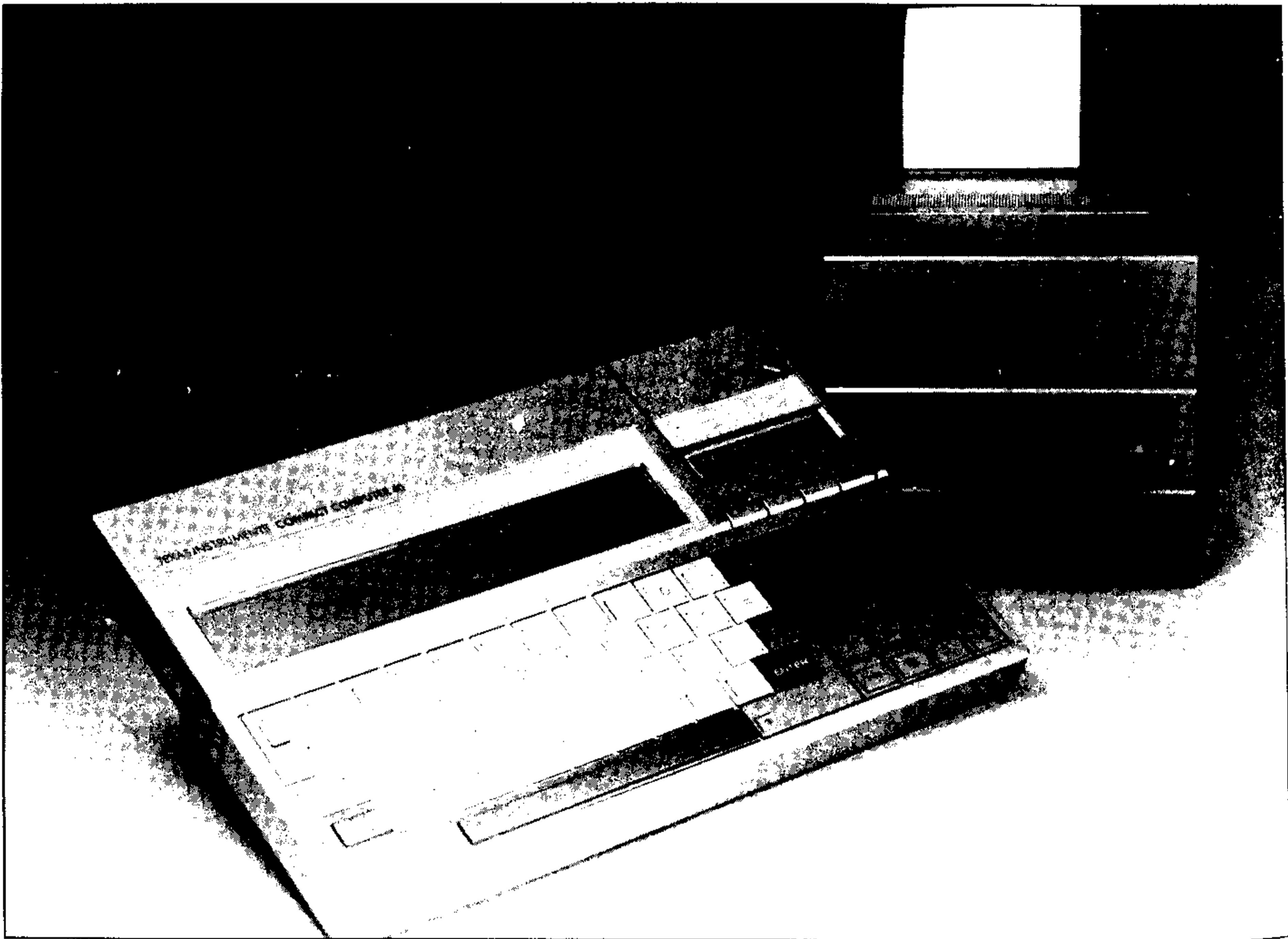


TI Writes the Book on Portables

by Bob McElwain

Texas Instruments' book-size CC-40 portable computer offers advanced features, a superb manual, and numerous peripherals. In short, the buyer can't go wrong.



The Compact Computer 40 (CC-40) is a book-size portable computer (9-1/4"-by-5-3/4"-by-1") from Texas Instruments (Dallas, TX) that offers more power than some currently popular low-end micros. Although more likely to be used on a desktop or on your lap, it can be held in one hand, leaving the other free for entry. (It weighs about 23 oz.) The

base unit provides 5,742 bytes of usable memory at \$250. An additional 16 KB chip can be added at a cost of \$150. The Basic is excellent. It is powerful in itself and provides for assembly language sub-routines. Among several firmware packages, an Editor/Assembler is available. Quality peripherals are also available, including a high-speed cassette tape drive.

Those looking for micro power in a small, easily carried package may find that this computer is precisely what they need.

The keyboard is in QWERTY format with a numeric pad at the right. Although quite large compared to pocket computers, touch typing won't work; the width of eight fingers exceeds keyboard width. Some mode of multi-finger use will be

convenient with a full

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Pressing followed b enters one functions.

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convenient, but full two-handed use, as with a full size keyboard, is not practical.

A line of 31 characters can be displayed. The length of the display is nearly 6", allowing room for character sizes that are easy to read. Lower-case characters are available; user-defined characters are allowed. The 17 enunciators (e.g., SHIFT, DEG) are also a good size. One enunciator gives warning of weak batteries, allowing ample time for saving code and replacement. (Six enunciators are user-assignable.) Display brightness is adjustable.

Pressing FN, the special function key, followed by the appropriate alpha key, enters one of 30 common statements or functions of Basic with two keystrokes (e.g., GOSUB, Print, Sine, and Arcsine). A plastic overlay is provided to show key associations. It would be more convenient if symbols were printed directly on the computer; I had to tape the overlay to hold it in place.

A built-in stand folds out that tilts the computer at an angle of about 30 degrees. This facilitates key access and display viewing when used at a desk. This simple feature adds a great deal of convenience.

The CPU is the TMS70C20 and 8-bit CMOS technology is used throughout. The unit is powered by two AA type batteries. An AC adaptor is available for \$16 and an auto-off feature is provided. Code is retained when power is turned off but, strangely, variable values are lost. It is not clear why this design was implemented. There could be some user inconvenience here. If interrupted by a phone call, auto-off could easily occur unnoticed. Whatever values are lost, will need to be recomputed or manually restored.

An eight-pin connector is provided at the rear of the machine for serial attachment of peripherals. Although deeply recessed, there is no cover when not in use. Considering vulnerability to static electricity, this is a weakness. No case is available for this computer. When I asked about this, I was told it was expected that users would carry the computer in a briefcase. This seems reasonable, but the inside of my briefcase contains its share of debris. I'd rather not have this debris co-mingled with the 8-pin connector or settling onto the keyboard. If I were to purchase this computer, I'd find a case somewhere or seal off the connector port with masking tape.

All one could ask

In calculator mode, the CC-40 offers all one could ask. The functions from Basic are available and 30 can be entered with two keystrokes. Previously assigned

variables can be used. An expression to be calculated can be as long as 80 characters in length. The result can be assigned to a variable or used in a subsequent calculation. Order of operation is algebraic. Angle measures may be radians, degrees, or grads.

When a result is displayed, the original expression is erased from the display. It can be restored, however, to the display with two keystrokes. This is a powerful feature, not available on all machines. Given an obviously incorrect result, it's much easier to edit the expression calculated than to reenter the entire expression.

Although display accuracy is limited to 10 significant figures, at least 13 are carried internally. Constants can be loaded

*TI will offer an
exchange rate
for which your
computer is
swapped for one
that has been
fully serviced
and has an
additional warranty.*

or assigned with as many as 13 significant figures.

Each of the numeric keys can be associated with an expression of as many as 80 characters. This powerful feature adds 800 bytes of usable memory. Expressions stored can be used in calculator mode or in Basic. Expressions are retained on power off.

Editing is straightforward. The cursor can be moved left or right as needed. To examine a program, scrolling up and down is supported. All keys repeat if held down. Even scrolling is quite fast. Deletion is a two key function. Press SHIFT, then DEL to delete the character under the cursor. Holding the SHIFT and DEL keys down continues deletion of characters right to left. To insert characters, the cursor is placed over the character to the right of the position of insertion. SHIFT, INS allows the insertion of characters until the cursor is moved, thus ending the insert mode.

The Basic provided is extremely powerful. It includes the conventional functions

and statements, but also many others not usually found on small machines (see accompanying figure). For example, as with many larger computers, there is no calculator versus program, or run mode. If the machine is on, any of these modes is directly available.

Edit features

The edit features described above are applicable here, including DELETE and INSERT. In addition, CTL right arrow tabs to the next position and CTL left arrow tabs back to the previous position, provided characters exist at the target positions. Tab positions are set at 1, 25, and 50. CTL up arrow moves the cursor to the beginning of a line and CTL down arrow deletes all characters from the cursor to end-of-line. DEL 150, 320-350, 560 deletes lines 150 and 560 specifically and all lines between 320 and 350.

A syntax check is performed on ENTER. An errant line can be redisplayed with two keystrokes. If a run time error occurs, right arrow displays the line and error number; up or down arrow displays the errant line of code. Spaces are required after line numbers and preceding and following key words. Failure to space properly results in syntax error. I find this a bit annoying; I prefer machines that allow entry without spaces. But the keyboard includes a large space bar and one should quickly become accustomed to spacing requirements. Certainly manual examples are clear and definitive.

Of the unusual features supported, the most notable may be IF-THEN-ELSE. When used as follows, an extremely powerful entry checking routine is provided with minimal code.

```
IF NUMERIC(A$)
  THEN A=VAL(A$)
  ELSE PRINT "NOT NUMERIC"
NUMERIC tests string A$ to see that all characters are numeric. If so (NUMERIC(A$)=-1), then A$ is converted to its numeric input. Otherwise, an error message is printed and the program can return for reentry. The above statement assumes A$ was input prior to execution. Here's an even more powerful structure for input, the ACCEPT statement. Parenthesized items are optional.
ACCEPT (AT A) (SIZE B) (BEEP)
(ERASE ALL) (VALIDATE C$)
(NULL D), E
```

In use, A, B, C\$ and D are enclosed in parentheses and E is the variable (or string) entered. AT(A) optionally positions the cursor in column A. Size (B) limits the number of characters that will be accepted. Beep sounds a tone to indicate entry is required. ERASE ALL

clears the display and NULL(D) assigns D to E on ENTER only. VALIDATE tests entry to see if it contains only the characters given in C\$. Optionally, C\$ can be set to ALPHA (Alpha input), UALPH (only upper-case alpha), DIGIT (0-9), NUMERIC (0-9,.,+,-, or E), ALPHANUM (ALPHA + DIGIT), or UALPHANUM (upper case + DIGIT). When I think of the time and bytes typically used to test entry, the above structure is at least neat.

Space does not allow a complete discussion of all Basic features provided. Ideally, the above suggests the power available on the CC-40. Output with format control is equally sophisticated. In brief form, here are additional features users will find significant.

Variable names can contain a total of 15 characters. Numeric and string arrays can have up to three dimensions. A, B, C=0 assigns zero to A, B, and C. RESTORE N sets the data pointer to Line N. KEYS accepts a character without ENTER. Errors, warnings, and BREAK can be trapped and subsequent program execution controlled by code. Break points can be set and cleared as needed.

A complete set of logic functions is available including XOR, exclusive or. IF M<M is true, A=M<N assigns 1 (true) to A, while A=N<M assigns 0 (false) to A.

The set of error messages seems comprehensive. There are 29 I/O error messages and 47 others. Certainly this list covered the errors made in testing. Syntax error is a bit general, but other messages seem quite to the point.

Unlike many other manufacturers of small handheld computers, Texas Instruments has held back no secrets. The ability to build and use assembly language subroutines is built in and well documented. To write your own assembly code, the Assembler/Editor cartridge (\$126) will be useful. However, the basic CC-40 computer has a variety of subroutines built in. Each is accessible with Call. As with other higher level languages, variables can be passed to and from subroutines. Existing subroutines provide Peek, Poke, memory allocation for subroutines and release of memory as required, a routine to define characters and another to control the six display enunciators designed for user control. Key can be used to determine which key, if any, is pressed. Cleanup frees variable space not in current use and Debug provides for debugging an assembly language program. A portable, battery-operated computer, expandable to nearly 22 KB of usable space, given this Basic and assembly language capability, is a

COMMANDS

LIST M,N — Lists line M through N. Also: LIST M for Line M and LIST for List ALL
RUN — Execute current program. Also: RUN N, to run beginning at Line N
NEW — Clear existing code
NUMBER M,N — Auto number for code entry beginning with Line M and increment of N
RENUMBER M, N — Renumber an existing program beginning with line number M, incrementing by N
CONTINUE — On Breakpoint

STATEMENTS

DEG,RAD,GRAD — Mode for angle measure
DATA — Quotes not required on string data
DIM — Up to three dimensional numeric or string arrays
FOR-NEXT-STEP — Conventional usage, parameters need not be integral
GOSUB — RETURN — Conventional usage
GOTO — Conventional usage
IF-THEN-ELSE — Branch on true or false
ON GOSUB — Computed GOSUB
ON GOTO — Computed GOTO
REM — Conventional usage
RESTORE (N) — Reset data pointer (to Line N)

I/O STRUCTURES

DISPLAY — Output format control
FORMAT — Specification
IMAGE — Output format control
PRINT — Conventional usage
INPUT — Conventional usage; prompt may be included
LINPUT — Conventional usage
ACCEPT — Input validation

SYSTEM SUBROUTINES

CHAR — User-defined characters
DEBU — Assembly language debugger
ERR — Error messages
GETMEM — Allocate memory
INDIC — Control enunciators
PEEK — Examine memory location
POKE — Write to memory location
RELMEM — Release memory allocated
SETLANG — Set language for prompts and error messages

FUNCTIONS

Circular — SIN, COS, TAN, ASN, ACS, ATN
Logarithm — LOG, LN, EXP (Antilog of LN)
Numeric —
ABS — Absolute value
INT — Integer
SGN — Sign of variable
SQR — Square root
PI — 3.14159265359
String —
ASC — ASCII code of string character
CHR\$ — ASCII code to string
LEN — Length of string
RPT\$ — Repetitions of a given string
SEG\$ — Substring (MID\$ in some Basics)
STR\$ — String equivalent of numeric
VAL — Numeric value of numeric string
POS — Position of first occurrence of one string in another
Random numbers —
RANDOMIZE — Random seed for generation
RND — Random number between 0 and 1
INTRND — Random integer within specific range

TRAPS

ON BREAK
ON ERROR
ON WARNING

Principal commands, statements, and functions

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machine to be noted. I have not seen such power in so small a package. Functionally, this computer, the CC-40 at \$250, is tough to beat.

As good as the computer is, the manual is better. It is remarkable to find a readable, comprehensive computer manual that clearly indicates limitations. It is beautifully printed, another rarity. A comprehensive table of contents and index is provided. An excellent reference section provides complete details on instruction commands and functions. All entries are cross referenced to related elements. In short, I like it very much; I don't recall seeing a better one.

Beginners will need more; the manual assumes the user knows something of computers in general and how to write programs in Basic. However, there are many general pieces from which one can learn to write programs in Basic. Since the computer is easy to use and the manual gives complete information, one can learn with this computer, given additional guidance from other materials.

Peripherals

The key unit is the Wafer Tape drive (\$140). With a capacity of 48 KB and a data transfer rate of 1,000 bytes per second, performance is reported to be midway between that of audio cassettes and floppy disks. When used for data files, sequential and random access modes are provided. A four-color printer-plotter (\$200) prints 34 characters per line. Also available are an RS-232 Interface (\$125), Modem (\$100), and TV Interface (\$100). If the tape drive performs as reported, selection of other peripherals as appropriate can provide an excellent system for nearly any task a portable computer could be expected to perform.

Firmware available at this writing includes the Editor/Assembler (\$130), two game packages at \$40 each, and the following, each priced at \$60: Memo Processor for Data Communications, packages for Mathematics, Statistics, Finance Business Graphics, Electrical Engineering, and Chemical Engineering. More is reportedly in production. Firmware is delivered in a ROM cartridge that is easily installed in the slot provided in the base unit.

Service is to be provided at a flat rate. At this writing, rates have not been established. However, a toll-free number is available to call for rates in advance. Further, there will be an exchange rate for which your computer is exchanged for one that has been fully serviced and carries an additional warranty. The exchange policy is intriguing. It will be interesting to see how it works in practice.

Texas Instruments appears to be making a real effort to support their users. In the manual, they offer an address and also a toll-free phone number. Out of curiosity, I called, asked some dumb questions, and received good information delivered in a professional manner.

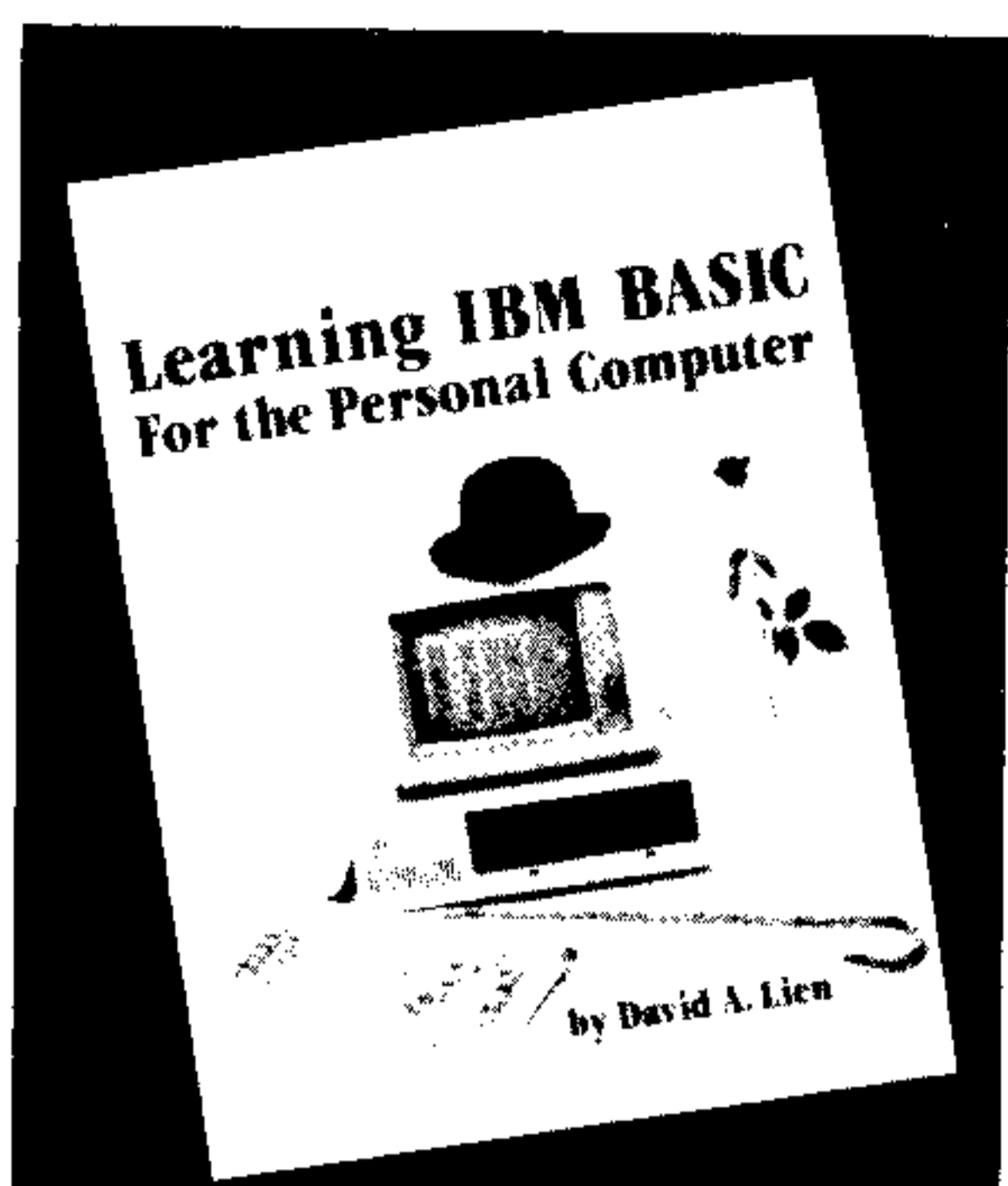
Comparing the Texas Instruments' CC-40 to other computers is difficult. As with so many of the newer designs, the CC-40 has some nice features. In function, with appropriate peripherals, it is comparable to many micros. But it suffers from several limitations in such comparisons, particularly its speed. CMOS technology is slow, but ideal for a battery-operated system because of low power consumption.

In a sense, the CC-40 is comparable to Radio Shack's Model 100, but not in price. The CC-40 costs much less. Since there is so much power and memory space, comparisons to pocket computers seem futile. Every computer has its applications. The wrong computer for a given job is always a waste.

Given a task or set of tasks appropriate to the CC-40, the only comparable machine I have used is the Sharp CP-1500. Sharp has recently announced a 16 KB expansion chip, which means memory is roughly equivalent. Pricing is about the same except in peripherals. Sharp peripherals, although less costly, lack the power and performance of those for the CC-40. Execution speed is about the same. Sharp has recently released details of their assembly language, thus the bit pickers can now have their way with the PC-1500.

Consequently, given a set of tasks appropriate to the CC-40, you may also wish to consider the Sharp 1500. If you do, you'll have to take some time with each unit before deciding. In addition to the above, here are the basic differences. The Sharp is smaller, comes with a sturdy case and may be more easily (and safely) carted about. It has a speed advantage when number crunching. Perhaps most importantly, values, as well as code, are held on power-off. The CC-40, on the other hand, has a more powerful Basic and is generally the stronger computer when function is the criteria. If you choose the CC-40, it is hard to believe you'll have made a mistake. []

Contributing Editor Bob McElwain is a graduate of Pepperdine College with an MA in Mathematics from Boston College. He works with Los Angeles City Schools as a computer science instructor, and as a software consultant for business and industry.



For Personal Computers

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