one exception. After it was over a year old it stopped working. I saw a dim indicator light, and the printhead wouldn't go. Since I am a "do-it-yourself" sort of person, I saved the price of a service call and located the problem myself. It didn't take long to find a shorted power transistor in the printhead drive amplifier. I couldn't find an exact replacement so I used a Sylvania ECG (general replacement) transistor with about the same ratings and it's worked ever since.

The electronics is almost all on plug-in modules and the maintenance manual that comes with the printer is extremely good. It goes into a great deal of theory of operation and has accurate schematics and parts layouts.

An 8080 microprocessor is used in the Diablo 1620. This permits backwards printing, for more efficient movement of the printhead. Absolute tabs which permit software control of the printhead allow it to move directly to a line position without printing spaces to get there. It also resolves a series of line feeds and carriage returns to move the printhead to the desired position through the shortest path. Thus, by the time the paper is moved to the desired line, the printhead is at the proper point to begin printing.

The terminal uses a 158 character buffer, meaning that it can keep up with the computer's output.

The Diablo prints at 110, 150 or 300 bits per second (bps). The printer can accept data at up to 1200 bits per second, but it can only print at a maximum of 450 bits per second. Because of this, special techniques must be used in order to achieve this speed. Readers with more advanced backgrounds in hardware and software might be interested in pursuing this possibility.

A form feed character can be used

Ken Knecht has written several books and technical articles and is now free-lancing in the field of radio and television engineering. He has a custom software development company, Kencom, in Yuma AZ.

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in software to set the printer to a manually set position on a form (simply press the TOF button at that position). Forms can be 3, 3.5, 4, 5.5, 6, 7, 8, 8.5, 11, 12 or 14 inches long. This is set by a front panel switch. Obviously this is useful for forms or to position the printhead to the next sheet of paper when perforated paper is used.

I might mention at this point that paper is readily available in most computer stores with fine perforations every 11 inches along its length and with holes along the edge for a forms tractor. The paper can be torn at the perforations leaving sheets 8½ by 11 inches, or standard typewriter paper size. Other sizes are also available. The Diablo can use paper up to 15 inches in width.

The printer uses a very simple mechanical interface. Three motors are used, to rotate the platen, move the printhead and turn the daisy wheel. A solenoid is used to operate the print hammer. The only relatively complex mechanism is a cable used to pull the printhead back and forth along the platen. This is a closed loop wound around a pully on the printhead drive motor.

According to my manual, 20 different printwheels are available, including an APL character set.

Front panel controls include power on/off, reset, form feed, set top of form, scroll, break, local and upper case only. The last three are keys to the left of the keyboard.

The reset is used to turn off the error light. The error light signals parity error, buffer overrun, "framing" error, cover open, and out of paper.

The form feed switch advances the paper to the point where the set TOF (set top of form) was last set. I use this to begin a new sheet of perforated paper. It beats keeping track in software of the number of lines printed in order to start a new page at the correct point. Manually rotating the platen will affect the TOF setting as the printer doesn't sense these movements.

I don't like the scroll feature. It is used to shift the paper up one line when you stop typing or the terminal stops so you can see the line just typed. Normally the printhead covers the last few characters typed. It works well with normal platen use (like a typewriter) or the pin feed platen but doesn't work well with the forms tractor as the paper doesn't always pull back to the exact line where it was previously printing. The continual up and down motion of the paper annoys me, so I generally keep the scroll switched off. There is also a slight delay when you start typing after a pause while the paper pulls back. If you don't mind this it works fine.

The price was higher than I had expected to pay and I had to do terrible things to my savings account to purchase it, but I haven't regretted it for a minute.

The three keys to the left of the keyboard with break, local and upper case only are useful. The break doesn't work with my computer but is useful with some systems. The local key is used to set margins, etc, and to use the printer as a typewriter. It removes the printer from computer control. The upper case only key is used for listings or whenever I want to type all upper case and don't want to bother using the shift key. It affects only the letters and can print lower case from the computer even if it is set to upper case only.

Under the cover are seven more switches. A rotary switch sets the forms length (settings mentioned earlier) for use with the form feed. I generally set it at 11 inches for standard perforated paper size (8½ by 11). The speed switch sets the data rate (110, 150 or 300). If the data rate is internally jumpered for 1200 this switch doesn't work. I use 300 bps. A spacing switch selects ten or 12 characters per inch and is set according to the type font used. The spacing can also be set in software. A parity switch selects even, odd or mark (no parity). The duplex switch is used to select full or half duplex. In half duplex, locally generated data is printed, as well as sent to the computer. In full duplex, the only data which is printed is that generated and sent by the computer. I use full duplex and let the software provide the echo which confirms transmission. A line feed switch is available for automatic line feed after a carriage return. I leave this set off unless I'm using the printer as a typewriter in local mode, as my software provides the line feeds automatically. Last is a clear button which resets all previously set functions such as margins, software spacing, etc.

Installing or removing the forms tractor, changing platens, changing daisy wheel, changing the ribbon, etc, are all easily and quickly done. The front cover has to be removed (friction catches) and the printer won't run with the cover off unless an interlock switch is up (rather awkward to set).

My keyboard has a separate numeric section. I've never gotten into the habit of using this but some users may find it useful for inputting figures. The larger unmarked white key is another space bar.

An impression control switch is available under the front cover. It sets at L, H and M for light, heavy and medium impressions. I use only a single sheet of paper and use the M setting which works very well.

The ribbon is in a cartridge and

This is an example of text printed on the Diablo HyType II mechanism with a cloth ribbon. The text is typed at medium print density with a Courier 72 plastic print wheel...
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
!"#$%&'()=^@[]_+*\<>?
1234567890-~`{}_;:|,./

This is an example of text printed on the Diablo HyType II mechanism with a carbon film ribbon. The text is typed at medium print density with a Courier 72 plastic print wheel...
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
!"#$%&'()=^@[]_+*\<>?
1234567890-~`{}_;:|,./

Figure 1: Two samples of text produced by the Diablo printer mechanism with different types of ribbons. In both cases, a standard Courier 72 typewriter style font was used, and the print was set at the medium position.

snaps in and out easily. The cartridges cost about $5 and are usable for a long time. You can use a two color ribbon and change colors under local or software control. Some suppliers will reload the cartridges for a reasonable price (half price). Cartridges are available in cloth ribbon and carbon film ribbon styles.

As I mentioned earlier, the printer can be used for graphics. The horizontal movement is in increments of 1/120 inch, vertical movement in increments of 1/48 inch. The printhead will backspace and the platen will move in either direction. In graphics mode the printhead doesn't move after each impression but has to be moved with a backspace or space. The distance of the movement is set in software (or locally). Horizontal movement is from 1/120 inch to 125/120 inch for each space or backspace or any intermediate point; vertical movement from 1/48 inch to 125/48 inch with each positive or negative line feed. Thus you have a great deal of freedom in selecting the spacing you wish in your graphics printout. All graphics movements can be set in software or locally. One disadvantage is that the continual use of one character on the daisywheel, such as the period, will soon wear out that character on the wheel. Incidentally, plastic printwheels run about $8, metal at $35. I suspect the metal printwheels wouldn't wear out very quickly but I haven't tried one. You should have the pin feed platen for printing graphics, because negative line feeds don't work well with the forms tractor.

You can also set the spacing between characters for normal printing (other than the standard ten or 12 characters per inch) in software. I use this feature for spacing the characters to fill out a line when using fully justified copy with even left and right margins.

The printer will also do half line feeds under local or software command for super or subscripts. The backwards printing mentioned earlier requires the line to be reversed in software. The printer doesn't reverse the line. I've never tried this as the carriage return, line feed sequence doesn't take enough time to make the software writing worthwhile.

Margins can also be set under local or software control and limit the printhead movement. The right margin is set with a sequence of "escape" and "0" ASCII characters, left margin is set with an "escape" and "9" sequence. When the printhead reaches the right margin it overprints characters, as there is no automatic carriage return, line feed sequence.

The operator's instruction manual goes into great detail explaining the uses of all these features (there are 30 of them). Two manuals are provided, an operator's manual and a maintenance manual.

The keyboard uses Hall effect switches and n-key rollover. I have had no keyboard problems. The switches all work beautifully and have a nice feel.

The Diablo 1620 uses the standard RS-232 serial interface to the computer and requires one stop bit. (I couldn't find this specified anywhere in either manual but my input/output (I/O) board is set to one stop bit and it works so this must be so.) The plug is the usual 25 pin "D" connector and the cable is hardwired into the printer. There is no Teletype style current loop interface available that I know of.

The terminal is very impressive. It looks like a large legal typewriter. It operates very quietly for an impact printer.

The electronics resembles a computer, with an 8080A, programmable memory, read only memory, digital to analog and analog to digital converters, an input/output (I/O) board with an asynchronous communications circuit as in all serial computer terminals, plus servos and motor drive amplifiers. The printer software is in erasable memory.

As you can see, I'm very happy with my Diablo, and would heartily recommend it to anyone, if you need the features available. It's not cheap, but I've seen a few used Diablos for sale in the ads, so you might consider this choice. There is little to wear out, so a used terminal in operable condition should be a good buy. The maintenance manual is very thorough and few special tools are needed for major adjustments. So far I've not had to make any adjustments at all.■

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Illustration by Robert Tinney

ATARI'S NEW HYBRID COMPUTERS

Text and photos by Chris Morgan

Video games are getting smarter all the time. The other day I ventured into a local games arcade and spent several quarters in pursuit of a gang of interstellar marauding riffs. The unit I was playing on was one of the latest space war electronic gadgets from Atari.

As my turn came to an end, a message appeared on the screen: SENSORS DETECT THE PRESENCE OF AN ADDITIONAL QUARTER IN YOUR POCKET. DO YOU WISH TO CONTINUE? The diabolical machine was right, and I emerged from the arcade an hour later, my quarters gone, but with the glow of a job well done.

Over 20,000,000 electronic game machines have been sold to date — an impressive statistic, and one which belies the claims of those who had predicted that the video game would be a short-lived phenomenon. People have not tired of video games, due in large part to the ingenuity of companies like Atari. Today's games make the original ping-pong video games look static by comparison: starships rocket through space at dizzying speeds accompanied by sound effects with an Armageddon flavor.

Enter Atari

Last fall I attended the unveiling of two new personal computers from a surprise source: Atari. I spent some time talking with the Atari representatives present at the press conference, but the most exciting part of the unveiling came later — the chance to play with the machines.

These two new personal computers represent a marriage of the video game with the personal computer, or what I call a *hybrid* computer. This term is not to be confused with another, older type of hybrid computer that combines analog and digital circuitry. The idea is to create a device that looks and acts like a video game, but which also has the features of a personal computer.

Atari is the acknowledged leader in the video games market. How well have they carried this technology over into the personal computer field? I feel they have done this with great success. The game of basketball I played on the model 400 (suggested retail price of the 400 is $549) was reminiscent of an arcade game: the basketball players are manipulated with joysticks, their arms and legs move, and the machine supplies electronic dribbling sounds. Everything is displayed in high resolution color on a standard color television set.

The features on the model 400 and its more expensive cousin, the 800 (with a suggested retail price of $1000), are in some cases refinements of, and in other cases adoptions of, similar features found on


The Atari Model 400 personal computer.

other personal computers. For instance, the cassette recorder used to enter and store programs plugs directly into the front of the machine (which is also where the joystick paddles plug in) via one integrated cable—a real convenience. This gives you one less cable to worry about. Also, there is no volume control on the cassette recorder. The volume is preset, much like the Commodore Pet computer's cassette recorder. The advantage here is that you don't have to guess the optimal setting for reading or writing programs on cassettes. (The cassette recorder is an optional accessory for the model 400, but is included in the price of the model 800.)

A small feature, but an important one, is that the reset key is recessed to prevent accidental return to the monitor program—on some machines, this could cause part or all of a BASIC program to be accidentally erased.

These new personal computers represent a marriage of the video game and the personal computer, creating a device that looks and acts like a video game, but which also has the features of a personal computer.

The Model 400

The model 400 keyboard is the flat, touch sensitive type, which may or may not be to your taste. An audible beep serves as feedback when you touch a key. The unit contains 8 K bytes of programmable memory, and both the 400 and 800 contain an interesting design innovation: *two* microprocessors instead of one. One microprocessor (a modified 6502) handles the computational duties, while the other (a custom large scale integrated circuit) is devoted to displaying graphics. Like the 800, the 400 accepts video game cartridges which plug directly into the top of unit. In addition, special cartridges, such as a BASIC cartridge, can be plugged into the unit to allow users to do their own programming. The color graphics package on both units features 16 colors and 8 brightness levels. The brightness levels add an extra degree of subtlety to the displays.

The Model 800

The more expensive model 800 offers a conventional keyboard and the capacity to hold up to 48 K bytes of memory. It also has two cartridge slots on top. This enables you to plug a BASIC cartridge into one slot and a diagnostic cartridge into the other slot for use in debugging an ailing program. The company promises more such interesting combinations of cartridges.

Software

Atari plans to market an extensive variety of software for both computers, and will mass-market the machines in discount stores as well as computer stores. To help sell the 400 and 800 models, video taped demonstrations will be shown and

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The Atari Model 800 personal computer.

special programs used. I enjoyed one ingenious use of the cassette format that Atari has developed: cassettes with computer programs on one of the two stereo tracks, and a voice on the other track for use in programmed learning.

Projected model 400 software includes educational packages treating subjects such as algebra, psychology, economics, sociology, zoology, and others. Thinking games such as chess, backgammon, a stock market simulation, Life, and Tank are in the works, as are an income tax preparation guide, budget and financial planning, and so forth.

Software for the model 800 will include a record keeping program, appointment calendar, accounts payable, touch typing trainer, space adventure, and historical strategy games. Atari also plans to market a set of peripherals for its computers, including a light pen, music synthesizer, and an appliance controller.

Both Atari computers feature not one but two *microcomputers: one microcomputer is used strictly to generate the graphics images that appear on the screen; the other is used for the remaining computational duties.*

Other Developments

At least two other manufacturers have been involved in the production of hybrid computers. Bally made an aborted attempt to get into the market with a building block approach to personal computers earlier in the year, but delays because of problems in passing FCC radio frequency emission tests forced a halt to the project. Several other manufacturers have reportedly been stymied by these increasingly more stringent tests. The FCC is trying to prevent personal computers from causing interference with nearby television reception.

Mattel's new Intellivision unit, first shown at the winter Consumer Electronics Show this year, is scheduled to be available in the fall. The unit offers a $250 master entertainment module (a sophisticated video game unit) which can later be mated to a $250 personal computer module with keyboard.

Final Thoughts

Look for limited availability for the Atari computers now, with full production scheduled for this fall. More information can be obtained from Atari, 1265 Borregas Ave, Sunnyvale CA.

We expect to see a continuation of the trend toward personal computers that look like video games on the surface, but which offer a lot more in terms of computing power and user interaction. There may be some more surprises in the wings at the next Consumer Electronics Show. ■

For more information, contact:
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1265 Borregas Ave
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408-745-2083

BOOK REVIEW

The Wired Society

by James Martin
Prentice-Hall
Englewood Cliffs NJ 1978
300 pages, hardback
$12.95
Reviewed by Mike Emery

You might prepare to read a new book written by an author of twelve books on computers and telecommunications by surrounding yourself with several volumes of reference material and a large notepad. A comfortable lounge chair by a warm fireplace would be more appropriate to absorb *The Wired Society* by James Martin. It's the type of book you curl up with, losing yourself in your imagination, rather than studying it.

Martin uses a self-imposed nontechnical language in presenting his version of our society in the future and, in particular, how the growth of telecommunications and computer use will affect our way of life. He explores the role of communications and computer systems in our society and the relationship of telecommunication to our culture, now and in the future. Ecology, medicine, education, business, homelife, travel, industry and world politics are just some of the broad topics analyzed with meticulous care. Details that reflect the essence of our society are exposed; we are then shown how they might be improved or expanded by telecommunications and computer based data management.

Here's an example: according to the author, the world will be running out of petroleum in the next 35 years. As the cost of petroleum rises, the cost of telecommunications will continue to drop. Imagine how much energy could be saved if white collar workers could work at home using a terminal to communicate with the company's computer, a videotelephone to attend meetings, and a teleprinter or facsimile machine (a copying machine that produces photocopies via a communications link) to transport or receive documents. When the worker has a letter to be typed or needs secretarial services, the work can be sent to the central computer using a terminal. A secretary working at home can request work from the computer via a terminal and can perform that work without ever leaving home. The finished work can then be placed back in the central computer for examination and correction by the originator. It may also be transmitted over the telecommunication lines to be reproduced only at its destination by a facsimile machine, eliminating conventional mail delivery delays and expenses. The potential for these innovations is summed up with the author's statement, "A study by the Office of Telecommunications Policy concluded that the use of automobile travel for acquisition, exchange, and dissemination of information uses 500 times as much energy in total as would be needed to do the same by telecommunications."

The book, at times, does not seem to flow from one analysis to another. Many arguments are presented repeatedly under different headings. My greatest criticism of the book is that it paints too pleasant a picture of telecommunications and computer involvement in the future society. The author plays down the possible reaction of the populace to the impersonal relationships that might develop in a telesociety. On the whole the book is a positive statement about technology's role in our society. The author has succeeded in describing the vast potential of the "wired society."■

Mike Emery is an electrical engineer specializing in microcomputer hardware and software.

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onComputing interview:

TODD RUNDGREN

by Tom Harvey

Photos by Jacqueline Earnshaw

Todd Rundgren's name has yet to become a household word, but a growing number of people in the world of pop and rock music are aware of who he is and what he has accomplished. A 20th century renaissance man, Todd is a producer, composer, engineer and visionary. He has brought a remarkable degree of innovation and vitality to the recording scene through his pioneering efforts in joining music to computer technology, physics and video recording techniques.

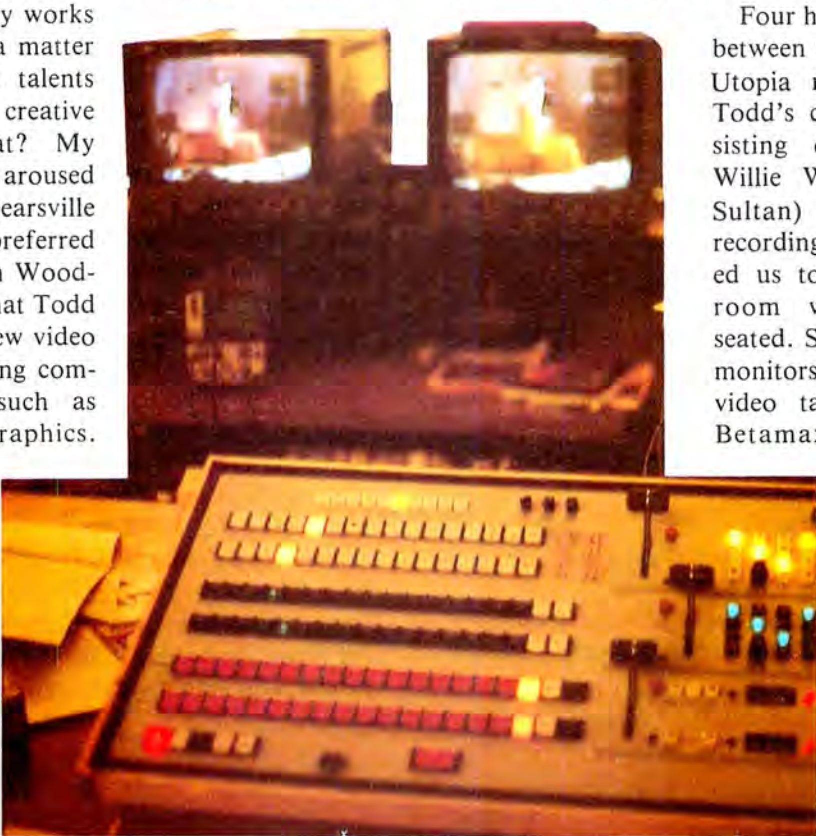
"Hermit of Mink Hollow," his latest album, is a solo work written and performed by Todd. The album incorporates electronic music synthesis and a highly developed musical sense. Rundgren is a performer in complete control of the 32 track technology required to produce so complex a work.

At a recent computer fair in New York I discovered that Todd had been buying keyboards, terminals, and other computer equipment. How does he use microcomputers? I asked myself the same question. Being aware of Todd's interest in electronics from his early works on, it seemed only a matter of time before his talents would seek a new creative medium, but what? My curiosity was further aroused when a friend at Bearsville Studios (Todd's preferred recording grounds in Woodstock NY) told me that Todd was working on a new video disk project, involving computer techniques, such as animation and graphics. Knowing all this, and that Todd was a subscriber to *BYTE* magazine, I thought it was natural that I interview him for onComputing. The only problem was squeezing adequate time from his busy schedule.

"His time is very precious now," Todd's agent, Eric Gardener, told me. "He's finishing the production of an album and the first half of his film, while getting his studio set up and starting his Japan tour."

After some false starts, photographer Jackie Earnshaw and I were on our way to Woodstock. At Bearsville we were escorted by our friend Frank Campbell to the rehearsal studio, which had been transformed into a video taping studio complete with staging, backdrops, and 14-foot fixed-mount camera towers. The pace in the studio was frantic. In one corner of the room a laser sprayed green and red beams of light against the wall, producing a fascinating sequence of geometric shapes and transformations.

Frank introduced us to Paul Fishkin, the president of Bearsville records, and Bob Campbell, the video projects production manager. We were assured by Paul that this was not an unusually active day, "so relax and watch the show till Todd can see you."



Four hours later, crunched between the video project, a Utopia meeting (Utopia is Todd's current group, consisting of Roger Powell, Willie Wilcox, and Kasim Sultan) and a Meatloaf recording session, Bob guided us to the video control room where Todd was seated. Surrounded by video monitors, a row of Sony video tape recorders, two Betamax video cassette decks, and an ISC Compucolor video terminal, interfaced to the central recording and mixing panel, we began our interview.

onComputing: *What is your technical background? Were you a child prodigy, burning the midnight oil in a basement physics lab?*

Todd Rundgren: No, not hardly (laughing). Aside from some minute degree of theory, I still have no great knowledge of electronics, per se. I find it very frustrating having to deal with design concepts, partially because I have no desire to become a digital design technician. I don't need that level of expertise. I know there are people who are totally involved and fascinated in that field, and I rely upon them for the development of the tools I need. I know how to apply the technology for the ends I have in mind, and that's all I feel I need to know.

oC: *Then you think of electronics as a tool?*

TR: Not a tool for me so much as a vehicle, I guess. If something breaks, I know how to kick it, unplug it, flip the reset switch, or cajole it into working, but if there's something really wrong with the equipment, I'm totally helpless. I could never remember the resistor color code.

oC: *What were you doing with electronics that led you to the realization that a microprocessor could assist you?*

TR: I've always been fascinated with the concept of synthetic intelligence. I'm for anything that simplifies or elevates the human condition. I don't think I was in the middle of a particular project when we incorporated microcomputers into our inventory; however, I do think I followed some natural progression from basic electronic equipment through to the complex forms we use now such as synthesizers, digital mixers, and microcomputers. I am willing to try anything that promises to be of use.

oC: *Did the thought of using a computer turn you off, or were you eager to involve yourself with this aspect of technology?*

TR: In any kind of technology I'm associated with, my only interest is in making it functional, finding humanistic applications for it. I'm eager to utilize computer technology, but I'm only involved in the applications end. I have discovered that I have no real love for digital technology, and I want to know no more about it than I need to in order to utilize it for the particular application I have in mind.

oC: *Are you feeling more liberated or more removed from your work by your involvement with technical electronics?*

TR: I understand the language of technology, I understand the way you communicate with machines and the way they communicate with equipment; that doesn't put me off so much as it gives me access to more tools. You don't have to know how to make the equipment, just how to use it.

oC: *Do you find it difficult to keep the artistic and creative sides of you alive as you become more and more involved with electronics?*

TR: Actually no. I realize that, for some people, electronics, or computer technology more specifically, can be alienating. You have to submerse yourself in a technology in order to understand how to create what you want to create, but you don't have to drown in it. A lot of the equipment I am involved with is by-product technology. That is, it was built with another function in mind. With me, I know what result I want, so I just research till I find something, whether it be a laser, or terminal, or digital composer, that will meet that end. I believe that whole industries are built upon this: as a result of an experiment here, we've found that this computer is also useful here—that sort of thing. In a way, I think the armed forces do a great deal to advance our technology; they have the money to do the research, and then the people who watch what they do can interpret prac-

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"I don't think that faster processing time and larger memories are going to get the average person involved with computers if the ultimate function is boring, or if the complete units remain too expensive. We need simpler input and much more software."

tical usage from their results. It seems to me that technology could be alienating if it is seen as something alien.

oC: *Do you feel that too much attention is paid to technological discoveries?*

TR: No, but I think people tend to forget that they *are* discoveries. They think of technology as existing without us, like some deity that shows itself to us in glimpses and is in no way connected to humanity. We make such a big deal out of the existence of some form of technology that we forget its intended purpose. Electronics by itself is not amazing—it's energy transference—but what we can do with that energy is amazing. Do you see my point? It's like computers: they aren't alien beings—they are our new tools, and I never feel stranded by a tool. It isn't something to be worshipped, it's to be used. If there were a choice in life and I had to be either a scientist or a philosopher, no matter how much I enjoy being involved with technical things, I would just try to keep that perspective. Electronics is only a fragment of human understanding and development, and it doesn't deserve deification.

oC: *Is it difficult to keep abreast of the new developments in the computer field?*

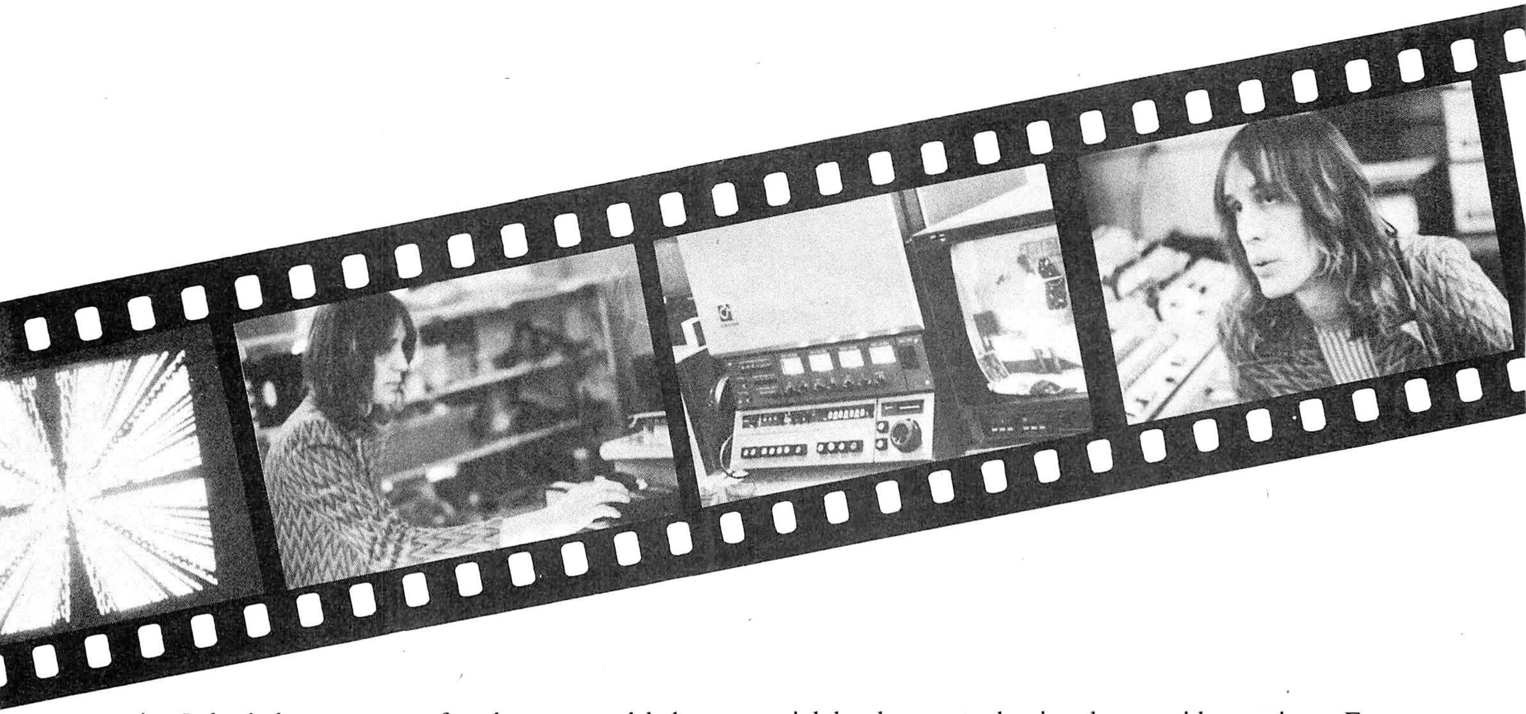
TR: It seems as if hardware technology changes month to month. I'm not a hardware enthusiast. I don't become totally absorbed by the so-called new developments. There is a hardware race on now and it's very easy for the consumer to be lost in it. It seems to me there is almost too much information available. I think that now would be a good time for the industry to slow down a little, rethink functionality, and possibly standardize its ideas. They've proven that minicomputers work. They're almost as fast as the mainframe units, and contain enormous amounts of memory. Minicomputers can compete with the mainframe units on many levels, but I don't think that faster processing time and larger memories are going to get the average person involved with computers if the ultimate function is boring, or if the complete units remain too expensive. We need simpler input and much more software.

oC: *But hasn't the industry's "hardware race," as you call it, helped to lower the cost factor of computing and increased the availability to the general public?*

TR: First of all, I don't think that the lower cost of mini and micro systems is due to any philanthropic design on the part of the industry. It's a result of technological developments that make the elements involved in computers considerably cheaper to produce. They have just designed more efficient ways to make memory chips and boards. There is no one in the industry who is thinking "Gee, wouldn't it be nice if we could design a 10 dollar computer that everyone would be able to use and afford." What they are thinking is "Gee, wouldn't it be nice if we could produce a 10 dollar computer that we'd make 5 bucks on." But that is business. It is good that computers are becoming less expensive and more available, but is that reason enough to buy one? I think we have to make technology fit our needs, not our needs fit technology.

oC: *Do the mechanisms you use save you work?*

TR: Yes, for a designated function, but the problem is this: a microcomputer is almost too general a tool for my needs. I have no interest in keeping a file system; I'd just as soon write something down on a piece of paper and keep it until the information is useless. I have no need for unnecessary button pushing. I don't need a computer to figure out my taxes—my accountant does that. He probably uses a computer to work it out; I don't know. But at this



point I don't have any use for these general ledger functions that microprocessors have been applied to so far.

oC: *Could you isolate a particular album which you consider your "coming out" as far as your involvement with microprocessors goes?*

TR: Well, I think I used a Putney synthesizer on my second solo album, but I suppose "Initiation," where I did one whole side with a synthesizer, was my biggest step. That was in 1975. After that I used some form of digital synthesis in all my work.

oC: *Have you used digital recording equipment, or do you see the possibility of its usefulness in a creative sense?*

TR: I have done some computer mixing in the Audio Studio. It's a relatively simple and convenient process in terms of computer operation. As for digital recording, I haven't really done much with it because I think it's an unjustifiably involved process. The whole idea of having to edit electronically is so complex. I much prefer mechanical splicing. Electronic editing requires a lot of additional equipment in order to keep things synchronized, and two machines as opposed to only one mechanical splicer. I just don't believe technology has gotten there yet with the digital system and, at this point, the recorders are only available in two track or mono. Beyond that, the amount of noise that can be eliminated from a recording is ultimately subject to the consumer's own playback equipment or pressing process. I think digital technology will find much greater acceptance in the video field just because of its editing characteristics.

oC: *Why are you changing your direction from music to video?*

TR: A couple of factors. One is what is happening to music nowadays, and the other is some recent financial developments that involve my video projects. For the past several years I've been becoming increasingly disenchanted with the business of music. Music is not now what I originally got involved in it for. It was originally vital and expressive and anti-establishment, and now it is very establishment oriented. Even the punk and new wave music are very establishment directed forms. It's hard to explain. It's just not the same.

oC: *Is it as a result of this disenchantment that you became involved with video?*

TR: Not as a result; but along with the frustration of music, I saw some leeway in another medium. I have been interested in the video field for a while, but it wasn't till recently that I had some lucrative productions, so I decided to become completely involved in it. I believe that people concentrate greater attention on watching TV than they do on listening to home stereo, so this is the vital medium. The audience is much larger, there is a good distribution network, cable stations, local stations, home cassette players and video disks, a lot of syndications on the smaller stations, and as a result people aren't so dependent upon commercial programming. I also think there is a lot of room in the field for experimentation and development, which has a great deal of appeal for me. Using the recording technology I already have, and incorporating digital and microprocessor technology, I can envision solo performances completely controlled by a minicomputer. It may not be the standard but it is certainly plausible, and would be unique.

oC: *What do you see as the next big breakthrough for the audio-video field?*

TR: The home video systems without a doubt.

oC: *Do you think the average American is going to get involved in video systems in a big way?*

"Computers aren't alien beings—they are our new tools, and I never feel stranded by a tool."

TR: Well, not immediately, but as programs become more diverse and more available, and as the peripherals become cheap enough to make home interplay practical, I think you'll find a lot of people owning systems in the next couple of years.

oC: *Are you thinking of video cassette or disk here?*

TR: Well, both actually. Both cassette and disk have their pluses. The disk is cheaper, its color reproductions are finer, and it doesn't tangle or erase. It doesn't rerecord either at this point, which of course the cassette does. So there is a good deal of choice dependent upon individual needs, and all at a relatively affordable price.

oC: *Will computers play a part in the development of your video disk system and studio?*

TR: I am presently involved in an animation film project for RCA, and microprocessors have a definite function to perform in that.

oC: *For instance?*

TR: For instance, remembering a camera motion. We program a certain sequence of maneuvers for a motorized camera stand, have those entered into a memory, then the program can be repeated as called for.

oC: *Is that what you use the ISC Compucolor computer for?*

TR: What, this? (chuckling and turning in his chair to face the remote control console and Compucolor video screen). The thing we've been doing most with the ISC is photographing some graphic routines that look visually interesting. That's what I want out of a computer, but there isn't one, at least I haven't found a microcomputer that has really sophisticated color graphic capabilities. I'm considering buying a computer for that specific graphics function, but it is totally out of the price range of the home hobbyist or nonprofessional. So far we haven't had a lot of serious applications for computers, but we're finding out how and when they can be useful.

oC: *What computer equipment do you own?*

TR: The ISC Compucolor is the first computer I bought: the Model 8001 with two Datel Power Mite power supplies. It has always been temperamental—too much static electricity. Squeak around in your chair too much and you blow a program you've been working on for two hours. I got a KIM computer after that, to experiment with, then an IMSAI Z-80, and the latest I've purchased is the Commodore PET. We also have a modem for the Compucolor so we can tie in with more genuine computers, since the ISC is really just a terminal.

oC: *Do you do timesharing, then?*

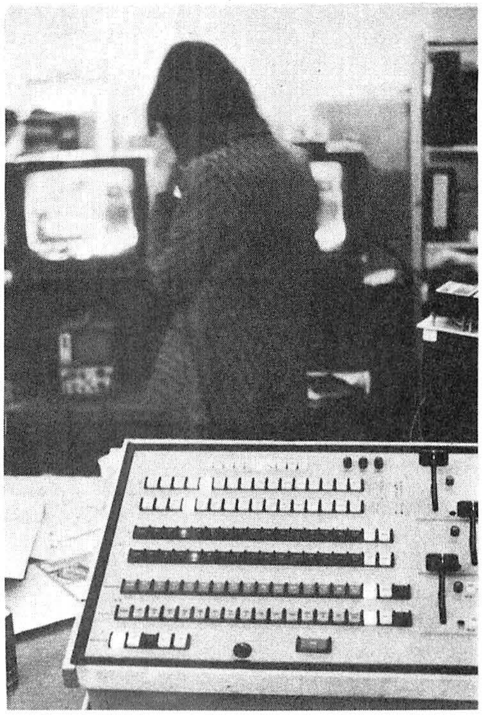
TR: Not actually. We're not that serious with it yet, but I do have friends at Bell Telephone, Princeton and Columbia University who are willing to give us assistance. We call them up and pick up a program or two. At this point our needs don't justify the cost of timesharing.

oC: *Are all of your computers for your professional interests or do you use them recreationally as well?*

TR: Mostly I just use the computers for work, but I've just been looking into these new systems offered by Atari. They look as if they could be quite enjoyable and fairly easy to operate, and they're at a reasonable price.

oC: *How much of an investment have you made in computing equipment?*

TR: It's difficult to say, but if you mean in my entire operation I'd say that by the time my new video studio is completed I'll have tied up somewhere near a million dollars—of course not solely on computers, but computers as well as cameras, mikes, recorders, mixing boards... there's a lot of stuff involved. If you mean my own personal equipment, I'd say about



ten thousand dollars total, software included.

oC: *Do other members of your group own or operate computing systems?*

TR: Roger Powell's keyboard that he designed for the band is a digitally scanned device and does some very limited computation. We've also just purchased a new Roland Microcomposer that we're all very excited about. It should have a lot of applications for us even beyond its composition functions.

oC: *Such as?*

TR: Well, for one thing, we're thinking of bringing it into the control room and setting it up so it can do some of those things we require a computer for, such as remembering camera movements. Essentially the composer is a computer with 8 K bytes of digital memory, so it can remember up to eight sets of events, allowing us to synchronize effects. For instance: feed it a synch pulse from our system, use our clock instead of the clock that's in it, and it will repeat events for us. Now that to me is a useful device; it dispenses with all the unnecessary hardware and has a specified function. It costs as much as any elaborate computer system, but it's worth having because there is no telling you, "Oh, you can do anything with it once you have these peripherals."

oC: *Is anyone writing computer software programs that can assist the average musician in composing, performing or recording?*

TR: I haven't found any software programs that are useful to me yet, so I'd have to say I don't think so.

oC: *Do you see a time for that?*

TR: Yes, right now. It's a tremendous drag to have machines sitting around that are capable of so much, yet which aren't working up to their abilities due to a lack of programming material. I think the need for software is very immediate. There are accounting and filing and general business packages in abundance, but for graphics or composition or camera plotting and control there is nothing. I think the industry at this point is geared toward hardware, because that's where the money is... I think the public has to determine more what its application needs are going to be and have industry meet them, rather than having the industry assign function.

oC: *What about the format of software? Have you used a floppy disk?*

TR: I've had so many hardware problems that I haven't had much experience with many software forms. The Compucolor has a floppy tape which has had its problems (it's easy to erase) and I have an IMSAI disk, but I've never gotten to use it because when we bought the system we didn't receive a connector cable for the terminal, and the company didn't supply us with one for several months even after persistent pleading from us.

oC: *Are there any pitfalls that you might alert the novice experimenter to avoid?*

TR: Don't think that digital and microprocessor oriented equipment is simple to understand and utilize, it takes a lot of time and thought.... Regardless of how miraculous computers can be, they can also be one of the most frustrating technologies you can be involved with. My last thought is, don't be afraid to try experimenting. If you think a computer can be of use, go to one of the local stores and check the regional computer clubs. I did. Know your needs, ask some questions, and take it from there. The way things keep changing, the whole process should be becoming easier to understand and interact with. I just hope the industry realizes that before computers become an everyday tool, they will have to be better supported (specifically, more and better software), and be much more dedicated in function. ■

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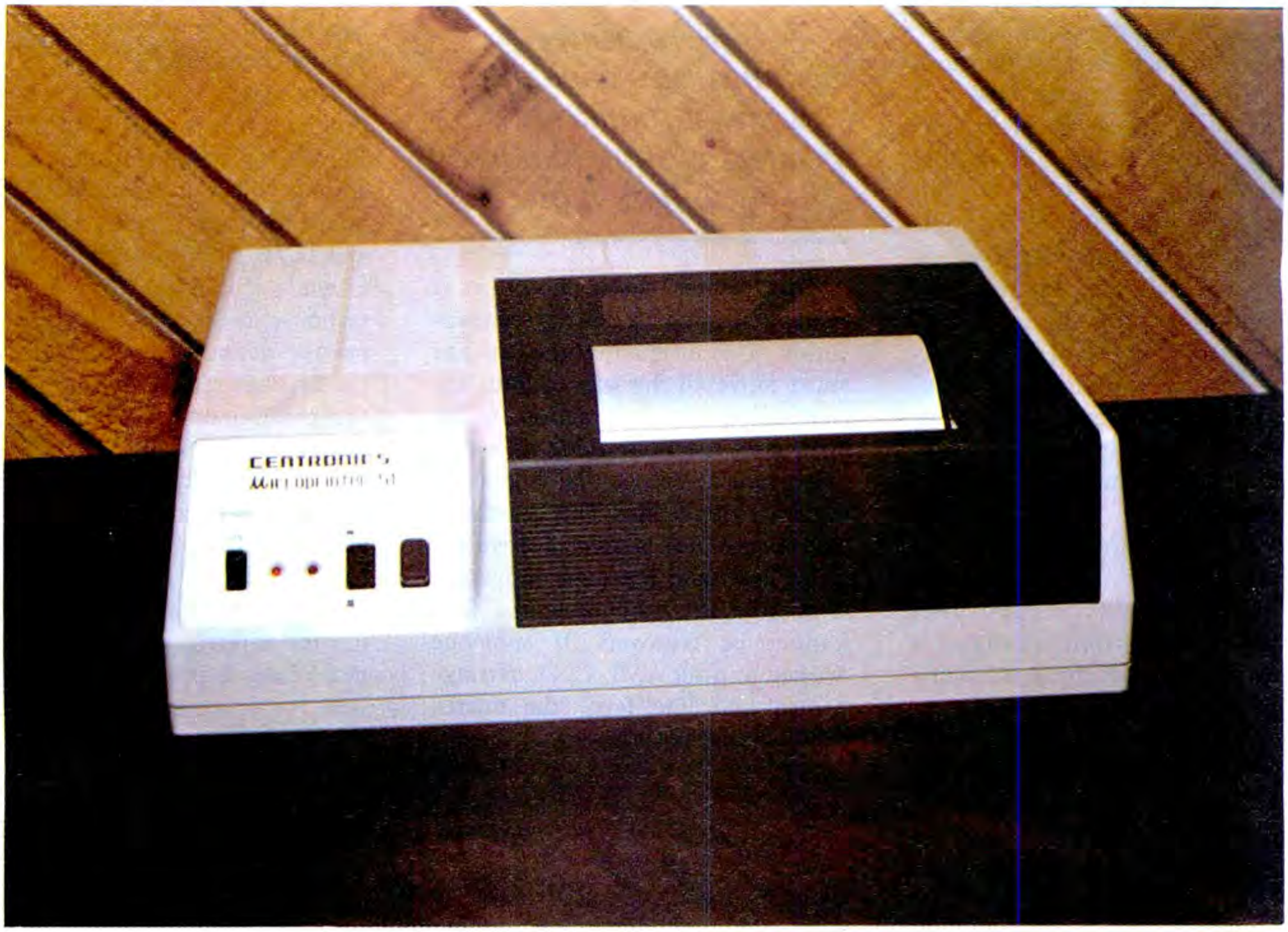


The Centronics Microprinter

A USER REVIEW

Text and photos by Steven A Ciarcia

It doesn't take long for a small computer system owner to realize that hard copy is a necessity rather than a luxury. Software development using only a video display is a tedious endeavor. It was for that reason that many enthusiasts like me bit the bullet in the mid 1970s and spent $1500 to $2000 for a printer which by today's price performance standards might look like a very bad deal. Fortunately, technology has advanced considerably since I purchased my "dinosaur." Thanks to Centronics Corp in Hudson NH, economical hard copy is now within the scope of most computer budgets.

At first glance it's hard to believe that so much printer comes in so small a package. At a mere 10 pounds (4.5 kilograms) the Centronics Microprinter demonstrates capabilities formerly found only in printers costing hundreds of dollars more. For the cost conscious computer enthusiasts, or for the case where fast, efficient and inexpensive hard copy is required, the Microprinter is worth considering.

The Microprinter is not a kit, but a professional quality, fully assembled machine selling for as low as $595, depending upon communications interface options. The Model P1 is a parallel interface unit while Model S1 uses a serial interface. A Model S1 printer is shown above. Using 4¾ inch electrosensitive roll paper it prints 5 by 8 dot matrix (9th dot for underline) characters formatted 20, 40 or 80

Steve Ciarcia is a computer consultant and author of BYTE Magazine's monthly column "Ciarcia's Circuit Cellar"

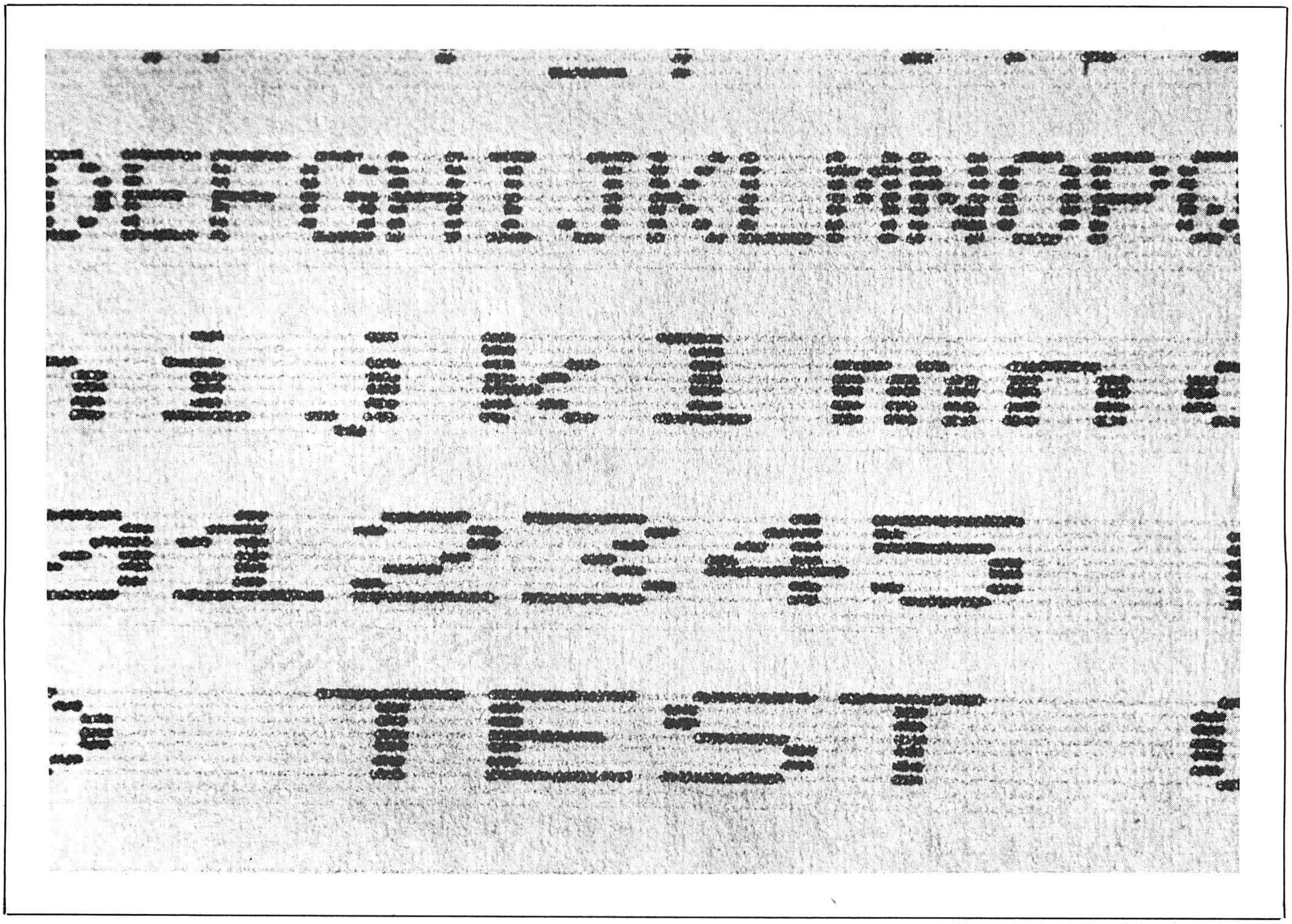
per line. The close-up photo below illustrates how these dots appear on the aluminized paper and shows the different character sizes. Print head life is conservatively estimated at 1 million characters, even at its normal printing speed of 150 lines per minute.

Using the printer for the first time is an enlightening experience if you are used to Teletype printers. Turn on the power, press the select button,and you're in business. As characters are sent to the printer it appears that nothing is happening because it isn't printing. Then suddenly upon receipt of a carriage return it quietly zips across the paper and prints the line in a single stroke. Until either a carriage return is acknowledged or the line is full, the printer buffers the data so that it prints and advances the paper a line at a time.

. . . the Centronics Microprinter demonstrates capabilities formerly found only in printers costing hundreds of dollars more.

This printer has a motor in it which must make a 360 degree revolution. This means that the carriage must move all the way to the right and return in a single action. A line feed does the same thing as a carriage return, except that it doesn't print across the line. This is because the same motor is used to drive the print head and the paper advance. Therefore the automatic line feed cannot be removed. If someone wished to print A, B, C, D, carriage return and line feed, the microprinter would print ABCD, take the carriage return and advance the paper on the way back and then do another line feed.

The solution to this auto line feed problem, if it is a problem, is fairly simple for the technically minded among you. On the printed circuit board the trace between IC2A pin 6 and IC2B pin 2 can be cut. This, in effect, eliminates the printer's response to the carriage return. The printer acknowledges and ignores the carriage return and does the actual printing upon receipt of the line feed. Care must be taken by any user who makes this modification so that any software printing routine always sends carriage return/line feed. If you are still in doubt about this modification, contact Centronics directly and they will be more than happy to discuss it with you.



Close-up of some characters printed on the aluminized paper used by the Centronics printer.

The well documented electronics uses relatively few esoteric components and should be easy to troubleshoot, if the need arises.

At first glance the Microprinter appears to be using heat sensitive paper, which is just a little shinier than most. In actuality it is paper coated with a one micron thick aluminum layer. The printing is done by an electric discharge between the head and the paper. The aluminum coated paper is the grounded side of the power supply while the print head is at -32 volts. The action of printing is done simply by closing the circuit to the appropriate pins on the print head, resulting in an arc between the print head and the paper. The aluminum is literally vaporized in less than 100 microseconds, leaving a pattern of dots which represents a character. The printed letters appear black because that is the color of the paper beneath the aluminum.

This type of paper is not unique to Centronics. There is at least one other printer company using the same paper from Japan. There are manufacturers of this same type paper in the US, but Centronics advises against using any except from their qualified vendors. Apparently, if the coating is too thick, the aluminum will not vaporize and no printing will result. There are machines which operate at discharge voltages approaching 100 volts, which is three times that of the Microprinter! Paper used in one of these machines, while possibly a great buy, may not work.

A further consideration is abrasion. The surface texture of the paper is important. If it is too abrasive it will decrease print head life from the 1 million character specified life. In actuality typical head life has far exceeded this value due to extremely smooth paper from their supplier. Centronics has, in fact, resorted to shipping a piece of sandpaper with each machine. Normally, the paper abrasion would keep all of the pins even and in contact with the aluminum. But the printing process uses pins 1 thru 7 more frequently than it uses pins 8 and 9. Now Centronics suggests running the print head across this "sandpaper" a few times after every 20 hours of operation, to even out the pins.

The electronics of the Microprinter is a read only memory for the character generator, a buffer to hold data and control codes, and the print head driver. The well docu-

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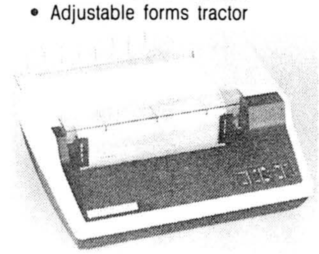

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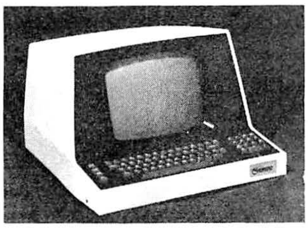

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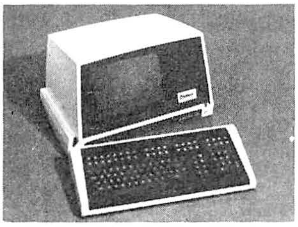

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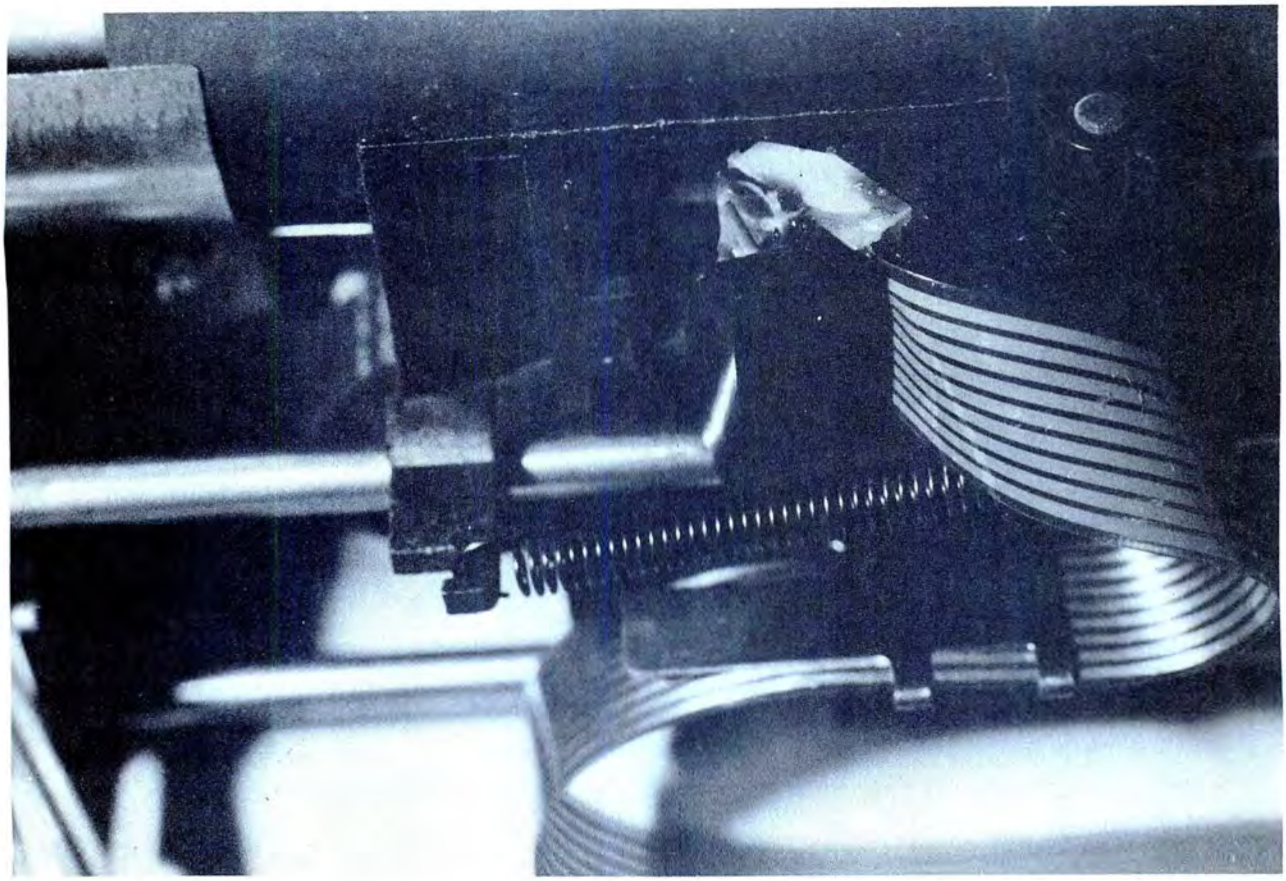
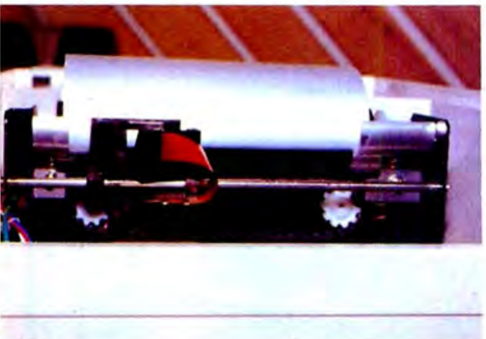
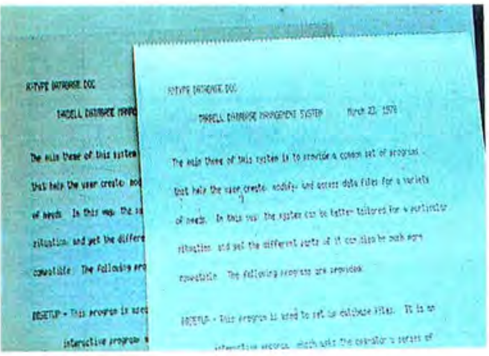


Close-up of the print head.





mented electronics uses relatively few esoteric components and should be easy to troubleshoot if the need arises.

The serial version of the Microprinter includes an additional 256 by 8 bit input buffer and serial RS232C interface. It can be preset to 15 standard values between 50 and 9600 bits per second. This buffer allows the printer to receive a data line faster than it can print it. Care must be taken when using the S1 model with regard to the buffer and the front control select key. The "not selected" mode does not inhibit entry of characters into the character buffer and any spurious data in the buffer will be printed upon the first carriage return in the selected mode. This is only a problem when the printer is continually cycled on and off while connected to a line with continuous data on it.

In conclusion, I think that the Centronics Microprinter is a terrific printer for the price. The aluminized paper prohibits its use for text editing your business correspondence, but, then, Centronics offers printers to cover that area of the market as well. It's important to recognize that while this printer cannot be everything to all people it was designed to fill a need within the microcomputer based system market. The documentation is written so that even Heathkit could appreciate it, and the construction is first rate. The Microprinter is a reliable and useful tool and because of its versatility, it should meet the needs of the hobbyist, software developer, and to a limited extent, small business people. ■

Photo at top shows the complete print mechanism. At bottom is shown the original aluminum printout and a photocopy of the same on the left. Photocopying the aluminized paper can often improve the contrast of the original.

Fall 1979 © onComputing Inc

BOOK REVIEW

Beginner's Guide to Home Computers

by Marvin Grosswirth
Doubleday & Company Inc
Garden City NY 1978
128 pages, paperbound
$3.95
Reviewed by Richard Shuford

This book represents the reaction of a large book publisher to new market demands. The firm sees a demand for books about the fast growing personal computer field. Its managers seek out a writer who "popularizes technology." The writer studies the new field, and a book is written and published.

The organization of the book is fairly ordinary. It contains chapters on fundamental computer operation, computer communication with humans, computer languages, programming, computer games, applications, and a discussion of how to obtain a computer. Various glossaries, appendices, and other material fill out the volume.

Does this book make a positive contribution to the literature on personal computing? I think not. There is some useful information in the book, but there is also much information which is irrelevant or misleading. The author seems to have started his project by obtaining information about large computers such as those which are used in business data processing. He apparently studied personal type computers later on, but was not able to sort out which information would be useful and appropriate for the reader trying to understand home computing.

An example of this confusion is the inordinately long discussion of the Extended Binary Coded Decimal Interchange Code (EBCDIC). This system for encoding data is used almost exclusively in large computers made by IBM. The American Standard Code for Information Interchange (ASCII) is explained less well, even though it is almost universally used in the small computers that the book purports to be about.

Further evidence of a large computer bias is found in the chapter on languages. The author is on firm enough ground when discussing COBOL and FORTRAN, but the discussion of BASIC shows plainly that he has only a superficial knowledge of microcomputer language interpreters.

There is little or no mention of the merits or faults of any particular home computer systems. Several photographs of popular appliance computers appear, but the book never gets around to any detailed description.

There is a fairly complete and faintly humorous discussion of the "tools of the trade" of the electronics kit builder. The applications chapter waxes interesting in a section on methods of stock market prediction. More discouragingly, the glossary lists "conversion" under no less than ten headings, when one might do.

Previous books by this author include *Fat Pride, The Art of Growing a Beard,* and *The Truth About Vasectomy.* Perhaps those books have utility for people interested in those topics. The *Beginner's Guide to Home Computers,* however, has very little to recommend it except its relatively low price. Even under $4, though, it is not much of a bargain. ■

Richard S Shuford is an editor at BYTE magazine.

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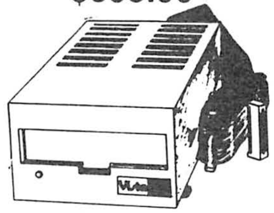

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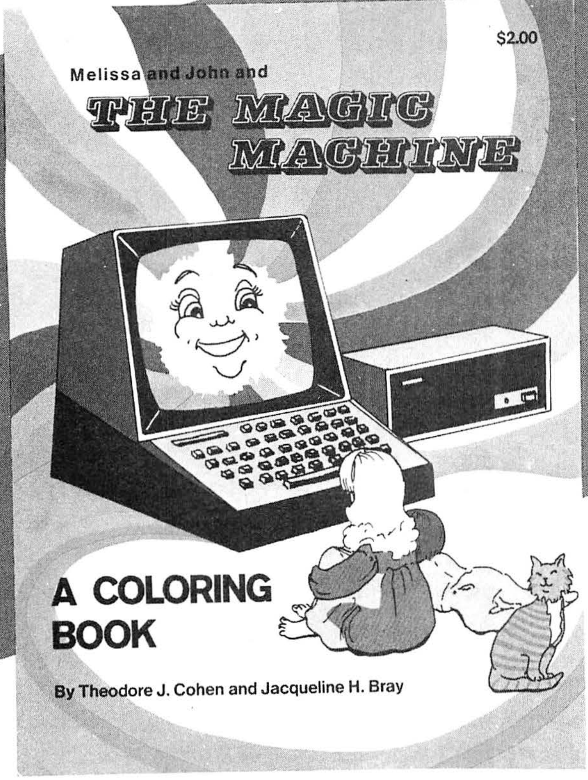

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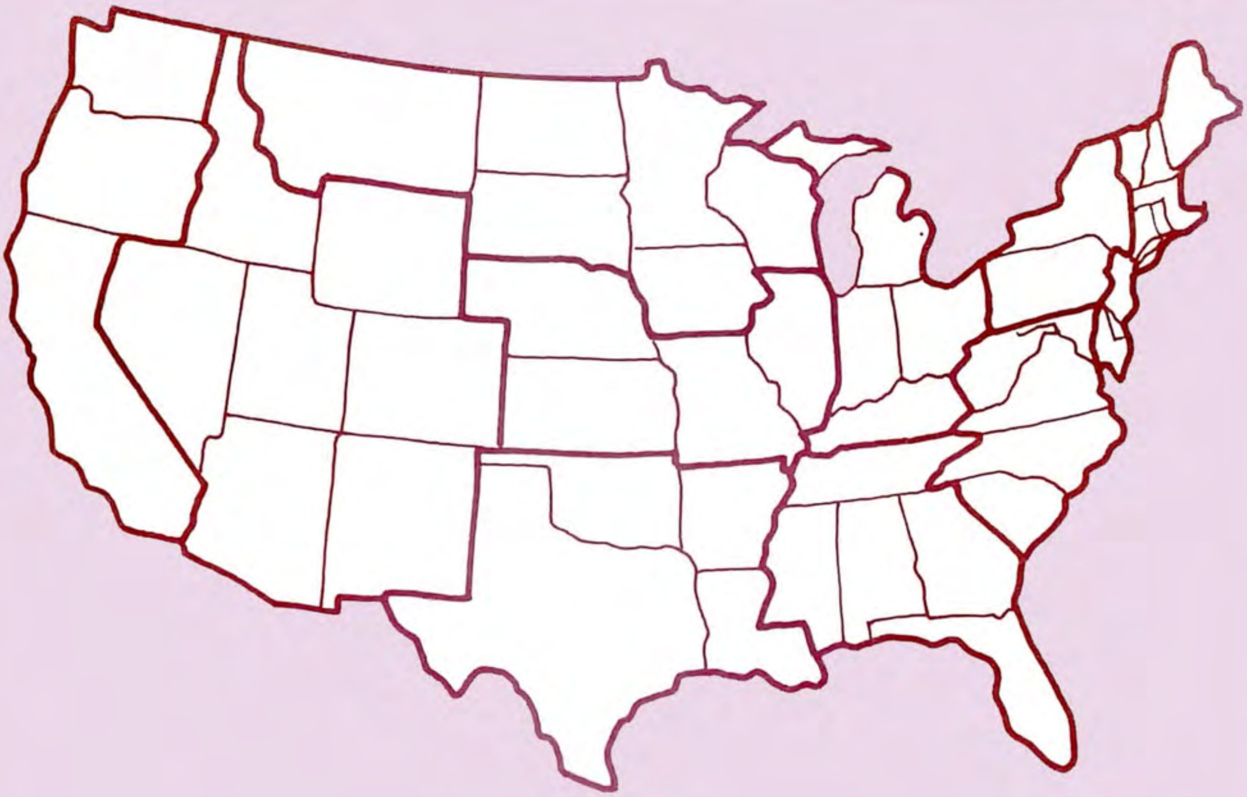

A COMPUTER STORE DIRECTORY

ORGANIZED ACCORDING TO ZIP CODE AREA

If you're in the market for a personal computer, the chances are that you'll be buying it at a computer store. One advantage of shopping at a computer store is the personal service you receive, as well as the chance to see and compare working computers of various brands. Most computer stores also service what they sell—an important feature when dealing with electronic equipment such as personal computers.

Although every effort has been made to assure the accuracy and completeness of this list, computer retailing is a dynamic industry. We constantly see new stores, mergers, name and ownership changes. Any errors or omissions may be reported to Store Listing, onComputing, 70 Main St, Peterborough NH 03458.

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Retail Computer Store
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Needham Heights MA 02194

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Boston MA 02215

Computer Warehouse Store
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Boston MA 02215

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Warwick RI 02886

Computer Mart of NH
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Microcomputers Inc
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3878 Main St
Bridgeport CT 06606

Hoboken Computer Works
20 Hudson Pl
Hoboken NJ 07030

Computer Corner of NJ
240 Wanague Av
Pompton Lakes NJ 07442

Computerland — Bergen Co
E65 Rt 4
Paramus NJ 07652

Computer Lab of NJ
141 Rt 46
Budd Lake NJ 07828

Computer Hut Inc
15 Rt 10
Succasunna NJ 07876

Computerland — Morristown
2 Dehart St
Morristown NJ 07960

Computer Emporium
2428 Rt 38 Bldg 103
Cherry Hill NJ 08002

Computerland — Cherry Hill
1434 E Rt 70 Pine Tree Pl
Cherry Hill NJ 08034

Computer Encounter
2 Nassau St
Princeton NJ 08540

Radio Shack Associate Store
562 Brick Blvd
Riveira Pl
Bricktown NJ 08723

Shore Computers Corp
3 Washington St
Toms River NJ 08753

Computer Mart — NJ
501 Rt 27
Iselin NJ 08830

1·20000

New York
Pennsylvania
Delaware

Computer Mart of NY Inc
118 Madison Av
New York NY 10016

Computer Store of NY
55 W 39th St
New York NY 10018

Comput-O-Mat Systems
41 Colby Av
Rye NY 10580

Computer Corner
200 Hamilton Av
White Plains Mill
White Plains NY 10601

Computer Microsystems
6 Wooleys Ln
Great Neck NY 11023

Computer Microsystems
1309-1311 Northern Blvd
Manhasset NY 11030

The Computer Mart
2072 Front St
East Meadow NY 11554

Byte Shop East
2721 Hempstead Tpke
Levittown NY 11756

The Computer Den
82 East St
Patchogue NY 11772

The Computer Shoppe
385 Swezey Ln
Middle Island NY 11953

Micro Systems Store Inc
269 Osborn Rd
Albany NY 12211

Mini-Micro Mart
1618 James St
Syracuse NY 13203

Computer Shop of Syracuse
3470 Erie Blvd E
Dewitt NY 13214

The Computer Tree
409 Hooper Rd
Endwell NY 13760

Micro World
435 Main St
Johnson City NY 13790

Computerland
1612 Niagara Falls Blvd
Buffalo NY 14150

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Readout Computer Store
6 Winspear Av
Buffalo NY 14214

Home Computer Centers
671 Monroe Av
Rochester NY 14607

Computer House Inc
721 Atlantic Av
Rochester NY 14609

The Computer Store — Rochester
2423 Monroe Av
Rochester NY 14618

Compuworld Inc
125 White Spruce Blvd
Rochester NY 14623

Radio Shack Franchise
Chautaugua Mall
Lakewood NY 14750

Computerland of Ithaca
225 Elmira Rd
Ithaca NY 14850

The Computer Workshop
4170 Wm Penn Hwy
Murraysville PA 15668

The Computer Shop
116 S Pugh St
State College PA 16801

Gallion Data Systems Shop
4341 Carlisle Pike
Camp Hill PA 17011

Microcomputer Systems Inc
243 W Chocolate Av
Hershey PA 17033

Computerland
4640 Carlisle Pike
Mechanicsburg PA 17055

Byte Shop — Computer Store
1045 Lancaster Pike
Bryn Mawr PA 19010

Computer Room
Juniper and Sansome Sts
Philadelphia PA 19103

Computer Room
c/o Carol Groves Castle Systems
1028 Spruce St
Philadelphia PA 19107

Caldwell Computer Co
546 W Olney Av
Philadelphia PA 19120

Personal Computer Corp
Frazer Mall
Lancaster Av and Rt 352
Frazer PA 19355

Creative Computer Systems and Software
145 Church St
West Chester PA 19380

Computer Mart — Pennsylvania
550 DeKalb Pike
King of Prussia PA 19406

Computerland — New Castle Co
Kirkwood Hwy
Astro Shop C
Newark DE 19711

Artificial Intelligence
3308 Altamont Dr
Wilmington DE 19810

2·30000

District of Columbia
Maryland
Virginia
West Virginia
North Carolina
South Carolina

Georgetown Computer Emporium
3268 M St NW
Washington DC 20007

Comm Center
9624 Ft Meade Rd
Laurel MD 20810

Computer Workshop
1776 E Jefferson
Rockville MD 20852

Computerland
16065 Frederick Rd
Rockville MD 20855

Computers Etc
13A Allegheny Av
Towson MD 21204

Computers Unlimited Inc
907 York Rd
Towson MD 21204

Micro Center Inc
129 West St
Annapolis MD 21401

Media Reactions Inc
11303 South Shore Dr
Reston VA 22090

Computer Systems
1984 Chain Bridge Rd
McLean VA 22101

Microsystems Computer Corp
6605A Backlick Rd
Springfield VA 22150

Computer Workshop — North Virginia Inc
5240 Port Royal Rd #203
Springfield VA 22151

Computerland — Tysons Cor
8411 Old Court House Rd
Vienna VA 22180

Computer Plus Inc
678 S Pickett St
Alexandria VA 22304

Computer Hardware Store
818 Franklin St
Alexandria VA 22314

H/B Computers Inc
217 E Main St
Charlottesville VA 22901

Altair Computer Store
6223 W Broad Street Rd
Richmond VA 23230

Computers To Go #1
1905 Westmoreland
Richmond VA 23230

Computer Hobbyists Unlimited
9601 Kendrick Rd
Richmond VA 23235

Home Computer Center Inc
2927 Virginia Beach Blvd
Virginia Beach VA 23452

Home Computer Center
12588 Warwick Blvd
Newport News VA 23606

The Computer Place Inc
2718 Colonial Av SW
Roanoke VA 24015

Business Computer Service
1027 Virginia St E
Charleston WV 25301

The Computer Store
Municipal Park Bldg
Charleston WV 25301

The Computer Corner
22 Buckhurst Av
Morgantown WV 26505

Byte Shop of NC
218 N Elm St
Greensboro NC 27401

Dixie Computers Inc
108 Henderson
Chapel Hill NC 27514

Byte Shop
1213 Hillsborough St
Raleigh NC 27605

Altair Computer Center
Computer Stores — Carolina Inc
5212 Hollyridge Dr
Raleigh NC 27612

Roms N Rams
Crabtree Valley Mall
Raleigh NC 27612

Futureworld
2514 University Dr
Durham NC 27707

Computerroom
1729 Garden Ter
Charlotte NC 28203

Altair Computer Center
Computer Stores — Carolina Inc
1808 E Independence Blvd
Charlotte NC 28205

Computerland of Charlotte
3915 E Independence Blvd
Charlotte NC 28205

Byte Shop
Loehmann Plz
6341 Albemarle Rd
Charlotte NC 28212

Microcomputer Services
108110 Arcade Bldg
Hickory NC 28601

Byte Shop of Columbia
2018 Green St
Columbia SC 29205

Computer Company
73 State St
Charleston SC 29401

Computer Dimensions Inc
203 W Elm St
Florence SC 29501

CDS Computers
214 W Evan
Florence SC 29501

3·40000

Georgia
Florida
Alabama
Tennessee

Computerland of Atlanta
2423 Cobb Pky
Smyrna GA 30080

Altair Software Distribution Center
3330 Peachtree NE
Atlanta GA 30305

Datamart Inc
3001 N Fulton Dr
Atlanta GA 30305

The Computer Systemcentre
3330 Piedmont NE
Atlanta GA 30305

Byte Shop
290 Hildebrand Av NE
Atlanta GA 30328

REC Computer Systems
5730 Glenridge Dr
Atlanta GA 30328

Atlanta Computer Mart
5091-B Buford Hwy
Atlanta GA 30340

Compushop
5600 Roswell Rd
The Prado
Atlanta GA 30342

Baileys Computer Shop
2418 Black Orchard Rd
Augusta GA 30906

Digital Microcomputer Systems
927 Blanding Blvd
Orange Park FL 32073

Douglas Computer Systems
710 Oaks Plantation Dr
Jacksonville FL 32211

Radio Shack Associate Store
1412 W Fairfield Dr
Pensacola FL 32501

Computer Stores Inc
3804 N 9th Av
Pensacola FL 32503

Economy Computing Systems
2200 Forsyth Rd
Orlando FL 32807

Altair Computer Center — Orlando
6220 S Orange Blossom Trl
Orlando FL 32809

Byte Shop
1325 N Atlantic Av
Cocoa Beach FL 32931

Computer Hut Inc
6737 Red Rd
Hialeah FL 33012

Personal Computing Center
1326 N St Rd 7 Shop Ctr
Margate FL 33063

Sunny Computer Stores Inc
117 Newton Rd
West Hollywood FL 33123

Sunny Computer Stores Inc
138A S Dixie Hwy
Coral Gables FL 33146

Byte Shop
7825 Bird Rd
Miami FL 33155

Computer Associates Inc
6900 N Kendall #A103
Miami FL 33156

Computerland — Ft Lauderdale
3993 N Federal Hwy
Ft Lauderdale FL 33308

Computers For You
3608 W Broward Blvd
Ft Lauderdale FL 33312

Computer Age
999 SW 40th Av
Plantation FL 33317

Byte Shop
1044 E Oakland Pk Blvd
Ft Lauderdale FL 33334

Computer Center — Palm Beach
2827 Exchange Ct
W Palm Beach FL 33409

Computerland of Boca Raton
500 E Spanish River Blvd
Boca Raton FL 33432

The Computer Store — Tampa Bay
1021B Manatee Av W
Bradenton FL 33505

Computer Store
1549 W Branden Blvd
Brandon FL 33511

Computer Mart
4981 72nd Av N
Pinellas Park FL 33565

Calculator Place
12 S Orange Av
Sarasota FL 33577

Micro Computer System
144 S Dale Mabry Hwy
Tampa FL 33609

Marsh Data Systems
5405B Southern Comfort Blvd
Tampa FL 33614

The Computer Center Inc
303B Poplar Pl
Birmingham AL 35209

ICP Computerland
1550D Montgomery Hwy
Birmingham AL 35226

Computerland
3020 University Dr NW
Huntsville AL 35805

Computers and Peripherals
928 S Hull St
Montgomery AL 36104

Byte 'Tronics
1600 Hayes St
Nashville TN 37203

Computer World
625 Main St
Nashville TN 37206

Byte 'Tronics
5604 Kingston Pike
Knoxville TN 37919

The Byte Shop — Tennessee
5613 Kingston Pike
Knoxville TN 37919

Computer Power
3540 Walker Av
Memphis TN 38111

Computerlab
627 S Mendenhall
Memphis TN 38117

The Computer Store Inc
2910 Southway
Memphis TN 38118

4·50000

Kentucky
Ohio
Indiana
Michigan

Contemporary Computer Sales
Bowman Fld Admin Bldg
Louisville KY 40205

Logic Systems
324 W Woodlawn Av
Louisville KY 40214

Data Domain
3028 Hunsinger Ln
Louisville KY 40220

Jrs Data Systems
Computerland of Louisville
813B Lyndon Ln
Louisville KY 40222

Data Domain
506½ Euclid Av
Lexington KY 40502

Ohio Microcomputer Specialists
1265 Grandview Av
Columbus OH 43212

Micro-Mini Computer World
62 County Rd
POB 13207
Columbus OH 43213

Personal Computers
3264 E Main St
Columbus OH 43213

Byte Shop of Columbus
2432 Chester Ln
Columbus OH 43221

Cybershop
1451 S Hamilton Rd
Columbus OH 43227

Computer Store — Toledo
8 Hillwyck
Toledo OH 43615

Ridgeway East Retail Computer Center
161 Bell St
Chagrin Falls OH 44022

Digitrends Inc
1813 E 12th St
Cleveland OH 44114

Byte Shop of Ohio Inc
19524 Center Ridge Rd
Rocky River OH 44116

United Computer & Controls
1496 S Green Rd
S Euclid OH 44121

Computerland — Cleveland East
1288 Som Ctr Rd
Mayfield Heights OH 44124

Ohio Micro System Inc
233 S Water St
Kent OH 44240

The Basic Computer Shop
2671 W Market St
Akron OH 44313

Data Domain
7694 Camargo Rd
Cincinnati OH 45243

Digital Design
7696 Camargo Rd
Cincinnati OH 45243

Cincinnati Computer Store
4816 Interstate Dr
Cincinnati OH 45246

Altair Computer Center
45 Murry Hill Dr
Dayton OH 45403

Computer Solutions Inc
1932 Brown St
Dayton OH 45409

Dayton Computer Mart
2665 S Dixie Av
Dayton OH 45409

Altair Computer Center #4
5252 N Dixie Dr
Dayton OH 45412

Home Computer Center
2115 E 62nd St
Indianapolis IN 46220

Home Computer Shop
10447 Chris Dr
Indianapolis IN 46229

Byte Shop
5947 E 82nd St
Indianapolis IN 46250

Computers Unlimited
7724 E 89th St
Indianapolis IN 46256

Data Domain
7027 Michigan Rd
Indianapolis IN 46268

Quantum Computer Works
6637 Kennedy Av
Hammond IN 46323

Computer Specialists
415 N Michigan St
South Bend IN 46601

Data Domain — Ft Wayne
2805 E State Blvd
Ft Wayne IN 46805

Data Domain
406 S College Av
Bloomington IN 47401

Hobbytronic Distributors
1218 Prairie Dr
Bloomington IN 47401

Digital Technology
10 N 3rd
Lafayette IN 47906

Country Computer Store
5430 Prophets Rock Rd
W Lafayette IN 47906

Data Domain
219 Columbia
W Lafayette IN 47906

Computerland — Southfield
29673 Northwestern Hwy
Southfield MI 48034

The Computer Store
42946 Garfield
Mount Clemens MI 48044

Computer Store — Detroit
505-507 W 11 Mile Rd
Madison Heights MI 48071

Computer Mart Inc
1800 W 14 Mile Rd
Royal Oak MI 48073

General Computer Store
2011 Livernois
Troy MI 48084

Computermart Inc
245 S Wagner Rd
Ann Arbor MI 48103

Computer Store — Ann Arbor
310 E Washington St
Ann Arbor MI 48104

Small Scale Systems
13003 Ostrander Rd
Maybee MI 48159

Tri-Cities Computermart
3145 Shattuck
Saginaw MI 48603

Computronix
423 S Saginaw Rd
Midland MI 48640

New Dimensions-Computing
541 E Grand River Av
E Lansing MI 48823

Micro Computer World
313 Michigan NE
Grand Rapids MI 49503

Computerland — Grand Rapids
2927 28th St SE
Grand Rapids MI 49508

5·60000

Iowa
Wisconsin
Minnesota
Montana

Syncronized Systems Inc
3711 Douglas St
Des Moines IA 50310

The Computer Center
302 Commercial
Waterloo IA 50701

DCO Computer Co
102 E 4th St
Waterloo IA 50703

The Computer Store
616 W 35th St
Davenport IA 52806

Milwaukee Computer Store
4710 W North Av
Milwaukee WI 53208

Itty Bitty Machine Co
2221 E Capitol Dr
Shorewood WI 53211

Milwaukee Computer Store
6916 W North Av
Milwaukee WI 53213

Byte Shop
6019 W Layton Av
Greenfield WI 53220

Computerland — Milwaukee
10111 W Capitol Dr
Milwaukee WI 53222

Computerland of Madison
690 S Whitney Way
Madison WI 53711

Madison Computer Store
1910 Monroe St
Madison WI 53711

Microcomp
785 S Main St
Fond Du Lac WI 54935

Fox Valley Computer Store
218 N Commercial St
Neenah WI 54956

Frisch Computer Systems
1415 Arcade
St Paul MN 55106

Byte Minnesota Inc
1434 Yankee Doodle Rd
Eagan MN 55121

Computer Room
3938 Beau D'Rue Dr
Eagan MN 55121

Computerland — Minneapolis
8070 Morgan Cir Dr
Bloomington MN 55431

Computer Depot Inc
3515 W 70th St
Minneapolis MN 55435

Minnesota Computers Inc
7710 Computer Av
Edina MN 55435

Minnesota Micro Systems
514 Cedar Av
Minneapolis MN 55454

Big Sky Byte Shop
1201 Grand Av
Billings MT 59102

Montana Computer Co
2512 Grand Av
Billings MT 59102

Four-G Computers
1515 Wyoming
Missoula MT 59801

6·70000

Illinois
Missouri
Kansas
Nebraska

Computerland
50 E Rand Rd
Arlington Heights IL 60004

Compushop
5920 W Dempster
Morton Grove IL 60053

Chicago Computer Store
517 Talcott Rd
Park Ridge IL 60068

American Microprocessors
241 Indian Creek Rd
Prairie View IL 60069

Data Domain
42 W Roosevelt
Lombard IL 60148

Midwest Microcomputer Inc
708 S Main St
Lombard IL 60148

Data Domain
1612 E Algonquin Rd
Schaumburg IL 60195

Itty Bitty Machine Co
1316 Chicago Av
Evanston IL 60201

Computerland of Oak Lawn
10935 S Cicero
Oak Lawn IL 60453

Bits and Bytes Computer Store
147th St Box G2928
Posen IL 60469

Farnsworth Computer Center
1891 N Farnsworth
Aurora IL 60505

Computerland —
Downers Grove
136 W Odgen Av
Downers Plz
Downers Grove IL 60515

Byte Shop #67
5 S Lagrange Rd
Lagrange IL 60525

Illini Micro Computers
612 E Odgen Av
Naperville IL 60540

AAA Chicago Computer Center
3007½ W Waveland Av
Chicago IL 60618

Aspen Computer Inc
7519 W Irving Park
Chicago IL 60634

Computerland of Niles
9511 N Milwaukee Av
Niles IL 60648

Computer Store — Rockford
2320 N Central Av
Rockford IL 61103

Computerland — Peoria
4507 N Sterling
Peoria IL 61614

Bloomington — Normal
Computer Workshop
209 North St
Normal IL 61761

Champaign Computer Co
318 N Neil St
Champaign IL 61820

The Byte Shop
1602 S Neil
POB 1678
Champaign IL 61820

Number Racket
518 E Green St
Champaign IL 61820

Computer Station DBA
3659 Nameoki Rd
Granite City IL 62040

Kappels Computer Store Inc
125 E Main St
Belleville IL 62220

Computer Systems Center —
St Louis
13461 Olive Blvd
Chesterfield MO 63017

The Logic Shop Inc
14342 Woods Mill Ctr
Chesterfield MO 63017

Computer Country
251 Dunn Rd
Florissant MO 63031

Computer Systems Center
7143 N Linbergh Blvd
Hazelwood MO 63042

Computer Country
4479 Lemay Ferry Rd
St Louis MO 63129

Computer Systems Center
1170 Colonnade Center
Manchester and Ballas
Des Peres MO 63131

Futureworld Inc
12304 Manchester Rd
St Louis MO 63131

Computer Workshop
of Kansas City
4027 N Oak St
Kansas City MO 64116

Computer Workshop
6903 Blair Rd
Kansas City MO 64152

Computerland — Springfield
1950B S Glenstone
Springfield MO 65804

The Computer Bit
1925 Ann East Bennett
Springfield MO 65804

Computer Center — Byte #61
5815 Johnson Dr
Mission KS 66202

Personal Computer Center
3819 W 95th St
Overland Park KS 66206

Computerland — Overland Park
10049 Santa Fe Dr
Overland Park KS 66212

The Computer Room Inc
7105 W 105th
Overland Park KS 66212

Computer Hut
521 N Hillside Av
Wichita KS 67214

Computerland
1262 N Hillside
Wichita KS 67214

Computer Systems Design
906 N Main
Wichita KS 67214

Omaha Computer Store
4540 S 84th St
Omaha NE 68127

Altair Computer Center #5
611 N 27th St
Lincoln NE 68503

7·80000

Louisiana
Arkansas
Oklahoma
Texas

The Computer Shoppe
3225 Danny Pk
Metairie LA 70002

Computer Shoppe
344 Camp St
New Orleans LA 70130

Executone Microcomputer
6969 Titian Av
Baton Rouge LA 70806

Micro Business Systems Inc
Computer Store
3821 Gilbert
Shreveport LA 71104

Delta Microcomputer
3402 Jackson St
POB 7999
Alexandria LA 71301

Datacope
5706A W 12th St
Little Rock AR 72204

Computer Products Unlimited
2412 S Broadway
Little Rock AR 72206

Computerland — Little Rock
11121 Rodney Parham Rd
Little Rock AR 72212

Computer Store —
Niemeyer Feed
4818 Asher
POB 4045
Little Rock AR 72214

Bits-Bytes and Micros
2918 N MacArthur Blvd
Oklahoma City OK 73127

Altair Computer Center #6
110 Annex 5345 41st St
Tulsa OK 74135

Byte Shop
1474 W Spring Valley Rd
Richardson TX 75080

Micro Store
634 S Central Expy
Richardson TX 75080

CompuShop
13929 N Central Expy
Dallas TX 75201

Digitex
2111 Farrington St
Dallas TX 75207

Computerland — Dallas
The Corner Shopping
8061 Walnut Hill Ln
Dallas TX 75231

Computer Imagineering
Unltd
2925 Valley View
Dallas TX 75243

Computer Shop
13929 N Central
Dallas TX 75243

Computer Shops Inc
211 Keystone Park
13933 N Central Expy
Dallas TX 75243

Computer Port
926 N Collins
Arlington TX 76011

Tandy Computers
1 Tandy Ctr
Fort Worth TX 76102

The Computer Center
210 Tri Mar Valley
Wichita Falls TX 76301

Basic Computer & Software
4310 Jacksboro Hwy
Wichita Falls TX 76302

Computertex
2300 Richmond Av
Houston TX 77006

Polaris Computer Systems
3311 Richmond
Houston TX 77006

Houston Computer Mart
8029 Gulf Fwy
Houston TX 77017

Interactive Computer
7620 Dashwood
Houston TX 77036

Microtex Inc
9305 D Harwin Dr
Houston TX 77036

The Communications Center
7231 Fondren Rd
Houston TX 77036

Computerland SW Houston
6439 Westheimer
Houston TX 77057

Computerland — Houston
Bay Area
17647 El Camino Real
Houston TX 77058

Computercraft Inc
3211 Fondren Rd
Houston TX 77063

Altair Computer Center
12902 Harwin Dr
Houston TX 77072

Altair Computer Center
5750 Bentliff Dr
Houston TX 77072

Mr Computer
744 FM 1960
Houston TX 77090

Northwest Newstand
5003A Antoine
Houston TX 77092

Microcomputer Origin Store
1853 Richmond Av
Houston TX 77098

Bit Barn
1111 Burke #313
Pasadena TX 77506

The Computer Shop
Vanguard Systems Corp
6812 San Pedro
San Antonio TX 78216

Computer Solutions Inc
9200 Broadway
San Antonio TX 78217

Microcomputer Shoppe
5301 Everhart
Corpus Christi TX 78411

Computer N Things
2825 Hancock Dr
Austin TX 78731

Computerland of Austin
3330 Anderson Ln
Austin TX 78757

Computer Encounters Inc
3440 Bell
Amarillo TX 79109

Neighborhood Computer Store
4902 34th St I
20 Terrace Shopping Ctr
Lubbock TX 79410

Computer Patch
3952 E 42nd Santa Fe Sq
Odessa TX 79762

Computer Terminal
2101 Myrtle
El Paso TX 79901

8·90000

Colorado
Wyoming
Utah
Arizona
New Mexico
Nevada

Byte Shop of Englewood
3464 S Acoma
Englewood CO 80110

Miti Mini Computer Co
8535 E Orchard Rd #401
Englewood CO 80110

Amptec Inc
5975 Broadway
Denver CO 80216

Computer Tech
6311 N Federal Bldg
Denver CO 80221

Computerland of Denver
2422 S Colorado Blvd
Denver CO 80222

Computer Country
2200 W Alameda
Denver CO 80223

Micro World Electronix
6340 W Mississippi
Lakewood CO 80226

Byte Shop
3101 Walnut St
Boulder CO 80301

Byte Shop
2040 30th St
Boulder CO 80301

Intermountain Digital
1027 Dellwood Av
Boulder CO 80302

Poor Richard's
Calculator Co
204 W Laurel St
Ft Collins CO 80521

Bits and Chips
718 9th St
Greeley CO 80631

Computer Source
1845 Circle Dr
Colorado Springs CO 80909

Computerland —
Colorado Springs
4543 Barnes Av
Colorado Springs CO 80909

The Computer Shop
835 Main #206
Durango CO 81301

Lands Ends Computers
1404 Coburn Av
Worland WY 82401

Computers & Stuff
1092 S State St
Orem UT 84057

Microdata Systems
796 E Lazon Dr
Sandy UT 84070

Computer Room
1455 S 1100 E
Salt Lake City UT 84105

Byte Shop — Salt Lake City
261 S State St
Salt Lake City UT 84111

Computerland — Salt Lake
161 E 2nd St
Salt Lake City UT 84111

Byte Shop
28 W Camelback Rd
Phoenix AZ 85013

Bits & Bytes Computer Shop
6819 CN 21st Av
Phoenix AZ 85015

Byte Shop
12654 N 28th Dr
Phoenix AZ 85019

Personal Computer Place
1840 W Southern
Mesa AZ 85202

Byte Shop — Phoenix
813 N Scotsdale Rd
Tempe AZ 85282

Computer World Inc
214 W Southern
Tempe AZ 85282

Desert Data
POB 1334
Tucson AZ 85702

Altair Computer Center #9
4941 E 29th St
Tucson AZ 85711

The Byte Shop
2612 E Broadway
Tucson AZ 85716

Computer Shack
3120 San Mateo
Albuquerque NM 87110

Southwest Computer Center
121 Wyatt Dr
Las Cruces NM 88001

Johnson TV Micro Computer
2607 E Charleston
Las Vegas NV 89104

Byte Shop of Reno
Crossroads Ctr
4104 Kietzke Ln
Reno NV 89502

90000

California
Oregon
Washington

Opamp/Computer
1033 N Sycamore Av
Los Angeles CA 90038

Byte Shop
8711 La Tiera Av
Westchester CA 90045

Arrowhead Computer Co
11656 W Rico Blvd
Los Angeles CA 90064

Computers Are Fun
2268 Westwood Blvd
Los Angeles CA 90064

Pacesetting Computers Inc
4473 S Sepulveda Blvd
Culver City CA 90230

Jade Computer Products
4901 W Rosecrans Av
Hawthorne CA 90250

Byte Shop
16508 Hawthorne Blvd
Lawndale CA 90260

Computerland of South Bay
16720 S Hawthorne Blvd
Lawndale CA 90260

Computerland
6840 Lacienega
Englewood CA 90302

Computer Store
820 Broadway
Santa Monica CA 90401

Computer Merchant
14747 Artesia #1-F
La Mirada CA 90638

The Computer Carousel
11872 E Rosecrans Blvd
Norwalk CA 90650

Sunshine Computer Co
20710 S Leapwood
Carson CA 90746

Byte Shop
5453 Stearns St
Long Beach CA 90815

Byte Shop
496 S Lake Av
Pasadena CA 91101

Data Center
136 N Maryland Av
Glendale CA 91206

Computer Store
17353 Citronia St
Northridge CA 91325

Rainbow Computing Inc
10723 White Oak Av
Granda Hills CA 91344

Byte Shop
18424 Ventura Blvd
Tarzana CA 91356

Byte Shop of 1000 Oaks
2707 Thousand Oaks Blvd
Thousand Oaks CA 91360

Computerland — Elcid Plz
171 E Thousand Oaks Blvd
Thousand Oaks CA 91360

Computer Components
5848 Sepulveda Blvd
Van Nuys CA 91411

People's Computer Shop
13452 Ventura Blvd
Sherman Oaks CA 91423

Byte Shop — Burbank
1812 W Burbank Blvd
Burbank CA 91506

Computer Power & Light Co
12321 Ventura Blvd
Studio City CA 91604

Upland Computer Labs
75 E 9th St
Upland CA 91786

Computer Metrics Inc
1251 Broadway
El Cajon CA 92021

Computerware
830 1st St
Encinitas CA 92024

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Cyberdux Micro Applications
1210 Santa Fe Dr
Encinitas CA 92024

Computer Center
8205 Ronson Rd
San Diego CA 92111

Computerland
4233 Convoy St
San Diego CA 92111

The Byte Shop
8250-H Vickers St
San Diego CA 92111

Inland Computers
and Electronics
516 N East St
San Bernardino CA 92401

Computerland — San Bernardino
289 E Highland Av
San Bernardino CA 92404

Computer Center
3517 Tyler Mall
Riverside CA 92503

Computer Plus
795 W Imperial Hwy
Brea CA 92621

Coast Computer Center
1685 Tustin Av #9
Costa Mesa CA 92627

Orange County Computer Center
1913 Harbor Blvd
Costa Mesa CA 92627

Bits N Bytes
1216 W Wilshire Av
Fullerton CA 92633

Modern Micro Computers
14282 Bookhurst
Garden Grove CA 92643

Computer Way Inc
15525 Computer Ln
Huntington CA 92649

Computer Mart
625 W Katella 10
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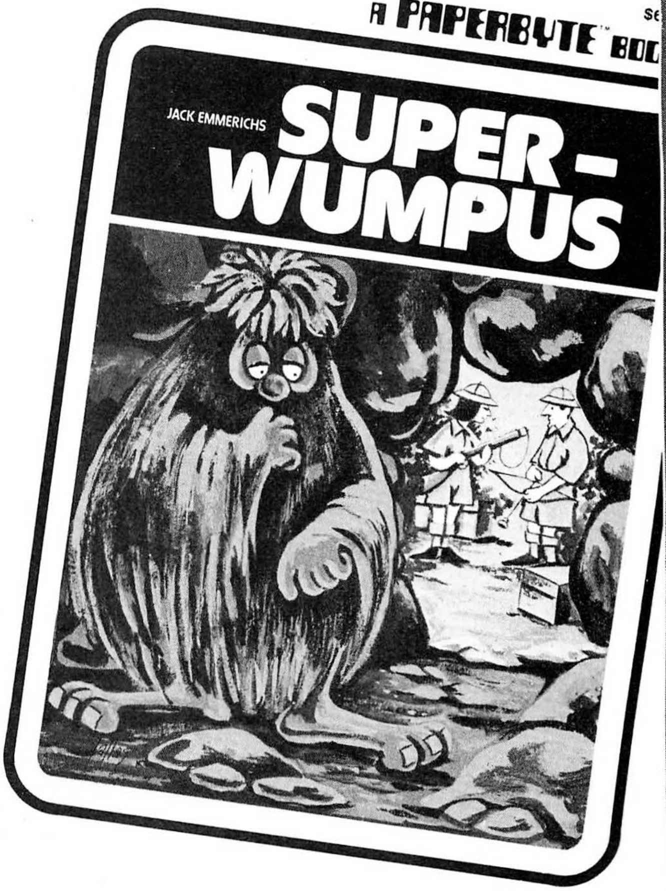

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LET US ASSEMBLE

by Leonard M Lazar

Deep down inside, where it counts, your computer does not understand you. There is a communication gap, and a huge language barrier. Computers are very precise, but they have a limited vocabulary. People tend to be imprecise. People use idioms, and speak in incomplete sentences. Computers speak binary; they think in terms of strings of zeros and ones. People like to use other, more convenient number bases, such as 10 or 16 or 13. People use many characters:

A B C a b c # ? !

What is needed is a translator or interpreter to act as a go-between. Many types of translation schemes and languages have evolved. Each programming language has some feature which makes it attractive for people to use. Some languages, such as BASIC, Pascal, FORTRAN or COBOL, are nearly computer independent. The user does not have to know what the computer really looks like or what it really does. The translator takes user supplied statements, which are similar to algebraic formulas or simple declarative sentences, and reduces these statements to a large number of minute, detailed commands for the computer to execute. These higher level languages are extremely useful for most commercial and scientific computations. They allow the user to concentrate on the algorithms specific to the problem at hand, and ignore completely the intricate computer details. Specific details of which registers to use, indicator settings, storage allocation, peripheral device control and number base conversion are supplied by the translator.

There are times when the user must get down to the computer's level. There are times when the user must talk bits and bytes. There are times when the user must manipulate the computer's registers, check the indicators, and control the peripheral devices. There are times when the user must talk to the computer using the computer's vocabulary. Fortunately for most applications these times are rare. In most professional computer

---

Len Lazar is vice president of General Digital Corp and is involved with software development for minicomputers and microcomputers. When not occupied with his seven children he teaches computer science courses at the Hartford Graduate Center.

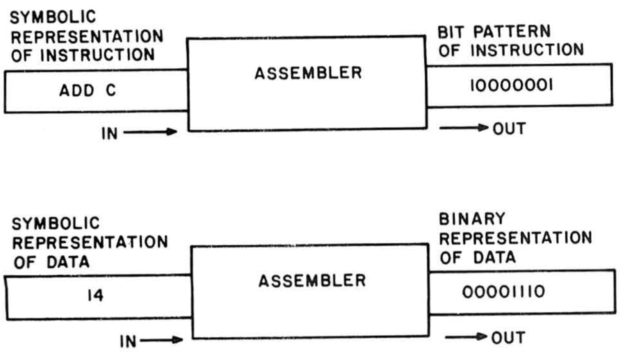


Figure 1: The purpose of an assembler is to convert symbolic representations, entered by the user, to binary patterns, which can be directly accepted and executed by the computer.

installations these types of problems are handled by a rare breed of masochists, usually called systems programmers. A low level language, called assembly language, and an automated clerical system, called the assembler, are used when detailed control of the computer is required. These programming aids help take some of the drudgery out of these dialogues, and reduce human errors. In personal computers it is often possible to get away with no use of assemblers at all. But it helps to know what is involved in this area even though you may never use it. Specifically, the assembler assists and simplifies the coding of programs in the following areas:

1) storage location representation
2) operation code representation
3) data representation
4) summaries of usage, listings and some error detection

We shall describe what assemblers do in each of these four areas. The reader will find that the descriptions are based on a very simple translation or substitution model. Unlike the programmer using the higher level language, the programmer using assembly language must supply each and every instruction and data item that is to be used by the computer. The programmer writes code using symbols, numbers and combinations of letters which are known as mnemonics. The assembler performs a one-for-one substitution on each instruction and data item, as shown in figure 1.

The assembler and its assembly language are usually very machine dependent. Each command occurring in the assembly language corresponds to an instruction in the instruction set of the computer for which the assembler is written. The symbolic program which is the input to the assembler is called the *source* program. There is a special format that has to be followed when writing symbolic source programs. Each symbolic instruction has three parts:

LABEL OP CODE OPERAND

Some of the parts are mandatory for each line of code, some of the parts are optional. The purpose and use of these parts will be covered later.

The binary string which is the output of the assembler is called *object* code or *machine* code. The object code is written into memory directly, or onto tape or disk. If the intermediate copy of the object code was written on tape or disk, when you wish to execute the program, a special program in the computer, called the *loader*, copies the binary program from the disk or tape into the computer's memory. When the binary program is in memory it can be executed.

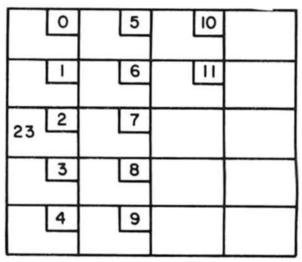
Memory Reference

The memory of a computer is arranged in groups of bits called *words.* In most present day personal computers, the word length is eight bits, sufficient to store one byte of information. Each word has a unique number associated with it called the *location* or *address.* Every instruction and every data item in the memory is referenced by the computer by using the location of the instruction or data. The memory can be regarded as a "post office box" system, as illustrated in figure 2.

The locations are like post office box numbers and the data is the contents of the box. In order to use the data we must refer to it by its box number. If the data 23 were in location 2 the symbolic instruction LOAD 2 would move the number 23 into a register.

Since computers can have tens of thousands or millions of words of memory, trying to keep track of what is stored where would be an overwhelming chore for a programmer to attempt. Furthermore, from the programmer's view, the exact location of data is usually not too important. Consistency of reference is the essential requirement. If a business program always refers to gross pay data by using location 40, then an equally good payroll program would result if another, unused location were

Figure 2: Memory storage seen as a post office box system: the locations are the box numbers, and data is the content of the box. Here the data, 23, is in location 2.



substituted for 40, every place location 40 occurs in the program.

Names and words are usually easier to memorize than arrays of numbers. This is even more true if the names or words have special meanings associated with them. This is the basis for the assembler's assist in programming. The programmer invents a name, which is meaningful to the programmer, to use for the location of data. This name, or *symbolic address*, is stored by the assembler in a table called the *symbol table.*

The table is used by the assembler to substitute the actual location for the symbolic address. Using the symbol table in table 1 the symbolic instruction STORE HEIGHT is transformed to STORE 900.

Whenever the programmer wishes to name the location of an instruction or the location of a data item, the label part of the symbolic instruction is filled in by the programmer with the desired name. The assembler enters the label into the symbol table along with the location where it occurred. Most instructions will not have a label specified. Usually only the start of routines and places to which jumps or branches can occur require a label. Conversely, nearly every data item will have a symbolic name and label.

There are special instructions or directives, called *pseudo operations*, which do not generate any binary output. These are used to control the translation process. Some pseudo operations are used specifically to position code sequences in memory or to assign values to symbols in the symbol table. The ORG pseudo operation is used for positioning code in absolute assemblers. The EQU pseudo operation is used to define symbols.

Consider the following piece of symbolic assembly code:

LABEL	OPERATOR	OPERAND
TTY	EQU	3
	ORG	3000
START	LOAD	SAM
	OUT	TTY

The above would generate a code sequence, which begins with the symbolic name START, positioned in storage from location 3000 onward. The symbol TTY is assigned the value 3 by the EQU statement. The fourth line of code is the same as: OUT 3.

Operation Code

The binary code, which the computer executes, is decoded by the central processing unit, which is often abbreviated as CPU in advertisements for computers. Another word which means the same thing is "processor."

SYMBOL	LOCATION
CASH	500
TEMP	782
ABC	350
VOL	8000
HEIGHT	900
WEIGHT	904
BASE	5

Table 1: The programmer invents a name to identify the location of data. This name, or symbolic address, is stored by the assembler in a symbol table. The symbol table is used by the assembler to insert the actual location for the symbolic address where necessary.

A machine instruction can have several internal formats, depending on the design of its central processing unit. The three most common formats for minicomputers and the microcomputers found in personal computer products are:

```
OPERATOR
OPERATOR OPERAND
OPERATOR OPERAND1 OPERAND2
```

The operator portion of a machine instruction tells the computer *what* to do (ADD, JUMP, etc).

The operand portions, when they occur, tell *where* to do it (memory location 900, register B, input port 3).

If memorizing long lists of decimal numbers is hard, memorizing sequences of binary ones and zeros is probably impossible. To avoid this feat, an easy to memorize name or letter combination is assigned to each machine instruction.

Built into the typical assembler program is a table which associates the symbolic name for each machine instruction with the bit pattern for the symbolic op code. An assembler for a machine with operation codes given in table 2, and a symbolic program generating the symbol table given in table 1 would translate the symbolic instruction ADD BASE into a machine instruction with:

```
OPERATOR  = 10000  (from table 2)
OPERAND   = 00101  (BASE is location 5)
```

Data Representation

All information and commands inside the computer appear as binary strings. The meaning of any particular string depends on where it is used. Some bit patterns are used as instructions, to be decoded by the processor. Some bit patterns are used as numbers to be operated on by the arithmetic instructions of the processor. Other bit patterns are

SYMBOLIC OP CODE	BIT PATTERN
ADD	10000
SUB	10010
AND	10100
XOR	10101
OR	10110
CMP	10111
ROT	00000
CALL	11001
*	*
*	*

Table 2: Within every assembler is an instruction table, which associates the symbolic name of each machine instruction with its machine code bit pattern.

codes for character messages to be displayed on a terminal screen or printed on a printer. There are several different ways to represent binary or bit strings. Each representation either reflects the intended usage, or is a compact way to express the bit pattern. The simplest number representation for many uses is the base ten or decimal representation.

A typical assembler will normally treat all numbers it encounters in the operand part of an instruction as decimal numbers. Some assemblers have pseudo operations which allow the user to change the number base. In some assembly languages, special flags or symbols can be inserted either at the front of a number or at the end of a number to indicate a base change. But, if you leave it alone, it is old-fashioned base ten. An assembler converts decimal numbers to the correct binary, or base two, representation. To indicate constants in storage the operation part of the symbolic instruction is filled in with a special code word peculiar to the assembler in use, and then the constant is written in the operand part of the instruction. In some assemblers the code word to indicate constants is DC, which stands for define constant.

Using this method of defining constants, the following piece of assembly language code:

LABEL	OP CODE	OPERAND
	ORG	7200
TEN	DC	10
AREA	DC	189
BLOB	DC	74

will produce the following results:

- The name TEN is assigned to location 7200 and entered in the symbol table.
- The binary equivalent to the number 10 (ie: 00001010 for a computer which uses 8 bit bytes as its memory locations) is placed in memory location 7200.
- The name AREA is assigned to location 7201 and entered in the symbol table.
- The binary equivalent to the number 189 (ie: 10111101 in an 8 bit computer) is placed in memory location 7201.
- The name BLOB is assigned to location 7202 and entered in the symbol table.
- The binary equivalent to the number 74 (ie: 01001010) is placed in memory location 7202.

Referring to numbers in decimal bears no simple relationship to the internal form of bits in a computer. As a result, programmers use a form of abbreviation for bit patterns taken as groups of three or four bits at a time. Since most computers have architectures with multiples of four bits in each memory word, the easiest and most commonly used form of notation is hexadecimal. A bit string of four bits can be encoded using the equivalents shown in table 3. The bit patterns on the right are numbers 0 through 15, written in binary notation. The lefthand column shows the same numbers in hexadecimal (so called because of the six (hexa) states above the ten decimal states, 0 through 9).

Any binary string can be defined in groups of four bits. If the original string length is not a multiple of four, simply insert enough zeros in front of the string to fill it out. Then write the hexadecimal equivalent of each group. This coding is the hexadecimal representation of the bit string. To further illustrate:

If the original bit string is:	11 1011 0111
Two zeros are inserted to make the length a multiple of four:	0011 1011 0111
The table is used on each group of four	3 B 7

The reverse conversion, from hexadecimal to bit string, is to simply write the four bits for each hexadecimal code character. To illustrate:

If the hexadecimal code is:	8 3 2 A
The 16 bit string (4 for each character) is:	1000 0011 0010 1010

In many assemblers the DC instruction (define constant) is used to insert bit string constants. The letter H is written immediately after the quantity to

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Hexadecimal Digit	Equivalent 4 Bit String	Hexadecimal Digit	Equivalent 4 Bit String
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

Table 3: To reduce the number of digits necessary to define a character, programmers often divide the bit strings into groups of four digits and convert those 4 bit strings to hexadecimal notation. This table shows the hexadecimal equivalents of 4 bit binary numbers.

distinguish it from a decimal number. In such an assembler, 03FCH is the notation used for hexadecimal 03FC. Other assemblers use special punctuation marks to distinguish hexadecimal from decimal. One typical notation is a dollar sign preceding the number, as in $03FC.

Every input-output device that handles text has a character code made up of five, six, seven or eight bits for each character. It is this disparity of character codes which sometimes creates the need to use the assembler in order to manipulate bits to convert code for different devices. Most devices that are used with personal computers use a 7 bit code called *ASCII*, an acronym for American Standard Code for Information Interchange. The code word usually has an additional eighth bit appended to the left end of the character code to create a parity check bit. Some devices are "even parity," meaning the parity bit is selected to keep the num-

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ASCII Character	Hexadecimal Code	ASCII Character	Hexadecimal Code	ASCII Character	Hexadecimal Code
(SPACE)	20	A	41	N	4E
0	30	B	42	O	4F
1	31	C	43	P	50
2	32	D	44	Q	51
3	33	E	45	R	52
4	34	F	46	S	53
5	35	G	47	T	54
6	36	H	48	U	55
7	37	I	49	V	56
8	38	J	4A	W	57
9	39	K	4B	X	58
		L	4C	Y	59
		M	4D	Z	5A

Table 4: Most input-output devices which communicate with a computer use a 7 bit code called ASCII. The table shows the 2 digit hexadecimal codes for the ASCII characters A through Z and 0 through 9.

ber of ones in the code word even. Other devices are "odd parity." Some ignore parity and the choice of the eighth bit is thus immaterial.

A portion of the ASCII code (without the parity bit) is given in table 4.

In addition to the alphabet, numbers and punctuation marks, the ASCII code includes communication and device control codes and record and file marks.

In order to print the message:

HOT DOG

the seven characters convert to 56 bits (remember there is a space between the T and the D) with the hexadecimal representation:

484F5420444F47H

which would have to be output to the printer. The use of tables to look up the hexadecimal code is very awkward so most assemblers will convert text directly to the ASCII code. The text is indicated by the use of quotation marks.

The above message would appear in a program as:

LABEL	OP CODE	OPERAND
MESG	DC	"HOT DOG"

The typical assembler converts the characters to ASCII and the 56 bits would be placed into storage. The starting position of the message would have the symbolic name MESG.

Listings and Diagnostics

Alas, all assemblers are not created equal. It is in the area of hard copy output that the differences are most dramatically exposed. The lack of a feature or two in other areas is usually just a minor nuisance, and can be "worked around." But poor listings and diagnostics can hinder software update or modification and software debugging. If you intend to learn to use assembly language, you may have to do some shopping around until you find an assembler which does what you want on the computer you use. The most obvious requirement is a list of what the translation generated, the binary strings equivalent to our symbolic instructions. This is usually accomplished by printing out the original symbolic source program, but preceding each line of code with two hexadecimal strings. The first hexadecimal quantity is the memory location where the instruction will be stored. The second hexadecimal quantity is the representation of the binary value which is stored at that location, and possibly two or three locations following it. Listing 1 shows a typical example.

While coding is being done, the actual location of data and instructions is not critical, since the programmer uses symbolic name references. But when debugging is in process, knowing the actual locations of data and instructions can become important. Most assemblers will print out their symbol table. The symbol table printout consists of pairs of columns of quantities. The entries in one column are the hexadecimal location of the symbol, and in the second column are the corresponding symbol names. The order of the entries in the tables is of interest. There are two types of questions which arise in program checkout:

1) What is stored in a specified location?
2) Where is a given quantity stored?

For this reason it is desirable that the assembler print out the symbol table twice, in different orders.

One table printout should be in increasing location order to help answer the first type of question. The second table printout should be organized by alphabetically sorted symbols. This second table assists in answering the second question.

Symbol Table

For table 1, the printed symbol table sorted by symbol would appear as:

ABC	0350
BASE	0005
CASH	0500
HEIGHT	0900
TEMP	0782
VOL	8000
WEIGHT	0904

The same table printed by ascending location value would appear as:

0005	BASE
0350	ABC
0500	CASH
0782	TEMP
0900	HEIGHT
0904	WEIGHT
8000	VOL

Symbol table listings, while very valuable, do not contain all the information required about symbols.

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Location	Instruction			Label	Op code	Operand
0EF0					ORG	0EF0H
0EF0	CD	68	00	READ	CALL	SETUP
0EF3	CD	90	0F		CALL	STSPC
0EF6	21	00	3D		LXI	H, INBF
0EF9	CD	C0	05		CALL	MOVFM
0EFC	21	90	3D		LXI	H, METBF
0EFF	CD	C0	05		CALL	MOVFM
0F02	06	02			MVI	B, 2
0F04	0E	1B			MVI	C, 27
0F06	CD	B0	07		CALL	CURPS
0F09	11	9E	0F		LXI	D, RMODE
0F0C	CD	D0	09		CALL	DSPLM
0F0F	CD	A7	0C		CALL	ISCRD
0F12	CD	30	08	KYBD1	CALL	KEYBD

Listing 1: The assembler prints out the original symbolic source program in a format which illustrates actual storage location, hexadecimal instruction code, symbol name and operation.

If you are trying to debug a program and you discover that a certain computed quantity is wrong, what do you do about it? After some quiet frustration, blaming the hardware, etc, you calm down and ask the following types of questions:

1) Where is the quantity created (computed)?
2) Where is the quantity updated?
3) What other quantities are affected?
4) Why did I ever want to program in assembly language in the first place?

A major help in answering the first three questions (the fourth has no rational answer) is a cross-reference table. This is a list of every reference to a symbol. The form of the list is the symbolic name, followed by the locations in storage of those instructions which use that symbol in their symbolic instruction. Some cross-reference listings even include the line number in the printout where the symbol occurs. If a symbol only has one reference in the listing this could indicate a label which is never referenced elsewhere in the program. This could be a possible oversight or error on the programmer's part. Many assemblers do not even produce a cross-reference table, so look for this feature in shopping around for assemblers.

Nobody is perfect. Even I make mistakes (not offen [sic]). To err is human, to diagnose is the assembler program's responsibility. What types of errors can an assembler detect? How does the assembler tell us about these detected errors? These two questions should be asked of an assembler, when selecting an assembler for use. Some assemblers are very useful in detecting errors and informing the user, while others are horrid.

The simplest errors for an assembler to detect are:

1) Use of a symbolic operation code which is not defined for the computer or as a pseudo operation of the assembler.
2) Two identical labels which give two meanings to a symbol.
3) The appearance of a symbol name in the operand part of an instruction when there is no label or EQU in the program defining that symbol.
4) The use of a decimal or hexadecimal number which is too large to fit into a word of storage.
5) The user has specified ORG values which cause parts of the code to overwrite other code.

These types of errors are usually clerical errors on the human's part, due to oversight or typographical errors when keying in the symbolic program.

There are other types of errors which are machine specific. Some computers have limitations on storage reference extent. For example, on some computers certain instructions can only reference data on page 0, or only reference data in a certain range relative to the current location. A good assembler should detect the most common clerical errors and all the machine violations.

The error message techniques used by assemblers vary considerably. Some assemblers will simply place a mark, such as an asterisk (*), in front of the line of code in the listing. It is up to the programmer to guess what is wrong. Others use a code letter or number:

TYPE 17 ERROR

This requires the programmer to look in a manual to find out what that error is. If the manual only gives 16 types of errors, then you have real problems. The ideal error message or indicator is self-explanatory, indicating where the error occurred and the nature of the error.

Finally, there is one pseudo operation which occurs in the symbolic program. It is a directive to the assembler that there is no more source code. Many assemblers will issue an error message if this pseudo operation is not present. Other assemblers will rebel and not even assemble. This pseudo operation is:

LABEL	OP CODE	OPERAND
	END	

■

Continued from page 11

magnetically coated tape which, while passing a recording head, receives a magnetic image of the character to be printed. The image is then toned with a powdered magnetic ink and, when a full line of text has been put on the tape and toned, the tape contacts and prints onto the paper. While the ink is being fused onto the paper, the tape passes another recording head which erases it. Although speeds of up to 200 lines per minute are possible with this arrangement, it is still too new to have had a significant effect on the market. Perhaps, in a few years, when the print quality has been improved and it can be more price competitive, it will win greater acceptance.

Conclusion

Obviously, there's more to character printing than meets the eye. One would almost suspect that wherever two or three engineers are gathered together in the name of computing, a new technique of printing is being developed. In truth, improved printing techniques offering greater speed, better resolution, and high flexibility at lower cost continually occupy some of the best minds in the country. Each advance in the technology offers new possibilities, and the delays are few between the perception of these possibilities and the appearance of a printing device utilizing them. For this reason, no article of this sort can hope to cover all sides of the industry. I have tried instead to provide a thorough picture of the current situation in character printing, to give you a useful familiarity with the terminology, and an overview of what's available. But do you hear that low rumbling off in the distance? That's the latest thing in printers coming off the assembly line — and it has capabilities beyond our wildest dreams.

A DIRECTORY OF AFFORDABLE PRINTERS

The following is a selected list of printers available for under $3000. Data rates are sometimes given in the comments column. These are expressed in bits per second, and are a measure of how quickly data can be transferred from the computer to the printer. This table is meant to be representative rather than exhaustive. Many computer companies offer printers that are manufactured by other companies; for example, Centronics manufactures printers for Radio Shack under the Radio Shack name. See note at end of table for more information.

Company	Model	Speed	Price Range	Comments
Anadex 9825 DeSoto Chatsworth CA 91311	DP-1000	75 lines per minute	under $700 (and up)	ASCII 64 character subset, data rate of 110 to 2400 bits per second, 40 characters per line, impact dot matrix printer.
Anderson Jacobson 521 Charot Av San Jose CA 95131	AJ841	14.9 characters per second	$995	Unit is converted IBM Selectric typewriter, serial or parallel interfaces available, special character set available for APL (a high level computer language).
Axiom 5932 San Fernando Rd Glendale CA 91202	EX-800, EX-810	120 lines per minute	$600 and up	Electrographic matrix printer with variable horizontal dot resolution, can store several lines of characters from the computer in its buffer, three character sizes available as well as upper and lower case; automatic signal when paper supply is low, can plot up to 8192 dots per second in graphics mode, uses aluminized paper.

Company	Model	Speed	Price Range	Comments
Bowmar Instruments Corp 8000 Bluffton Rd Fort Wayne IN 46809	TP-3120	29.4 characters per second	$149	5 by 5 matrix thermal printer, has left and right justification.
Centronics Data Computer Corp Hudson NH 03051	Microprinter P-1, S-1	150 lines per minute	$400 (approximate)	P-1 is parallel interface model, S-1 is serial interface model, standard ASCII 96 character set; unit can print 5, 10 or 20 characters per inch horizontally, low paper detect signal, electrographic matrix printer; uses aluminized paper.
	730	21 lines per minute with 80 columns per line, 58 lines per minute with 20 columns per line.	Under $1000	7 by 7 dot matrix; ASCII 96 character set, parallel interface will accept up to 15,000 characters per second, flexible forms handling: can accept 8½ by 11 inch rolls of Teletype style paper or 80 column single form and multiform fanfold paper, electrographic printer.
Computer Printers International Inc 340 E Middlefield Rd Mountain View CA 94043	Comprint Model 912	225 characters per second	$560	5 by 7 matrix printer; uses 8½ inch wide paper, can automatically print in 11 inch long (page size) blocks.
Cromemco Inc 280 Bernardo Av Mountain View CA 94040	3703	180 characters per second	$2995	132 column printer
Data Interfaces Inc 27 Gill St (Building B6) Woburn MA 01801	DIP-40	50 characters per second	$395	Dot matrix impact printer, uses adding machine paper tape.
Datel Systems Inc 1020 Turnpike St Canton MA 02021	AIP-40	50 characters per second	$425	5 by 7 dot matrix impact printer, uses adding machine paper tape, 40 columns, choice of parallel or serial interfaces.
Diablo POB 2261 Oakland CA 94621	2300	55 characters per second	$2400	Daisy wheel printer, 132 columns, tractor feed.
Digital Equipment Corp Maynard MA 01754	DECwriter II	10 to 30 characters per second	$1495 and up	Dot matrix printer, full keyboard and tractor feed available for $200 more, 132 column line.

Company	Model	Speed	Price Range	Comments
General Electric Co Data Communications Products Business Dept Waynesboro VA 22980	Terminet Multiform Printer	30 characters per second	$1695	80 or 120 columns per line; makes up to nine copies.
Integral Data Systems Inc 14 Tech Cir Natick MA 01760	IP-125 Brighter Writer	80 characters per second	$799	7 by 7 dot matrix, built-in microprocessor plus graphics capability, friction feed for paper, uses 8½ inch wide paper, upper and lower case; serial or parallel interfaces available.
	IP-225	80 characters per second	$949	Same as above, but with tractor feed drive for paper control. Both units have a 132 column per line option available.
Lear Seigler 714 N Brookhurst Anaheim CA 92803	200	200 characters per second	$2495	7 by 9 dot matrix impact printer, 132 columns, tractor feed.
Master Digital Corp 1308-F Logan Av Costa Mesa CA 92626	MDC 300	180 lines per minute	$595 and up	21 columns per line, options available: data and time clock, event counter, low paper detect.
Microperipherals Inc 2900 Corda La Los Angeles CA 90049	MP-40, SSP-40, KP-40	75 lines per minute	$179 and up	5 by 7 dot matrix impact printer, 40 characters per line, 12 characters per inch, extended width characters (six per inch) available under software control, has parallel interface.
Peripheral Vision POB 6267 Denver CO 80206	None given	120 characters per second	$495 and up	5 by 7 dot matrix impact printer, 96 characters per line on 8½ inch wide paper, makes up to four copies. Software variable font and pitch.
Qume 2323 Industrial Pkwy Hayward CA 94545	Sprint Micro-5	55 characters per second	$1675 and up	Built-in microprocessor with 58 commands, extensive options.
Radio Shack Division of Tandy Corp POB 2625 Fort Worth TX 76101	Quick Printer II	64 characters per second	$219	5 by 7 dot matrix printer, designed for use with the Radio Shack TRS-80 personal computer, but can also be used with a variety of other computers, uses 2⅜ inch wide aluminized paper.

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Company	Model	Speed	Price Range	Comments
Southwest Technical Products Inc 219 W Rhapsody San Antonio TX 78216	PR-40	75 lines per minute	$250 (kit)	5 by 7 matrix impact printer, standard ASCII 64 character subset.
Telpar 4134 Billy Mitchell Rd Box 796 Addison TX 75001	PS-40	20 characters per second	$250 and up	Thermal printer, standard 64 character ASCII subset (upper case only).
Terminal Systems Inc 1130 Hartland St N Hollywood CA 91605	43	up to 130 characters per second	$1377	9 by 6 matrix printer, upper and lower case, 132 characters per line.
Texas Instruments Distributor: Consolidated Data Terminals 7850 Edgewater Dr Oakland CA 94621	Omni 810	150 characters per second	$1895	9 by 7 dot matrix impact printer.
United Systems Corp 918 Woodley Rd Dayton OH 45403	6410	120 lines per minute	$395	5 by 7 dot matrix printer.

In addition to these new printers, many printers, typewriters for output, and teletypewriter equivalents are made available by a number of suppliers in used or reconditioned form and at a wide range of prices.

Other suppliers and surplus houses to consider when seeking a printer include Applied Computer Systems, Celdat, Cheap Inc, Computer Components, Computer Transceiver Systems, Computer Warehouse Store, Dal-Data, Digital Electronics Corp, Disc/3, El Com, Heath, Jefftronics, Mini-Computer Business Applications, Mini Micro Mart, NEC Information Systems, Newman Computer Exchange, Ohio Scientific, Processor Technology, Scientific Research, Sharp Associates, Synchro Sound, Tandy, Vector Graphic, Wilcox Enterprises, and Worldwide Electronics. Some of these only sell printers for or as part of their computer systems, but many carry printers suitable to any system. Prices range from very inexpensive to $3000 and up.

A Glossary of Printer Terms

ASCII Character Set: a standard set of characters used in the computer industry.

Justify: to adjust lines of type so that the edges of the copy are even and straight, both on the left and on the right.

Matrix: an array of dots in a square or rectangular layout. Every character in a dot matrix printer is created by using some combination of these dots.

Parallel interface: a type of interface which enables the computer to send all the bits required to represent a character to the printer simultaneously.

Pin feed platen: a type of paper guiding mechanism which controls the movement of the paper by inserting pins into corresponding holes in the edges of the paper.

Serial interface: a type of interface in which the characters are sent from the computer to the printer one bit at a time, in serial fashion.

Tractor feed mechanism: a device used to control printer paper motion precisely.

Glossary

The purpose of this glossary, a regular onComputing feature, is to define terms used in this issue that might be unfamiliar to readers.

Application: An application is a use of a computer system to accomplish a specific goal. A general-purpose personal computer can be used for any one of a number of applications depending upon what programs are chosen or written by its owner. An application is to the small computer what a destination is to the personal automobile.

ASCII Character Set: The most common character-coding convention in personal computers is the ASCII character set. The name is the acronym for American Standard Code for Information Interchange. In its fullest form, it is the definition of a set of 256 different standard meanings for the 8-bit codes which can be generated by a typical computer or computer terminal. Most small computers and terminal products only support a subset of this full ASCII character-set definition, typically including upper and lower-case alphabetic characters, numbers and a set of special symbols.

Character: A character is the name given to a byte of information in the personal computer when that byte is used to store a code number corresponding to one of the standard characters of, for example, the ASCII character set. A character in memory corresponds to the depression of one key on the typewriter-style keyboard of the typical computer or computer terminal.

COBOL: COBOL is one of the standard set of languages most often implemented on large computer systems. It is oriented toward business applications, and is beginning to make an appearance on personal computers which have a business orientation. Thus, COBOL stands for common business oriented language.

Comment: A comment is a note incorporated in the source text of a program which is intended to make later understanding of the program easier. With languages such as assembly language, FORTRAN, or BASIC, comments are absolutely essential as a part of good programming practice. With better conceived languages like Pascal, PL/I, or COBOL, comments are less essential, but recommended whenever nonstandard and possibly obscure practices are employed. Every programming language has some form of comment statement.

Computer Language: A computer language is an artificial language concocted for purposes of communication between human beings and computer systems. These languages range from the primitive symbolic assemblers available in some way for nearly all computers, through high-level, application-oriented languages including the mathematical language APL and the artificial-intelligence (ie: robotics) language LISP. Most inexpensive personal computers use a relatively primitive computer language called BASIC; more expensive personal computers are delivered with software for a more powerful and simpler to use language called Pascal.

Conditional Jump: In an assembly language for some computers, the conditional jump is the main way of affecting the course of execution of instructions. It will cause execution of the program to jump to an alternate instruction location in the program depending upon the state of 1 or more *flag* bits in the *condition code register* of the computer's processor. A typical example might be "jump if zero," which would cause execution to go to the specified location if the *zero* flag of the processor was *true* after the last previous operation.

Cross-reference Listing: When using a programming language, various names of variables, procedures and other items are created by the programmer. These are the *symbols* used by the program. Any language system is improved if it incorporates an automatically created *cross-reference listing* of symbols. This listing gives information about where the symbol was first defined, and where it is referenced within the program. This information can often be used to great advantage when writing and debugging your own programs. So in comparing 2 different computer systems for which you intend to write your own programs, give extra weight to the one which has cross-reference listings available for its various languages.

Decimal: The decimal system is the system of numbers which most people begin using in childhood. It is the most prevalent system of notation in our civilization. However, since computers can calculate inherently well in a binary system,other systems are often employed which use a power of 2 as the base: binary uses 2, octal uses 2 raised to the third power, and hexadecimal uses 2 raised to the fourth power. When an external decimal representation of a number is produced from a computer program, it thus must reflect an automated binary-to-decimal conversion procedure.

Diagnostic: A diagnostic is a message sent to the user of a program or system of programs which complains about something extraordinary. In a high-level language system, a diagnostic might be the message explaining that an improper form of expression was used. In an application of a computer, a diagnostic message might be used to inform the user of the computer that the data just entered was inconsistent with the expected form or purposes of entering that data. The response to a diagnostic on the part of this user is to try again, using the diagnostic message as feedback to change the attempted input.

Dialects: In human languages, dialects are local variations upon the language which in general lead to mostly humorous interferences with communications. In computer languages, similarly, a dialect is a variation on the basic theme of the language which makes for strange results when interpreted by a "foreign" system which allegedly speaks the same language. Thus BASIC is by no means the same for every system, but largely similar. Similarly, Pascal, FORTRAN, PL/I and so on all suffer variations in the way they are implemented on different computers.

Dot-Matrix Printer: A dot-matrix printer is one which employs a small array of dots to represent a course image of the characters printed. Most dot-matrix printers which print uppercase characters only use a 5 by 7 matrix of dots to represent each character of the alphabet. Printers capable of uppercase and lowercase printing typically use a 7 by 9 matrix of dots to represent a full set of alphabetic characters. The ultimate in dot-matrix technology is found in various high-resolution dot-matrix devices such as inkjet or precision impact printers which can assemble characters from matrices of perhaps 30 by 50 dots which may overlap.

EBCDIC Character Set: The character-coding convention used in computers manufactured by the IBM corporation is known as EBCDIC. The name is the acronym for Extended Binary Coded Decimal Interchange Code. Like the ASCII character set used in most small computers, EBCDIC assigns a unique interpretation to the 256 possible codes which may be stored in an 8-bit byte of information.

Electrographic Printing: In electrographic printing, characters are formed on the resulting printout in a 2-stage process: first the image of the printed output is transferred onto a printing surface. Then the surface is toned by the addition of opaque particles which are bonded to the surface. This technique is based on the principles of operation of the Xerox machine, and is not typically used in inexpensive printers for personal computers.

Electrostatic Printing: In electrostatic printing, an image is made on a suitable special-purpose conductive paper by discharging a spark between the printhead electrode and the paper. As a result of the spark, the surface layers of the paper are indelibly marked, changing the appearance from a reflective silvery color to the dark color of the underlying layers of the paper.

Font: A font is the set of images associated with a given character set such as ASCII, EBCDIC, or the special-purpose sets used in computerized typesetting machines such as the ones used for this magazine. A typical font for computer output from an impact printer might be one which duplicates the font of a typical typewriter. For a low-resolution dot-matrix printer, the font might be a program in the printer's read only memory which translates each ASCII code into a visual representation as a matrix of dots.

Graphics: The techniques of creating visual images using a computer are called graphics. With personal computers, graphics features use some form of black and white or color television display. Graphic displays are used to display the normal letters, numbers and special symbols of a character set in all modern personal computers. Some personal computers have more elaborate and flexible interfaces which give the ability to draw pictures instead of using words for interactions.

Handshaking: Handshaking refers to the method by which 2 different computer systems (or a computer and a peripheral device) coordinate communications through some form of interconnection. A key part of this process is the ability to send messages about the status of the communications link, as well as messages which are part of the intended transfer of data.

Hard Copy: Hard copy refers to graphic images which get recorded on paper in a humanly readable form. Hard copy facilities are often missing on the least expensive computers. To be most convenient, present day computers require hard copy.

Hexadecimal: A number system which uses the base 16 for its representation of integers is called hexadecimal. In computers which have fundamental units of information in memory which are byte-sized (8 bits), this provides a more convenient, external, humanly readable representation of internal data than use of binary digits. It takes 2 digits selected from the numeric character set 0,1,2,3,4,5,6,7,8,9, and the 6 letters A,B,C,D,E,F to represent a byte of information, as opposed to 8 digits to represent the same number in an external binary form. Each hexadecimal digit stands for 4 bits, so hexadecimal is a very natural representation to use with byte-oriented computer systems.

Impact Printing: Impact printing refers to the methods of making a printed image where the paper is struck in some way, usually involving some form of ribbon as in a standard typewriter. These techniques of impact printing sometimes use dot-matrix character formation and sometimes use predefined fonts as in the typewriter or on bands or chains of characters contained in some high-speed printers. Impact printing methods are capable of producing multiple copies at the same time using some form of carbon paper or its equivalent.

Interpreter: An interpreter is a program which usually comes with a small computer, used to implement a high-level language such as BASIC. In an interpreted implementation of a computer language, every time a statement is executed, it must first be translated from a humanly readable form into a form which the machine can execute. In a compiled form of the same language, this translation is done once before the program is executed. Thus in the common interpretive forms available, the same program will run much slower than would be the case if the program were compiled.

Loading: The act of transferring the contents of 1 or more bytes of data from a memory bank into the local memory of a computer is called loading. Loading can refer to the loading of a program from a disk or tape copy into the main memory of the computer prior to execution of that program. It can also refer to the loading of a register when a few bytes are transferred from the main memory into the registers of the central processor in an assembly-language program.

Location: The location of a byte of data, a record of information, or a program is its unique address in a particular address space. For bytes of data in main memory, locations are the addresses in that main memory. For records stored on a random-access disk file, a location is the starting address of the first byte of the record in the address space of all possible bytes on the disk. For a program stored in the file structure of a disk system, its location is the choice of its name, which gets looked up in a directory and automatically translated into the appropriate disk addresses.

Main Memory: Main memory is the primary resource for storage of data and programs in a computer. It is a random-access form of memory which can be altered and changed under the control of programs. As implemented in contemporary personal computers, main memory is a transient storage area, for when power is turned off its information content evaporates. Thus some form of mass storage using a different technology is required if permanent records of programs and data are to be kept.

Mass Storage (also called bulk storage): Mass storage is provided in a computer system as a technique for keeping track of large amounts of permanently available data in a machine readable form. Mass storage is invariably slower in access than main memory, a price which is gladly paid in trade for larger potential amounts of data and its permanent qualities. In small personal computers, mass storage is provided by cassette tapes or the much more convenient floppy disks.

Mnemonic: A mnemonic is the name for a machine-language operation code of a computer, chosen so that the assembly-language programmer can easily remember its function based on its abbreviation. Thus, in some computers the operation "push registers onto user stack" might have the mnemonic form PSHU as a short easily coded abbreviation for a long, verbal description.

Modulator: A modulator (in personal computing circles) is an electronic black box used to translate the television video output signals of the computer into a standard radio-frequency television signal which can then be fed into the antenna terminals of a television tuned to an appropriate channel.

Object Code: When using assembly language, or a high-level language compiler (as opposed to an interpreter), the output of the automatic translation process is a machine-language program for the computer. This machine-language form of the program is called the object code of the program. An object code program can thus be directly loaded into memory and executed since it has already been translated from its humanly readable, equivalent form into the internal, executable form.

Octal: A system of number representation in which the base 8 is chosen and the digits 0,1,2,3,4,5,6, and 7 are used is called octal.

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CIRCLE 5 ON INQUIRY CARD

Many programmers prefer octal to hexadecimal notation, although octal is a natural notation of numbers only on machines whose "word size" is a multiple of 3 bits. On the typical, byte-oriented personal computer, use of octal for machine language is awkward because the 8 bits of a byte become 3 octal digits grouped as 2, 3, and 3 bits, versus 2 hexadecimal digits of a uniform size, 4 bits.

Operating System: An operating system is a set of programs which are usually created by the manufacturer of a large computer, to allow that computer to be conveniently used by many different programs. Carried over into the world of small personal computers, the operating system is what gives the computer its "personality" as seen by the interactive user. In addition to the many manufacturer-supplied operating systems of personal computers, several machine-independent operating systems exist which can be run on many different computers. These manufacturer-independent operating systems include the Microsoft forms of BASIC, a very traditional, large-computer-like operating system called CP/M, and the interactive, Pascal-language operating system called UCSD Pascal.

Parallel Interface: A parallel interface for a peripheral device is a method of plugging that device into a computer such that a whole byte (or group of bytes) of data is transferred at one time. Thus in a parallel interface, one typically finds multiple wires. For a printer, a parallel interface might include 7 or 8 data wires and perhaps from 3 to 5 control wires. At the price of a more expensive connector, a much higher data rate results from parallel techniques compared to the alternative serial techniques.

Pascal: A compiled computer language called Pascal is personal computing's answer to the elaborate conventional languages COBOL, Algol and PL/I often found on large systems. Pascal is an invention (circa 1970) of computer scientist Niklaus Wirth, which was initially intended as an aid to teaching computer languages. Its success as a general-purpose programming language for computer systems and applications programming has led to its widespread use in computers at every level of size, from the Apple II computers available in every computer store to the world's largest and fastest supercomputer, the Cray-1.

Pin Feed: When paper is put in a typewriter-style friction-feed platen of a printer, it will typically stay aligned over the course of a sheet of paper. But when continuous computer forms are put through that same printer using friction feed, problem with alignment accumulates as the paper is printed, unless a pin-feed arrangement is used with holes along both edges of the paper. Pin feed is thus a standard feature of many computer printers, to solve the problems of alignment which can otherwise occur.

Pixel: In a graphics display device, a pixel is the smallest available unit of output which can be controlled by the computer. In a dot-matrix printer, the pixel is 1 dot within the matrix; on a television display device, the pixel is 1 dot on the screen of the television. In ordinary printing or noncolor displays, pixels are either black or white; in color displays, each pixel can typically have 1 of several different colors.

Program: A program is a set of instructions for a computer to execute, oftentimes the implementation of an algorithm. Programs are written in programming languages such as BASIC, FORTRAN, Pascal, COBOL, PL/I or even a symbolic assembly language.

Programming Language: See Computer Language.

Protocol: A protocol is the definition of a computer communications procedure, including the hardware of the interface and the software conventions of what standard patterns will be imposed on the data being communicated.

Pseudo-Operation: In a symbolic assembly language, a pseudo-operation is an operation code symbol which has no direct correspondence to an operation code which is available in the instruction set of the computer involved. Pseudo-operations are most often used to communicate something about the assembly process to the assembler, such as "skip to the next page of the listing," "define a constant data word with this value," etc.

Serial Interface: An interface between a computer and a peripheral device can be done over as few as 3 wires if a serial communications interface is employed. In a serial discipline which allows data to be sent in both directions, the RS-232C interface most common in personal computers, 1 wire is used for each direction of communications (2 wires total) and a third wire is needed to establish a common ground between the 2 devices. In this serial discipline, a time-ordered protocol is used to establish the beginning of a new byte of data, followed by the 8 bits of the byte and possibly 1 or 2 additional "overhead" bits which define the end of the character. The data rate of a serial communications interface is usually slower than the equivalent, parallel-communications interface, since all 8 bits of a byte must be funneled through the 1 wire available in each direction.

Software: Software is the term used to describe the intellectual value added to a technological system after its fundamental design has been determined. Thus in computer systems, the software constitutes the programs written or bought by its user after purchase of the system; in audio and video mass-entertainment systems, software is the content of programs bought on tape, phonograph or video disk; in music, the software is the score played by an orchestra or an individual soloist.

Source Program: Whenever a program is written by a human being, its source-program form is the humanly readable form seen on the terminal. A corresponding object-code form also exists when that program is executed. In systems with compilers or assemblers, the source program is translated explicitly into the object code version; in systems such as BASIC, the source program is translated into executable form immediately prior to execution. Because it is humanly readable, the source program is what gets edited, changed and updated in the process of creating a program.

Symbol: An arbitrary string of characters chosen for use in a source-language form of a program is called a symbol. The arbitrariness refers to the fact that any English language word can be used to form a symbol. Thus it is possible through the choice of symbols to make a program much more readable in its source-language form by choosing symbols which refer to the problem at hand.

Symbol Table: A listing of symbols provided by a compiler or assembler is called a symbol table. In its simplest form, a symbol table simply gives the symbol along with its translated address in the internal form of the program. If the symbol table also includes a list of the lines in the program which refer to the symbol, it is called a cross-reference listing.

Symbolic Address: An address is just a number identifying a place in some memory bank. As a number, it has no inherent correspondence with the way one thinks about the problem being solved with a computer. A symbolic address is a much more appropriate form in which a name (or symbol) is used to refer to a piece of data in a memory bank. The name can be chosen so that it is a good reminder of the interpretation to be given the data at the location. Symbolic addresses only exist in the source-language forms of programs.

Telecommunications: The art and practice of sending computer (or verbal) messages through the telephone network or via radio is called telecommunications. In the field of personal computing, this refers to the use of serial communications techniques and modems to allow messages to be sent via telephone to other personal computers or to centralized information services.

Thermal Printing: In thermal printing methods, a special heat-sensitive paper is scanned by a moving printhead which contains a dot matrix of electronically controllable heated areas. These heated zones are turned on if a dot image is to be recorded as part of the dot matrix representation of a character during the paper scan.

Value: A value is the content of a storage location (or set of locations) in the memory of a computer. Examples of values include numbers (eg: 3.14), character strings (eg: "this is a string"), and more comprehensive extensions to concepts like arrays, data structures and the like. Values are the basic items of data manipulated by programs.

Variable: A variable is a specific location (or set of locations) in a computer's memory that can contain some form of value used by a program. It usually has a symbolic name which is created by the person writing the program.

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Conducted by Laura Hanson

These pages are designed to keep our readers in touch with the marketplace. The material which appears here is obtained from manufacturers and is not to be taken as an endorsement by onComputing. We invite manufacturers to submit material and we publish the information we feel will be of interest to our readers.

Enhanced Apple II Computer Eases User Programming

The Apple II Plus is an enhanced version of the Apple II computer offering resident Applesoft Extended BASIC language and a new Auto-Start control read only memory for simplified start-up and screen editing. Applesoft is especially designed for business, scientific, and educationally oriented applications. The Auto-Start control read only memory provides easier programming, including automatic start-up, automatic disk load, reset protection, and easy screen editing. The Apple II Plus is available in three versions. The 16 K byte system is $1,195, the 32 K byte system is $1,345; and the 48 K byte system sells for $1,495. Contact Apple Computer Inc, 10260 Bandley Dr, Cupertino CA 95014.

CIRCLE 208 ON INQUIRY CARD

Radio Shack Introduces More Powerful TRS-80 Model II

Radio Shack has introduces their TRS-80 Model II, designed for more data storage, greater versatility and higher computing speed. It can perform as a general purpose data processing machine, an intelligent terminal, or a word processor. Software is immediately available for general ledger, accounts receivable, inventory control, mailing list management and payroll.

In addition to either 32 or 64 K bytes of internal programmable memory, the Model II has one built-in 8-inch floppy disk that stores an additional one-half million bytes. The system has a built-in 12-inch high resolution video monitor that displays 24 lines of 80 normal characters or 40 expanded characters. It features upper and lower case letters. The 76 key keyboard is detachable and movable to allow more convenient data entry.

The system is priced upward from $3450 for the 32 K byte one disk system. Contact Radio Shack, 1300 One Tandy Center, Fort Worth TX 76102.

CIRCLE 209 ON INQUIRY CARD

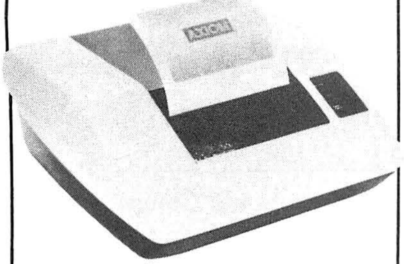
Personal Computer Introduced by Texas Instruments

Texas Instruments has introduced a personal computer for personal finance, home management, family entertainment and education. The TI-99/4 system consists of a console with 16 K bytes of programmable memory, a wide range of sound effects, 16 colors for graphic display, an Extended BASIC programming language, and a 13-inch color video monitor. Solid State Software command modules provide a complete assortment of programs for family use. Among peripheral accessories offered are a speech synthesizer to build a basic vocabulary and remote controls for game programs.

The price of the TI-99/4 system is $1,150. Solid State Software command modules carry prices ranging from $19.95 to $69.95 each. Contact Texas Instruments Inc, Consumer Relations, POB 53 (Attn: TI 99/4), Lubbock TX 79408.

CIRCLE 210 ON INQUIRY CARD

Micrographics Printer Combines Graphics and Alphanumerics



A MicroGraphics printer, the EX-820, which can mix high resolution graphics and full ASCII alphanumerics, is available from Axiom, 5932 San Fernando Rd, Glendale CA 91202, for $795.

The user can define the size of each graphic field and can choose from four preprogrammed horizontal dot resolutions, up to 128 dots per inch. Once the fields have been defined, the EX-820 automatically formats graphic and alphanumeric printouts to user specifications. The paper carries a conductive aluminized coating which is vaporized by a low voltage discharge from the print head to produce highly readable characters.

Standard features include: RS-232C serial input as well as parallel ASCII, software selection of three character sizes to give 80, 40 or 20 column printing, software which permits use of reverse printing in which light characters are formed on a dark background, and 2 K bytes of user programmable read only memory (low cost option) which converts the printer into an intelligent printer.

Dimensions are 11 by 4¼ by 12 inches (28 by 10.8 by 30.5 cm). It weighs 12 pounds (5.4 kg), including a 230 foot roll of paper.

CIRCLE 200 ON INQUIRY CARD

Nonimpact Ink Jet Printer

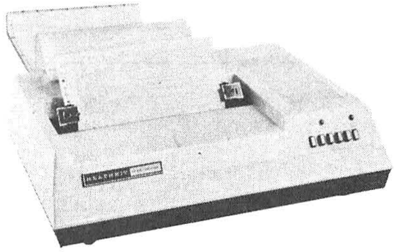
Called Quietype, this nonimpact ink jet printer prints 180 characters per second and is well suited for desktop operation in offices, libraries, hospitals and other environments where minimum noise levels are desirable.

Quietype prints 80 characters per line as standard format, and can switch to 132 characters per line in compressed format.

The Quietype has been designed for video hardcopy, minicomputer and microcomputer outputs, and message switching applications. Printing is done on a self-contained roll of class II Teletype paper.

The single unit price for the printer with an RS-232 interface is $2995. Disposable ink cartridges capable of printing six million characters (about 3000 pages) are priced at $17.50 each. For further information contact Silonics Inc, 525 Oakmead Pky, POB 9025, Sunnyvale CA 94086.

CIRCLE 201 ON INQUIRY CARD



Heath's Low Cost Line Printer

Heath Company has a low cost line printer designed for use with its H8 and H11A computer systems (and others) using a standard serial interface. The WH-14 Line Printer prints the standard 96 character ASCII set (upper and lower case) in a 5 by 7 dot matrix, with a maximum print speed of 135 characters per second. Line spacing is six lines per inch (eight lines per inch software selectable) with selectable line length of 80, 96 or 132 characters.

The WH-14 connects to the H8 or H11A computer via a standard RS-232C serial interface or 20 mA current loop. A 25 pin male EIA connector is provided for hookup, and a paper rack is included at no extra cost.

For information on the WH-14 Line Printer, which is priced at $895, contact the Heath Co, Dept 350-820, Benton Harbor MI 49022.

CIRCLE 202 ON INQUIRY CARD

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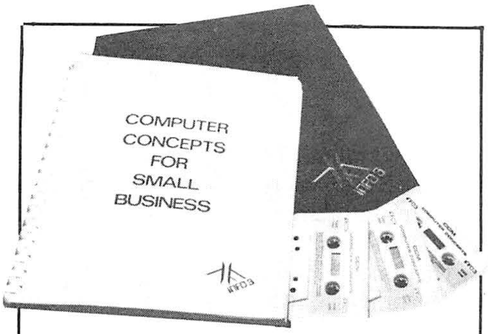

Self-Instructional Course Covers Basic Computer Concepts

A self-instructional course has been announced by Info 3, 21241 Ventura Blvd, Woodland Hills CA 91364. *Computer Concepts for Small Business* covers basic computer concepts, including types of data and how they are processed, how systems are developed, the operation of implemented systems and how to select a computer.

The course is designed to aid people in business to prepare for their first computer by presenting the prerequisites of sound business computer applications, showing how systems are developed and operated and covering critical management decisions like security and personnel staffing.

The course contains over two hours of cassette tapes, plus a workbook of over 200 pages. The price is $140. ■

CIRCLE 207 ON INQUIRY CARD

Computer Cassette Listing for TRS-80, PET and Apple

Robert Elliott Purser's *Reference List of TRS-80, PET and Apple Computer Cassettes* is a directory of over 1000 cassettes for sale or trade from over 100 sources. The list is published quarterly and the subscription rate is $12 per year. Single copies are available for $4 postpaid. Contact Robert Elliott Purser, POB 466, El Dorado CA 95623. ■

Coming Events

September 5-8, Info/Asia, Ryutsu Center, Tokyo. This exposition will be devoted to information management, computers, word processing and advanced business equipment. The exposition will be accompanied by a four day conference. Contact Clapp & Poliak, 245 Park Av, New York NY 10017.

September 8, Second Annual Microcomputer Faire, Cullen College of Engineering, University of Houston. 70 exhibitors are expected at this computer faire. Contact Dr John L Hubisz, Division Natural Science & Math, College of the Mainland, Texas City TX 77590.

September 25-27, Mini/Micro Conference and Exposition, Convention Center, Anaheim CA. Contact Robert D. Rankin, Managing Director, Mini/Micro Conference and Exposition, 5528 E La Palma Av, Suite 1A, Anaheim CA 92807.

September 25-27, WPOE '79, San Jose Convention Center, San Jose CA. This show will be dedicated to word processing and office/business equipment, services and materials. Complementing the exhibit will be a three day executive conference program that focuses on emerging technologies and their applications in the office. Contact Cartlidge & Associates, Inc, 491 Macara Av, Suite 1014, Sunnyvale CA 94086.

September 28, 29, &30, Northeast Personal & Business Computer Show, Hynes Auditorium, Boston MA. Displays and exhibits will showcase microcomputers and small computer systems of interest to businesspeople, hobbyists, professionals, etc. Lectures and seminars will be presented for all categories and levels of enthusiasts, including introductory classes for novices. Contact Northeast Exposition, POB 678, Brookline MA 02147.

October 15-18, 6th Information Management Exposition and Conference, New York Coliseum, New York NY. Contact Clapp & Poliak, Inc, 245 Park Av, New York NY 10017.

October 28-30, The Tenth North American Computer Chess Championship, Detroit Plaza, Detroit Michigan. Sponsored by the Association for Computing Machinery, this is a four round, Swiss style tournament with the first two rounds to be played on October 28th (1 PM and 7:30 PM), one on October 29th (7:30 PM) and the last round on Tuesday, October 30th (7:30 PM). Contact Monroe Newborn, McGill University, School of Computer Science, 805 Sherbrooke St W, Montreal PQ, CANADA H3A 2K6.

October 30-November 1, Interface West, Anaheim Convention Center, Anaheim CA. This third annual west coast small computer and office automation systems conference and exposition will feature over 100 company exhibits and 60 conference sessions covering a variety of data processing, word processing, data communications, management hardware, software and service topics. Contact the Interface Group, 160 Speen St, Framingham MA 01701.

Coming in onComputing

Games: How do computer games relate to personal computers? What did onComputing find out at a recent visit to the Summer Consumer Electronics Show?

Sargon vs Microchess: Which Plays Better Chess? A comparative software review of two chess playing programs.

Computers & Education: The Talcott Mountain Science Center uses computers large and small in an exciting program for gifted students in central Connecticut.

Plus the regular onComputing departments, features and much more.

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5	25	45	65	85	105	125	145	165	185	205	225	245	265	285
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295
16	36	56	76	96	116	136	156	176	196	216	236	256	276	286
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300

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Fall 1979

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September 1977

THE TRAP DOOR

March 1979

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Popular Electronics March, 1979

"(Their) new Challenger 1P weighs in at $349 and provides a remarkable amount of computing for this incredible price."

Kilobaud Microcomputing February, 1979

"Over the past four years we have taken delivery on over 25 computer systems. Only two have worked totally glitch free and without adjustment as they came out of the carton: The Tektronic 4051 (at $7,000 the most expensive computer we tested) and the Ohio Scientific Superboard II (at $279 the least expensive) . . . The Superboard II and companion C1P deserve your serious consideration."

Creative Computing January, 1979

"The Superboard II and its fully dressed companion the Challenger 1P series incorporate all the fundamental necessities of a personal computer at a very attractive price. With the expansion capabilities provided, this series becomes a very formidable competitor in the home computer area."

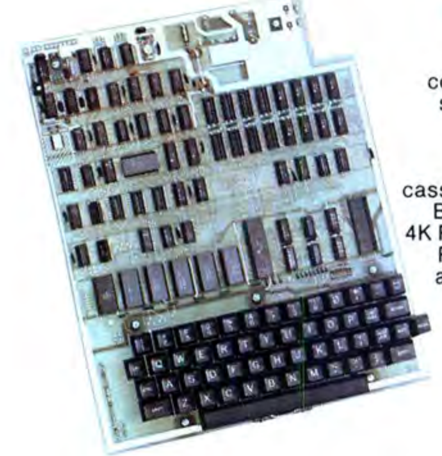
Interface Age April, 1979

"The graphics available permit some really dramatic effects and are relatively simple to program . . . The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. Everything is there that you need; you simply build on to what you already have. You don't have to worry about trading off existing equipment to get the system that will really do what you want it to do. At $279, Superboard II is a tough act to follow."

Radio Electronics June, 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."

Byte May, 1979



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