

*Photo 1: A view of the complete TRS-80 computer with the Radio Shack supplied video monitor and audio cassette recorder, supplied courtesy of Radio Shack. Priced at \$599.95 for a 4 K byte version, this personal computer includes a BASIC interpreter and cassette interface software in 4 K bytes of read only memory. This is a BASIC only machine. The user cannot gain access to the machine language of the Z-80 processor which runs the BASIC interpreter.*



## The Radio Shack TRS-80: An Owner's Report

On August 3 1977, the Radio Shack division of Tandy Corporation announced its entry into the personal computing market with the TRS-80 microcomputer. The move held special significance for the personal computing industry, for with parent company sales of nearly a billion dollars and over 6000 retail stores including 500 overseas, Radio Shack is in a unique position to help bring personal computers to the average man or woman.

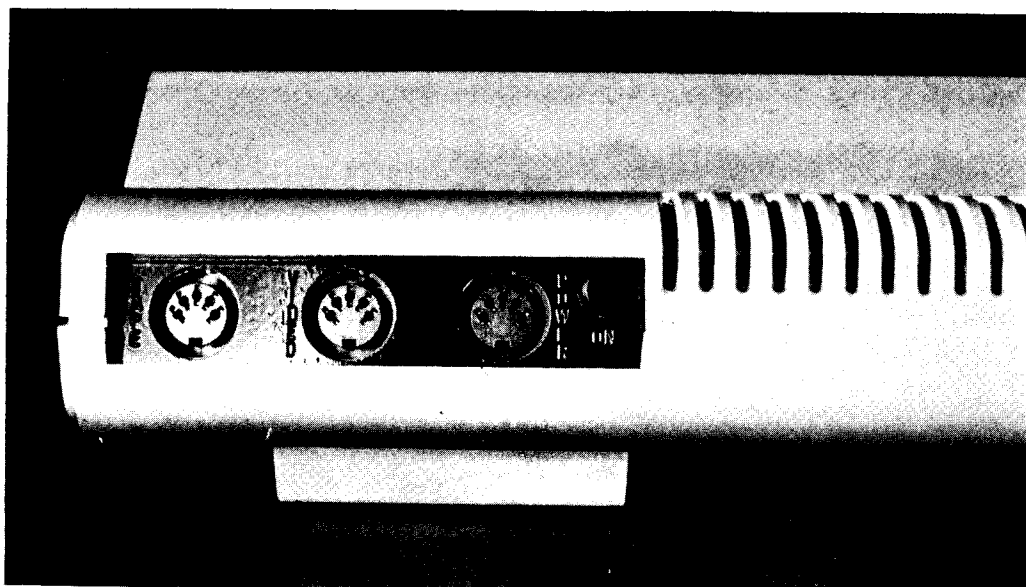
The TRS-80 is an "appliance" computer, preassembled and warranted with a built-in BASIC language interpreter, and at a price of under \$600 it will be affordable by many new personal computing enthusiasts. But \$600 still represents a major investment for most of us, and it's desirable to know as much as possible about the detailed speci-

fications of a computer before buying one. If you're contemplating purchase of one of the "appliance" computers now on the market, this review should be helpful to you in making your evaluation.

I ordered a TRS-80 the day after Radio Shack's press announcement, and hence I received one of the early units without a complete user's manual or any technical information on the TRS-80's provisions for expansion. Radio Shack has announced plans to introduce several significant hardware and software extensions to the basic TRS-80, some of which may become available before this article appears in print. As you read this, bear in mind that it was written in late October 1977, based on the somewhat limited information available at that time.

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Boston MA 02134

Photography by Dan Comly



*Photo 2: This back view of the TRS-80 processor unit shows the three 5 pin DIN type connectors used to attach the power supply, video monitor and cassette recorder. DIN connectors are commonly used in the audio component field, and are available at most Radio Shack retail outlets. If the complete system of photo 1 is purchased, all necessary cables are supplied.*

### General Specifications

Photo 1 illustrates the complete TRS-80 package, consisting of the keyboard which houses the microcomputer and memory, a video monitor, an audio cassette recorder and a power supply. The keyboard unit measures 16.5 by 8 by 3.5 inches (41.9 by 20.3 by 8.9 cm) and is very portable. The entire package including the video monitor and cassette recorder is a lot to carry, but I did take the entire computer with me on one half mile walk from the Boston home of Radio Shack to my apartment.

The components of the TRS-80 are easily plugged together using standard 5 pin DIN type audio connectors and cords which are supplied with the complete package. Jacks for the power supply, video monitor and cassette recorder are mounted on the back side of the keyboard unit, as illustrated in photo 2. For the experimenter, the DIN type plugs and jacks are available (you guessed it) as a stock item in most Radio Shack stores.

The video monitor and cassette recorder are standard items, and if you already own one or both of these you can probably use them with the TRS-80 to save on your investment. I actually bought only the keyboard unit for \$400 and attached it to a Radio Shack CTR-35 cassette recorder which I already owned, and a Hitachi TV set modified for direct video entry using the Pickles & Trout kit. My home setup is shown in photo 3. The cassette recorder you use should have "earphone" and "auxiliary input" jacks and a "remote" jack for starting and stopping the cassette drive motor. The connection cords for the cassette recorder are supplied with the keyboard unit. The video monitor or TV set should accept a direct video signal

(EIA standard, 75 ohm input) rather than a radio frequency (RF) signal generated by a modulator in order to provide the bandwidth required for the TRS-80's display. For the prospective buyer who doesn't already own this sort of equipment or who doesn't possess the special skills needed to modify a TV set, the complete TRS-80 package includes the video monitor and cassette recorder.

Inside the TRS-80's keyboard unit are 4 K bytes of read only memory containing Radio Shack's Level I BASIC interpreter as well as software to control the cassette recorder and display screen, and 4 K bytes of programmable memory which holds the user's BASIC program. The eight integrated circuit chips inside the unit which provide the 4 K bytes of programmable memory can be replaced by higher density memory chips to provide 8 K or 16 K bytes of memory inside the basic keyboard unit. Similarly, the two chips which provide 4 K bytes of read only memory can be replaced by higher density chips to provide 8 K or 12 K bytes of read only memory, enough to hold a much more powerful BASIC language interpreter and disk operating system which are said to be planned for later introduction.

Radio Shack has priced separately every component and memory option in the TRS-80 system. The microcomputer with keyboard and 4 K bytes of user memory is \$399.95; the video monitor is priced at \$199.95; and the CTR-41 cassette recorder is \$49.95. These components can be purchased as a complete package deal for \$599.95. An additional 4 K bytes of programmable memory for a total capacity of 8 K is priced at \$99.95, while an additional 12 K bytes of memory for a total capacity

of 16 K is priced at \$289.95. For planning purposes it is important to note that there is no "trade-in allowance" on the lower density memory chips if the user decides to expand to the higher density chips. Thus it would not make sense to order the TRS-80 now with 8 K bytes of memory if the owner later intended to expand to 16 K bytes (which will probably be necessary to support the future disk operating system) since the total outlay for 16 K bytes of memory would then be \$389.90.

BASIC programs in memory are stored in character form rather than encoded form, but abbreviations for most of the BASIC keywords are provided to save space. Thus you can write P. instead of PRINT and G. instead of GOTO, and thereby save a considerable amount of memory space since these keywords occur so frequently in a large program.

The TRS-80 is based on the Z-80 microprocessor, but this fact is really only important from the standpoint of designing and implementing the computer's read only memory software. At present the TRS-80 user is "insulated" from the hazards (and

pleasures) of programming the Z-80 directly, since the BASIC interpreter is automatically activated when power is turned on, and there is no way at present to drop into machine language.

#### Display Screen

The TRS-80 includes a 12 inch (30.5 cm) black and white, high resolution video monitor which presents 1024 characters, arranged in 16 lines of 64 characters each. (The display is said to be "software selectable" for 32 or 64 characters per line, but no documentation is available at this writing on how the selection is made.) The display is memory mapped (ie: continuously read out of a section of programmable memory separate from the BASIC program and data memory), and is easily controlled from BASIC for both alphabetic and graphic displays.

Built-in software provides an underline cursor and automatic scrolling from the bottom of the display. The keyboard includes four keys to move the cursor in any direction, but present software supports only the "cursor left" key which deletes the character



*Photo 3: The author's home setup showing the TRS-80 processor unit with its keyboard, connected to an ordinary Hitachi television set modified for direct video entry using a kit from Pickles & Trout, POB 2276, Goleta CA 93018. This setup permits conventional program reception on the television and saves about \$100 over the price of the complete Radio Shack system; but it requires some electronics skill in order to modify the television set. Use of this television set and modification kit is further described in the article "Convert Your TV Set to a Video Monitor" which will appear in a forthcoming issue of BYTE.*

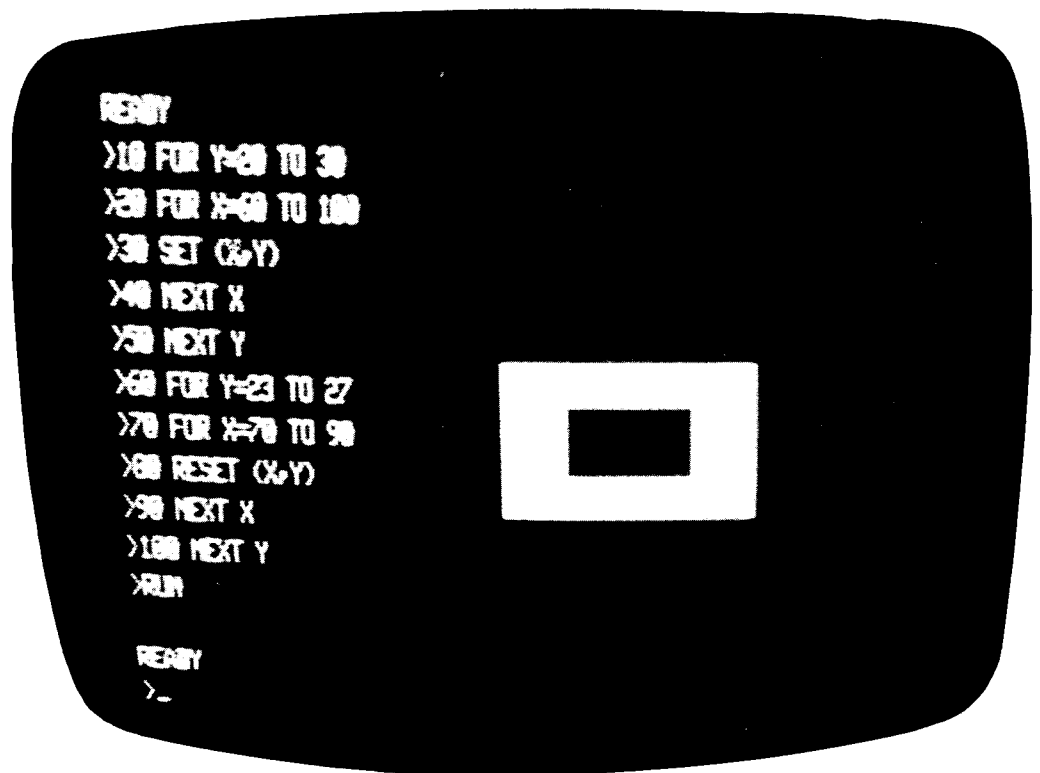


Photo 4: An illustration of the use of the TRS-80's graphics capabilities. The BASIC program shown on the screen created the square and cutout by using the SET and RESET statements to turn points on and off. This illustrates the arbitrary way in which text and graphics can be interspersed on the display.

or characters just entered on the current line. (The cursor can be moved to arbitrary positions under BASIC program control, as described below.) The "cursor up" key is used to continue a line by line listing of a program which has already filled the display screen. Another key is provided to clear the screen.

#### Character Set and Graphics

The TRS-80's character set consists of 58 characters including upper case alphabetic and various numeric and special characters. In addition, each character position on the screen is divided into six tiny squares, two across and three down, and each of these squares can be set on (white) or off (black) under program control. Thus graphic displays with a resolution of 128 by 48 points can be created on the screen.

The BASIC language features for controlling the graphic display are especially convenient. A point can be turned on with a statement of the form SET (X,Y), where X ranges from 0 to 127 and Y ranges from 0 to 47, or turned off with the statement RESET (X,Y). The function POINT (X,Y) can be used in an IF statement to determine whether a particular point on the display is currently on or off. Besides the graphic point addressing, the 1024 character positions on the screen are numbered sequentially from left to right, line by line, and the cursor can be set to an arbitrary position with a statement such as PRINT AT Z,

"EXAMPLE MESSAGE", A+B, where Z varies between 0 and 1023. Thus displayed messages, which can be interspersed with graphics, are easily placed at any position on the screen. Finally, the CLS statement in BASIC can be used to clear the screen.

Photo 4 provides a simple illustration of the use of the TRS-80's graphics capabilities. The BASIC program shown on the screen created the graphic display by first filling in a solid square with the SET statement, and they blanking out the inner square cutout with the RESET statement. A variety of simple pictures could be drawn in this manner. The TRS-80's graphics features are especially convenient for plotting data or mathematical functions, due to the ability to address single points on the display.

#### Keyboard

The TRS-80's keyboard includes 53 keys with the standard spacing and arrangement used on a typewriter keyboard. It is well-suited for touch typing and will be quite familiar to the experienced user of the Teletype terminals found on timesharing systems and minicomputers. The keys are of the mechanical contact type, and they have a reasonably good "feel" and seem quite reliable in use. A BASIC program can read numeric quantities and character strings from the keyboard with the INPUT statement, which allows a message to be displayed at the same time, as in INPUT "ENTER STARTING VALUE";X.

<b>Data Types</b>	Real numbers (eg: A) and two string variables (A\$ and B\$), each up to 16 characters long.		
<b>Arrays</b>	One array variable, A (subscript), with one dimension. The array is as large as the entire memory remaining, after allowing for the program and ordinary variables.		
<b>Precision</b>	Six significant digits for real numbers.		
<b>Speed</b>	Executes the loop 10 FOR I=1 TO 10000, 20 NEXT I in about 22 seconds.		
<b>Statements</b>	LET	GOTO	REM
	READ	IF ... THEN	RUN
	DATA	FOR ... TO ... STEP	CONT
	RESTORE	NEXT	NEW
	PRINT	GOSUB	LIST
	INPUT	RETURN	
		ON ... GOTO	
		ON ... GOSUB	
		STOP	
		END	
<b>Operators</b>	=	=	
	+	< >	
	-	< =	
	*	> =	
	/	<	
		>	
<b>Built-in Functions</b>	ABS	MEM	
	INT	TAB	
	RND		
<b>Other Features</b>	CLOAD	CLS	PRINT AT
	CSAVE	SET	INPUT#
		RESET	PRINT#
		POINT	

Table 1: A brief summary of the features and performance of Radio Shack Level I BASIC, as available in the TRS-80.

### Cassette Drive

The cassette drive interface can be used with any reasonably good audio cassette recorder, as outlined above. Data is recorded at a rate of about 250 bits per second. The recording method is designed to be reliable but does not employ any data redundancy or error correction capability. At first I had some trouble recording and playing back programs, but my results improved considerably when I set the tone control to zero. Like most cassette interface systems, the TRS-80 can get hung up searching for a signal on the tape that it never finds. A reset button near the expansion connector can be used to halt the cassette loading process, but afterwards memory may contain some "garbage" from the partially loaded program.

A problem frequently encountered when using audio cassette recorders with personal computers is that when a long program recorded on cassette is being read into memory, you don't know whether the computer is reading properly or has been unable to find the recorded program. The TRS-80 lets you know what's happening while a cassette is being read by flashing two asterisks on the screen when a program is found, and alternating between one and two asterisks while the program is being read. The TRS-80

also starts and stops the cassette drive motor automatically through the "remote" jack, but this means that you must remove the "remote" plug in order to manually rewind or fast forward the tape. This inconvenience is a necessary consequence of using a separate, standard audio cassette recorder without a manual motor control override implemented through operating system software.

### Operating System

The TRS-80's operating system controls the cassette interface in response to commands and BASIC language statements. You simply type CSAVE to write the BASIC program currently in memory onto a cassette, and CLOAD to reload it later. The saved programs are not named and the CLOAD command will always load the next program it finds on the tape, but you can save several programs on the same cassette and find them later by writing down the settings of the tape index counter on a piece of paper. Also provided are PRINT# and INPUT# statements in BASIC which let you write and reread the values of program variables on cassette. Although Radio Shack plans to offer a second cassette interface, the syntax of the PRINT# and INPUT#

statements does not provide for references to different cassette units, so use of a second cassette drive will probably depend on support from "Level II" BASIC, which Radio Shack is said to be readying for future release.

**Radio Shack Level I BASIC**

Table 1 summarizes the features and performance of the Level I BASIC interpreter built into the TRS-80. The BASIC language features provided are somewhat limited, as might be expected in view of the fact that the BASIC interpreter and operating system fit in only 4 K bytes of read only memory. 26 possible variables can consist of one letter, but not a letter followed by a digit. Two string variables, A\$ and B\$, are provided and can be used in INPUT, PRINT and assignment statements, but string values cannot be compared. One singly dimensioned array variable, A(subscript), is provided, and all memory space remaining after the BASIC program and ordinary variables are allocated to this array. Each element of the array, a real number of up to six significant digits, takes four bytes of memory. Users requiring multiple arrays such as B(I) and C(J) must simulate by writing, for example, A(I) and A(10+J). Multiple dimensions may be simulated with expressions such as A(I+10\*(J-1)), so having one array is obviously better than having none at all. Addition, subtraction, multiplication and division are provided but exponentiation is omitted, since this would require the EXP and LOG functions for exponentiation of real numbers.

Presumably Radio Shack's Level II BASIC, said to be due for release in early 1978 according to current expectations, will include a much more comprehensive set of BASIC language features. In the meantime, Level I BASIC can be used effectively for many computer games and for business applications with straightforward arithmetic calculations such as payroll (see below). But you can't plot a sine wave unless you write your own sine calculation subroutine.

**Expansion**

Radio Shack has announced plans to offer a variety of expansion options for the TRS-80, but very little detailed information on them is available at the time of this writing. Photo 5 shows the expansion port built into the TRS-80 which reaches the outside world through a small flip-up opening in the case. This 40 pin card edge connector no doubt includes the address and data bus, input, output, read, write, interrupt and interrupt acknowledge signals from the Z-80 microprocessor. A cable can be run

**TRS-80**

# TRS-80

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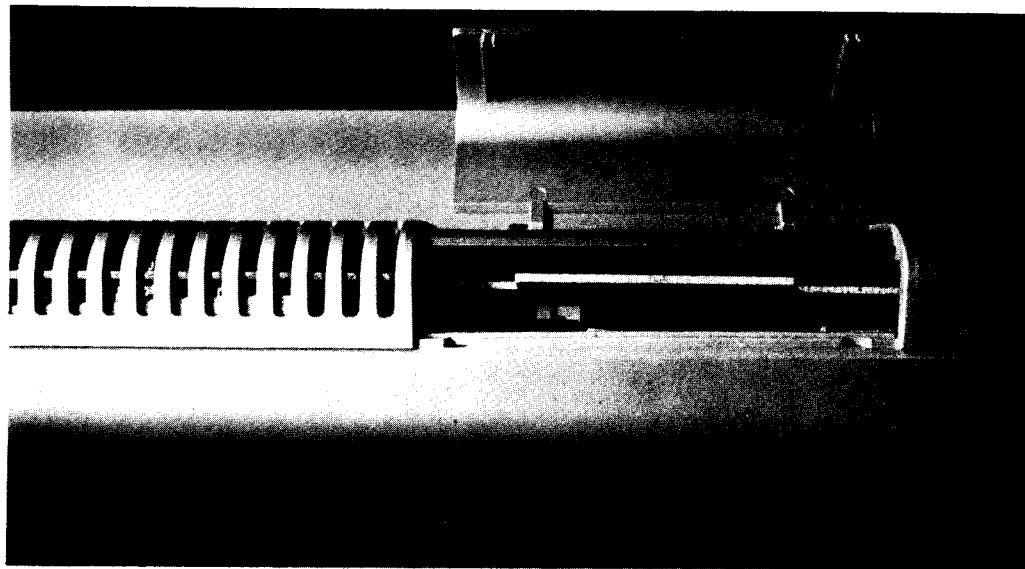


Photo 5: The TRS-80's expansion port, a 40 pin card edge connector which includes the address, data and control buses. This connector reaches the outside world through this flip-up opening on the back of the processor's case.

from this connector through various peripherals and a memory expansion unit. In all probability Radio Shack will use a daisy chaining arrangement which permits a single cable to be run from device to device. (Each device in the daisy chain would either accept an IO request or interrupt acknowledge signal, or pass the signal on to the next device.)

Peripherals for the TRS-80 currently foreseen by Radio Shack include a second audio cassette recorder interface, a printer

reliable enough for business applications for about \$1500, a smaller printer for less demanding individual applications for about \$700, and a floppy disk drive also for about \$700. Other planned options include a memory expansion unit and a modem to connect the TRS-80 to a timesharing or data communications system. Perhaps most significantly, however, Radio Shack has announced plans to offer an interface to the Altair (S-100) bus, which would provide access to the many memory and peripheral cards offered at competitive prices by other manufacturers.

### Software

When the TRS-80 was announced, Radio Shack also introduced five small application software packages on cassette, all of which are designed to run on the basic TRS-80 with 4 K bytes of programmable memory. The first of these is a pair of game programs for blackjack and backgammon, which is included free with every TRS-80 computer. The display produced by the backgammon program is shown in photo 6. The program rolls the dice and maintains the board for two players, but does not provide for a 1 person game against the computer.

Other applications include a "kitchen" package which is said to provide menus, conversion tables, a directory and message center for \$4.95; a "personal finance" package, apparently for checkbook balancing, for \$14.95 including seven cassettes; an "education" package which provides drills in addition, subtraction and multiplication for \$19.95 including three cassettes and a teacher's guide; and a "payroll" package for \$19.95. The payroll package, which has been demonstrated to

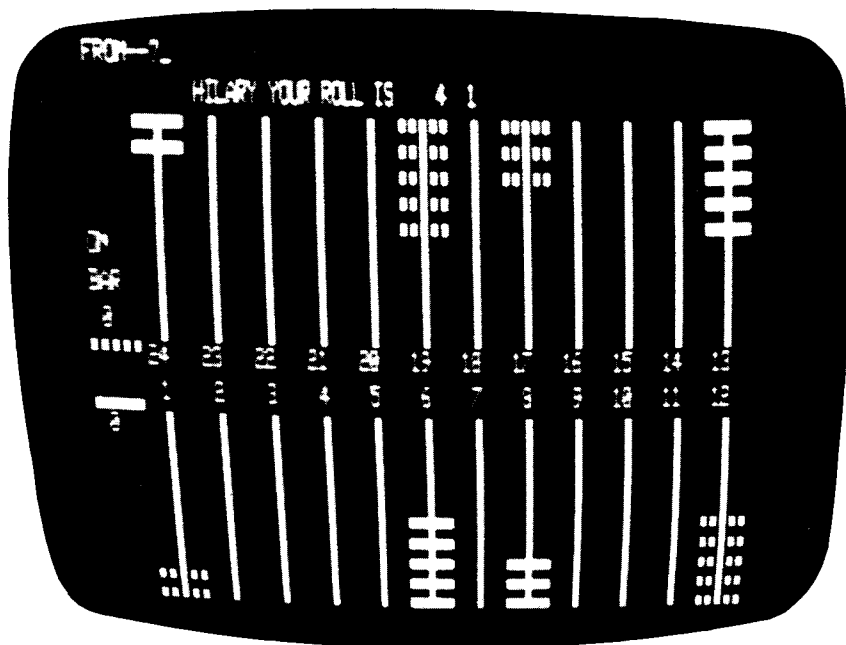


Photo 6: The display created by Radio Shack's backgammon game program, which is included free with every TRS-80 computer. This demonstration program acts as the dice roller and scorekeeper for the game, but makes no attempt to replace the two human players.

many interested businesspeople at trade shows, seems to require most of the 4 K memory for the program and handles just 15 employees on the basic TRS-80, but will handle 100 employees with 8 K of memory, and 300 employees with 16 K.

BASIC programs potentially useful with the TRS-80 can also be found in a number of books. Users will have to modify any such programs to fit the features of Radio Shack's Level I BASIC. In particular, variable names will have to be renamed and array references may have to be modified. And of course the total number of variable names used must be kept within Level I BASIC's limits. But this may still be easier than writing the programs from scratch.

Additional application packages are said to be planned for future release. The larger applications will probably require extended BASIC and a floppy disk. Also said to be in the works are an assembler, text editor, disk operating system and possibly compilers for other programming languages. It is not clear whether all this software will be developed in-house or will be obtained from outside sources. Some software undoubtedly will be developed by Tandy Advanced Products, another division of Tandy Corporation; Radio Shack also is thought to be negotiating with other software developers. In any case an enormous amount of effort will have to be invested in the development of this software.

Overall it seems that Radio Shack is aiming its application software and peripheral support primarily at the small business market, although applications for education, entertainment and home use are also clearly contemplated. Many related services, such as custom tailoring of application software and training of clerical staffs, will be required to meet the needs of small businesses, and perhaps knowledgeable hobbyists and small systems developers will be able to fill this need.

#### Availability and Delivery

When first announced, the TRS-80 was difficult to obtain like almost every personal computer. I ordered one on August 4 1977 and picked it up at my local Radio Shack store on October 11. The delay would have been even longer but for the special efforts of the store manager, Steve Lambert, who called me when another customer cancelled his order for a unit that had arrived at the store. In time, however, the TRS-80 should be among the most widely available personal computers, due to Radio Shack's widespread retail distribution and considerable manufacturing capacity.

At present you can order the TRS-80 at any Radio Shack store by placing a deposit of \$100, which can be charged to a major bank credit card. The units generally are not stocked at the stores, although this is planned as the supply permits. When ordered the unit is delivered to the local store from Radio Shack headquarters in Fort Worth TX, where the TRS-80 is produced, with a planned order to delivery cycle of 30 days. Some stores have a demonstration unit on display. *[We recently saw one for example, at the Radio Shack store in Keene NH, not exactly America's biggest town ... CH]*

A major problem for Radio Shack is the education of store managers who will have to answer questions from customers on the TRS-80. The managers of the first 100 stores to receive the computer were flown to Fort Worth for a special training session, and this sort of training effort may well be necessary in the future. But with Radio Shack's profit incentives for store managers, it is a safe bet to predict that the TRS-80 will be effectively merchandised.

#### Warranty and Service

Service has always been a problem in the personal computer industry, and because of the complexity of the product and the possibility that the user will misinterpret some peculiar but correct action of the computer as a failure, service is likely to be a problem for Radio Shack as well. In anticipation of possible servicing problems, Radio Shack apparently has tried to make the TRS-80 as foolproof as possible. The inability of the user to drop into machine language is a good example of this approach. Similarly, the plastic case of the keyboard unit is sealed, and the warranty is voided if the user opens the case.

The user can return the unit to a local Radio Shack store, which will ship the unit to a service center and receive it and notify the user when the repairs are complete. Initially all servicing will be done in Fort Worth, but it is planned that regional service centers will handle the TRS-80 eventually. This servicing practice also applies to the removal and insertion of memory chips when the user wants to upgrade to a larger (8 K or 16 K) memory.

#### Conclusion

Like other "appliance" computers now on the market, the TRS-80 brings the personal computer a good deal closer to the average consumer. It is as easy to plug in and turn on as a TV set or a stereo system, and should be usable for a wide variety of interesting games, calculations and educa-



tional drills. With a floppy disk and a printer it should be suitable for some business applications. Its BASIC language is somewhat limited at present, but this should be remedied when Radio Shack Level II BASIC is finally available.

The TRS-80 is not the only alternative for the aspiring personal computer user, but it is a strong contender. If you are

thinking about a purchase, compare its features against other offerings along all dimensions, including capabilities, software, warranty and service, and expansion possibilities. Talk to owners of the TRS-80 and other personal computers, and think about what you intend to do with your own computer. I hope that this review article will help you in your evaluation. ■

## Chapter 4

### Are There More Stars or Grains of Sand?

In this mathematical world we are blessed with very large and very small numbers. Millions of these and billionths of those. To cope with all this, your Computer uses "exponential notation", or "standard scientific notation" when the number sizes start to get out of hand. The number 5 million (5,000,000), for example, can be written "5E+06". This means, "the number 5 followed by six zeros."

If an answer comes out "5E-06", that means we must shift the decimal point, which is after the 5, six places to the left, inserting zeroes as necessary. Technically, it means  $5 \times 10^{-6}$ , or 5 millionths (.000,005). It's really pretty simple once you get the hang of it, and a lot easier to keep track of numbers without losing the decimal point. Since the Computer insists on using it with very large and very small numbers, we can just as well get in the good habit, too.

**EXERCISE 4-1:** If one million cars drove ten thousand miles in a certain year, how many miles did they drive altogether that year? Write and run a simple program which will give the answer.

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**EXERCISE 4-2:** Changes lines 20 and 30 in the Car Miles Solution program (from Exercise 4-1) to express the numbers written there in exponential notation, or SSN (Standard Scientific Notation). Then RUN it.

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Or technically,  $5 \times 10^6$ , which is 5 times ten to the sixth power:

$$5 \times 10^6 = 10 \times 10^5 = 100 \times 10^4 = 1000 \times 10^3 = 10000 \times 10^2 = 100000 \times 10^1$$

Now you can see the value of scientific notation!

In our BASIC, that's 5/10/10/10/10/10

Didn't forget the **ENTER** did you? Up till now we've been reminding you that you have to enter each line or command — but from now on, we'll assume you've got that little routine matter down pat.

### A Last Minute Note

*As this article was being prepared, we received a copy of the Radio Shack User's Manual For Level 1. The manual is 232 pages long with a GBC binding and is written by Dr David A Lien of San Diego CA. A note from the author states its purpose as a tutorial:*

... This book is written specifically for people who don't know anything about computers, and who don't want to be dazzled by fancy footwork from someone who does. It is written to teach you how to use your Radio Shack TRS-80 and start you on a fast track to becoming a competent programmer. To that end, every fair

and unfair, conventional and unconventional, flamboyant and ridiculous technique I could think of was used. I want you to have fun with your computer! I don't want you to be afraid of it, because there is nothing to fear. . . .

*The basic layout of the manual is illustrated by the reproduction of page 23 above. It features a wide page format with details on the lefthand side of the page, and points of emphasis (sometimes including cartoons) represented as screened boxes of text on the righthand side of each page. On a basis of first impressions, Dr Lien has completed an excellent tutorial presentation to accompany the TRS-80 computer. . . CH*